The past decade has witnessed a surge of interest in exploring emergent particles in condensed matter systems. Novel particles, emerged as excitations around exotic band degeneracy points, continue to be reported in real materials and artificially engineered systems, but so far, we do not have a complete picture on all possible types of particles that can be achieved. Here, via systematic symmetry analysis and modeling, we accomplish a complete list of all possible particles in time-reversal-invariant systems. This includes both spinful particles such as electron quasiparticles in solids, and spinless particles such as phonons or even excitations in electric-circuit and mechanical networks. We establish detailed correspondence between the particle, the symmetry condition, the effective model, and the topological character. This obtained encyclopedia concludes the search for novel emergent particles and provides concrete guidance to achieve them in physical systems.

Unlike elementary particles in high energy physics which are strongly constrained by the Poincaré symmetry, the emergent particles in condensed matters only need to respect much smaller subgroups of the Poincaré symmetry—the crystal space group symmetries [1]. It follows that the emergent particles can have much richer types and dramatically different properties [2–11]. For example, besides the elementary Weyl, Dirac and Majorana type fermions, electron quasiparticles in solids, as emerged around certain band degeneracy points, can exhibit a variety of pseudospin structures [5, 12–14], dispersion types [15–18], topological charges [19–21], and their distribution in momentum space can form manifolds of various topologies [22–26]. The study has also been extended to bosons like phonons, photons and magnons [27–30], and excitations in artificial periodic systems like electric circuit arrays and mechanical networks [31–33].

A central task of the field is to classify all possible emergent particles for each space group. So far, most works are case-by-case type studies, focusing on a specific material or a specific type of emergent particle [34–41]. There do exist a few systematic attempts [5, 42–45]. For example, Bradlyn et al. classified emergent fermions beyond Weyl and Dirac types at high-symmetry points in the Brillouin zone (BZ) in the presence of spin-orbit coupling (SOC) and time reversal symmetry [5]. And based on the theory of symmetry indicators, thousands of topological semimetal materials have been identified [46–48], which possess nontrivial emergent fermions. However, the grand task is still far from being accomplished: the emergent particles not at high-symmetry points (like those on high-symmetry lines) as well as the classification of spinless particles (as appropriate for the large class of bosonic and artificial systems) have not been systematically explored; and while the symmetry indicators are most useful for characterizing gapped phases, they do not give direct classification of the emergent particles.

In this work, we address this challenging task by offering a complete classification of both spinful and spinless emergent particles for three-dimensional (3D) systems with time reversal symmetry. The classification is done for each of the 230 space groups, namely, for a given group, we identify all possible (spinful and spinless, essential and accidental) emergent particles that can appear. Based on this, we obtain a comprehensive list of emergent particles, including 20 types of spinless particles and 23 types of spinful particles (see Table 1), along with the space groups that can host them (see Supplemental Material (SM) [49]). Furthermore, for each type of emergent particles, we provide its \( k \cdot p \) effective model, which characterizes the emergent particle (including its topological charge) and serves as the starting point for any subsequent studies of its properties.

Essentially, the results of this work constitute an encyclopedia of emergent particles in condensed matter, which is not only of fundamental significance but also highly useful for various purposes. For example, for any given system, such as electronic band structure or phonon spectrum of a specific material, the characterization of any spotted emergent particles can be done by directly looking up our table. The provided effective models can be directly utilized to fit the experimental or first-principles spectra and to study the system properties. Meanwhile, one can also search for a particular type of particle in concrete systems with the guidance of our table. Besides realistic materials, this could be especially useful for realizing spinless emergent particles in artificial systems, which can be precisely engineered and probed with current technology.

Rationale. We first describe the working procedure that leads to our results. As mentioned, the novel par-
articles emerge around band degeneracy points. The classification of emergent particles is therefore equivalent to the classification of all possible band degeneracies. Any stable degeneracy must require certain protection. For spatially periodic systems, the protection comes from the space group symmetries with the action on the BZ. In this work, we consider the systems with time reversal symmetry \( \mathcal{T} \), so the relevant symmetries are the 230 so-called type-II magnetic space groups \( \mathcal{M} = \mathcal{G} + \mathcal{T}\mathcal{G} \) [1], where \( \mathcal{G} \) is the crystallographic space group. With the exception of Weyl points which only requires the translational subgroup and can be topologically protected at generic \( k \) points, all other types of degeneracies will require a nontrivial little group at the corresponding \( k \) points [4].

The little group \( M^{k_1} \) at point \( k_1 \) takes the form of either

\[
M^{k_1} = C^{k_1},
\]

or

\[
M^{k_1} = G^{k_1} + A G^{k_1},
\]

where \( G^{k_1} \) is the corresponding crystallographic little group and \( A \) is certain anti-unitary operator. The band degeneracies are associated with the irreducible representations (IRs) of the group \( M^{k_1} \) [1]. At high-symmetry points of the BZ, band degeneracies correspond to the IRs with dimensions \( n > 1 \). At high-symmetry lines, band degeneracies may involve nodal lines which correspond to IRs with \( n > 1 \), or nodal points which correspond to the crossing of bands with different IRs. Similarly, at high-symmetry planes, the generic degeneracies are the nodal surfaces corresponding to IRs with \( n > 1 \), and nodal lines corresponding to two different IRs.

Hence, to obtain the possible band degeneracies for each space group \( \mathcal{M} \), we first find its little groups for all high-symmetry points, lines, and planes. Then for each little group, we find its matrix IRs. For \( M^{k_1} \) having the form of Eq. (1), the matrix IRs are available in Ref. [1]. For the cases in (2), the representations (known as corepresentations) can be derived from those of \( G^{k_1} \) whenever \( A \) is known. This is discussed in detail in SM [49]. Our obtained complete list of the single-valued (for spinless particles) and double-valued (for spinful particles) matrix representations for the little groups of the 230 space groups are presented in Sec. S7A and S8A of SM [49], respectively. Based on this information, we find all possible band degeneracies, and we characterize the emergent particles around these degeneracies by constructing the \( k \cdot p \) effective models. The model Hamiltonian \( \mathcal{H}_{k_1} \) expanded at the degeneracy point \( k_1 \) is solved from the constraint equations

\[
D(O_i)\mathcal{H}_{k_1}(q) [D(O_i)]^{-1} = \mathcal{H}_{k_1}(\hat{O},q),
\]

where \( O_i \) runs through the generators of the little group, \( D(O_i) \) denotes its matrix representation at the considered band degeneracy, and \( q \) is the momentum measured from \( k_1 \). With the help of the effective models, we can classify the emergent particles by the dimension of degeneracy manifold, the degree of degeneracy, the type of dispersion, and the topological charge, as in Table I. The list of all possible emergent particles along with their effective models for each space group is presented in Sec. S7 and S8 of SM [49].

We have two remarks before proceeding. First, certain degeneracies at high-symmetry points (lines) may not be isolated nodal points, instead, they could be residing on a higher-dimensional degeneracy manifold (nodal lines or surfaces). The effective models are helpful for distinguishing such cases.

Second, nodal lines may form various connection patterns in the BZ, such as nodal chains, crossed nodal loops, nodal boxes, and etc [22, 24, 50]. Such connectivity cannot be directly inferred from the effective modeling which is valid locally in BZ. Hence, in this work, we do not make a differentiation based on the connectivity for multiple nodal lines, but refer to them collectively as nodal-line nets.

**An example: SG 211.** To illustrate the usage of our results, we discuss one concrete example—a spinless system with space group No. 211 (SG 211).

Table II shows the excerpt from our result in Sec. S7 of SM [49] for this group. SG 211 (\( O^5 \)) is a cubic space group with a body-centred cubic Bravais lattice. The first line in Table II presents several basic information, including the BZ type, the symmetry generators (translations are not included here), whether centro-symmetry \( I \) is contained in the group, and whether SOC is considered (i.e., spinful or spinless). Here, the \( I \) symmetry is highlighted, because the presence of \( I \) would lead to a combined \( IT \) symmetry for every \( k \) point. For spinless systems, this combined symmetry prevents the existence of Weyl points but can protect Weyl nodal lines [22].

The BZ for SG 211 is illustrated in Fig. 1(a). In Table II, we show the results for high-symmetry points \( \Gamma \) and \( P \), and high-symmetry line \( \Sigma \) (\( \Gamma \Sigma \)). The results for other \( k \) points can be found in Sec. S7 of SM [49]. First, let’s look at the \( \Gamma \) point. Here, the different pieces of information are separated by the semicolons. After the \( \Gamma \) symbol, we give the coordinate for the \( \Gamma \) point. Then there are the generating elements of the little group at \( \Gamma \), including five elements \( C_{311}, C_{222}, C_{22x}, C_{22a}, \) and \( T \). Here, \( C_{3i1} \) denotes \( C_{33}^{0,111} \), and \( C_{2a} \) denotes \( C_{2,110} \) [1]. This little group has five distinct irreducible corepresentations, labelled as \( R_i \) with \( i = 1, 2, \ldots, 5 \). (A correspondence between \( R_i \) and the band-representation notations can be found in Refs. [1, 51].) The number following \( R_i \) gives the dimension of \( R_i \). Here, one observes that \( R_1 \) and \( R_2 \) are 1d representations, \( R_3 \) gives a twofold degeneracy, and \( R_4 \) and \( R_5 \) represent threefold degeneracies. After that, the matrix representations of the five generating elements are given. Here, the \( a \)'s (for \( R_3 \)) are the Pauli matrices, and the \( A \)'s (for \( R_4 \) and \( R_5 \)) are 3 × 3 matrices defined in Sec. S6B in SM [49]. Note that the complex conjugation operator \( \mathcal{K} \) in the anti-unitary element \( \mathcal{T} \) is not explicitly written out in the table. The next column shows the effective model constructed according to Eq. (3) based on each matrix representation. For example,
### TABLE I. Notation of the emergent particles listed in this work. Abbr. indicates the abbreviation of notation, $d_c$ and $d$ indicates the dimensionality and degeneracy of the particles, $L_d$ indicates the leading order of the band splitting of particles in BZ, and $|C|$ indicates the maximum topological charge of the particles. The possible Hamiltonian and typical band structure of the emergent particles are given in Sec. S3 of SM \[49\].

| Notation                                | Abbr.  | $d_c$ | $d$ | $L_d$ | $|C|$ | Realization  | with SOC |
|-----------------------------------------|--------|-------|-----|-------|------|--------------|----------|
| Charge-1 Weyl point                     | C-1 WP | 0     | 2   | (111) | 1    | √            | √        |
| Charge-2 Weyl point                     | C-2 WP | 0     | 2   | (122) | 2    | √            | √        |
| Charge-3 Weyl point                     | C-3 WP | 0     | 2   | (133) | 3    | √            | √        |
| Charge-4 Weyl point                     | C-4 WP | 0     | 2   | (223) | 4    | √            | ×        |
| Triple point                            | TP     | 0     | 3   | (111) |      | √            | √        |
| Charge-2 triple point                   | C-2 TP | 0     | 3   | (111) | 2    | √            | √        |
| Quadratic triple point                  | QTP    | 0     | 3   | (122) |      | √            | ×        |
| Quadratic contact triple point          | QCTP   | 0     | 3   | (222) | 0    | √            | ×        |
| Dirac point                             | DP     | 0     | 4   | (111) | 0    | √            | √        |
| Charge-2 Dirac point                    | C-2 DP | 0     | 4   | (111) | 2    | √            | √        |
| Charge-4 Dirac point                    | C-4 DP | 0     | 4   | (111) | 4    | ×            | √        |
| Quadratic Dirac point                   | QDP    | 0     | 4   | (122) | 0    | √            | √        |
| Charge-4 quadratic Dirac point          | C-4 QDP| 0     | 4   | (122) | 4    | ×            | √        |
| Quadratic contact Dirac point           | QCDP   | 0     | 4   | (222) | 0    | ×            | √        |
| Cubic Dirac point                       | CDP    | 0     | 4   | (133) | 0    | ×            | √        |
| Cubic crossing Dirac point              | CCDP   | 0     | 4   | (223) | 0    | √            | ×        |
| Sextuple point                          | SP     | 0     | 6   | (111) | 0    | √            | √        |
| Charge-4 sextuple point                 | C-4 SP | 0     | 6   | (111) | 4    | ×            | √        |
| Quadratic contact sextuple point        | QCSP   | 0     | 6   | (222) | 0    | ×            | √        |
| Octuple point                           | OP     | 0     | 8   | (111) | 0    | ×            | √        |
| Weyl nodal line                         | WNL    | 1     | 2   | (11)  | $\pi$ | √            | √        |
| Weyl nodal-line net                     | WNL net| 1     | 2   | (11)  | $\pi$ | √            | √        |
| Quadratic nodal line                    | QNL    | 1     | 2   | (22)  | 0    | √            | √        |
| Cubic nodal line                        | CNL    | 1     | 2   | (33)  | $\pi$ | ×            | √        |
| Dirac nodal line                        | DNL    | 1     | 4   | (11)  | 0    | √            | √        |
| Dirac nodal-line net                    | DNL net| 1     | 4   | (11)  | 0    | √            | √        |
| Nodal surface                           | NS     | 2     | 2   | (1)   | 1    | √            | √        |

The emergent particles around the double degeneracy of $R_3$ are described by

$$\mathcal{H}_{\text{C-4 WP}} = (c_1 + c_2 k^2) \sigma_0 + c_3 k_x k_y k_z \sigma_2 + c_4 [\sqrt{3}(k_x^2 - k_y^2) \sigma_1 + (k^2 - 3 k_z^2) \sigma_3],$$

where the $c$'s are real model parameters. Interestingly, from the effective model (4), one finds that the dispersion of the emergent particle is cubic along the (111) direction and quadratic in the plane perpendicular to (111). Furthermore, the nodal point carries a large topological...
TABLE II. Part of the single-valued corepresentation of SG 211, including both the essential and accidental degeneracies. At the top, the columns from left to right list the high-symmetry momentum $k$, the position of $k$, the generating elements of the little group of $k$, the dimension of the representation, the matrix representations of the generating elements, and the effective Hamiltonian, the species and the topological charge of the degeneracies. The bottom part lists the accidental degeneracy.

SG 211

$\Gamma_v; \{C_{3v}[000], \{C_{2v}[000], \{C_{2v}[000], \{C_{2v}[000], \mathcal{T}; Non-Centrosymmetric; without SOC

$\Gamma; (000); C_{31}, C_{22}, C_{2x}, C_{2y}, \mathcal{T}; R_1; 1, 1, 1, 1, 1;
R_2; 1, 1, 1, -1, 1;
R_3; 2, \frac{c_0 + \sqrt{3}c_2}{2}, \sigma_0, \sigma_0, \sigma_3, \sigma_3; (c_1 + c_2 k^2) \sigma_0 + c_3 k_z k_y k_z \sigma_2 + c_4 \left[ \sqrt{3}(k_x^2 - k_y^2) \sigma_1 + (k_x^2 - 3k_y^2) \sigma_3 \right]; C-4 WP; 4
R_4; 3, A_{11}, -\frac{4c_0 + 2\sqrt{3}c_2}{3}, A_{13}, A_{11}, A_0; A_0 c_1 + c_2 (A_3 k_x - A_2 k_y + A_1 k_z); C-2 TP; 2
R_5; 3, A_{11}, -\frac{4c_0 + 2\sqrt{3}c_2}{3}, A_{13}, -A_{11}, A_0; A_0 c_1 + c_2 (A_3 k_x - A_2 k_y + A_1 k_z); C-2 TP; 2
P; \left( \frac{1}{3}, \frac{1}{3}, \frac{1}{3} ; C_{31}, C_{22}, C_{2y}, C_{2c}, \mathcal{T}; R_1; 1, 1, 1, 1,
R_2; 1, 1, 1, 1, 1,
R_3; 1, (-1)^{2/3}, 1, 1, 1,
R_4; 3, A_9, -\frac{4c_0 + 2\sqrt{3}c_2}{3}, A_{10}, A_{15}, c_1 A_0 + c_2 (A_3 k_x - A_6 k_y + A_4 k_z) + c_3 (A_3 k_x - A_2 k_y + A_1 k_z); C-2 TP; 2
R_5; 3, A_9, -\frac{4c_0 + 2\sqrt{3}c_2}{3}, A_{10}, A_0, A_6 c_1 + c_2 (A_3 k_x - A_2 k_y + A_1 k_z); C-2 TP; 2
\Sigma; \Gamma N; C_{2y}, C_{2O} \mathcal{T}; R_1; 1, 1, 1;
R_2; 1, -1, 1;
Sigma; \Gamma N; C_{22}, C_{2O} \mathcal{T}; \{R_1 \}; \{R_2 \}; 2, \sigma_3, \sigma_0; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_x - k_y); C-1 WP; 1

Accidental degeneracies on high-symmetry line

$\Sigma; \Gamma N; C_{22}, C_{2O} \mathcal{T}; \{R_1 \}; \{R_2 \}; 2, \sigma_3, \sigma_0; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_x - k_y); C-1 WP; 1$

charge (Chern number) $C = \pm 4$, hence it is named as a charge-4 Weyl point (C-4 WP). Here, we follow the convention to use Weyl/Dirac to denote twofold/fourfold degeneracy. Notably, the dispersion and the topological charge of this C-4 WP are distinct from the previously known multi-Weyl points [19], which invariably have a direction with linear dispersion and have topological charges less than 4. In addition, we find that C-4 WP can only exist in spinless systems. As shown Sec. S2 in SM [49], it can appear in space groups with $T$ or $O$ point groups, including space group No. 195-199 and 207-214. The type of the band degeneracy and the topological charge are presented in the last two columns in Table II.

From Table II, one can see that $R_4$ and $R_5$ at $\Gamma$ both give a charge-2 triple point (C-2 TP), i.e., a threefold nodal point with topological charge $\pm 2$. This type of nodal point also can appear for the $R_1$ representation at $P$. As summarized in Sec. S2 in SM [49], C-2 TP can appear in both spinless and spinful systems. However, it only occurs at non-$T$-invariant momenta for the spinful systems, while it can occur at both $T$-invariant and non-$T$-invariant momenta for spinless systems.

The similar analysis is performed for the high-symmetry line $\Sigma$. The little group at $\Sigma$ has two distinct irreducible representations $R_1$ and $R_2$. These are 1$d$ representations, indicating that there is no essential degeneracy along the $\Sigma$ line. However, there could exist an accidental degeneracy formed by crossing between $R_1$ and $R_2$ bands, as described in the last row in Table II. The effective model for this accidental crossing is constrained by

$$\Delta(\mathcal{O}) \mathcal{H}(k) [\Delta(\mathcal{O})]^{-1} = \mathcal{H}(\hat{O}k),$$

where $\mathcal{O} \in \{C_{2x}, C_{2O} \mathcal{T}\} \{C_{2O} \text{ denotes } C_{2,110}\}$ is one of the two generators, and $\Delta(\mathcal{O}) = D_1(\mathcal{O}) \oplus D_2(\mathcal{O})$, which is $\sigma_3$ for $C_{2x}$ and $\sigma_0 \mathcal{K}$ for $C_{2O} \mathcal{T}$. The obtained model in Table II shows that this crossing is a conventional Weyl point with $|C| = 1$.

Signatures of emergent particles. Methods for detecting the emergent particles have been well established. For example, electronic excitations in solid materials can be directly probed by the angle-resolved photoemission spectroscopy (ARPES) [4]. Similar spectroscopy techniques for detecting excitations in photonic, phononic, cold-atom optical lattices, and mechanical systems have also been developed [27–31]. These methods can directly detect the band degeneracy and map out the dispersion for the emergent particles.

Of most interest are the chiral particles in Table I
with nontrivial topological charges. For example, let’s consider the C-4 WP discussed above for spinless systems with SG 211. To confirm the existence of such a nodal point, we explicitly construct a tight-binding (TB) model based on a body-centred cubic lattice with SG 211 (see SM [49]). From the calculated band structure in Fig. 1(b), one finds that at Γ, there exist a twofold nodal point and a threefold nodal point, as indicated by the arrows. By checking Table II (or Sec. S7 in SM), one immediately knows that they correspond to C-4 WP and C-2 TP, respectively. Similarly, the two threefold degeneracies at P are two C-2 TPs, and the two nodal points at H are C-4 WP and C-2 TP. The effective models for the emergent particles around these degeneracies can be directly read off from our tables and used to fit the spectrum in Fig. 1(b). This demonstrates the powerfulness of our established encyclopedia.

Focusing on the C-4 WP, its nontrivial topological charge dictates that at the surface of the system, there must be four Fermi arcs emanating from the projection of the C-4 WP. This is confirmed by the calculation using the tight-binding model, as shown in Fig. 1(c). The topological charge also can manifest in the Landau spectrum [52]. In Fig. 1(d), we consider a magnetic field along the z direction and plot the Landau spectrum along k_z around the energy of the C-4 WP (set to be zero here). One clearly observes that there are four chiral Landau bands crossing the zero energy, showing that the original nodal point has a topological charge of 4. Experimentally, the surface Fermi arcs can be probed by scanning tunneling spectroscopy (STS) or ARPES, and the chiral Landau bands can be probed by STS or magneto-infrared spectroscopy.

Moreover, we find that two C-4 Weyl points may merge together and form a fourfold Dirac points with cubic band crossing, which has not been reported before. For example, in Fig. 1(f), the blue dashed curves show a band structure for SG 208, where two C-4 Weyl points of opposite charges appear at the R point. When the inversion symmetry (I) is further imposed to promote the space group to SG 223, one finds that the two C-4 Weyl points will merge into the mentioned Dirac point [see Fig. 1(f)]. The leading order band splitting is cubic along the (111) direction and is quadratic in the plane normal to this direction. This novel Dirac point is termed as the cubic crossing Dirac point (CCDP) in our Table I. For the case in Fig. 1(f), an effective model for the CCDP is derived as

$$\mathcal{H}_{\text{CCDP}} = c_0 \Gamma_{0,0} + k_x k_y k_z (c_1 \Gamma_{2,2} - c_2 \Gamma_{1,0}) + \frac{c_5}{2} \left[ \sqrt{3} (k_y^2 - k_z^2) \Gamma_{3,3} + (k^2 - 3k_z^2) \Gamma_{3,1} \right] \quad (6)$$

where $\Gamma_{i,j} = \sigma_i \otimes \sigma_j$ and the c’s are real model parameters.

Discussion. In this work, we have systematically investigated all possible spinless and spinful emergent particles protected by space group and time reversal symmetries. With a unified classification scheme and unified notations, a complete characterization is performed for each space group and for each type of emergent particles. This offers an extremely useful toolbox for subsequent studies. For example, the possible emergent particles in a concrete system can be directly checked by looking up our tables in Sec. S7 and S8 of SM [49]. The effective models there provide a starting point for understanding the system properties. Using Tables in Sec. S2 of SM [49], one can search for a specific type of particles in material database (with the detailed guidance regarding the location in BZ and the band symmetry). Recently, several high-throughput computation works have searched over all stable non-magnetic solid materials [46–48], resulting in thousands of possible topological semimetals. However, the detailed characterization of the emergent particles is lacking. It will be important to make a cross-reference between our encyclopedia and that list of materials, which helps to fully characterize all existing realistic materials. Particularly, some of us have established a
SpaceGroupIrep package [51] to analyze the band representation based on the notation of Ref. [1], which greatly facilitates the study. Probably the more intriguing application of our result is in the design of artificial systems with novel emergent particles. For example, the photonic and acoustic crystals can be well controlled with current technology. With the guidance of the encyclopedia, any spinless particles can be readily realized in these systems.

Our approach here can be extended to systems with broken time reversal symmetry, namely, the so-called type-III and type-IV magnetic space groups. And it can extended to systems with additional particle-hole symmetry or chiral symmetry, which appear, e.g., in superfluids and superconductors. Adding such symmetries will change the classification in a fundamental way. For example, a type of $\mathbb{Z}_2$-charged nodal surfaces with variable shapes can exist for spinless systems with chiral symmetry [26]; but without this symmetry, we find that nodal surfaces can only exist at certain boundary planes of the BZ (see Sec. S2 of SM [49]).

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Supplemental Material for “Encyclopedia of emergent particles in three-dimensional crystals”

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CONTENTS

S1. Derivation of lattice models in main text 6
S2. Quantitative mapping between emergent particles and type-II MSGs 7
S3. Emergent particles in 3D crystals 9
   A. Twofold degeneracy point 9
      1. Charge-1 Weyl point 9
      2. Charge-2 Weyl point 9
      3. Charge-3 Weyl point 10
      4. Charge-4 Weyl point 10
   B. Threefold degeneracy point 11
      1. Triple point 11
      2. Charge-2 Triple point 11
      3. Quadratic triple point 12
      4. Quadratic contact triple point 12
   C. Fourfold degeneracy point 12
      1. Dirac point 12
      2. Charge-2 Dirac point 12
      3. Charge-4 Dirac point 13
      4. Quadratic Dirac point 13
      5. Charge-4 quadratic Dirac point 13
      6. Quadratic contact Dirac point 15
      7. Cubic Dirac point 15
      8. Cubic crossing Dirac point 15
   D. Sixfold degeneracy point 16
      1. Sextuple point 16
      2. Charge-4 sextuple point 16
      3. Quadratic contact sextuple point 16
   E. Eightfold degeneracy point 17
      1. Octuple point 17
   F. Twofold degeneracy line 18
      1. Weyl nodal line 18
      2. Weyl nodal-line net 18
      3. Quadratic nodal line 18
      4. Cubic nodal line 18
   G. Fourfold degeneracy line 18
      1. Dirac nodal line 18
      2. Dirac nodal-line net 19

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H. Twofold degeneracy surface 19
  1. Nodal surface 19

S4. Derivation of the coreps of type-II MSGs 19
  A. Abstract group 19
  B. Magnetic space groups and corepresentations 21
  C. Concrete steps of the derivation of corep 23
  D. Examples of deriving coreps 23
    1. Single-valued coreps of type II MSG 76 23
    2. Double-valued coreps of type II MSG 92 26

S5. Spatial operators of 230 SGs 30

S6. Notations and defined matrices used in Sec. S7 and Sec. S8 31
  A. Notations 31
  B. Defined matrixes 32
    1. Two-dimensional matrixes 32
    2. Three-dimensional matrixes 33
    3. Four-dimensional matrixes 34
    4. Six-dimensional matrixes 35
    5. Eight-dimensional matrixes 35

S7. Encyclopedia of emergent particles in 3D crystals without SOC effect 36
  A. The single-valued corepresentations of the 230 type-II MSGs and the essential degeneracies 36
    1. Notes to Sec. S7 A 36
    2. SG 1-10 36
    3. SG 11-20 43
    4. SG 21-30 54
    5. SG 31-40 67
    6. SG 41-50 78
    7. SG 51-60 93
    8. SG 61-70 112
    9. SG 71-80 130
   10. SG 81-90 143
   11. SG 91-100 154
   12. SG 101-110 165
   13. SG 111-120 177
   14. SG 121-130 189
   15. SG 131-140 207
   16. SG 141-150 227
   17. SG 151-160 238
   18. SG 161-170 248
   19. SG 171-180 258
   20. SG 181-190 271
   21. SG 190-200 285
   22. SG 201-210 299
   23. SG 211-220 309
   24. SG 221-230 319
  B. The accidental degeneracies on high-symmetry line 335
    1. Notes to Sec. S7 B 335
    2. SG 1-10 335
    3. SG 11-20 337
    4. SG 21-30 340
    5. SG 31-40 347
    6. SG 41-50 354
    7. SG 51-60 364
    8. SG 61-70 374
    9. SG 71-80 387
   10. SG 81-90 394
C. Effective Hamiltonian of both essential and accidental degeneracies

1. Notes to Sec. S7 C
2. SG 1-10
3. SG 11-20
4. SG 21-30
5. SG 31-40
6. SG 41-50
7. SG 51-60
8. SG 61-70
9. SG 71-80
10. SG 81-90
11. SG 91-100
12. SG 101-110
13. SG 111-120
14. SG 121-130
15. SG 131-140
16. SG 141-150
17. SG 151-160
18. SG 161-170
19. SG 171-180
20. SG 181-190
21. SG 191-200
22. SG 201-210
23. SG 211-220
24. SG 221-230

S8. Encyclopedia of emergent particles in 3D crystals with SOC effect

A. The double-valued corepresentations of the 230 type-II MSGs and the essential degeneracies

1. Notes to Sec. S8 A
B. The accidental degeneracies on high-symmetry line

1. Notes to Sec. S8 B
2. SG 1-10
3. SG 11-20
4. SG 21-30
5. SG 31-40
6. SG 41-50
7. SG 51-60
8. SG 61-70
9. SG 71-80
10. SG 81-90
11. SG 91-100
12. SG 101-110
13. SG 111-120
14. SG 121-130
15. SG 131-140
16. SG 141-150
17. SG 151-160
18. SG 161-170
19. SG 171-180
20. SG 181-190
21. SG 191-200
22. SG 201-210
23. SG 211-220
24. SG 221-230

C. Effective Hamiltonian of both essential and accidental degeneracies

1. Notes to Sec. S8 C
2. SG 1-10
3. SG 11-20
4. SG 21-30
5. SG 31-40
6. SG 41-50
7. SG 51-60
8. SG 61-70
9. SG 71-80
10. SG 81-90
11. SG 91-100
12. SG 101-110
13. SG 111-120
14. SG 121-130
15. SG 131-140
16. SG 141-150
17. SG 151-160
18. SG 161-170
19. SG 171-180
20. SG 181-190
21. SG 191-200
22. SG 201-210
23. SG 211-220
24. SG 221-230
S1. DERIVATION OF LATTICE MODELS IN MAIN TEXT

In the main text, we construct two spinless TB models based on a body-centred cubic lattice with SG 211 and a primitive cubic lattice with SG 223 to demonstrate the existence of C-4 WP and CCDP, respectively. For the lattice model with SG 211, we assume a unit cell contains six sites locating at 12Wyckoff positions and put one s-like orbital state on each site \([1, 2]\). Following the method by Wieder and Kane \([3]\) as implemented in the MagneticTB package by Zhang et. al \([4]\), the lattice Hamiltonian then can be established as

\[
H_{\text{C-4 WP}} = c_0 + \begin{bmatrix} f(0, k_y, k_z) & h_{12} & h_{13} \\ h_{12}^\dagger & f(k_x, 0, k_z) & h_{23} \\ h_{13}^\dagger & h_{23}^\dagger & f(k_x, k_y, 0) \end{bmatrix},
\]

with \(f(k) = c_1 \cos \frac{k_y}{2} \cos \frac{k_z}{2} \cos \frac{k_x}{2} \sigma_1\) and

\[
\begin{align*}
h_{12} &= c_2 \begin{bmatrix} e^{i \frac{k_x + k_y}{2} + k_y} & e^{i \frac{k_x + k_y}{2} - k_y} \\ e^{-i \frac{k_x + k_y}{2} + k_y} & e^{-i \frac{k_x + k_y}{2} - k_y} \end{bmatrix} + c_3 \begin{bmatrix} e^{-i \frac{k_x + k_y + 2k_z}{4}} & e^{i \frac{k_x + k_y + 2k_z}{4}} \\ e^{i \frac{k_x - k_y + 2k_z}{4}} & e^{-i \frac{k_x - k_y + 2k_z}{4}} \end{bmatrix}, \\
h_{13} &= c_2 \begin{bmatrix} e^{i \frac{k_x - k_y}{4} + k_x} & e^{i \frac{k_x - k_y}{4} - k_x} \\ e^{-i \frac{k_x - k_y}{4} + k_x} & e^{-i \frac{k_x - k_y}{4} - k_x} \end{bmatrix} + c_3 \begin{bmatrix} e^{2i \frac{k_x - k_y + k_z}{4}} & e^{-2i \frac{k_x - k_y + k_z}{4}} \\ e^{-2i \frac{k_x - k_y - k_z}{4}} & e^{2i \frac{k_x - k_y - k_z}{4}} \end{bmatrix}, \\
h_{23} &= c_2 \begin{bmatrix} e^{i \frac{k_y + k_z}{2} - k_y} & e^{i \frac{k_y + k_z}{2} + k_y} \\ e^{-i \frac{k_y + k_z}{2} + k_y} & e^{-i \frac{k_y + k_z}{2} - k_y} \end{bmatrix} + c_3 \begin{bmatrix} e^{i \frac{k_x - k_y + 2k_z}{4}} & e^{-i \frac{k_x - k_y + 2k_z}{4}} \\ e^{i \frac{k_x - k_y - 2k_z}{4}} & e^{-i \frac{k_x - k_y - 2k_z}{4}} \end{bmatrix}.
\]

The coefficient \(c_i\) with \(i = 0, 1, 2, 3\) is real model parameter. For the results shown in the main text, we have taken the following parameter values: \(c_0 = 2.8\), \(c_1 = -1.8\), \(c_2 = 1\). and \(c_3 = -0.5\).

For the lattice model with SG 223, we assume a unit cell contains two sites locating at 2a Wyckoff positions and put two basis states \(d_{z^2}\) and \(d_{x^2-y^2}\) orbital on each site \([1, 2]\). Following the method by Wieder and Kane \([3]\) as implemented in the MagneticTB package by Zhang et. al \([4]\), the lattice Hamiltonian then can be established as

\[
H_{\text{CCDP}} = c_0 + \begin{bmatrix} h_{11} & h_{12}^\dagger \\ h_{12} & h_{22} \end{bmatrix} e^{i \frac{k_x + k_y + k_z}{2} h_{12}},
\]

with

\[
\begin{align*}
h_{11} &= c_3 \begin{bmatrix} \sqrt{3} (\cos k_y - \cos k_x) & \cos k_x + \cos k_y - 2 \cos k_z \\ \cos k_x + \cos k_y - 2 \cos k_z & \sqrt{3} (\cos k_x - \cos k_y) \end{bmatrix}, \\
h_{12} &= \left( e^{i(k_x + k_y + k_z)} + e^{i(k_x + k_y)} + e^{i(k_y + k_z)} \right) \begin{bmatrix} c_2 & c_1 \\ -c_1 & c_2 \end{bmatrix} + \left( 1 + e^{i(k_x + k_y)} + e^{i(k_x + k_z)} + e^{i(k_y + k_z)} \right) \begin{bmatrix} c_2 & c_1 \\ -c_1 & c_2 \end{bmatrix}, \\
h_{22} &= c_3 \begin{bmatrix} \sqrt{3} (\cos k_x - \cos k_y) & - (\cos k_x + \cos k_y - 2 \cos k_z) \\ - (\cos k_x + \cos k_y - 2 \cos k_z) & \sqrt{3} (\cos k_y - \cos k_x) \end{bmatrix}.
\]

Also the coefficient \(c_i\) is real model parameter. For the band structure of CCDP \([\text{solid curves in Fig. 1(f)}]\) in the main text, we have taken the following parameter values: \(c_0 = 0.\), \(c_1 = 0.5\), \(c_2 = -0.5\) and \(c_3 = -0.8\). A possible term breaking \(I\) symmetry may be written as

\[
H' = \begin{bmatrix} 0 & e^{-i \frac{k_x + k_y + k_z}{2} h_{12}^\dagger} \\ e^{i \frac{k_x + k_y + k_z}{2} h_{12}} & 0 \end{bmatrix},
\]

with

\[
h_{12}^\dagger = \left( 1 + e^{i(k_x + k_y)} + e^{i(k_x + k_z)} + e^{i(k_y + k_z)} \right) \begin{bmatrix} c_4 & c_3 \\ -c_3 & c_4 \end{bmatrix}.
\]

For the results \([\text{dashed curves in Fig. 1(f)}]\) shown in the main text, we have set \(c_3 = -0.5c_1\) and \(c_4 = c_2.\)
S2. QUANTITATIVE MAPPING BETWEEN EMERGENT PARTICLES AND TYPE-II MSGS

For each emergent particle listed in main text, we explicitly present the number of the type-II magnetic space group (MSG) that can host it. Table S1 is for the 3D crystals without SOC and Table S2 is for the crystals with SOC.

**TABLE S1.** List of the type-II MSGs hosting the symmetry-protected degeneracies in the crystals without SOC.

| Species | SG No. |
|---------|--------|
| C-1 WP  | 24, 80, 98, 150, 152, 154, 168-173, 177-182, 199, 210, 214 |
| C-2 WP  | 75-80, 89-98, 143-146, 149-155, 168-173, 177-182, 196, 207-210 |
| C-4 WP  | 195-199, 207-214 |
| TP      | 204, 217, 229 |
| C-2 TP  | 195-199, 207-214 |
| QCTP    | 200-206, 215-230 |
| DP      | 29, 33, 52, 54, 56, 60, 73, 103, 104, 106, 110, 130, 138, 142, 158, 159, 161, 163, 165, 167, 184, 185, 192, 193, 206, 219, 220, 226, 228, 230 |
| C-2 DP  | 19, 92, 96, 198, 212, 213 |
| QDP     | 114, 124, 126, 128, 130, 133, 135, 137, 176, 184-186, 188, 190, 192-194, 222 |
| CCDP    | 218, 220, 222, 223, 230 |
| SP      | 218, 220, 222, 223, 230 |
| WNL     | 7, 9, 13-15, 27-34, 37, 39-41, 43, 45, 46, 48-50, 52-54, 56, 58, 60, 64, 66-68, 70, 72-74, 84-88, 100-110, 112, 114, 116-118, 120-122, 124-126, 128, 130-142, 147, 148, 156-167, 175, 176, 183-186, 188-194, 200-206, 215-230 |
| WNL net | 7, 9, 13-15, 27-34, 37, 39-41, 43, 45, 46, 48-50, 52-54, 56, 58, 60, 64, 66-68, 70, 72-74, 84-86, 88, 100-110, 112, 114, 116-118, 120-122, 124-126, 128, 130-142, 147, 148, 156-167, 184, 188, 190, 192, 200-206, 215-230 |
| QNL     | 81-88, 99-142, 174-176, 183-194, 215-230 |
| DNL     | 57, 60-62, 205 |
| DNL net | 61, 205 |
| (one) NS| 4, 11, 14, 17, 20, 26, 29, 31, 33, 36, 51-54, 63, 64, 76, 78, 91, 95, 169, 170, 173, 176, 178, 179, 182, 185, 186, 193, 194 |
| (two) NS| 18, 55-60, 90, 94, 113, 114, 127-130, 135-138 |
| (three) NS| 19, 61, 62, 96, 198, 205, 212, 213 |

The accidental degeneracies on high-symmetry line

| Species | SG No. |
|---------|--------|
| C-1 WP  | 3-5, 16-24, 35-37, 44-46, 75-82, 89-98, 111-122, 139, 143-146, 149-156, 158, 168-174, 177-182, 187-188, 195-199, 207-216, 218, 219 |
| C-2 WP  | 75-80, 89-98, 168-173, 177-182, 207-214 |
| C-3 WP  | 168-173, 177-182 |
| TP      | 81-88, 99-142, 147, 148, 156-167, 174-176, 183-194, 200-206, 215-230 |
| QTP     | 175, 176, 183-186, 191-194 |
| DP      | 26, 29, 31, 33, 36, 51-64, 113, 114, 127-130, 135-138, 175, 176, 183-186, 191-194, 205 |
| C-2 DP  | 18, 19, 90, 92, 94, 96, 198, 212, 213 |
| QDP     | 113, 114, 127-130, 135-138 |
| WNL     | 10-15, 25-74, 83-88, 99-142, 156-167, 174-176, 183-194, 200-206, 215-230 |
| WNL net | 25-74, 83-88, 99-142, 156-167, 175-176, 183-194, 200-206, 215-230 |
| Species | SG No. |
|---------|--------|
| **The essential degeneracies at high-symmetry point and high-symmetry line** | |
| C-1 WP | 1, 3-5, 8-9, 16-24, 35-37, 42-46, 75-82, 89-98, 111, 112, 119-122, 143-146, 149-155, 168-173, 177-182, 195-199, 207-214 |
| C-2 WP | 80, 88, 210 |
| C-3 WP | 143-146, 149-155, 168-173, 177-182, 196, 209, 210 |
| TP | 220 |
| C-2 TP | 199, 214 |
| DP | 11, 13-15, 26-27, 29-34, 36-37, 43, 48-50, 52-54, 56, 58, 60, 64, 66-68, 70, 72-74, 84-86, 88, 100-106, 108-110, 112, 114, 116-118, 122, 124-126, 128, 130-138, 140-142, 158, 159, 161, 163, 165, 167, 184-186, 188, 190, 192, 198, 201, 203-204, 206, 215-220, 222-224, 226-230 |
| C-2 DP | 18, 19, 90, 92, 94, 96, 198, 212, 213 |
| C-4 DP | 195-199, 207-214 |
| QDP | 142, 228 |
| C-4 QDP | 92, 96 |
| QCDP | 200-206, 221-230 |
| CDP | 163, 165, 167, 184-186, 192, 226, 228 |
| SP | 206, 230 |
| C-4 SP | 198, 212, 213 |
| QCSP | 205 |
| OP | 130, 135, 218, 220, 222, 223, 230 |
| WNL | 6-9, 25-46, 81-82, 99-122, 156-161, 174, 183-190, 215-220 |
| WNL net | 45, 109, 110, 120, 122, 156-161, 174, 184, 187-190, 215-220 |
| QNL | 174, 187-190 |
| CNL | 183-186 |
| DNL | 51-64, 113-114, 127-130, 135-138, 176, 193-194, 205 |
| DNL net | 52, 54-56, 58, 60, 62, 127-128, 130, 135-136, 138, 176, 193-194, 205 |
| (one) NS | 4, 17, 20, 26, 29, 31, 33, 36, 76, 78, 91, 95, 169, 170, 173, 178, 182, 185, 186 |
| (two) NSs | 18, 90, 94, 113, 114 |
| (three) NSs | 19, 92, 96, 198, 212, 213 |

| **The accidental degeneracies on high-symmetry line** | |
| C-1 WP | 3-5, 16-24, 35-37, 44-46, 75-82, 89-98, 111-122, 143-146, 149-155, 158, 168-174, 177-182, 187-188, 195-199, 207-216, 218, 219 |
| C-2 WP | 75-80, 89-98, 168-173, 177-182, 207-214 |
| C-3 WP | 168-173, 177-182 |
| TP | 156-161, 174, 183-190, 215-220 |
| DP | 13-15, 26, 29, 31, 33, 36, 48-50, 52-54, 56, 58-60, 64, 66-68, 70, 72-74, 83-88, 99-110, 123-142, 147-148, 162-167, 175, 176, 183-186, 191-194, 200-206, 221-230 |
| C-2 DP | 18-19, 90, 92, 94, 96, 198, 212, 213 |
| QDP | 175-176, 191-194 |
| WNL | 25-46, 99-122, 156-161, 174, 183-190, 215-220 |
| WNL net | 28-34, 40-41, 43, 100, 102, 104, 106, 109-110, 117, 118, 122, 156-161, 183-190, 215-220 |
| DNL | 51-64, 128-130, 136-138, 176, 193-194, 205 |
| DNL net | 57, 60-62, 205 |
S3. EMERGENT PARTICLES IN 3D CRYSTALS

As discussed in main text, we have performed an exhaustive investigation over all the symmetry-protected band degeneracies in 3D crystals with $T$ symmetry, as shown in Sec. S7. Thus it becomes possible to introduce a uniform notation to label the degeneracies and then the emergent particles. In this work, we classify the band degeneracy from four perspectives: the dimension of degeneracy manifold, the degree of degeneracy, the type of dispersion, and the topological charge. For dimension of degeneracy manifold, we term the 0D, 1D and 2D band degeneracy as point, line and surface, respectively, and for degree of degeneracy, we term the two-, three-, four-, six- and eight-fold degeneracy as Weyl, triple, Dirac, sextuple, and octuple point/line/surface, respectively. Moreover, we find that the leading order band energy splitting of emergent particles along certain direction can be linear, quadratic and cubic. At last, a $d$-D degeneracy in 3D systems can be topologically characterized by a topological charge defined on a $(3-d)$-D sphere enclosing the degeneracy [5]. Specifically, the nodal point is characterized by Chern number, which is a $\mathbb{Z}$-valued topological charge, the nodal line is characterized by Berry phase, which is a $\mathbb{Z}_2$-valued topological charge, and the nodal surface also is characterized a $\mathbb{Z}_2$-valued topological charge [6, 7].

A complete list of the emergent particles according to this classification has been presented in Table I in main text. In the following, we discuss the possible Hamiltonian and the typical band structure of the emergent particles one by one.

A. Twofold degeneracy point

1. Charge-1 Weyl point

The charge-1 Weyl point (C-1 WP) is a 0D two-fold band degeneracy. It features a linear energy splitting along any direction in momentum space, and can occur at a generic $k$ point in BZ. Moreover, the topological charge (Chern number) of C-1 WP is $C = \pm 1$. A typical band structure of C-1 WP is schematically shown in Fig. S1(a).

A general Hamiltonian of C-1 WP is

$$H_{\text{C-1 WP}} = \sum_{i=0}^{3} (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) \sigma_i.$$  \hspace{1cm} (S1)

With additional symmetry, the Hamiltonian (S1) would be simplified. A possible simple Hamiltonian for C-1 WP may be written as

$$H_{\text{C-1 WP}} = c_1 k_z + c_2 k_x \sigma_3 + (\alpha k_+ \sigma_+ + h.c.),$$  \hspace{1cm} (S2)

with $k_\pm = k_x \pm ik_y$ and $\sigma_\pm = (\sigma_x \pm i\sigma_y)/2$. The C-1 WP can be further classified as type I and type II [8]. For example, the C-1 WP described by Eq. (S2) is type I when $|c_2| > |c_1|$ and is type II when $|c_2| < |c_1|$. However, when C-1 WP locates at $T$-symmetric point, it can not be type II, as $T$-symmetry requires $c_1 = 0$.

2. Charge-2 Weyl point

The charge-2 Weyl point (C-2 WP) is a 0D two-fold band degeneracy with a topological charge $C = \pm 2$. It features a linear dispersion along one direction and a quadratic energy splitting in the plane normal to the direction. The C-2 WP can occur on high-symmetry line or at high-symmetry point in BZ. A typical band structure of C-2 WP is schematically shown in Fig. S1(b).

A possible Hamiltonian for C-2 WP may be written as

$$H_{\text{C-2 WP}} = c_1 k_z + c_2 k_\parallel^2 + c_3 k_x \sigma_3 + (\alpha k^2_+ \sigma_+ + h.c.),$$  \hspace{1cm} (S3)

with $k_\parallel = \sqrt{k_x^2 + k_y^2}$. The C-2 WP can be further classified as type I, type II and type III [9]. For example, the C-2 WP described by Eq. (S3) is type I when $|c_3| > |c_1|$ and $|\alpha| > |c_2|$, is type II when $|c_3| < |c_1|$, and is type III when $|c_3| > |c_1|$ and $|\alpha| < |c_2|$. Similarly, the C-2 WP at a $T$-symmetric point cannot be type II.
3. Charge-3 Weyl point

The charge-3 Weyl point (C-3 WP) is a 0D two-fold band degeneracy with a topological charge $C = \pm 3$. It features a linear dispersion along one direction and a cubic energy splitting in the plane normal to the direction. The C-3 WP can occur on high-symmetry line or at high-symmetry point in BZ. A typical band structure of C-3 WP is schematically shown in Fig. S1(c).

A possible Hamiltonian for C-3 WP may be written as

$$H_{C-3 \text{ WP}} = c_1 k_z + c_2 k^2_\parallel + c_3 k_z \sigma_3 + (\alpha k^3_+ \sigma_+ + h.c.) .$$

(S4)

The C-3 WP can be further classified as type I, type II and type III, depending on model parameters.

4. Charge-4 Weyl point

The charge-4 Weyl point (C-4 WP) is a 0D two-fold band degeneracy with a topological charge $C = \pm 4$. It features a cubic energy splitting along one direction and a quadratic energy splitting in the plane normal to the direction. The C-4 WP only occurs at certain $T$-symmetric points in spinless systems. Besides this work, C-4 WP was also recently unveiled in Ref. [10] and Ref. [11]. A typical band structure of C-4 WP is schematically shown in Fig. S1(d).

A possible Hamiltonian for C-4 WP may be written as

$$H_{C-4 \text{ WP}} = c_1 k^2 + c_2 \left[ \sqrt{3}(k^3_x - k^3_y)\sigma_1 + (k^2_x + k^2_y - 2k^2_z)\sigma_3 \right] + c_3 k_x k_y k_z \sigma_2 ,$$

(S5)

with $k = \sqrt{k^2_x + k^2_y + k^2_z}$, which shows a cubic energy splitting along $k_{(111)}$ direction and quadratic energy splitting along $k_{x,y,z}$ direction.
FIG. S2. Typical band structure of possible three-fold nodal points in 3D crystals. The black and blue curves denote non-degenerate and doubly degenerate bands, respectively.

**B. Threefold degeneracy point**

1. **Triple point**

The triple point (TP) is a 0D three-fold band degeneracy, formed by a linear crossing between a doubly degenerate band and a non-degenerate band. The TP does not have a well-defined topological charge of Chern number, as there does not exist a fully gapped sphere surrounding TP in BZ. It features a linear energy splitting along any direction in momentum space, and can occur on high-symmetry line or at high-symmetry point in BZ. A typical band structure of TP is schematically shown in Fig. S2(a).

A possible Hamiltonian for TP may be written as

\[
H_{\text{TP}} = c_1 k_z + \begin{pmatrix}
c_2 k_z & \alpha k_y & \alpha k_x \\
\alpha^* k_y & -c_2 k_z & 0 \\
\alpha^* k_x & 0 & -c_2 k_z
\end{pmatrix},
\]  

(S6)

The TP can be further classified as type I and type II depending on model parameters. For example, the TP described by Eq. (S6) is type I when \(|c_2| > |c_1|\) and is type II when \(|c_2| < |c_1|\).

2. **Charge-2 Triple point**

The charge-2 triple point (C-2 TP) is a 0D three-fold band degeneracy with a topological charge \(C = \pm 2\). It features a linear energy splitting along any direction in momentum space. The C-2 TP only occurs at high-symmetry point in BZ. A typical band structure of C-2 TP is schematically shown in Fig. S2(b).

A possible Hamiltonian for C-2 TP may be written as

\[
H_{\text{C-2 TP}} = \begin{pmatrix}
0 & ik_z & ik_y \\
-ik_z & 0 & ik_x \\
-ik_y & -ik_x & 0
\end{pmatrix},
\]  

(S7)

which actually describes the conventional spin-1 Weyl fermion.
3. Quadratic triple point

The quadratic triple point (QTP) is a 0D three-fold band degeneracy, formed by a linear crossing between a doubly
degenerate band and a non-degenerate band along certain high-symmetry line. The QTP also does not have a well-
defined topological charge of Chern number. However, in contrast to TP, QTP features a quadratic energy splitting
in the plane normal to the high-symmetry line. The QTP only occurs on high-symmetry line in spinless systems. A
typical band structure of QTP is schematically shown in Fig. S2(c).

A possible Hamiltonian for QTP may be written as

\[
H_{\text{QTP}} = c_1 k_z + c_2 k_z^2 + \begin{bmatrix}
    c_3 k_z + c_4 k_z^2 & 0 & 0 \\
    0 & -c_3 k_z - c_4 k_z^2 & 0 \\
    0 & 0 & -c_3 k_z - c_4 k_z^2 \\
\end{bmatrix}
+ c_5 \begin{bmatrix}
    0 & 2i k_x k_y & i(k_x^2 - k_y^2) \\
    -2i k_x k_y & 0 & 0 \\
    -i(k_x^2 - k_y^2) & 0 & 0 \\
\end{bmatrix}
+ c_6 \begin{bmatrix}
    0 & 0 & 0 \\
    0 & k_x^2 & -k_x k_y \\
    0 & -k_x k_y & k_y^2 \\
\end{bmatrix}.
\]  

(S8)

The QTP can be further classified as type I, type II and type III, depending on model parameters.

4. Quadratic contact triple point

The quadratic contact triple point (QCTP) is a 0D three-fold band degeneracy with a topological charge \(C = 0\). It
features a quadratic energy splitting along any direction in momentum space, and splits into a doubly degenerate
band and a non-degenerate band along certain high-symmetry line(s), and three non-degenerate bands at generic
momentum points. The QCTP only occurs at high-symmetry point in spinless systems. A typical band structure of
QCTP is schematically shown in Fig. S2(d).

A possible Hamiltonian that captures the essential physics of QCTP may be written as

\[
H_{\text{QCTP}} = \begin{bmatrix}
    c_1 k_x^2 + c_2 (k_y^2 + k_z^2) & c_3 k_x k_y & c_3 k_x k_z \\
    c_3 k_x k_y & c_1 k_y^2 + c_2 (k_x^2 + k_z^2) & c_3 k_y k_z \\
    c_3 k_x k_z & c_3 k_y k_z & c_1 k_z^2 + c_2 (k_x^2 + k_y^2) \\
\end{bmatrix}.
\]  

(S9)

C. Fourfold degeneracy point

1. Dirac point

The (charge-0) Dirac point (DP) is a 0D four-fold band degeneracy with a topological charge \(C = 0\). It features
a linear dispersion along any direction in momentum space. The DP can occur on high-symmetry line or at high-
symmetry point in BZ. The DP in a spinful system with spatial inversion symmetry \(I\) and \(T\) splits into two doubly
degenerate bands at each \(k\) in BZ. For the other cases, the DP splits into four non-degenerate bands at a generic
\(k\), but into two doubly degenerate bands along certain high-symmetry line(s). A typical band structure of DP is
schematically shown in Fig. S3(a).

A possible Hamiltonian for DP may be written as

\[
H_{\text{DP}} = c_1 k_z + \begin{bmatrix}
    c_2 k_z & -ic_3 k_+ & 0 & 0 \\
    ic_3 k_- & -c_2 k_z & 0 & 0 \\
    0 & 0 & c_2 k_z & ic_3 k_- \\
    0 & 0 & -ic_3 k_+ & -c_2 k_z \\
\end{bmatrix}.
\]  

(S10)

The DP also can be further classified as type I and type II, depending on model parameters. However, the DP at
\(T\)-symmetric points cannot be type II.

2. Charge-2 Dirac point

The charge-2 Dirac point (C-2 DP) is a 0D four-fold band degeneracy with a topological charge \(C = \pm 2\). It also
features a linear dispersion along any direction in momentum space, and can occur on high-symmetry line or at
high-symmetry point in BZ. Contrast to DP which can be considered as a combination of two C-1 WPs with opposite topological charge, the C-2 DP contains two C-1 WPs with same topological charge. The C-2 DP splits into four bands at a generic \( \mathbf{k} \) but into two doubly degenerate bands along certain high-symmetry line. A typical band structure of C-2 DP is schematically shown in Fig. S3(b).

A possible Hamiltonian for C-2 DP may be written as

\[
H_{\text{C-2 DP}} = c_1 k_z + \begin{bmatrix}
0 & c_2 k_z & \alpha k_- & \beta k_+ \\
0 & \alpha^* k_+ & -\beta k_- & -c_2 k_z \\
\beta^* k_- & \alpha k_+ & 0 & 0 \\
\end{bmatrix}.
\]

(S11)

The C-2 DP can be further classified as type I and type II, depending on model parameters, while it at \( T \)-symmetric point cannot be type II.

3. Charge-4 Dirac point

The charge-4 Dirac point (C-4 DP) is a 0D four-fold band degeneracy with a topological charge \( C = \pm 4 \). It features a linear dispersion along any direction in momentum space with all the four bands being fully splitted at each generic \( \mathbf{k} \). The C-4 DP only occurs at high-symmetry point in spinful systems. A typical band structure of C-4 DP is schematically shown in Fig. S3(c).

A possible Hamiltonian for C-4 DP may be written as

\[
H_{\text{C-4 DP}} = \begin{bmatrix}
-c_1 k_z & c_1 k_+ & a k_+ k_z - \sqrt{3} k_z^2 & e^{-i2\pi/3} \alpha k_z^2 \\
-c_1 k_- & c_1 k_z & e^{-i2\pi/3} \alpha^* k_z & -\alpha k_+ k_z + \sqrt{3} k_z^2 \\
a^* k_+ k_z & e^{i2\pi/3} \alpha^* k_z & c_1 k_z & -c_1 k_+ \\
-e^{i2\pi/3} \alpha^* k_z & -c_1 k_+ & -c_1 k_z & \end{bmatrix},
\]

(S12)

which essentially describes the conventional spin-3/2 Weyl fermion.

4. Quadratic Dirac point

The (charge-0) quadratic Dirac point (QDP) is a 0D four-fold band degeneracy with a topological charge \( C = 0 \). It is formed by a linear crossing between two doubly degenerate bands along certain high-symmetry line, and has a quadratic energy splitting in the plane normal to the high-symmetry line. The QDP in a spinful system with \( I \) and \( T \) symmetries splits into two doubly degenerate bands at each \( \mathbf{k} \) in BZ. For the other cases, it splits into four non-degenerate bands at a generic \( \mathbf{k} \). The QDP can occur on high-symmetry line or at high-symmetry point in BZ. A typical band structure of QDP is schematically shown in Fig. S3(d).

A possible Hamiltonian for QDP may be written as

\[
H_{\text{QDP}} = c_1 k_z + c_2 k_z^2 + \begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & -1 & 0 \\
0 & 0 & 0 & -1 \\
\end{bmatrix} (c_3 k_z + c_4 k_z^2)
\]

\[
+ \begin{bmatrix}
0 & 0 & 0 & 0 \\
0 & 0 & 0 & \alpha_2 \\
0 & \alpha_2 & 0 & 0 \\
0 & 0 & \alpha_2 & 0 \\
\end{bmatrix} k_x k_y + \begin{bmatrix}
0 & 0 & \alpha_3 & \alpha_4 \\
0 & 0 & \alpha_4 & -\alpha_3 \\
\alpha_3 & -\alpha_4 & 0 & 0 \\
\alpha_4 & -\alpha_3 & 0 & 0 \\
\end{bmatrix} (k_x^2 - k_y^2),
\]

(S13)

The QDP can be further classified as type I, type II and type III depending on model parameters, while it at \( T \)-symmetric point cannot be type II.

5. Charge-4 quadratic Dirac point

The charge-4 quadratic Dirac point (C-4 QDP) is a 0D four-fold band degeneracy with a topological charge \( C = \pm 4 \). It has a linear dispersion along certain high-symmetry line and a quadratic energy splitting in the plane normal to
FIG. S3. Typical band structure of possible Dirac points in 3D crystals. The black and blue curves denote non-degenerate and doubly degenerate bands, respectively.

Such a line. The C-4 QDP can be considered as a combination of two C-2 WPs with same topological charge, and only occurs at certain high-symmetry points in spinful systems. The C-4 QDP splits into two doubly degenerate bands at three high-symmetry planes and along certain high-symmetry line. However, it would split into four non-degenerate bands at a generic $k$. A typical band structure of C-4 QDP is schematically shown in Fig. S3(e).

A possible Hamiltonian for C-4 QDP may be written as

$$H_{\text{C-4 QDP}} = c_1 k^2_{\parallel} + \begin{pmatrix} c_3 k_x k_y & ic_2 k_z & \beta k_x k_y & \alpha k_z \\ -ic_2 k_z & -c_3 k_x k_y & -\alpha k_z & -\beta k_x k_y \\ \beta^* k_x k_y & -\alpha^* k_z & -c_3 k_x k_y & -ic_2 k_z \\ \alpha^* k_z & -\beta^* k_x k_y & ic_2 k_z & c_3 k_x k_y \end{pmatrix} + c_4 \begin{pmatrix} k_x^2 - k_y^2 \\ 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}. \quad (S14)$$
6. Quadratic contact Dirac point

The quadratic contact Dirac point (QCDP) is a 0D four-fold band degeneracy with a topological charge \( C = 0 \). It feature a quadratic energy splitting along any direction in momentum space. The QCDP in a spinful system with \( I \) and \( T \) symmetries splits into two doubly degenerate bands at each \( k \) in BZ. For the other cases, it splits into four bands at a generic \( k \) but into two doubly degenerate bands along certain high-symmetry line. The QCDP only occurs at high-symmetry point in BZ. A typical band structure of QCDP is schematically shown in Fig. S3(f).

A possible Hamiltonian for QCDP may be written as

\[
H_{\text{QCDP}} = c_1 k^2 + c_2 (3k_x^2 - k^2) \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} + c_3 \begin{bmatrix} k_y^2 - k_z^2 \\ k_y^2 - k_z^2 \\ k_z c_2 \\ k_z c_2 \end{bmatrix} + c_4 k_x k_y \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix} + \sqrt{2} c_4 k_y k_z \begin{bmatrix} 0 & i & 0 \\ 0 & 0 & -i \\ 0 & 0 & 0 \end{bmatrix}.
\] (S15)

7. Cubic Dirac point

The (charge-0) cubic Dirac point (CDP) is a 0D four-fold band degeneracy with a topological charge \( C = 0 \). It is formed by a linear crossing between two doubly degenerate bands along certain high-symmetry line, and has a cubic energy splitting in the plane normal to the high-symmetry line. The CDP only occurs at certain high-symmetry points in spinful systems. When the systems have \( I \) and \( T \) symmetries, the CDP would split into two doubly degenerate bands at each \( k \) in BZ. For the other cases, the CDP would split into four non-degenerate bands at a generic \( k \), but into two doubly degenerate bands along certain high-symmetry line. A typical band structure of CDP is schematically shown in Fig. S3(g).

A possible Hamiltonian for CDP may be written as

\[
H_{\text{CDP}} = \begin{bmatrix} c_1 k^2 \| & i (c_3 k_x^3 + c_4 k_z^3) & 0 & k_z c_2 \\ -i (c_3 k_x^3 + c_4 k_z^3) & c_1 k^2 \| & k_z c_2 & 0 \\ 0 & c_2 k_z & i (c_4 k_x^3 + c_3 k_z^3) & c_1 k^2 \| \\ c_2 k_z & 0 & -i (c_4 k_x^3 + c_3 k_z^3) & c_1 k^2 \| \end{bmatrix}.
\] (S16)

8. Cubic crossing Dirac point

The (charge-0) cubic crossing Dirac point (CCDP) is a 0D four-fold band degeneracy with a topological charge \( C = 0 \). It is formed by a cubic (not linear) crossing between two doubly degenerate bands along certain high-symmetry line, and has a quadratic energy splitting in the plane normal to the high-symmetry line. It would split into four non-degenerate bands at a generic \( k \). The CDP can be considered as a combination of two C-4 WP with opposite topological charge, and hence only appears in spinless systems. The CDP is a new emergent particle that has never been reported before. A typical band structure of CDP is schematically shown in Fig. S3(h).

A possible Hamiltonian for CCDP may be written as

\[
H_{\text{CCDP}} = \begin{bmatrix} 0 & h_{12} \\ h_{12}^\dagger & 0 \end{bmatrix},
\] (S17)

with

\[
h_{12} = \begin{bmatrix} \sqrt{3} \alpha_1 (k_x^2 - k_y^2) + i \alpha_1 (k_x^2 + k_y^2 - 2k_z^2) \\ -\alpha_2 k_x k_y k_z \end{bmatrix} - \sqrt{3} \alpha_1 (k_x^2 - k_y^2) + i \alpha_1 (k_x^2 + k_y^2 - 2k_z^2) \begin{bmatrix} \alpha_2 k_x k_y k_z \\ \sqrt{3} \alpha_1 (k_x^2 - k_y^2) + i \alpha_1 (k_x^2 + k_y^2 - 2k_z^2) \end{bmatrix}.
\] (S18)

which shows a cubic energy splitting along \( k_{(111)} \) direction and quadratic energy splitting along \( k_{x,y,z} \) direction, similar to the band splitting of the C-4 WP.
D. Sixfold degeneracy point

1. Sextuple point

The (charge-0) sextuple point (SP) is a 0D six-fold band degeneracy with a topological charge $C = 0$. It features a linear energy splitting along any direction in momentum space. The SP only occurs at high-symmetry point in BZ. A typical band structure of SP is schematically shown in Fig. S4(a).

A possible Hamiltonian for SP may be written as

$$H_{SP} = \begin{pmatrix}
0 & c_1k_x & -c_1k_y & 0 & \alpha k_x & \alpha k_y \\
c_1k_x & 0 & -c_1k_z & -\alpha k_x & 0 & -\alpha k_z \\
-c_1k_y & -c_1k_z & 0 & -\alpha k_y & \alpha k_z & 0 \\
0 & \alpha k_x & \alpha k_y & 0 & c_1k_y & c_1k_z \\
-\alpha k_x & 0 & -\alpha k_z & -c_1k_x & 0 & c_1k_z \\
-\alpha k_y & \alpha k_z & 0 & c_1k_y & 0 & c_1k_z \\
\end{pmatrix}.$$  \(\text{(S19)}\)

2. Charge-4 sextuple point

The charge-4 sextuple point (C-4 SP) is a 0D six-fold band degeneracy with a topological charge $C = \pm 4$. It linearly splits into six bands at a generic $\mathbf{k}$, but into three doubly degenerate bands along certain high-symmetry line and in three high-symmetry planes. The C-4 SP can be considered as a combination of two C-2 TPs with same topological charge, and only occurs at certain high-symmetry points in spinful systems. A typical band structure of C-4 SP is schematically shown in Fig. S4(b).

A possible Hamiltonian for C-4 SP may be written as

$$H_{C-4\ SP} = \begin{pmatrix}
0 & \alpha_1k_x & \alpha_1^*k_y & 0 & \alpha_2k_x & \alpha_2k_y \\
\alpha_1^*k_x & 0 & \alpha_1k_z & \alpha_2k_x & 0 & \alpha_2k_z \\
\alpha_2k_y & \alpha_1k_y & 0 & \alpha_2k_z & 0 & 0 \\
0 & \alpha_2k_x & \alpha_2^*k_y & 0 & -\alpha_1k_z & -\alpha_1k_y \\
\alpha_2^*k_x & 0 & \alpha_2k_z & -\alpha_1k_x & 0 & -\alpha_1k_z \\
\alpha_2k_y & \alpha_2^*k_z & 0 & -\alpha_1k_y & -\alpha_1k_z & 0 \\
\end{pmatrix}.$$  \(\text{(S20)}\)

3. Quadratic contact sextuple point

The quadratic contact sextuple point (QCSP) is a 0D six-fold band degeneracy with a topological charge $C = 0$. It features a quadratic dispersion along any direction in momentum space. Interestingly, the QCSP only occurs in spinful systems with SG 205 locating at high-symmetry point $R$. The QCSP splits into three doubly degenerate bands at each $\mathbf{k}$ in BZ as SG 205 has $I$ symmetry. A typical band structure of QCSP is schematically shown in Fig. S4(c).

A possible Hamiltonian for QCSP may be written as

$$H_{QCSP} = c_1 \begin{pmatrix}
k^2_x & 0 & 0 & 0 & 0 & 0 \\
0 & k^2_x & 0 & 0 & 0 & 0 \\
0 & 0 & k^2_y & 0 & 0 & 0 \\
0 & 0 & 0 & k^2_x & 0 & 0 \\
0 & 0 & 0 & 0 & k^2_y & 0 \\
0 & 0 & 0 & 0 & 0 & k^2_z \\
\end{pmatrix} + c_2 \begin{pmatrix}
k^2_y & 0 & 0 & 0 & 0 & 0 \\
0 & k^2_y & 0 & 0 & 0 & 0 \\
0 & 0 & k^2_z & 0 & 0 & 0 \\
0 & 0 & 0 & k^2_y & 0 & 0 \\
0 & 0 & 0 & 0 & k^2_z & 0 \\
0 & 0 & 0 & 0 & 0 & k^2_y \\
\end{pmatrix} + c_3 \begin{pmatrix}
k^2_z & 0 & 0 & 0 & 0 & 0 \\
0 & k^2_z & 0 & 0 & 0 & 0 \\
0 & 0 & k^2_x & 0 & 0 & 0 \\
0 & 0 & 0 & k^2_z & 0 & 0 \\
0 & 0 & 0 & 0 & k^2_x & 0 \\
0 & 0 & 0 & 0 & 0 & k^2_z \\
\end{pmatrix} + \begin{pmatrix}
0 & \alpha_1k_yk_z & \alpha_1^*k_xk_z & 0 & \alpha_2k_yk_z & 0 \\
\alpha_1k_yk_z & 0 & \alpha_1k_xk_z & -\alpha_2k_yk_z & 0 & \alpha_2k_xk_y \\
0 & \alpha_1^*k_xk_y & 0 & \alpha_2k_zk_y & -\alpha_2k_zk_y & 0 \\
0 & -\alpha_2^*k_yk_z & 0 & \alpha_1^*k_xk_y & 0 & \alpha_1k_yk_z \\
\alpha_2^*k_yk_z & 0 & -\alpha_2^*k_xk_y & \alpha_1k_zk_y & 0 & \alpha_1^*k_zk_y \\
-\alpha_2^*k_xk_z & \alpha_2^*k_zk_y & 0 & \alpha_1^*k_zk_y & 0 & \alpha_1k_zk_y \\
\end{pmatrix}.$$  \(\text{(S21)}\)
FIG. S4. Typical band structure of possible six-fold and eight-fold nodal points in 3D crystals. The black, blue and dark blue curves denote non-degenerate, doubly degenerate and four-fold degenerate bands, respectively.

E. Eightfold degeneracy point

1. Octuple point

The (charge-0) octuple point (OP) is a 0D eight-fold band degeneracy with a topological charge $C = 0$. It features a linear energy dispersion along any direction in momentum space, and is formed by a linear crossing between two fourfold degenerate bands along certain high-symmetry line. When the systems have $I$ and $T$ symmetries, the OP splits into four doubly degenerate bands at a generic $k$ in BZ. For the other cases, it would split into eight non-degenerate bands at a generic $k$. The OP only occurs at certain high-symmetry points in spinful systems. A typical band structure of SP is schematically shown in Fig. S4(d).

A possible Hamiltonian for OP may be written as

$$H_{OP} = \begin{bmatrix} h_{11} & h_{12} \\ h_{12}^\dagger & h_{22} \end{bmatrix},$$

(S22)

with

$$h_{11} = \begin{bmatrix} c_1 k_y & c_1 k_x + ic_3 k_z & -ic_3 k_y & ic_3 k_x \\ c_1 k_x - ic_2 k_z & -c_1 k_y & -ic_3 k_z & ic_3 k_x \\ ic_3 k_y & -ic_3 k_z & -c_1 k_y & c_1 k_x - ic_2 k_z \\ -ic_3 k_x & -ic_3 k_z & -c_1 k_x + ic_2 k_z & c_1 k_y \end{bmatrix},$$

(S23)

$$h_{12} = \begin{bmatrix} 0 & \alpha_1 k_z & -\alpha_2 k_y & \alpha_2 k_x \\ -\alpha_1 k_z & 0 & \alpha_2 k_x & \alpha_2 k_y \\ \alpha_2 k_y & -\alpha_2 k_x & 0 & -\alpha_1 k_z \\ -\alpha_2 k_x & \alpha_2 k_y & \alpha_1 k_z & 0 \end{bmatrix},$$

(S24)

$$h_{22} = \begin{bmatrix} c_1 k_y & c_1 k_x - ic_2 k_z & ic_3 k_y & -ic_3 k_x \\ c_1 k_x + ic_2 k_z & -c_1 k_y & -ic_3 k_z & ic_3 k_x \\ -ic_3 k_y & ic_3 k_x & -c_1 k_y & c_1 k_x + ic_2 k_z \\ ic_3 k_x & ic_3 k_y & -c_1 k_x - ic_2 k_z & c_1 k_y \end{bmatrix}.$$
F. Twofold degeneracy line

1. Weyl nodal line

The Weyl nodal line (WNL) is a 1D two-fold band degeneracy. The WNL features a linear energy dispersion in the plane normal to the line. Moreover, the topological charge (Berry phase) for WNL is $C = \pi$. The WNL generally appears along high-symmetry line or in high-symmetry plane in BZ. A typical band structure of WNL is schematically shown in Fig. S5(a).

A possible Hamiltonian expanded at a general point $K$ on WNL may be written as

$$H_{\text{WNL}} = c_1 q_x + c_2 q_y + c_3 q_x \sigma_1 + c_4 q_y \sigma_2,$$

with the wave vector $q$ measured from $K$. Here, we assume the $q_x-q_y$ plane passes through $K$ point and is normal to the WNL. The WNL can be further classified as type I, type II [12] and hybrid type [13], depending on model parameters.

2. Weyl nodal-line net

The Weyl nodal-line net (WNL net) contains multiple two-fold NLs, which share (at least) one nodal point in momentum space, as schematically shown in Fig. S5(b). The joint nodal point of the WNLs must locate at high-symmetry line or high-symmetry point in BZ, and are termed as P-WNLs in Sec. S7 A and Sec. S8 A. WNL net can take various form in BZ, such as crossed nodal line [14], nodal chain [15] nodal box [16] and so on.

A possible Hamiltonian expanded around a P-WNLs may be written as

$$H_{\text{WNL net}} = \left[ c_1 k_z + c_2 k^2_{\parallel} + c_3 k_x (k^2_x - 3k^2_y) \right] \sigma_3 + \alpha k_y (3k_x^2 - k_y^2) \sigma_1,$$

which indicates that the point described by Eq. (S27) is not isolated but shall be an joint point of three WNLs lying in three vertical mirror planes dictated by equation $3k_x^2 - k_y^2 = 0$. The band structure obtained from Eq. (S27) is shown in Fig. S5(b), where we set $c_2 = c_3 = 0$ for the convenience of a clear presentation.

3. Quadratic nodal line

The quadratic nodal line (QNL) is a 1D two-fold band degeneracy with a topological charge $C = 0 \mod 2\pi$. The QNL features a quadratic energy splitting in the plane normal to the line. It only appears along high-symmetry line in BZ. A typical band structure of QNL is schematically shown in Fig. S5(c).

A possible Hamiltonian expanded at a general point $K$ on QNL may be written as

$$H_{\text{QNL}} = c_1 k^2_{\parallel} + (\alpha k^3_x \sigma_+ + h.c.).$$

The QNL can be further classified as type I, type III and hybrid type depending on model parameters.

4. Cubic nodal line

The cubic nodal line (CNL) is a 1D two-fold band degeneracy with a topological charge $C = \pi \mod 2\pi$. The CNL features a cubic energy splitting in the plane normal to the line. It only appears along high-symmetry line in BZ. A typical band structure of CNL is schematically shown in Fig. S5(d).

A possible Hamiltonian expanded at a general point $K$ on CNL may be written as

$$H_{\text{CNL}} = c_1 k^2_{\parallel} + (\alpha k^3_x \sigma_+ + h.c.).$$

G. Fourfold degeneracy line

1. Dirac nodal line

The Dirac nodal line (DNL) is a 1D four-fold band degeneracy with a topological charge $C = 0 \mod 2\pi$. It features a linear dispersion in the plane normal to the line. The DNL in spinful systems with $I$ and $T$ symmetries splits into two
doubly degenerate bands at a generic $k$ in BZ. For the other cases, it splits into four bands at a generic $k$, but would split into two doubly degenerate bands along certain high-symmetry line(s). It can appear along high-symmetry line or in high-symmetry plane in BZ. A typical band structure of DNL is schematically shown in Fig. S5(e).

A possible Hamiltonian expanded at a general point $K$ on DNL may be written as

$$H_{\text{DNL}} = c_1 k_z + \begin{bmatrix} 0 & c_2 k_y + ic_3 k_x & 0 & \alpha_1 k_x + \alpha_2 k_y \\ c_2 k_y - ic_3 k_x & 0 & -\alpha_1 k_x + \alpha_2 k_y & 0 \\ 0 & -\alpha_1^* k_x + \alpha_2^* k_y & 0 & -c_2 k_y - ic_3 k_x \\ \alpha_1^* k_x + \alpha_2^* k_y & 0 & -c_2 k_y + ic_3 k_x & 0 \end{bmatrix}. \quad (S30)$$

The DNL can be further classified as type I, type II and hybrid type depending on model parameters.

### 2. Dirac nodal-line net

The Dirac nodal-line net (DNL net) contains multiple four-fold NLs, which share (at least) one nodal point in momentum space, as schematically shown in Fig. S5(f). The joint nodal point of the DNLS must locates at high-symmetry line or high-symmetry point in BZ, and are termed as P-DNLs in Sec. S7 A and Sec. S8 A.

A possible Hamiltonian expanded around a P-DNLs may be written as

$$H_{\text{DNL net}} = \begin{bmatrix} c_1 k_x^2 + c_2 k_y^2 + c_3 k_z & 0 & c_7 k_x k_y & c_8 k_x k_y \\ 0 & c_1 k_x^2 + c_2 k_y^2 + c_3 k_z & -c_8 k_x k_y & c_7 k_x k_y \\ -c_8 k_x k_y & -c_7 k_x k_y & -c_4 k_x^2 - c_5 k_y^2 - c_6 k_z & 0 \\ c_8 k_x k_y & c_7 k_x k_y & 0 & -c_4 k_x^2 - c_5 k_y^2 - c_6 k_z \end{bmatrix}, \quad (S31)$$

which indicates that the point described by Eq. (S31) is not isolated but shall be an joint point of two DNLs lying in $k_x = 0$ and $k_y = 0$ mirror planes. The band structure obtained from Eq. (S31) is shown in Fig. S5(f).

### H. Twofold degeneracy surface

#### 1. Nodal surface

The nodal surface (NS) is a 2D two-fold band degeneracy. The NS only appears at the boundary plane of BZ and has linear dispersion along the direction normal to the surface. Moreover, the 2D nodal surface in 3D systems can be topologically characterized by a $\mathbb{Z}_2$-valued topological charge, which is defined on (a 0D sphere) two points surrounding the surface in BZ [5, 6]. A typical band structure of NS is schematically shown in the left picture of Fig. S5(g).

A possible Hamiltonian expanded around a general point $K$ in NS may be written as

$$H_{\text{NS}} = c_1 q + c_2 q \sigma_1, \quad (S32)$$

with the wave vector $q$ measured from $K$. Here, we assume the $q$ axis passes through $K$ point and is normal to the surface.

There only exist three possibilities for the NS semimetals, namely, the systems exhibits one NS, two NSs or three NSs, as illustrated in Fig. S5(g).

### S4. DERIVATION OF THE COREPS OF TYPE-II MSGS

#### A. Abstract group

It is known that for a generic momentum $k$ in BZ of a certain SG, its symmetry is described by a little group $G^k$. For high-symmetry point $k_1$, the reps of $G^{k_1}$ generally is related to those of Herring little group (see Sec. 3.8 in Ref. [17]) and for high-symmetry line $k_2$, the reps of $G^{k_1}$ is related to those of the central extension of the corresponding little co-group (see Sec. 3.7 in Ref. [17]). Notice that, different from the notation used in Ref. [17], we will abuse the symbol $G^{k_1}$ to denote Herring little group (at high-symmetry points) and central extension (on high-symmetry lines) in the following discussion. $G^{k_1}$ (the Herring little group or the central extension) for different high-symmetry momenta in one SG or for same high-symmetry momentum in different SGs may be isomorphic to one certain abstract
FIG. S5. Typical band structure of possible nodal line and nodal surface in 3D crystals. The black, blue and dark blue curves denote non-degenerate, doubly degenerate and four-fold degenerate bands, respectively.

group, leading to a great simplification for investigating the reps of 230 SGs. In Ref. [17], the abstract group for each $G_k^i$ in 230 SGs are explicitly given in Table 5.7 and Table 6.13, respectively, and the rep information of the relevant abstract groups are presented in Table 5.1. Moreover, the correspondence between the reps of abstract group (labelled as $R_i$ with $i = 1, 2, 3...$ in Ref. [17]) and the conventional notations of the reps of electronic bands can be found in Table 5.8 and Table 6.14 of Ref. [17], and a recent work by Liu et. al. [18].
B. Magnetic space groups and corepresentations

The MSGs also is called as Shubnikov SGs, and can be subdivided into four types [17]. There exist in total 1651 MSGs. The type I MSGs are the ordinary 230 SGs, containing only unitary operators. A type I MSG, $M$, is given by

$$ M = G, $$

(S33)

where $G$ is any ordinary SG. In the following, we use $G$ and $M$ to denote ordinary SG and MSG, respectively. The single- and double-valued reps of type I MSGs (e.g. the ordinary SGs) have been given in Ref. [17].

All the other three types of MSGs contain anti-unitary operators, e.g. the operators involve time-reversal symmetry $T$. A type II MSG, $M$, is given by

$$ M = G + T(G - H), $$

(S35)

where $H$ is a halving subgroup of $G$. The total number of type III MSG is 674, more than the number of the ordinary SG. At last, the type IV MSGs are defined on black and white Bravais lattices, which include two interpenetrating sublattices occupied by up-spin (black) and down-spin (white), respectively. A type IV MSG, $M$, is given by

$$ M = G + T \{ E | t \} G, $$

(S36)

where $t_0$ is a translation connecting black and white Bravais lattices. There are 517 type IV MSGs. Generally, one can use a general form to rewrite the type II, III, and IV MSG, expressed as

$$ M = G' + A G', $$

(S37)

with $G'$ a unitary subgroup of $M$ and $A$ an anti-unitary element of $M$. For type II MSG, $A$ is $T$ symmetry, and for type III MSG, $A$ is a combined operator containing $T$ and a spatial operator $O$. Notice that $O$ is not an element of $G'$. For type IV MSG, the anti-unitary operator $A$ is $T \{ E | t_0 \}$, namely, $T$ symmetry followed by a pure translation.

While one uses the representation theory to study the type I MSGs, e.g. the ordinary SGs, it is necessary to extend the representation theory to corepresentation theory [19] for studying type II, III, and IV MSGs, as they contain anti-unitary operators.

Without loss of generality, we consider a magnetic group

$$ M_0 = G_0 + A G_0, $$

(S38)

and assuming the rep information of $G_0$ is known. For a irreducible rep $\Gamma$ of $G_0$ and an operator $R \in G_0$, one has

$$ R \langle \psi | = \langle \psi | \Delta(R), $$

(S39)

with $\langle \psi |$ the basis state of $\Gamma$ and $\Delta(R)$ the matrix representation of $R$ in $\Gamma$. Then the basis state of $M_0$ can be written as $\langle \psi, \phi |$ with $\langle \phi | = A \langle \psi |$. A straightforward calculation gives [17]

$$ R \langle \psi, \phi | = \langle \psi, \phi | \left[ \begin{array}{cc} \Delta(R) & 0 \\ 0 & \Delta^* (A^{-1} R A) \end{array} \right], $$

(S40)

for $R \in G_0$, and

$$ B \langle \psi, \phi | = \langle \psi, \phi | \left[ \begin{array}{cc} 0 & \Delta(BA) \\ \Delta^* (A^{-1} B) & 0 \end{array} \right], $$

(S41)

for $B \in A G_0$. The matrices

$$ D(R) = \left[ \begin{array}{cc} \Delta(R) & 0 \\ 0 & \Delta^* (A^{-1} R A) \end{array} \right], \quad D(B) = \left[ \begin{array}{cc} 0 & \Delta(BA) \\ \Delta^* (A^{-1} B) & 0 \end{array} \right], $$

(S42)
are the coreps of \( M_0 \) derived from \( \Gamma \) of \( G_0 \), which are denoted as \( D\Gamma \). The relations of coreps are different from those of reps. The relations of reps are

\[
\Delta(R)\Delta(S) = \Delta(RS),
\]

with \( R, S \in G_0 \). In contrast, the relations of coreps have a dependence on the first rep, given as

\[
D(R)D(S) = D(RS), \quad D(B)D^*(S) = D(BS),
\]

with \( R \in G_0, B \in A G_0 \) and \( S \in M_0 \).

Notice that although \( \Gamma \) is an irreducible rep of \( G_0 \), it does not mean the deduced corep \( D\Gamma \) also is irreducible. If there exist a unitary transformation changing \( D\Gamma \) to \( D'\Gamma \) and all the matrices of \( D'\Gamma \) are in the same block diagonal form, then the corep \( D\Gamma \) is reducible. In contrast, if there does not exist such transformation, the corep \( D\Gamma \) is irreducible. A reducible (irreducible) corep \( D\Gamma \) means that for an electronic band belonging to the rep \( \Gamma \), its degeneracy is doubled (not affected) by the addition of \( A \) symmetry to the group \( G_0 \). There are three different cases for the deduced corep \( D\Gamma \) [17].

Case (a): The deduced corep \( D\Gamma \) is reducible, corresponding to the case that the addition of \( A \) symmetry does not change the degeneracy of the electronic band with \( \Gamma \) rep. The matrix representation of the operators in \( M_0 \) for the corep \( D\Gamma \) then is

\[
D(R) = \Delta(R), \quad D(B) = \Delta(BA^{-1})N,
\]

where \( N \) is determined by the following equations \( NN^* = \Delta(A^2) \) and \( \Delta(R) = N\Delta^*(A^{-1}RA)N^{-1} \). From Eq. (S45), one directly knows

\[
D(A) = N.
\]

Case (b): The deduced corep \( D\Gamma \) is irreducible, and \( \Delta(R) \) is equivalent to \( \Delta^*(A^{-1}RA) \). Then the matrix set for \( D\Gamma \) (S42) under unitary transformation can be written as

\[
D(R) = \begin{bmatrix} \Delta(R) & 0 \\ 0 & \Delta(R) \end{bmatrix}, \quad D(B) = \begin{bmatrix} 0 & -\Delta(BA^{-1})N \\ \Delta(BA^{-1})N & 0 \end{bmatrix},
\]

where \( N \) is determined by the following equations \( NN^* = -\Delta(A^2) \) and \( \Delta(R) = N\Delta^*(A^{-1}RA)N^{-1} \). The matrix representation of \( A \) in this case can be written as

\[
D(A) = \begin{bmatrix} 0 & -N \\ N & 0 \end{bmatrix}.
\]

Case (c): The deduced corep \( D\Gamma \) is irreducible, and \( \Delta(R) \) is not equivalent to \( \Delta^*(A^{-1}RA) \). The matrix set for \( D\Gamma \) then is

\[
D(R) = \begin{bmatrix} \Delta(R) & 0 \\ 0 & \Delta^*(A^{-1}RA) \end{bmatrix}, \quad D(B) = \begin{bmatrix} 0 & \Delta(BA) \\ \Delta^*(A^{-1}B) & 0 \end{bmatrix},
\]

and the matrix representation of \( A \) in this case is

\[
D(A) = \begin{bmatrix} 0 & \Delta(A^2) \\ 1 & 0 \end{bmatrix},
\]

with \( I \) denoting identity matrix. Hence, whenever the matrix \( N \) is solved, the coreps then are obtained. Notice that whether or not the degeneracy of the electronic bands is doubled by the addition of \( A \), the corresponding effective Hamiltonian of the bands would be inevitably affected, as \( A \) imposes additional symmetry constraint on the effective Hamiltonian.

The single- and double-valued reps of 230 SGs has been fully investigated in previous works and can be conveniently accessed, such as from the classic book “The mathematical theory of symmetry in solids: Representation theory for point groups and space groups” [17] and the Bilbao Crystallographic Server (BCS) [20]. However the notations of the reps used in Ref. [17] and Ref. [20] are different, and a correspondence between these two notations are given in a recent work by Liu et. al. [18]. The single-valued and double-valued reps of type II, III and IV MSGs based on BCS notation have been established [1, 21–23] and uploaded in BCS website [24]. In contrast, both single-valued and double-valued reps of type II, III and IV MSGs based on the notation of Ref. [17] are still missing.
C. Concrete steps of the derivation of corep

In this work we adopt the notations of reps used in Ref. [17] and establish the complete tables for both single-valued and double-valued coreps of type II MSGs from the reps of type I MSGs (the ordinary SGs) presented in Ref. [17]. As aforementioned, the corresponding abstract group, generating elements and the generating relations of the little groups of the high-symmetry momenta \( k_1 \) in BZ of each space group are given in Ref. [17], which is very helpful for obtaining the corep information of each type II MSG. While the type II MSG has one additional \( T \) symmetry comparing with the corresponding SG, the high-symmetry momenta \( k_1 \) in BZ of one certain type II MSG may or may not have additional symmetries comparing with that in corresponding SG. Nevertheless, the little groups \( M^{k_1} \) must take the form of either

\[
M^{k_1} = G^{k_1}, \tag{S51}
\]

or

\[
M^{k_1} = G^{k_1} + \mathcal{A}G^{k_1}, \tag{S52}
\]

with \( G^{k_1} \) the corresponding crystallographic little group, for which the rep information is known and available, and \( \mathcal{A} \) a certain anti-unitary operator. Starting from here, the subsequent steps for obtaining the (co)rep information of \( M^{k_1} \) are as follows.

First, for each \( M^{k_1} \), we find out all the symmetry operators to determine its suitable form [Eq. (S51) or Eq. (S52)].

Second, if \( M^{k_1} \) has the form of Eq. (S51), its reps \( \Gamma_i \) and the corresponding matrix representations \( \Delta_{\Gamma_i} \) are available in Ref. [17].

Third, if \( M^{k_1} \) has the form of Eq. (S52), we need to obtain the specific form of \( \mathcal{A} \) and derive the coreps \( D\Gamma \) of \( M^{k_1} \) from those (\( \Gamma \)) of \( G^{k_1} \) (which is available in Ref. [17]) using the method discussed in Sec. S4 B. A crucial point here is to determine which of the three cases, namely, Case (a)-(c) in Sec. S4 B, is appropriate for a given rep \( \Gamma_i^{k_1} \) of a SG \( G \). Generally, this can be inferred from the reality of the induced SG reps \( (\Gamma_i^{k_1} \uparrow G) \) (see Sec. 4.6, 5.2 and 7.6 in Ref. [17]). Fortunately, this has already been done by Ref. [17], where Table 5.7 (Table 6.13) explicitly indicate the case type for all the single-valued (double-valued) reps \( \Gamma_i^{k_1} \) of each \( G \) when adding \( T \) symmetry to \( G \).

Finally, by tedious but straightforward calculations, we establish complete tables of single-valued and double-valued coreps of type II MSGs, along with the matrix representations of the generating elements, and the effective Hamiltonian of the symmetry-protected band degeneracies.

D. Examples of deriving coreps

Here, we use two examples to show the details of deriving coreps of type II MSG from the reps of the corresponding SG, and discuss the underneath physics of extra degeneracy caused by the addition of \( T \) symmetry. For single-valued or double-valued rep \( \Gamma_i^{k_1} \), the relation between the reality of its induced SG reps \( (\Gamma_i^{k_1} \uparrow G) \) and the three cases of extra degeneracies described in Sec. S4 B is as follow [17]

| Reality | Degeneracy case | double-valued reps |
|---------|----------------|------------------|
| Reality | Degeneracy case | Reality | Degeneracy case |
| 1           | a              | 1              | b              |
| 2           | b              | 2              | a              |
| 3           | c              | 3              | c              |

1. Single-valued coreps of type II MSG 76

The single-valued reps of SG 76 can be found in Ref. [17], which is partially reproduced in Table S3. Table S3 also lists the corresponding part of the established single-valued coreps of type II MSG 76. We present the defining relations and the character tables of two related abstract groups \( G_1 \) and \( G_4 \) in Table S4. The BZ of SG 76 is shown in Fig. S6, along with the labels of high-symmetry points and high-symmetry lines. The single-valued reps describes...
FIG. S6. BZ of SG 76 and SG 92. We adopt the notation of Ref. [17] to label the high-symmetry points and high-symmetry lines.

the spinless systems or the systems with negligible SOC effect, where a \(2\pi\) rotation equals to identity operator and \(T^2 = 1\). We discuss the high-symmetry points \(\Gamma\) and \(R\), and high-symmetry line \(U\) in turn.

TABLE S3. Part of single-valued reps of SG 76 (reproduced from Ref. [17]) and the corresponding single-valued coreps of type II MSG 76 (see Sec. S7). For the left part, the columns from left to right list the high-symmetry momentum \(k\), the little group at \(k\): \(\Gamma(G)\) (presented as an abstract group \(G^{\text{*}}(\Gamma)\)), the generating elements of \(G^{\text{**}}(\Gamma)\) and a series of code \((R_i, j)\) separated by semicolons. \(R_i\) is the rep of \(G^{\text{**}}(\Gamma)\) corresponding to an allowed rep \(\Gamma_{p}^{\Gamma}\) of \(G^{\Gamma}\), and the integer \(j\) denotes the reality of the induced SG reps \(\Gamma_{p}^{\Gamma}\). Since \(\Gamma\) is invariant under \(T\) symmetry, \(\Gamma\) of the little group at \(k\) is isomorphic to point group \(C_1\), and the position of \(k\), the generating elements of the little group at \(k\) (only point-group operator of the elements are presented), the corep derived from the corresponding \(\Gamma_{p}^{\Gamma}\) \((R_i)\), the dimension of the corep, the matrix representations of the generating elements, the species and the topological charge of the degeneracies.

| SG 76         | type II MSG 76                      |
|---------------|-----------------------------------|
| \(\Gamma\)    | \(G_1^\Gamma\): \(\{C_{4s}^+, 000\}\): \(R_1, 1; R_2, 3; R_3, 1; R_4, 3.\) | \(\Gamma\): \((000)\) \(C_{4s}^+, T\); \(R_1\); 1; 1, 1; \(R_2, R_4\); 2; \(i\sigma_3, \sigma_3\); C-2 WP; 2 |
| \(R\)         | \(G_1^\Gamma\): \(\{C_{2s}^+, 000\}\): \(R_2, 2; R_4, 3.\) | \(R\): \((01\frac{1}{2})\) \(C_{2s}, T\); \(R_2, R_4\); 2; \(i\sigma_3, \sigma_3\); P-NS\(_{ZAR}\); |
| \(U\)         | \(G_1^\Gamma\): \((E, 0)\): \(R_1, 2.\) | \(U\); \(ZR\) \(E, C_{2s}, T\); \(R_1, R_4\); 2; \(\sigma_0, -i\sigma_2\); L-NS\(_{ZAR}\); |

TABLE S4. The defining relation and character tables of abstract groups \(G_1^\Gamma\) and \(G_1^{\text{**}}\) (reproduced from Ref. [17]).

| \(G_1^\Gamma\) | \(C_1 = E\) | \(P^4 = E\) |
|----------------|--------------|--------------|
| \(C_1\)        | \(C_1\)      | \(C_3\)      |
| \(R_1\)        | \(1\)        | \(1\)        |
| \(R_2\)        | \(1\)        | \(-i\)       |
| \(R_3\)        | \(1\)        | \(-i\)       |
| \(R_4\)        | \(1\)        | \(-i\)       |

\(\Gamma\): \(k = (000)\).

As shown in the left part of Table S3, \(G^{\Gamma}\), the (Herring) little group at \(\Gamma\) point in SG 76, is abstract group \(G_1^\Gamma\), which is isomorphic to point group \(C_4\), and its generating element is \(P = \{C_{4s}^+, 000\}\). After generating element is a series of code \((R_i, j)\) separated by semicolons. \(R_i\) is the rep of abstract group \(G_1^\Gamma\) corresponding to an allowed rep \(\Gamma_{p}^{\Gamma}\) of \(G^{\Gamma}\), and the integer \(j\) denotes the reality of the induced SG reps \(\Gamma_{p}^{\Gamma}\). Since \(\Gamma\) is invariant under \(T\) symmetry,
the little group $M^\Gamma$ of type II MSG 76 is
\[ M^\Gamma = G^\Gamma + TG^\Gamma, \] (S53)
which indicates the generating elements of $M^\Gamma$ can be chosen as $P \{ \{C_{4z}^+|00\frac{1}{2}\}\}$ and $T$.

All the four 1D reps of $G_1^\Gamma$ are the allowed reps of $G^\Gamma$. For $R_1$ rep, it belongs to Case (a), as the reality of its induced SG rep is 1. According to the discussions in Sec. S4B, the solution of $N$ can be calculated as
\[ N = 1. \] (S54)

Then the matrix representations of the generating elements in $M^\Gamma$ for the corep derived from $R_1$ are
\[ D_1(P) = \Delta_1(P) = 1, \quad D_1(T) = N = 1, \] (S55)
which are listed in the right part of Table S3.

For $R_2$ rep, it belongs to Case (c), as the reality of its induced SG rep is 3. Hence, the $T$ symmetry makes $R_2$ and one another rep degenerate in energy. A direct calculation gives the matrix representations of the corep derived from $R_2$,
\[ D_2(P) = \begin{bmatrix} \Delta_2(P) & 0 \\ 0 & \Delta_2(T^{-1}PT) \end{bmatrix} = \begin{bmatrix} i & 0 \\ 0 & -i \end{bmatrix} = i\sigma_3, \quad D_2(T) = \begin{bmatrix} 0 & \Delta(T^2) \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} = \sigma_1. \] (S56)

One can find that the matrix trace of $\Delta_2(T^{-1}RT)$ is identical to that of $\Delta_4(R)$ with $R$ the element of $G^\Gamma$, indicating that the rep degenerate with $R_2$ is $R_4$. Actually, in the present simple case, we can easily figure it out, as only $R_2$ and $R_4$ belong to Case (c).

We then discuss the physics underneath the degeneracy between $R_2$ and $R_4$. Since $\Gamma$ point has $P = \{C_{4z}^+|00\frac{1}{2}\}$ symmetry, the basis state of electronic bands at $\Gamma$ point can be chosen as the eigenstates of $P$, denoted as $|c_{4z}\rangle$ with $c_{4z} = \pm i$, $\pm 1$ as $P^4 = 1$. One observes that
\[ PT|\pm i\rangle = TP|\pm i\rangle = \mp i(T|\pm i\rangle), \] (S57)
which means that $T|\pm i\rangle = |\mp i\rangle$ and hence the two states $|i\rangle$ ($R_2$) and $|-i\rangle$ ($R_4$) would be degenerate due to the addition of $T$ symmetry. The low-energy $k \cdot p$ Hamiltonian expanded around this double degeneracy with $\{R_2, R_4\}$ rep is
\[ H = c_1 + c_2k^2 + c_3k_z^2 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i + c_4\sigma_3k_z, \] (S58)
from which we know the double degeneracy is a C-2 WP with a topological charge $|C| = 2$, as listed in Table S3.

For $R_3$ rep, it belongs to Case (a), as the reality of its induced SG rep is 1. The solution of $N$ can be calculated as
\[ N = 1, \] (S59)
and the matrix representations of the corep derived from $R_3$ are obtained as
\[ D_3(P) = \Delta_3(P) = 1, \quad D_3(T) = N = 1. \] (S60)

$R$: $k = (0\frac{1}{2}\frac{1}{2})$.

$R$ is invariant under $T$ symmetry and the little group $M^R$ is
\[ M^R = G^R + TG^R. \] (S61)

$G^R$ also is abstract group $G_1^\Gamma$, and its generating element is $P = \{C_{2z}|00\frac{1}{2}\}$. Since $R$ locates at the BZ boundary, one has $P^2 = -1$ at $R$ point, due to the presence of fraction translation in $P$. Consequently, only two of the four 1D reps of $G_1^\Gamma$, $R_2$ and $R_4$, are the allowed reps of $G^R$. Both $R_2$ and $R_4$ belong to Case (c), indicating they would degenerate in energy with the addition of $T$ symmetry. We use $R_2$ to calculate the coreps, obtained as
\[ D_2(P) = \begin{bmatrix} \Delta_2(P) & 0 \\ 0 & \Delta_2(T^{-1}PT) \end{bmatrix} = \begin{bmatrix} i & 0 \\ 0 & -i \end{bmatrix} = i\sigma_3, \quad D_2(T) = \begin{bmatrix} 0 & \Delta(T^2) \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} = \sigma_1. \] (S62)

The physics underneath the degeneracy is that the electronic bands with reps $R_2$ and $R_4$ respectively correspond to the electronic states of $|p = i\rangle$ and $|p = -i\rangle$, where $|p\rangle$ is the eigenstate of $P$, and one has
\[ PT|\pm i\rangle = TP|\pm i\rangle = \mp i(T|\pm i\rangle). \] (S63)
This means that $\mathcal{T}|\pm i\rangle = |\mp i\rangle$ and the two states $|i\rangle$ ($R_2$) and $|-i\rangle$ ($R_4$) would be degenerate. The low-energy $k \cdot p$ Hamiltonian (up to first order) expanded around this double degeneracy is

$$H = c_1 + c_2 \sigma_3 k_z.$$  \hfill (S64)

A careful analysis shows this degeneracy is not isolated but a point in a nodal surface locating at $ZAR$ plane ($P$-NS$_{ZAR}$), which will be further discussed below in detail. The corep information and the analysis of the degeneracy at $R$ point are listed in the right part of Table S3.

$U: \mathbf{k} = (0\alpha \frac{1}{2})$ with $\alpha \in (0, \frac{1}{2})$, ZR path.

$U$ is invariant under $\mathcal{A} = \{C_{2z}|00\frac{1}{2}\}T$ symmetry and the little group $\mathbf{M}^U$ is

$$\mathbf{M}^U = \mathbf{G}^U + A \mathbf{G}^U.$$  \hfill (S65)

$\mathbf{G}^U$ is $G_1^1$, and its generating element is $P = (E, 0)$. The $R_1$ rep of $G_1^1$ is the allowed reps of $\mathbf{G}^U$. It belongs to Case (b), as the reality of its induced SG reps is 2, which indicates that there exists a nodal line along $U$ (ZR path) formed by the two electronic bands with same rep ($R_1$). For $R_1$ rep, the matrix representation of $\{E|000\}$ is

$$\Delta_1(\{E|000\}) = \Delta_1(P)e^{-i2\pi \mathbf{k} \cdot (000)}e^{-i2\pi \times (0/g)} = \Delta_1(P),$$  \hfill (S66)

where $g = 1$ is determined by the factor system for the projected representation of $\mathbf{G}^U$. Since $A^2 = -1$ on $U$, we have $N = 1,$ \hfill (S67)

and the matrix representations of the corep derived from $R_1$ are

$$D_1(P) = \begin{bmatrix} \Delta_1(P) & 0 \\ 0 & \Delta_1(P) \end{bmatrix}, \quad D_1(A) = \begin{bmatrix} 0 & -N \\ N & 0 \end{bmatrix} = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} = -i\sigma_2.$$  \hfill (S68)

We then discuss the physics of the degeneracy along high-symmetry line $U$. While $\mathcal{T}^2 = 1$ for spinless systems, the anti-unitary operator $A^2 = -1$ on $U$, due to the half-integer translation following $C_{2z}$. This inevitably leads to Kramers-like degeneracies. Specifically, we can denote the eigenstate $|e\rangle$ by the eigenvalue of $\{E|000\}$, and then the two states $|e = 1\rangle$ ($R_1$) and $|A|e = 1\rangle$ ($R_1$) are linearly independent and would be degenerate in energy, due to $A^2 = -1$. In fact, all these points in ZAR plane have $A$ symmetry and $A^2 = -1$, which eventually leads to a nodal surface at ZAR plane [6]. Thus, the nodal line along $U$ is not isolated but resides in a nodal surface locating at ZAR plane (labelled as L-NS$_{ZAR}$ in Table S3). The low-energy $k \cdot p$ Hamiltonian (up to first order) expanded around a generic point on $U$ is

$$H = c_1 + c_2 k_x + c_3 k_y + \sum_{i=1}^{3} c_{i1}\sigma_i k_z.$$  \hfill (S69)

2. Double-valued coreps of type II MSG 92

The double-valued reps of SG 92 can be found in Ref. [17], which is partially reproduced in Table S5. Table S5 also lists the corresponding part of the established double-valued coreps of type II MSG 92. We present some relevant reps information of the related abstract groups $G^2_8, G^1_{14}$ and $G^1_{32}$ in Table S6. The BZ of SG 92 is same with that of SG 76, and is shown in Fig. S6. The double-valued reps describe the systems with strong SOC effect, where a $2\pi$ rotation leads to a minus sign and $\mathcal{T}^2 = -1$. We discuss the high-symmetry points $\Gamma$ and $M$, and high-symmetry lines $Y$ and $T$ in turn.

| Table S5. Part of double-valued reps of SG 92 (reproduced from Ref. [17]) and the corresponding double-valued coreps of type II MSG 92 (see Sec. S7). |
|---|
| Sigma | type II MSG 92 |
| $\Gamma$ | $G^1_{14}$: $\{C_4^+|00\frac{1}{2}\}, \{C_{2z}|\frac{1}{2}\frac{1}{2}\}R_6, 2; R_7, 2$. |
| $\Gamma$ | $G^1_{16}$: $\{C_4^+|00\frac{1}{2}\}, \{C_{2z}|\frac{1}{2}\frac{1}{2}\}R_6, 2; R_7, 2$. |
| $M$ | $G^1_{32}$: $\{C_4^+|00\frac{1}{2}\}, \{C_{2z}|\frac{1}{2}\frac{1}{2}\}R_6, 3; R_7, 3$. |
| $Y$ | $G^2_8$: $\{C_{2z}, 0\}, (E, 1)$ |
| $T$ | $G^2_8$: $\{C_{2z}, 0\}, (E, 1)$ |
| $\Gamma$ | $\{(000)\}$ $C_{4z}, C_{2z}, T_1; \{R_6, R_7\}; 2; \frac{\pi \cdot \mathbf{k} \cdot (000)}{\sqrt{2}}, \sigma_1, -i\sigma_2$; C-1 WP; 1 |
| $\Gamma$ | $\{(000)\}$ $C_{4z}, C_{2z}, T_1; \{R_6, R_7\}; 2; -\frac{\pi \cdot \mathbf{k} \cdot (000)}{\sqrt{2}}, \sigma_1, -i\sigma_2$; C-1 WP; 1 |
| $M$ | $\{(\frac{1}{2}\frac{1}{2}\frac{1}{2})\}$ $C_{4z}, C_{2z}, T_1; \{R_6, R_7\}; 4; \frac{\Gamma_{0,1} \pm i \Gamma_{3,0}}{\sqrt{2}}, \Gamma_{0,3}, -i\Gamma_{2,0}$; C-2 DP; 2 |
| $Y$ | $C_{2z}, E, C_{2y}T; \{R_5, R_7\}; 2; -i\sigma_3, \sigma_0, -i\sigma_2$; L-NS$_{ZAR}$ |
| $T$ | $C_{2z}, E, C_{2y}T; \{R_5, R_7\}; 2; -i\sigma_0, \sigma_0, -i\sigma_2$; L-NS$_8$ |
| $\Gamma$ | $\{R_5, R_7\}; 2; i\sigma_0, \sigma_0, -i\sigma_2$; L-NS$_8$ |
TABLE S6. The defining relation and the matrix representation of the generating elements of abstract groups $G_8^2$, $G_{16}^{14}$ and $G_{32}^{11}$ (reproduced from Ref. [17]).

|          | $G_8^2$ | $G_{16}^{14}$ | $G_{32}^{11}$ |
|----------|---------|---------------|---------------|
| $P^4 = E; Q^2 = E; \quad QP = PQ.$ | $P^8 = E; Q^4 = E; \quad QP = P^7Q.$ | $P^8 = E; Q^4 = E; \quad QP = P^3Q^1; Q^2P = PQ^2.$ |

| $P$ | $Q$ | $P$ | $Q$ | $P$ | $Q$ |
|-----|-----|-----|-----|-----|-----|
| $R_5$ | 1 | -1 | $R_6$ | $\frac{1}{\sqrt{2}}$ | $\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$ | $i$ | 0 | 1 | $R_6$ | $\frac{1}{\sqrt{2}}$ | $\begin{bmatrix} i & 1 \\ 1 & 0 \end{bmatrix}$ | 1 | 0 |
| $R_7$ | -1 | -1 | $R_7$ | $\frac{1}{\sqrt{2}}$ | $\begin{bmatrix} -1 & 1 \\ -1 & -1 \end{bmatrix}$ | $i$ | 0 | 1 | $R_7$ | $\frac{1}{\sqrt{2}}$ | $\begin{bmatrix} -i & 1 \\ 1 & -i \end{bmatrix}$ | 1 | 0 |

$\Gamma$: $k = (000)$.

$\Gamma$ is invariant under $T$ symmetry and the little group $M^\Gamma$ of type II double-valued MSG 92 is

$$M^\Gamma = G^\Gamma + T G^\Gamma.$$  \hspace{2cm} (S70)

$G^\Gamma$ is abstract group $G_{16}^{14}$, which is isomorphic to point group $D_4$, and its generating elements are $P = \{C_4^+; 00\}$ and $Q = \{C_2; 11\}$. Only two 2D reps of $G_{16}^{14}$, $R_6$ and $R_7$, are the allowed reps of $G^\Gamma$, as $P^4 = Q^2 = -1$ at $\Gamma$ point. For $R_6$ rep, the reality of its induced SG rep is 2 and then it belongs to Case (a).

The solution of $N$ is

$$N = -i\sigma_2,$$  \hspace{2cm} (S71)

as $T^2 = -1$ and $R = T^{-1}RT$ for any element $R$ in $G^\Gamma$. Therefore, the matrix representations of the corep derived from $R_6$ are

$$D_6(P) = \Delta_6(P) = \frac{1}{\sqrt{2}} \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix} = \frac{\sigma_0 + i\sigma_2}{\sqrt{2}},$$  \hspace{2cm} (S72)

$$D_6(Q) = \Delta_6(Q) = i \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} = i\sigma_1,$$  \hspace{2cm} (S73)

$$D_6(T) = N = -i\sigma_2.$$  \hspace{2cm} (S74)

The low-energy Hamiltonian expanded around this double degeneracy is obtained as

$$H = c_1 + c_2 k_z \sigma_2 + c_3 (k_x \sigma_1 + k_y \sigma_3),$$  \hspace{2cm} (S75)

from which we know the degeneracy is a C-1 WP with a topological charge $|C| = 1$, as listed in the right part of Table S5.

The $R_7$ rep also belongs to Case (a). Similarly, the solution for $N$ is

$$N = -i\sigma_2,$$  \hspace{2cm} (S76)

and we have

$$D_7(P) = \Delta_7(P) = \frac{1}{\sqrt{2}} \begin{bmatrix} -1 & 1 \\ -1 & -1 \end{bmatrix} = -\frac{\sigma_0 + i\sigma_2}{\sqrt{2}},$$  \hspace{2cm} (S77)

$$D_7(Q) = \Delta_7(Q) = i \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} = i\sigma_1,$$  \hspace{2cm} (S78)

$$D_7(T) = N = -i\sigma_2.$$  \hspace{2cm} (S79)

The low-energy Hamiltonian expanded around this double degeneracy is

$$H = c_1 + c_2 k_z \sigma_2 + c_3 (k_x \sigma_1 - k_y \sigma_3),$$  \hspace{2cm} (S80)
from which we know this degeneracy also is a C-1 WP with a topological charge $|C| = 1$, as listed in the right part of Table S5.

$M$: $k = (\frac{1}{2} \frac{1}{2} 0)$.

$M$ is invariant under $T$ symmetry and the little group $M^M$ is

$$M^M = G^M + TG^M.$$  \hspace{1cm} (S81)

$G^M$ is abstract group $G^{11}_{32}$, and its generating elements are identical with those of $\Gamma$ point, namely, $P = \{ C_{x+00}^T \}$ and $Q = \{ C_{2x+1 \frac{1}{2} \frac{1}{2}} \}$. However, due to the presence of fractional translation in the generating elements, the commutation relation between $P$ and $Q$ at $\Gamma$ and $M$ points are completely different, as shown in Table S6. Only two 2D reps of $G^{11}_{32}$, $R_6$ and $R_7$, are the allowed reps of $G^M$, due to the physical constraints of $P^4 = -1$ and $Q^2 = 1$ at $M$ point.

The two reps would degenerate in energy with the addition of $T$ symmetry, as they belong to Case (c). We use $R_6$ to calculate the coreps, obtained as

$$D_6(P) = \begin{bmatrix} \Delta_6(P) & 0 \\ 0 & \Delta_6(T P T) \end{bmatrix} = \begin{bmatrix} \Delta_6(P) & 0 \\ 0 & \Delta_6(P) \end{bmatrix} = \frac{\Gamma_{0,1} + i \Gamma_{3,0}}{\sqrt{2}},$$ \hspace{1cm} (S82)

$$D_6(Q) = \begin{bmatrix} \Delta_6(Q) & 0 \\ 0 & \Delta_6(T Q T) \end{bmatrix} = \begin{bmatrix} \Delta_6(Q) & 0 \\ 0 & \Delta_6(Q) \end{bmatrix} = \Gamma_{0,3},$$ \hspace{1cm} (S83)

$$D_6(T) = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} = -i \Gamma_{2,0},$$ \hspace{1cm} (S84)

We then discuss the physics of the four-fold degeneracy with $\{ R_6, R_7 \}$ rep. According to the defining relation of $G^{11}_{32}$ and the constraints $P^4 = -1$ and $Q^2 = 1$, we have the following algebra at $M$ point

$$P^3 Q^3 = P^3 Q = Q P.$$ \hspace{1cm} (S85)

The Bloch states at $M$ can be chosen as the eigenstates of $P$, which we denote as $|p\rangle$ with $p = e^{i\pi/4}, e^{i3\pi/4}$ due to $P^4 = -1$. Then, we have

$$P^3 Q |p\rangle = Q P |p\rangle = p Q |p\rangle,$$ \hspace{1cm} (S86)

which indicates that $Q |e^{i\pi/4}\rangle \sim |e^{i\pi/4}\rangle$ and $Q |e^{i3\pi/4}\rangle \sim |e^{i3\pi/4}\rangle$. Hence, the two states $|e^{i\pi/4}\rangle$ and $|e^{i3\pi/4}\rangle$ would be degenerate, corresponding to rep $R_6$, as $e^{i\pi/4} + e^{i3\pi/4} = \text{Tr}[\Delta_6(P)]$. Similarly, the two states $|e^{-i\pi/4}\rangle$ and $|e^{-i3\pi/4}\rangle$ would be degenerate, corresponding to rep $R_7$, as $e^{-i\pi/4} + e^{-i3\pi/4} = \text{Tr}[\Delta_7(P)]$. Moreover, the state $|e^{i\pi/4}\rangle$ and its time-reversal partner $T |e^{i\pi/4}\rangle = |e^{-i\pi/4}\rangle$, as well as the state $|e^{i3\pi/4}\rangle$ and its time-reversal partner $T |e^{i3\pi/4}\rangle = |e^{-i3\pi/4}\rangle$ are linearly independent. Therefore, the four states $\{ |e^{i\pi/4}\rangle, |e^{i3\pi/4}\rangle, T |e^{i\pi/4}\rangle, T |e^{i3\pi/4}\rangle \}$ must be degenerate, leading to a four-fold degeneracy (formed by reps $R_6$ and $R_7$).

The low-energy Hamiltonian of this four-fold degeneracy is obtained as

$$H = c_1 + c_2 k_x \Gamma_{3,1} + c_3 (k_x \Gamma_{3,3} - k_y \Gamma_{0,2}) + [\alpha (k_x \Gamma_{+,0} + i k_y \Gamma_{+,1}) + h.c.],$$ \hspace{1cm} (S87)

from which we know this degeneracy is a C-2 DP with a topological charge $|C| = 2$, as listed in the right part of Table S5. Here, we define $\Gamma_{i,j} = \sigma_i \otimes \sigma_j$ with $i, j = 0, 1, 2, 3, \pm$ and $\sigma_\pm = (\sigma_1 \pm i \sigma_2)/2$.

$Y$: $k = (\alpha \frac{1}{2} 0)$ with $\alpha \in (0, \frac{1}{2})$, $XM$ path.

$Y$ is invariant under $A = \{ C_{2y+1 \frac{1}{2} \frac{1}{2}} \}$ $\Gamma$ symmetry and the little group $Y^Y$ is

$$Y^Y = G^Y + A G^Y,$$ \hspace{1cm} (S88)

with $A^2 = -1$ at $Y$. $G^Y$ is $G^2_x$, and its generating element is $P = (C_{2x}, 0)$ and $Q = (E, 1)$. Only two 1D reps of $G^2_x$, $R_5$ and $R_7$, are the allowed reps of $G^Y$, due to the constraint $\{ C_{2x+1 \frac{1}{2} \frac{1}{2}} \}^2 = \{ E \text{100} \} = -e^{-i2\pi \alpha}$ at $Y$. The two reps would degenerate in energy with the addition of $A$ symmetry, as they belong to Case (c). Then one has a nodal line along $Y$ with $\{ R_5, R_7 \}$ rep. For $R_5$ and $R_7$ reps, the matrix representation of $\{ C_{2x+1 \frac{1}{2} \frac{1}{2}} \}$ and $\{ E \text{100} \}$ are \cite{17}

$$\Delta_{5(7)}(\{ C_{2x+1 \frac{1}{2} \frac{1}{2}} \}) = \Delta_{5(7)}(P)e^{-i2\pi k \cdot (\frac{1}{2} \frac{1}{2} 0)}e^{-i2\pi x \cdot (0/9)} = -ie^{-i\pi \alpha} \Delta_{5(7)}(P),$$ \hspace{1cm} (S89)

$$\Delta_{5(7)}(\{ E \text{100} \}) = \Delta_{5(7)}(Q)e^{-i2\pi k \cdot (000)}e^{-i2\pi x \cdot (1/9)} = -\Delta_{5(7)}(Q).$$ \hspace{1cm} (S90)
where \( g = 2 \) is determined by the factor system for the projected representation of \( G^T \). One finds that the matrix
\[
\Delta_5(\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}) = -e^{-i2\pi\alpha}\Delta_5(\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}) = -e^{-i2\pi\alpha} \text{ satisfies the constraint } \{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}^2 = -e^{-i2\pi\alpha} \text{ at } Y. \]
We use rep \( R_5 \) to calculate the coreps, obtained as
\[
D_5(C_2x) = \begin{bmatrix} \Delta_5(\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}) & 0 \\ 0 & \Delta_5(\{ A^{-1}\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\},A) \end{bmatrix} = -ie^{-i\pi\alpha} \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} = -i\sigma_3 e^{-i\pi\alpha}, \quad (S91)
\]
\[
D_5(E) = \begin{bmatrix} \Delta_5(\{ E[000]\}) & 0 \\ 0 & \Delta_5(\{ A^{-1}\{ E[000]\},A) \end{bmatrix} = - \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix} = \sigma_0, \quad (S92)
\]
\[
D_5(A) = \begin{bmatrix} 0 & \Delta(\{ A^2\}) \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} = i\sigma_2. \quad (S93)
\]

Notice that, for simplification we omit the phase factor containing \( \alpha \), e.g. \( e^{-i\pi\alpha} \), in Table S5 and all the tables in Sec. S7 and Sec. S8.

We then discuss the physics of the degeneracy between \( R_5 \) and \( R_7 \) reps. First, as we have \( A^2 = -1 \) at \( Y \), the electronic bands along this high-symmetry line are at least doubly degenerate due to the Kramers-like degeneracy. Then since \( A^{-1}\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\},A = \{ C_2x_{\frac{1}{2} \frac{1}{2} 1}\} \) and
\[
\Delta_5(\{ C_2x_{\frac{1}{2} \frac{1}{2} 2}\}) = \Delta_5(\{ \bar{C}_2x_{\frac{1}{2} \frac{1}{2} 1}\}) = \Delta_5(\{ C_2x_{\frac{1}{2} \frac{1}{2} 1}\}), \quad \Delta_5(\{ E[000]\}) = -\Delta_5(\{ E[000]\}) = \Delta_5(\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}), \quad (S94)
\]
we have
\[
\Delta_7(\{ C_2x_{\frac{1}{2} \frac{1}{2} 2}\}) = \Delta_7(\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}), \quad (S95)
\]
which means that the doubly degenerate bands is formed by the states with \( R_5 \) and \( R_7 \) reps.

Moreover, we find all the points in the boundary plane \( M\text{ARX} \) have \( A \) symmetry and \( A^2 = -1 \). Hence, the nodal line along \( Y \) is not isolated but lie in a nodal surface locating at \( M\text{ARX} \) plane \( (L\text{-NS}_M\text{ARX}) \). The low-energy Hamiltonian expanded around a general point on \( Y \) is obtained as
\[
H = c_1 + c_2k_x + (c_3\sigma_1 - c_4\sigma_2)k_y. \quad (S96)
\]

\( T \): \( k = (\alpha \frac{1}{2} \frac{1}{2}) \) with \( \alpha \in (0, \frac{1}{2}) \).

\( T \) also is invariant under \( A = \{ C_2y_{\frac{1}{2} \frac{1}{2} 1}\} \) symmetry and the little group \( M^T \) is
\[
M^T = G^T + AG^T, \quad (S97)
\]
with \( A^2 = -1 \) at \( T \). \( G^T \) is \( G^2 \), and its generating element is \( P = (C_2x, 0) \) and \( Q = (E, 1) \). Only two 1D reps of \( G^2 \), \( R_5 \) and \( R_7 \), are the allowed reps of \( G^T \), due to the constraint \( \{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}^2 = \{ E[000]\} = -e^{-i2\pi\alpha} \) at \( T \). Both two reps belong to Case (b), as the reality of their induced SG reps are 1, indicating there exist two different degenerate pairs: \( \{ R_5, R_5\} \) and \( \{ R_7, R_7\} \) at \( T \). For \( R_5(7) \) rep, the matrix representation of \( \{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\} \) and \( \{ E[000]\} \) are
\[
\Delta_5(7)(\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}) = \Delta_5(7)(\{ E[000]\}) = \Delta_5(7)(\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}) = \Delta_5(7)(\{ E[000]\}), \quad (S98)
\]
\[
\Delta_5(7)(\{ E[000]\}) = -\Delta_5(7)(\{ E[000]\}) = -\Delta_5(7)(\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}), \quad (S99)
\]
where \( g = 2 \) is determined by the factor system for the projected representation of \( G^T \).

The double degeneracies at \( T \) also are Kramers-like degeneracies caused by \( A^2 = -1 \). However, different from the case at \( Y \), the electronic band at \( T \) with rep \( R_{5(7)} \) would be degenerate with the band with same rep. This is because that we have \( A^{-1}\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\},A = \{ C_2x_{\frac{1}{2} \frac{1}{2} 1}\} \) and
\[
\Delta_5(7)(A^{-1}\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\},A) = \Delta_5(7)(\{ C_2x_{\frac{1}{2} \frac{1}{2} 1}\}) = -\Delta_5(7)(\{ C_2x_{\frac{1}{2} \frac{1}{2} 1}\}), \quad (S100)
\]
which leads to
\[
\Delta_5(7)(\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\}) = \Delta_5(7)(A^{-1}\{ C_2x_{\frac{1}{2} \frac{1}{2} 0}\},A). \quad (S101)
\]
For \( R_5 \), the solution of \( N \) matrix is
\[
N = 1. \quad (S102)
\]
and the deduced coreps are
\[
D_5(C_{2x}) = \begin{bmatrix}
\Delta_5(\{C_{2x}|\frac{1}{2} \frac{1}{2} 0\}) & 0 \\
0 & \Delta_5(\{C_{2x}|\frac{1}{2} \frac{1}{2} 0\})
\end{bmatrix} = -ie^{-i\pi\alpha} \begin{bmatrix} 1 & 0 \\
0 & 1 \end{bmatrix} = -i\sigma_0 e^{-i\pi\alpha},
\]  
(S103)

\[
D_5(E) = \begin{bmatrix}
\Delta_5(\{E|000\}) & 0 \\
0 & \Delta_5(\{E|000\})
\end{bmatrix} = -\begin{bmatrix} -1 & 0 \\
0 & -1 \end{bmatrix} = \sigma_0.
\]  
(S104)

\[
D_5(A) = \begin{bmatrix} 0 & -N \\
1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & -1 \\
1 & 0 \end{bmatrix} = -i\sigma_2.
\]  
(S105)

Again, for simplification we omit the phase factor containing \(\alpha\), e.g. \(e^{-i\pi\alpha}\), in Table S5 and all the tables in Sec. S7 and Sec. S8. Notice that \(T\) locates at the hinge of two boundary planes \([\text{MARX} \text{ and } \text{ZAR} \text{ plane}]\), which both exhibit nodal surface. The nodal surface at \(\text{ZAR}\) plane is generated by the \(\{C_{2z}|00\frac{1}{2}\}\) \(T\) symmetry. Therefore, the nodal line along \(T\) resides at the intersection of two nodal surface (which then is labelled as L-NSs in Table S5). The low-energy Hamiltonian expanded around a general point on the line with \(\{R_5, R_5\}\) rep is obtained as
\[
H = c_1 + c_2 k_x + [(\alpha\sigma + c_3\sigma_3)k_yk_z + h.c.].
\]  
(S106)

Similarly, the coreps deduced from \(R_7\) rep can be obtained as
\[
D_7(C_{2x}) = \begin{bmatrix}
\Delta_7(\{C_{2x}|\frac{1}{2} \frac{1}{2} 0\}) & 0 \\
0 & \Delta_7(\{C_{2x}|\frac{1}{2} \frac{1}{2} 0\})
\end{bmatrix} = -ie^{-i\pi\alpha} \begin{bmatrix} -1 & 0 \\
0 & -1 \end{bmatrix} = i\sigma_0 e^{-i\pi\alpha},
\]  
(S107)

\[
D_7(E) = \begin{bmatrix}
\Delta_7(\{E|000\}) & 0 \\
0 & \Delta_7(\{E|000\})
\end{bmatrix} = -\begin{bmatrix} -1 & 0 \\
0 & -1 \end{bmatrix} = \sigma_0.
\]  
(S108)

\[
D_7(A) = \begin{bmatrix} 0 & -N \\
1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\
1 & 0 \end{bmatrix} = -i\sigma_2.
\]  
(S109)

And the low-energy Hamiltonian expanded around a general point on the line with \(\{R_7, R_7\}\) rep is obtained as
\[
H = c_1 + c_2 k_x + [(\alpha\sigma + c_3\sigma_3)k_yk_z + h.c.].
\]  
(S110)

**S5. SPATIAL OPERATORS OF 230 SGS**

We use the Seitz symbols \(\{R|v\}\) to express the elements of the space group, with \(R\) a point-group operator and \(v\) a translation vector following \(R\). The space group operator denoted by Seitz symbol is an active operator, that
\[
\{R|v\} r = R r + v.
\]  
(S111)

Reference [17] lists all the elements of the 32 point group labeled by the Schonflies notation in Tables 1.3, as well as the effect of \(R\) acting on a generic vector \((xyz)\) in Tables 1.4. In the following, we present all the elements (not including the elements of translation group) of each of 230 SGs based on the convention used in Ref. [17].
S6. NOTATIONS AND DEFINED MATRICES USED IN SEC. S7 AND SEC. S8

A. Notations

(i) We adopt the notations used in Ref. [17] to describe the information of SG and SG rep. The tables and figures in Ref. [17] that are relevant to this work is listed as follows.

- Figure 1.1-1.3: identifying the point-group operators;
- Figure 3.2-3.15: the BZ of each of the 14 Bravais lattices, along with the label of high symmetry momenta;
- Table 1.4: the effect of each point-group operator on a vector (xyz);
- Table 3.1 (3.3): list of all 14 Bravais lattice and the corresponding basic vectors in real (reciprocal) space;
- Table 3.6: list of the coordinates of high-symmetry point and line with respect to reciprocal vectors ($g_1g_2g_3$);
- Table 5.1: defining relations, classes, character tables, and matrix representations of the relevant abstract groups;
- Table 5.7 (6.13): the single-valued (double-valued) reps of the 230 SGs;
- Table 6.7: the effect of point-group operators on spin.

It should be notice that there exist some typos in Ref. [17], which have been pointed out and corrected by Liu et al. [18]. We establish the corep tables of type II MSG based on the corrected results.

(ii) As discussed in Ref. [17], the reps of the little group ($G^k$) for high-symmetry line are obtained with the aid of the central extension of the corresponding little co-group ($\bar{G}^{k*}$). The relationship between the small reps $\Gamma_p^k$ of $G^k$ and the reps $D_p^k$ of $\bar{G}^{k*}$ is

$$\Gamma_p^k(\{R|v\}) = e^{-ik\cdot v}D_p^k(\{R, 0\}),$$

which would appear in certain effective Hamiltonian. The coordinates of $g_1$, $g_2$, and $g_3$ with respect to $k_x, k_y$ and $k_z$ axes for each Bravais lattice are listed in Table 3.3 of Ref. [17].

(iii) As discussed in Ref. [17], the reps of the little group ($G^k$) for high-symmetry line are given in the form of $\Gamma_p^k(\{R|v\})$. As the coordinate $k$ of high-symmetry line is a function of $\alpha$ with $0 < \alpha < \frac{1}{2}$ [such as the coordinate of $T$ in SG 92 is $k = (\alpha \frac{1}{2} \frac{1}{2})$], then generally the matrix representation of $\{R|v\}$ for rep $\Gamma_p^k$ also is a function of $\alpha$. However, for the sake of simplicity, we omit the factor involving $\alpha$ in the reps tables in Sec. S7 and Sec. S8, or in other word, we set $\alpha = 0$ for the phase $e^{-ik\cdot v}$.

(iv) As discussed in Sec. S4B, there exist three possible cases (a-c) for the corep derived from a rep $R_i$. The corep is label as $R_i$ for case (a), $\{R_i, R_i\}$ for case (b) and $\{R_i, R_j\}$ for case (c) in Sec. S7 and Sec. S8.

(v) Abbreviations used in the Tables of Sec. S7 and Sec. S8:

- NP/NL/NS: nodal point/line/surface;
- P-WNL$_{AB}$: a nodal point resides on a Weyl nodal line, which occurs along high-symmetry line $AB$, or at the joint point of multiple Weyl nodal lines, which all connected to WNL$_{AB}$ by symmetry operators.
- P-WNL: a nodal point resides on a Weyl nodal line, which however does not occurs along any high-symmetry line;
- P-WNLs: a nodal point resides at the joint point of multiple Weyl nodal lines;
• P-DNL\_AB: a nodal point resides on a Dirac nodal line, which occurs along high-symmetry line \(AB\), or at the joint point of multiple Dirac nodal lines, which all connected to DNL\_AB by symmetry operators.

• P-DNL: a nodal point resides on a Dirac nodal line, which however does not occurs along any high-symmetry line;

• P-DNLs: a nodal point resides at the joint point of multiple Dirac nodal lines;

• P-NS\_ABCD: a nodal point resides on a nodal surface, which occurs in high-symmetry plane \(ABCD\);

• P-NSs: a nodal point resides at the intersection of two or three nodal surfaces.

• P-WNL/NS: a nodal point resides at the intersection of a nodal line and a nodal surface.

• L-NS\_ABCD: a Weyl nodal line resides on a nodal surface, which occurs in high-symmetry plane \(ABCD\);

• L-NSs: a nodal line resides at the hinge of two nodal surfaces.

### B. Defined matrixes

#### 1. Two-dimensional matrixes

We define

\[
\sigma_0 = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}, \quad \sigma_1 = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, \quad \sigma_2 = \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix}, \quad \sigma_3 = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix},
\]

\[
\sigma_{\pm} = (\sigma_1 \pm i\sigma_2)/2
\]

\[
\sigma_4 = \frac{-\sigma_0 + i (\sqrt{2} \sigma_1 + \sigma_2)}{2}, \quad \sigma_5 = \frac{\sigma_1 - \sqrt{2} \sigma_2 - \sigma_3}{2i}, \quad \sigma_6 = \frac{-\sigma_0 - i (\sigma_1 - \sigma_2 - \sigma_3)}{2}, \quad \sigma_7 = \frac{i (\sigma_1 - \sigma_2 + \sigma_3)}{\sqrt{3}},
\]

\[
\sigma_8 = \frac{(3 + \sqrt{3}) \sigma_1 - (\sqrt{3} - 3) \sigma_2 - 2\sqrt{3} \sigma_3}{6i}, \quad \sigma_9 = \frac{((-1)^{1/3} - 1) \sigma_0 + (1 + (-1)^{1/3}) \sigma_3}{2},
\]

\[
\sigma_{10} = \frac{(-1 - (-1)^{2/3}) \sigma_0 + ((-1)^{2/3} - 1) \sigma_3}{2}, \quad \sigma_{11} = \frac{(\sqrt{3} + 3i) \sigma_0 + (\sqrt{3} - i) \sigma_3}{4},
\]

\[
\sigma_{12} = \frac{(\sqrt{3} - i) \sigma_0 + (\sqrt{3} + 3i) \sigma_3}{2}, \quad \sigma_{13} = \frac{2 ((-1)^{5/6} + i) \sigma_0 + (\sqrt{3} + i) \sigma_3}{4},
\]

\[
\sigma_{14} = \frac{2(-1)^{5/6} \sigma_0 + (\sqrt{3} + 3i) \sigma_3}{4}, \quad \sigma_{15} = \frac{(\sqrt{3} + i) \sigma_0 + 2 ((-1)^{5/6} + i) \sigma_3}{4},
\]

\[
\sigma_{16} = \frac{(-1)^{1/6} \sigma_0 + ((-1)^{5/6} + i) \sigma_3}{4}, \quad \sigma_{17} = \frac{2(-1)^{5/6} \sigma_0 + (\sqrt{3} - 3i) \sigma_0}{4},
\]

\[
\sigma_{18} = \frac{-2(-1)^{1/6} \sigma_3 + (\sqrt{3} - 3i) \sigma_0}{4}, \quad \sigma_{19} = \frac{(\sqrt{3} - i) \sigma_0 - (\sqrt{3} + 3i) \sigma_3}{4},
\]

\[
\sigma_{20} = \frac{-2(-1)^{1/6} \sigma_0 + (\sqrt{3} - 3i) \sigma_3}{4}, \quad \sigma_{21} = \frac{\sigma_1 + \sigma_2 + \sigma_3}{\sqrt{3}},
\]

\[
\sigma_{22} = \frac{(3 - \sqrt{3}) \sigma_1 - (3 + \sqrt{3}) \sigma_2 + 2\sqrt{3} \sigma_3}{6}, \quad \sigma_{23} = \frac{\sqrt{2} (\sqrt{3} - 3) \sigma_0 - 4i\sqrt{6} \sigma_1 + 2i(\sqrt{3} (2 + \sqrt{3}) \sigma_3)}{12},
\]

\[
\sigma_{24} = \frac{(3 - \sqrt{3}) \sigma_1 + (3 + \sqrt{3}) \sigma_2 + 2\sqrt{3} \sigma_3}{6},
\]

\[
\sigma_{25} = \frac{(6 + 6i) \sigma_0 + (1 - i) [(\sqrt{3} - 3) \sigma_1 - (3 + \sqrt{3}) \sigma_2 - 2\sqrt{3} \sigma_3]}{12},
\]

\[
\sigma_{26} = \frac{(-1 + i) [6i \sigma_0 + (\sqrt{3} - 3) \sigma_1 - (3 + \sqrt{3}) \sigma_2 - 2\sqrt{3} \sigma_3]}{12}.
\]
2. Three-dimensional matrices

We define

\[
A_0 = \begin{pmatrix}
1 & 0 & 0 \\
0 & 1 & 0 \\
0 & 0 & 1
\end{pmatrix},
A_1 = \begin{pmatrix}
0 & -i & 0 \\
i & 0 & 0 \\
0 & 0 & 1
\end{pmatrix},
A_2 = \begin{pmatrix}
0 & 0 & -i \\
0 & 0 & 0 \\
i & 0 & 0
\end{pmatrix},
A_3 = \begin{pmatrix}
0 & 0 & 0 \\
0 & 0 & -i \\
0 & i & 0
\end{pmatrix},
A_4 = \begin{pmatrix}
0 & 1 & 0 \\
0 & 0 & 0 \\
0 & 0 & 0
\end{pmatrix},
\]

\[
A_5 = \begin{pmatrix}
1 & 0 & 0 \\
0 & -1 & 0 \\
0 & 0 & 0
\end{pmatrix},
A_6 = \begin{pmatrix}
0 & 0 & 1 \\
0 & 0 & 0 \\
1 & 0 & 0
\end{pmatrix},
A_7 = \begin{pmatrix}
0 & 0 & 0 \\
0 & 0 & 1 \\
0 & 1 & 0
\end{pmatrix},
A_8 = \begin{pmatrix}
1 & 0 & 0 \\
0 & 1 & 0 \\
0 & 0 & 1
\end{pmatrix},
\]

and

\[
A_9 = -\frac{1}{2}iA_1 + iA_2 - iA_3 + A_4 + A_5 + A_7,
A_{10} = -\frac{1}{3}A_0 - A_5 + A_8 + \frac{1}{\sqrt{3}}A_{11} = \frac{i}{2}(A_1 - iA_2 + iA_3 + A_4 + A_5 + A_7),
A_{12} = -\frac{1}{3}A_6 + \frac{A_8}{\sqrt{3}}A_3,
A_{13} = -\frac{1}{3}A_6 + \frac{A_8}{\sqrt{3}}A_3,
A_{14} = \frac{A_7 + i[A_1 - A_2 - A_3 + i(A_4 + A_5)]}{2},
A_{15} = \frac{2A_0 - 3A_5 - \sqrt{3}A_8}{6},
A_{16} = \frac{2A_0 - 3A_5 - \sqrt{3}A_8}{6},
A_{17} = \frac{2A_0 - 3A_5 - \sqrt{3}A_8}{6},
A_{18} = \frac{2A_0 - 6iA_2 - 3A_5 + \sqrt{3}A_8}{6},
A_{19} = \frac{2A_0 - 6iA_2 - 3A_5 + \sqrt{3}A_8}{6},
A_{20} = \frac{2A_0 - 6iA_2 - 3A_5 + \sqrt{3}A_8}{6},
A_{21} = A_1 + A_2 + A_3 - i(A_4 - A_6 + A_7),
A_{22} = \frac{A_1 + A_2 + A_3 - i(A_4 - A_6 + A_7)}{2},
A_{23} = \frac{(-2 - 2i\sqrt{3})A_0 - 12((-1)^{5/6}A_2 + (3 + 3i\sqrt{3})A_5 - (\sqrt{3} + 3i)A_8}{12},
A_{24} = \frac{(-2 - 2i\sqrt{3})A_0 - 12((-1)^{5/6}A_2 + (3 + 3i\sqrt{3})A_5 - (\sqrt{3} + 3i)A_8}{12},
A_{25} = \frac{2A_0 + (3 - 3i)A_5 + \sqrt{-24 + 18iA_8}}{6},
A_{26} = \frac{2A_0 + (3 - 3i)A_5 + \sqrt{-24 + 18iA_8}}{6},
A_{27} = \frac{A_0 + iA_5 + \frac{A_8}{\sqrt{3}}}{3},
A_{28} = \frac{A_0 + iA_5 + \frac{A_8}{\sqrt{3}}}{3},
A_{29} = \frac{i(2A_0 + 3A_5 + \sqrt{3}A_8)}{6},
A_{30} = \frac{i(2A_0 + 3A_5 + \sqrt{3}A_8)}{6},
A_{31} = \frac{2A_0 + 3A_5 + \sqrt{3}A_8}{6},
A_{32} = \frac{2A_0 + 3A_5 + \sqrt{3}A_8}{6},
A_{33} = \frac{2A_0 + 3A_5 + \sqrt{3}A_8}{6},
A_{34} = \frac{4A_0 + 3(\sqrt{3} - 3i)A_3 + 6A_5 - 6((-1)^{1/3} - 1)A_7 + 2\sqrt{3}A_8}{12},
A_{35} = \frac{8A_0 - 6(\sqrt{-1} - 1)A_5 + (\sqrt{3} + 9i)A_8}{12},
A_{36} = \frac{8A_0 - 6(\sqrt{-1} - 1)A_5 + (\sqrt{3} + 9i)A_8}{12},
A_{37} = \frac{i(2A_0 + 6A_3 + 3A_5 + \sqrt{3}A_8)}{6},
A_{38} = \frac{i(2A_0 + 6A_3 + 3A_5 + \sqrt{3}A_8)}{6},
A_{39} = \frac{8A_0 - 6i\sqrt{3}A_3 + 3A_5 + \sqrt{3}A_8}{12},
A_{40} = \frac{8A_0 - 6i\sqrt{3}A_3 + 3A_5 + \sqrt{3}A_8}{12}.
\]
3. Four-dimensional matrices

We define $\Gamma_{i,j} = \sigma_i \otimes \sigma_j$ with $i, j = 0, 1, 2, 3, \pm$

\[ \Gamma_1 = \frac{\Gamma_{0,0} - i\sqrt{2}\Gamma_{0,2} - i\Gamma_{3,1} + \sqrt{3} (\sqrt{2}\Gamma_{1,0} + i\Gamma_{1,2} - \Gamma_{2,3})}{4}, \Gamma_2 = i\Gamma_{0,3} - \sqrt{2}\Gamma_{0,1} + \Gamma_{3,2} + \sqrt{3} (\Gamma_{1,1} + \sqrt{2}\Gamma_{1,3} - \Gamma_{2,0}), \]

\[ \Gamma_3 = \frac{\Gamma_{0,0} - i(\Gamma_{0,1} - \Gamma_{0,2} + \Gamma_{0,3})}{2}, \Gamma_4 = -\frac{\sqrt{3}\Gamma_{0,1} + \Gamma_{0,3} - i(\sqrt{3}\Gamma_{1,1} + \Gamma_{1,3})}{2\sqrt{2}}, \]

\[ \Gamma_5 = \frac{\Gamma_{0,0} - i\sqrt{3}\Gamma_{0,2} + i\Gamma_{1,0} + \sqrt{3}\Gamma_{1,2} - i\Gamma_{2,0} - \sqrt{3}\Gamma_{2,2} - i\Gamma_{3,0} - \sqrt{3}\Gamma_{3,2}}{4}, \]

\[ \Gamma_6 = -\frac{i(\sqrt{6}\Gamma_{0,2} + 3\sqrt{2}\Gamma_{3,1} - 2\sqrt{3}\Gamma_{3,3})}{6}, \Gamma_7 = -\frac{i(\sqrt{6}\Gamma_{0,2} - 3\sqrt{2}\Gamma_{3,1} - 2\sqrt{3}\Gamma_{3,3})}{6}, \]

\[ \Gamma_8 = \frac{-\Gamma_{0,0} + 3\Gamma_{0,3} + i\sqrt{3} (\Gamma_{3,0} + \Gamma_{3,3})}{4}, \Gamma_9 = \frac{\Gamma_{0,2} - \Gamma_{3,1} - \Gamma_{3,3}}{i\sqrt{3}}, \Gamma_{10} = \frac{(\sqrt{3} - 3)\Gamma_{0,2} - (3 + \sqrt{3})\Gamma_{3,1} + 2\sqrt{3}\Gamma_{3,3}}{6}, \]

\[ \Gamma_{11} = \frac{-\Gamma_{0,0} + i\Gamma_{0,2} - i\Gamma_{3,1} + i\Gamma_{3,3} + \sqrt{3} (\Gamma_{0,3} + i\Gamma_{3,0} - \Gamma_{0,1} + \Gamma_{3,2})}{4}, \Gamma_{12} = \frac{-\Gamma_{0,0} + i\sqrt{3} (\Gamma_{0,3} - i\sqrt{3}\Gamma_{3,0} + \Gamma_{3,3})}{4}, \]

\[ \Gamma_{13} = \frac{-\Gamma_{0,0} - i\sqrt{3}\Gamma_{0,2} - 3\Gamma_{3,0} + i\sqrt{3}\Gamma_{3,2}}{4}, \Gamma_{14} = \frac{\sqrt{3}\Gamma_{0,0} + 3i\Gamma_{0,3} + \sqrt{3}\Gamma_{3,0} - i\Gamma_{3,3}}{4}, \]

\[ \Gamma_{15} = \frac{-\sqrt{3}\Gamma_{0,0} + 3i\Gamma_{0,3} + \sqrt{3}\Gamma_{3,0} + i\Gamma_{3,3}}{4}, \Gamma_{16} = \frac{\sqrt{3}\Gamma_{0,0} + i(3\Gamma_{0,3} + i\sqrt{3}\Gamma_{3,0} + \Gamma_{3,3})}{4}, \]

\[ \Gamma_{17} = \frac{-\sqrt{3}\Gamma_{0,0} + 3i\Gamma_{3,0} - 3\Gamma_{3,3}}{4}, \Gamma_{18} = \frac{-\Gamma_{0,0} - \Gamma_{0,3} + \Gamma_{3,0} - \Gamma_{3,3}}{2}, \Gamma_{19} = \frac{-\Gamma_{0,1} - \Gamma_{0,2} + \Gamma_{3,1} + i\Gamma_{3,2}}{2}, \]

\[ \Gamma_{20} = \frac{\Gamma_{0,0} - \Gamma_{0,3} - \Gamma_{3,0} - \Gamma_{3,3}}{2}, \Gamma_{21} = \frac{\Gamma_{0,2} + \Gamma_{0,3} - \Gamma_{3,2} + \Gamma_{3,3}}{2}, \Gamma_{22} = \frac{\Gamma_{0,0} + \Gamma_{0,3} + \Gamma_{3,0} - \Gamma_{3,3}}{2}, \]

\[ \Gamma_{23} = \frac{-\Gamma_{0,0} + \Gamma_{0,1} + \Gamma_{3,0} + \Gamma_{3,1}}{2}, \Gamma_{24} = \frac{-i(\Gamma_{0,2} - \Gamma_{0,3} - \Gamma_{3,2} - \Gamma_{3,3})}{2}, \Gamma_{25} = \frac{-\Gamma_{0,0} + \Gamma_{0,3} - \Gamma_{3,0} - \Gamma_{3,3}}{2}, \]

\[ \Gamma_{26} = \frac{2\Gamma_{0,2} + \Gamma_{0,3} - i\Gamma_{3,2} + \Gamma_{3,3}}{2}, \Gamma_{27} = \frac{\Gamma_{0,0} + i(\Gamma_{0,1} - \Gamma_{0,2} - \Gamma_{0,3})}{2}, \Gamma_{28} = \frac{i(\Gamma_{0,1} - \Gamma_{0,2} + \Gamma_{0,3})}{\sqrt{3}}, \]

\[ \Gamma_{29} = \frac{(3 + \sqrt{3})\Gamma_{0,1} - (\sqrt{3} - 3)\Gamma_{0,2} - 2\sqrt{3}\Gamma_{0,3}}{6\sqrt{3}}, \Gamma_{30} = \frac{-\Gamma_{0,1} + \Gamma_{0,2} + \sqrt{3}}{\sqrt{3}}, \]

\[ \Gamma_{31} = \frac{-(\sqrt{3} - 3)\Gamma_{0,1} - (3 + \sqrt{3})\Gamma_{0,2} + 2\sqrt{3}\Gamma_{0,3}}{6}, \Gamma_{32} = \frac{-\Gamma_{0,2} + \Gamma_{3,1} + \Gamma_{3,3}}{\sqrt{3}}, \]

\[ \Gamma_{33} = \frac{-(3 + \sqrt{3})\Gamma_{0,2} - (\sqrt{3} - 3)\Gamma_{3,1} + 2\sqrt{3}\Gamma_{3,3}}{6}, \Gamma_{34} = \frac{-i(\sqrt{6}\Gamma_{0,2} - 3\sqrt{2}\Gamma_{3,1} + 2\sqrt{3}\Gamma_{3,3})}{6}, \]

\[ \Gamma_{35} = \frac{-i(\sqrt{6}\Gamma_{0,2} + 3\sqrt{2}\Gamma_{3,1} + 2\sqrt{3}\Gamma_{3,3})}{6}, \Gamma_{36} = \frac{2\Gamma_{0,0} + 2\Gamma_{0,1} + 2\Gamma_{0,2} + 2\Gamma_{0,3} + \sqrt{6}(\Gamma_{1,0} - i(\Gamma_{1,1} + \Gamma_{1,2} + \Gamma_{1,3} - i\Gamma_{2,0} - \Gamma_{2,1} - \Gamma_{2,2} - \Gamma_{2,3}))}{8}, \]

\[ \Gamma_{37} = \frac{(3 + \sqrt{3})\Gamma_{0,2} - (\sqrt{3} - 3)\Gamma_{3,1} + 2\sqrt{3}\Gamma_{3,3}}{6}, \]

\[ \Gamma_{38} = \frac{(1 + i)[-i(\sqrt{3} - 3)\Gamma_{0,1} + 2i\sqrt{3}\Gamma_{0,3} + 6\Gamma_{3,0} + i(3 + \sqrt{3})\Gamma_{3,2}]}{12}. \]
4. **Six-dimensional matrixes**

We define $S_{i,j} = \sigma_i \otimes A_j$ with $i = 0, 1, 2, 3$ and $j = 0, 1, 2, 3, 4, 5, 7, 8$, and

$$S_1 = \frac{2i (2S_{2,0} + \sqrt{3}S_{2,8}) + 3i (S_{0,2} - S_{0,3} - S_{1,2} - S_{1,3} + S_{2,6} - S_{2,7} + S_{3,2} + S_{3,3})}{12} + \frac{S_{0,6} - S_{0,7} - 2S_{1,5} + S_{1,6} + S_{2,2} - S_{2,3} + S_{3,6} + S_{3,7}}{4},$$

$$S_2 = \frac{-S_{0,0} + \sqrt{3}S_{0,8} + 2S_{1,0} + \sqrt{3}S_{1,8}, S_3 = \frac{-2S_{0,0} - 3S_{0,5} - \sqrt{3}S_{0,8} + 3S_{3,5} - 3\sqrt{3}S_{3,8}}{6},}{3}$$

$$S_4 = \frac{-S_{0,5} - S_{0,7} - S_{1,6} - S_{2,2} - S_{3,5} + S_{3,7}, S_5 = \frac{S_{0,4} - S_{0,6} + S_{1,7} + S_{2,3} + S_{3,4} + S_{3,6}}{2}}{2},$$

$$S_6 = i (S_{0,1} - S_{0,2} + S_{0,3} + i (S_{0,4} + S_{0,6} + S_{0,7}), S_7 = \frac{S_{0,0} - 3S_{0,5} - \sqrt{3}S_{0,8}}{3},}{2}$$

$$S_8 = S_{3,6} + \frac{-2S_{3,0} + 3S_{3,5} - \sqrt{3}S_{3,8}}{6},$$

$$S_9 = \frac{3 [S_{0,5} - S_{3,5} + \sqrt{3} (S_{0,8} - S_{3,8}) - 2i (S_{0,2} + S_{3,2})] + 2i (2S_{2,0} - 3S_{2,5} + \sqrt{3}S_{2,8})}{12},$$

$$S_{10} = \frac{2 (2S_{1,0} + \sqrt{3}S_{1,8}) + 3 (S_{0,6} + S_{0,7} - S_{1,6} - S_{1,7} - S_{2,2} + S_{2,3} + S_{3,6} - S_{3,7})}{12} + \frac{i (S_{0,2} + S_{0,3} + S_{1,2} + S_{1,3} - 2S_{2,5} - S_{2,6} + S_{2,7} + S_{3,2} - S_{3,3})}{4},$$

$$S_{11} = \frac{S_{0,0} + 3S_{0,5} - \sqrt{3}S_{0,8}}{3i}, S_{12} = \frac{-(-1)^{1/4} (2S_{3,0} + 6iS_{3,2} - 3S_{3,5} + \sqrt{3}S_{3,8})}{6},$$

$$S_{13} = \frac{-iS_{0,1} + iS_{0,2} + iS_{0,3} + S_{0,4} + S_{0,6} - S_{0,7}}{2}, S_{14} = \frac{i (-S_{3,0} + 3S_{3,4} + \sqrt{3}S_{3,8})}{3},$$

$$S_{15} = \frac{i (2S_{3,0} + 3S_{3,5} + 6S_{3,7} + \sqrt{3}S_{3,8})}{6}.$$

5. **Eight-dimensional matrixes**

We define $Q_{i,j,k} = \sigma_i \otimes \sigma_j \otimes \sigma_k$ with $i, j, k = 0, 1, 2, 3$, and

$$Q_1 = \frac{-Q_{0,0,0} - iQ_{0,0,2} + \sqrt{3}Q_{0,3,1} + \sqrt{3}Q_{0,0,3} + i [Q_{3,0,1} + Q_{3,0,3} + \sqrt{3} (Q_{3,3,0} + iQ_{3,3,2})]}{4},$$

$$Q_2 = \frac{Q_{0,0,0} - i\sqrt{2}Q_{0,0,2} + \sqrt{6}Q_{0,1,0} + i\sqrt{3}Q_{0,1,2} - \sqrt{3}Q_{0,2,3} - iQ_{0,3,1}}{4}.$$
S7. ENCYCLOPEDIA OF EMERGENT PARTICLES IN 3D CRYSTALS WITHOUT SOC EFFECT

A. The single-valued corepresentations of the 230 type-II MSGs and the essential degeneracies

1. Notes to Sec. S7A

(i) For each table in Sec. S7A, the first two lines present the SG number, the BZ type, the generating elements of the type II MSG (translations are not included here), whether centrosymmetry is contained in the group and whether SOC is considered.

(ii) Below the first two lines, the columns from left to right (separated by the semicolons) are the high-symmetry momentum \( k \), the location of \( k \) [with respect to reciprocal vectors \( \{g_1, g_2, g_3\} \)], the generating elements of the little group at \( k \) (only point-group operators are presented and a full expression of each generating element can be found in Ref. [17] and in Sec. S5), the deduced corep of the little group at \( k \), the dimension of the corep, the matrix representations of the generating elements, the species and the topological charge of the essential degeneracy.

(iii) A correspondence between the notation of the corep used here (\( R_i \)) and the band-representation notations can be found in Refs. [17, 18]. Moreover, Ref. [18] has established a SpaceGroupIrep package to analyze the band representation based on the notation of Ref. [17].
SG 1
\[ \Gamma \}; \{ E|000 \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \ (000); \ E,T; \ R_1; \ 1, 1, 1; \]
\[ B; \ (1/200); \ E,T; \ R_1; \ 1, 1, 1; \]
\[ F; \ (01/20); \ E,T; \ R_1; \ 1, 1, 1; \]
\[ G; \ (001/2); \ E,T; \ R_1; \ 1, 1, 1; \]

SG 2
\[ \Gamma \}; \ {I[000]}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; \ (000); \ I,T; \ R_1; \ 1, 1, 1; \]
\[ R_2; 1; \ -1, 1; \]
\[ B; \ (1/200); \ I,T; \ R_1; \ 1, 1, 1; \]
\[ R_2; 1; \ -1, 1; \]
\[ F; \ (01/20); \ I,T; \ R_1; \ 1, 1, 1; \]
\[ R_2; 1; \ -1, 1; \]
\[ G; \ (001/2); \ I,T; \ R_1; \ 1, 1, 1; \]
\[ R_2; 1; \ -1, 1; \]
SG 3

$\Gamma_m; \{C_{2z}\{000\}, T\};$ Non-Centrosymmetric; without SOC

$\Gamma;\ (000); \ C_{2z}, T; \ R_1; \ 1; \ 1,1;
\ R_2; \ 1; \ -1,1;

B;\ \left(\frac{1}{2}00\right); \ C_{2z}, T; \ R_1; \ 1; \ 1,1;
\ R_2; \ 1; \ -1,1;

Y;\ \left(0\frac{1}{2}0\right); \ C_{2z}, T; \ R_1; \ 1; \ 1,1;
\ R_2; \ 1; \ -1,1;

Z;\ \left(00\frac{1}{2}\right); \ C_{2z}, T; \ R_1; \ 1; \ 1,1;
\ R_2; \ 1; \ -1,1;

C;\ \left(0\frac{1}{2}\frac{1}{2}\right); \ C_{2z}, T; \ R_1; \ 1; \ 1,1;
\ R_2; \ 1; \ -1,1;

D;\ \left(\frac{1}{2}0\frac{1}{2}\right); \ C_{2z}, T; \ R_1; \ 1; \ 1,1;
\ R_2; \ 1; \ -1,1;

A;\ \left(\frac{1}{2}\frac{1}{2}0\right); \ C_{2z}, T; \ R_1; \ 1; \ 1,1;
\ R_2; \ 1; \ -1,1;

E;\ \left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); \ C_{2z}, T; \ R_1; \ 1; \ 1,1;
\ R_2; \ 1; \ -1,1;

\Lambda; \ \Gamma Z; \ C_{2z}; \ R_1; \ 1; \ 1;
\ R_2; \ 1; \ -1;

V; \ BD; \ C_{2z}; \ R_1; \ 1; \ 1;
\ R_2; \ 1; \ -1;

W; \ YC; \ C_{2z}; \ R_1; \ 1; \ 1;
\ R_2; \ 1; \ -1;

U; \ AE; \ C_{2z}; \ R_1; \ 1; \ 1;
\ R_2; \ 1; \ -1;
### SG 4

\[
\begin{array}{l}
\Gamma_m; \{C_{2z}[00 \frac{1}{2}\} \}; \text{Non-Centrosymmetric; without SOC} \\

\Gamma; (000); \quad C_{2z}, \mathcal{T}; \quad R_1; 1; 1,1; \\
\quad R_2; 1; -1,1; \\
B; \left(\frac{1}{2}00\right); \quad C_{2z}, \mathcal{T}; \quad R_1; 1; 1,1; \\
\quad R_2; 1; -1,1; \\
Y; \left(0\frac{1}{2}0\right); \quad C_{2z}, \mathcal{T}; \quad R_1; 1; 1,1; \\
\quad R_2; 1; -1,1; \\
Z; \left(00\frac{1}{2}\right); \quad C_{2z}, \mathcal{T}; \quad \{R_2, R_4\}; 2; \text{i} \sigma_3, \sigma_1; \text{P-NS}_{ZCDE}; \\
C; \left(0\frac{1}{2}\frac{1}{2}\right); \quad C_{2z}, \mathcal{T}; \quad \{R_2, R_4\}; 2; \text{i} \sigma_3, \sigma_1; \text{P-NS}_{ZCDE}; \\
D; \left(\frac{1}{2}0\frac{1}{2}\right); \quad C_{2z}, \mathcal{T}; \quad \{R_2, R_4\}; 2; \text{i} \sigma_3, \sigma_1; \text{P-NS}_{ZCDE}; \\
A; \left(\frac{1}{2}1\frac{1}{2}\right); \quad C_{2z}, \mathcal{T}; \quad R_1; 1; 1,1; \\
\quad R_2; 1; -1,1; \\
E; \left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); \quad C_{2z}, \mathcal{T}; \quad \{R_2, R_4\}; 2; \text{i} \sigma_3, \sigma_1; \text{P-NS}_{ZCDE}; \\
A; \Gamma Z; \quad C_{2z}; \quad R_1; 1; 1; \\
\quad R_2; 1; -1; \\
V; \text{BD}; \quad C_{2z}; \quad R_1; 1; 1; \\
\quad R_2; 1; -1; \\
W; \text{YC}; \quad C_{2z}; \quad R_1; 1; 1; \\
\quad R_2; 1; -1; \\
U; \text{AE}; \quad C_{2z}; \quad R_1; 1; 1; \\
\quad R_2; 1; -1; \\
\end{array}
\]

### SG 5

\[
\begin{array}{l}
\Gamma_m; \{C_{2z}[000]\}; \text{Non-Centrosymmetric; without SOC} \\

\Gamma; (000); \quad C_{2z}, \mathcal{T}; \quad R_1; 1; 1,1; \\
\quad R_2; 1; -1,1; \\
A; \left(\frac{1}{2}00\right); \quad C_{2z}, \mathcal{T}; \quad R_1; 1; 1,1; \\
\quad R_2; 1; -1,1; \\
Z; \left(0\frac{1}{2}\frac{1}{2}\right); \quad C_{2z}, \mathcal{T}; \quad R_1; 1; 1,1; \\
\quad R_2; 1; -1,1; \\
M; \left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); \quad C_{2z}, \mathcal{T}; \quad R_1; 1; 1,1; \\
\quad R_2; 1; -1,1; \\
L; \left(\frac{1}{2}0\frac{1}{2}\right); \quad E,T; \quad R_1; 1; 1,1; \\
V; \left(00\frac{1}{2}\right); \quad E,T; \quad R_1; 1; 1,1; \\
A; \Gamma Z; \quad C_{2z}; \quad R_1; 1; 1; \\
\quad R_2; 1; -1; \\
U; \text{AM}; \quad C_{2z}; \quad R_1; 1; 1; \\
\quad R_2; 1; -1; \\
\end{array}
\]
\[ \Gamma_m; \{\sigma_z|000\}; T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (000); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ B; (\frac{1}{2}00); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ Y; (0\frac{1}{2}0); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ Z; (00\frac{1}{2}); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ C; (0\frac{1}{2}\frac{1}{2}); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ D; (\frac{1}{2}0\frac{1}{2}); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ A; (\frac{1}{2}\frac{1}{2}0); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ E; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ \Lambda; \Gamma Z; \quad E,T\sigma_z; \quad R_1; 1; 1,1; \]
\[ \nu; \quad BD; \quad E,T\sigma_z; \quad R_1; 1; 1,1; \]
\[ \nu; \quad YC; \quad E,T\sigma_z; \quad R_1; 1; 1,1; \]
\[ \nu; \quad AE; \quad E,T\sigma_z; \quad R_1; 1; 1,1; \]

\[ \text{SG 7} \]
\[ \Gamma_m; \{\sigma_z|\frac{1}{2}00\}; T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (000); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ B; (\frac{1}{2}00); \sigma_z,T; \quad \{R_2,R_4\}; 2; i\sigma_3,\sigma_1; \quad \text{P-WNLs;} \]
\[ Y; (0\frac{1}{2}0); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ Z; (00\frac{1}{2}); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ C; (0\frac{1}{2}\frac{1}{2}); \sigma_z,T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ D; (\frac{1}{2}0\frac{1}{2}); \sigma_z,T; \quad \{R_2,R_4\}; 2; i\sigma_3,\sigma_1; \quad \text{P-WNLs;} \]
\[ A; (\frac{1}{2}\frac{1}{2}0); \sigma_z,T; \quad \{R_2,R_4\}; 2; i\sigma_3,\sigma_1; \quad \text{P-WNLs;} \]
\[ E; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \sigma_z,T; \quad \{R_2,R_4\}; 2; i\sigma_3,\sigma_1; \quad \text{P-WNLs;} \]
\[ \Lambda; \Gamma Z; \quad E,T\sigma_z; \quad R_1; 1; 1,1; \]
\[ \nu; \quad BD; \quad E,T\sigma_z; \quad \{R_1,R_1\}; 2; \sigma_0,-i\sigma_2; \quad \text{WNL}; \quad \pi \]
\[ \nu; \quad YC; \quad E,T\sigma_z; \quad R_1; 1; 1,1; \]
\[ \nu; \quad AE; \quad E,T\sigma_z; \quad \{R_1,R_1\}; 2; \sigma_0,-i\sigma_2; \quad \text{WNL}; \quad \pi \]
SG 8
\[ \Gamma^b_m; \{\sigma_z|000\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{array}{llll}
\Gamma & (000); & \sigma_z, T; & R_1; 1, 1, 1; \\
      &       &             & R_2; 1; -1, 1; \\
A   & (\frac{1}{2}00); & \sigma_z, T; & R_1; 1, 1, 1; \\
      &       &             & R_2; 1; -1, 1; \\
Z   & (0\frac{1}{2}\frac{1}{2}); & \sigma_z, T; & R_1; 1, 1, 1; \\
      &       &             & R_2; 1; -1, 1; \\
M   & (\frac{1}{2}\frac{1}{2}1); & \sigma_z, T; & R_1; 1, 1, 1; \\
      &       &             & R_2; 1; -1, 1; \\
L   & (\frac{1}{2}\frac{1}{2}0); & E, T; & R_1; 1, 1, 1; \\
V   & (00\frac{1}{2}); & E, T; & R_1; 1, 1, 1; \\
A   & \Gamma Z; & E, T \sigma_z; & R_1; 1, 1, 1; \\
U   & \text{AM}; & E, T \sigma_z; & R_1; 1, 1, 1; \\
\end{array}
\]

SG 9
\[ \Gamma^b_m; \{\sigma_z|\frac{1}{2}00\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{array}{llll}
\Gamma & (000); & \sigma_z, T; & R_1; 1, 1, 1; \\
      &       &             & R_2; 1; -1, 1; \\
A   & (\frac{1}{2}00); & \sigma_z, T; & \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \text{ P-WNLs;} \\
Z   & (0\frac{1}{2}\frac{1}{2}); & \sigma_z, T; & R_1; 1, 1, 1; \\
      &       &             & R_2; 1; -1, 1; \\
M   & (\frac{1}{2}\frac{1}{2}1); & \sigma_z, T; & \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \text{ P-WNLs;} \\
L   & (\frac{1}{2}\frac{1}{2}0); & E, T; & R_1; 1, 1, 1; \\
V   & (00\frac{1}{2}); & E, T; & R_1; 1, 1, 1; \\
A   & \Gamma Z; & E, T \sigma_z; & R_1; 1, 1, 1; \\
U   & \text{AM}; & E, T \sigma_z; \{R_1, R_1\}; 2; \sigma_0, -i\sigma_2; \text{ WNL;} \pi \\
\end{array}
\]
\( \Gamma_m; \{C_{2z}[000], \{I[000]\}, T; \text{Centrosymmetric; without SOC}\)
3. SG 11-20

SG 11

Γₘ; \{C₂z|00\frac{1}{2}\}, \{I|00\frac{1}{2}\}; T; Centrosymmetric; without SOC

Γ; (000); \(C₂z, I, T\); \(R₁; 1; 1,1,1;\)
\(R₂; 1; 1, -1,1;\)
\(R₃; 1; -1,1,1;\)
\(R₄; 1; -1, -1,1;\)

B; (\frac{1}{2}00); \(C₂z, I, T\); \(R₁; 1; 1,1,1;\)
\(R₂; 1; 1, -1,1;\)
\(R₃; 1; -1,1,1;\)
\(R₄; 1; -1, -1,1;\)

Y; (0\frac{1}{2}0); \(C₂z, I, T\); \(R₁; 1; 1,1,1;\)
\(R₂; 1; 1, -1,1;\)
\(R₃; 1; -1,1,1;\)
\(R₄; 1; -1, -1,1;\)

Z; (00\frac{1}{2}); \(C₂z, I, T\); \(R₅; 2; i\sigma₂, σ₃, -σ₀; P-NSZCDE;\)

C; (0\frac{1}{2}\frac{1}{2}); \(C₂z, I, T\); \(R₅; 2; i\sigma₂, σ₃, -σ₀; P-NSZCDE;\)

D; (\frac{1}{2}0\frac{1}{2}); \(C₂z, I, T\); \(R₅; 2; i\sigma₂, σ₃, -σ₀; P-NSZCDE;\)

A; (\frac{1}{2}\frac{1}{2}0); \(C₂z, I, T\); \(R₁; 1; 1,1,1;\)
\(R₂; 1; 1, -1,1;\)
\(R₃; 1; -1,1,1;\)
\(R₄; 1; -1, -1,1;\)

E; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \(C₂z, I, T\); \(R₅; 2; i\sigma₂, σ₃, -σ₀; P-NSZCDE;\)

Λ; ΓZ; \(C₂z, I, T\); \(R₁; 1; 1,1;\)
\(R₂; 1; -1,1;\)

V; BD; \(C₂z, I, T\); \(R₁; 1; 1,1;\)
\(R₂; 1; -1,1;\)

W; YC; \(C₂z, I, T\); \(R₁; 1; 1,1;\)
\(R₂; 1; -1,1;\)

U; AE; \(C₂z, I, T\); \(R₁; 1; 1,1;\)
\(R₂; 1; -1,1;\)
\( \Gamma_{2m}^b; \{ C_{2z}[000], \{ I[000], T; \text{Centrosymmetric}; \text{without SOC} \}

\Gamma; (000); C_{2z}, I, T; R_1; 1; 1, 1, 1;
\qquad R_2; 1; 1, -1, 1;
\qquad R_3; 1; -1, 1, 1;
\qquad R_4; 1; -1, -1, 1;

A; (\frac{1}{2}00); C_{2z}, I, T; R_1; 1; 1, 1, 1;
\qquad R_2; 1; 1, -1, 1;
\qquad R_3; 1; -1, 1, 1;
\qquad R_4; 1; -1, -1, 1;

Z; (0\frac{1}{2}\frac{1}{2}); C_{2z}, I, T; R_1; 1; 1, 1, 1;
\qquad R_2; 1; 1, -1, 1;
\qquad R_3; 1; -1, 1, 1;
\qquad R_4; 1; -1, -1, 1;

M; (\frac{1}{2}1\frac{1}{2}); C_{2z}, I, T; R_1; 1; 1, 1, 1;
\qquad R_2; 1; 1, -1, 1;
\qquad R_3; 1; -1, 1, 1;
\qquad R_4; 1; -1, -1, 1;

L; (\frac{1}{2}0\frac{1}{2}); I, T; R_1; 1; 1, 1;
\qquad R_2; 1; -1, 1;

V; (00\frac{1}{2}); I, T; R_1; 1; 1, 1;
\qquad R_2; 1; -1, 1;

A; ΓZ; C_{2z}, IT; R_1; 1; 1, 1;
\qquad R_2; 1; -1, 1;

U; AM; C_{2z}, IT; R_1; 1; 1, 1;
\qquad R_2; 1; -1, 1;
\[ \Gamma_m; \{C_{2z}|000\}, \{I|\frac{1}{2}00\}, T; \text{Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma; \ (000); & \quad C_{2z}, I, T; \quad R_1; \quad 1; 1, 1, 1; \\
& \quad R_2; \quad 1; 1, -1, 1; \\
& \quad R_3; \quad 1; -1, 1, 1; \\
& \quad R_4; \quad 1; -1, -1, 1; \\
B; \ (\frac{1}{2}00); & \quad \sigma_z, I, T; \quad R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs}; \\
Y; \ (0\frac{1}{2}0); & \quad C_{2z}, I, T; \quad R_1; \quad 1; 1, 1, 1; \\
& \quad R_2; \quad 1; 1, -1, 1; \\
& \quad R_3; \quad 1; -1, 1, 1; \\
& \quad R_4; \quad 1; -1, -1, 1; \\
Z; \ (00\frac{1}{2}); & \quad C_{2z}, I, T; \quad R_1; \quad 1; 1, 1, 1; \\
& \quad R_2; \quad 1; 1, -1, 1; \\
& \quad R_3; \quad 1; -1, 1, 1; \\
& \quad R_4; \quad 1; -1, -1, 1; \\
C; \ (0\frac{1}{2}\frac{1}{2}); & \quad C_{2z}, I, T; \quad R_1; \quad 1; 1, 1, 1; \\
& \quad R_2; \quad 1; 1, -1, 1; \\
& \quad R_3; \quad 1; -1, 1, 1; \\
& \quad R_4; \quad 1; -1, -1, 1; \\
D; \ (\frac{1}{2}0\frac{1}{2}); & \quad \sigma_z, I, T; \quad R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs}; \\
A; \ (\frac{3}{2}\frac{1}{2}0); & \quad \sigma_z, I, T; \quad R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs}; \\
E; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & \quad \sigma_z, I, T; \quad R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs}; \\
\Lambda; \ \Gamma Z; & \quad C_{2z}, I, T; \quad R_1; \quad 1; 1, 1; \\
& \quad R_2; \quad 1; -1, 1; \\
V; \ \text{BD}; & \quad C_{2z}, I, T; \quad \{R_1, R_2\}; \quad 2; \sigma_3, \sigma_1; \text{WNL}; \pi \\
W; \ \text{YC}; & \quad C_{2z}, I, T; \quad R_1; \quad 1; 1, 1; \\
& \quad R_2; \quad 1; -1, 1; \\
U; \ \text{AE}; & \quad C_{2z}, I, T; \quad \{R_1, R_2\}; \quad 2; \sigma_3, \sigma_1; \text{WNL}; \pi \\
\end{align*}
\]
\[ \Gamma_m; \{C_2z|00\frac{1}{2}\}, \{I|\frac{1}{2}0\frac{1}{2}\}; T; \text{Centrosymmetric; without SOC} \]

\[
\begin{array}{llll}
\Gamma & (000); & C_{2z}, I, T; & R_1; 1, 1, 1; \\
 & & R_2; & 1, 1, -1, 1; \\
 & & R_3; & 1, -1, 1, 1; \\
 & & R_4; & 1, -1, -1, 1; \\
B & (\frac{1}{2}00); & \sigma_z, I, T; & R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs}; \\
Y & (0\frac{1}{2}0); & C_{2z}, I, T; & R_1; 1, 1, 1; \\
 & & R_2; & 1, 1, -1, 1; \\
 & & R_3; & 1, -1, 1, 1; \\
 & & R_4; & 1, -1, -1, 1; \\
Z & (00\frac{1}{2}); & C_{2z}, I, T; & R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-NS}_{ZCDE}; \\
C & (0\frac{1}{2}\frac{1}{2}); & C_{2z}, I, T; & R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-NS}_{ZCDE}; \\
D & (\frac{1}{2}0\frac{1}{2}); & C_{2z}, I, T; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{P-WNL/NS}; \\
 & & \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{P-WNL/NS}; \\
A & (\frac{1}{2}\frac{1}{2}0); & \sigma_z, I, T; & R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs}; \\
E & (\frac{1}{2}\frac{3}{2}\frac{1}{2}); & C_{2z}, I, T; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{P-WNL/NS}; \\
 & & \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{P-WNL/NS}; \\
\Lambda & \Gamma Z; & C_{2z}, I, T; & R_1; 1, 1, 1; \\
 & & R_2; & 1, -1, 1; \\
V & \text{BD}; & C_{2z}, I, T; \{R_1, R_2\}; 2; \sigma_3, \sigma_1; \text{WNL}; \pi \\
W & \text{YC}; & C_{2z}, I, T; & R_1; 1, 1, 1; \\
 & & R_2; & 1, -1, 1; \\
U & \text{AE}; & C_{2z}, I, T; \{R_1, R_2\}; 2; \sigma_3, \sigma_1; \text{WNL}; \pi
\end{array}
\]
\( \Gamma_{\text{m}}^b; \{C_{2z}\{000\}, \{I\mid \frac{1}{2}00\}, T\}; \) Centrosymmetric; without SOC

\[
\begin{align*}
\Gamma: \ (000); & \quad C_{2z}, I, T; \quad R_1; \quad 1; 1, 1, 1; \\
 & \quad R_2; \quad 1; 1, -1, 1; \\
 & \quad R_3; \quad 1; -1, 1, 1; \\
 & \quad R_4; \quad 1; -1, -1, 1; \\
A: \ (\frac{1}{2}00); & \quad \sigma_z, I, T; \quad R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs;}
\end{align*}
\]

\[
\begin{align*}
Z: \ (0\frac{1}{2}\frac{1}{2}); & \quad C_{2z}, I, T; \quad R_1; \quad 1, 1, 1, 1; \\
 & \quad R_2; \quad 1; 1, -1, 1; \\
 & \quad R_3; \quad 1; -1, 1, 1; \\
 & \quad R_4; \quad 1; -1, -1, 1; \\
M: \ (\frac{1}{2}1\frac{1}{2}); & \quad \sigma_z, I, T; \quad R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs;}
\end{align*}
\]

\[
\begin{align*}
L: \ (\frac{1}{2}0\frac{1}{2}); & \quad I, T; \quad R_1; \quad 1, 1, 1; \\
 & \quad R_2; \quad 1; -1, 1; \\
V: \ (00\frac{1}{2}); & \quad I, T; \quad R_1; \quad 1, 1, 1; \\
 & \quad R_2; \quad 1; -1, 1; \\
\Lambda: \ \Gamma Z; & \quad C_{2z}, I T; \quad R_1; \quad 1, 1, 1; \\
 & \quad R_2; \quad 1; -1, 1; \\
U: \ \text{AM}; & \quad C_{2z}, I T; \quad \{R_1, R_2\}; \quad 2; \sigma_3, \sigma_1; \quad \text{WNL; \pi}
\end{align*}
\]
\( \Gamma_0; \{C_{2z}|000\}, \{C_{2y}|000\}, T; \) Non-Centrosymmetric; without SOC

\( \Gamma; (000); \ C_{2x},C_{2y},T; \ R_1; 1; 1,1,1; \)
\( R_2; 1; 1, -1,1; \)
\( R_3; 1; -1,1,1; \)
\( R_4; 1; -1, -1,1; \)

\( Y; (\frac{1}{2}00); \ C_{2x},C_{2y},T; \ R_1; 1; 1,1,1; \)
\( R_2; 1; 1, -1,1; \)
\( R_3; 1; -1,1,1; \)
\( R_4; 1; -1, -1,1; \)

\( X; (0\frac{1}{2}0); \ C_{2x},C_{2y},T; \ R_1; 1; 1,1,1; \)
\( R_2; 1; 1, -1,1; \)
\( R_3; 1; -1,1,1; \)
\( R_4; 1; -1, -1,1; \)

\( Z; (00\frac{1}{2}); \ C_{2x},C_{2y},T; \ R_1; 1; 1,1,1; \)
\( R_2; 1; 1, -1,1; \)
\( R_3; 1; -1,1,1; \)
\( R_4; 1; -1, -1,1; \)

\( U; (0\frac{1}{2}\frac{1}{2}); \ C_{2x},C_{2y},T; \ R_1; 1; 1,1,1; \)
\( R_2; 1; 1, -1,1; \)
\( R_3; 1; -1,1,1; \)
\( R_4; 1; -1, -1,1; \)

\( T; (\frac{1}{2}\frac{1}{2}0); \ C_{2x},C_{2y},T; \ R_1; 1; 1,1,1; \)
\( R_2; 1; 1, -1,1; \)
\( R_3; 1; -1,1,1; \)
\( R_4; 1; -1, -1,1; \)

\( S; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \ C_{2x},C_{2y},T; \ R_1; 1; 1,1,1; \)
\( R_2; 1; 1, -1,1; \)
\( R_3; 1; -1,1,1; \)
\( R_4; 1; -1, -1,1; \)

\( R; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \ C_{2x},C_{2y},T; \ R_1; 1; 1,1,1; \)
\( R_2; 1; 1, -1,1; \)
\( R_3; 1; -1,1,1; \)
\( R_4; 1; -1, -1,1; \)

\( \Delta; \Gamma Y; \ C_{2y}, TC_{2x}; \ R_1; 1; 1,1; \)
\( R_2; 1; -1,1; \)

\( D; \ X S; \ C_{2y}, TC_{2x}; \ R_1; 1; 1,1; \)
\( R_2; 1; -1,1; \)

\( P; \ UR; \ C_{2y}, TC_{2x}; \ R_1; 1; 1,1; \)
\( R_2; 1; -1,1; \)

\( B; \ Z T; \ C_{2y}, TC_{2x}; \ R_1; 1; 1,1; \)
\( R_2; 1; -1,1; \)

\( \Sigma; \Gamma X; \ C_{2x}, TC_{2x}; \ R_1; 1; 1,1; \)
\( R_2; 1; -1,1; \)
C; YS; $C_{2x,TC_{2z}}$; $R_1; 1, 1, 1$;  
$R_2; 1, -1, 1$;  

E; TR; $C_{2x,TC_{2z}}$; $R_1; 1, 1, 1$;  
$R_2; 1, -1, 1$;  

A; ZU; $C_{2x,TC_{2z}}$; $R_1; 1, 1, 1$;  
$R_2; 1, -1, 1$;  

A; \Gamma Z; $C_{2x,TC_{2z}}$; $R_1; 1, 1, 1$;  
$R_2; 1, -1, 1$;  

H; YT; $C_{2x,TC_{2z}}$; $R_1; 1, 1, 1$;  
$R_2; 1, -1, 1$;  

Q; SR; $C_{2z,TC_{2x}}$; $R_1; 1, 1, 1$;  
$R_2; 1, -1, 1$;  

G; XU; $C_{2z,TC_{2x}}$; $R_1; 1, 1, 1$;  
$R_2; 1, -1, 1$;
\( \Gamma_0; \{C_{2y}(000), C_{2y}(000), T\}; \text{Non-Centrosymmetric; without SOC} \)

\[
\begin{align*}
\Gamma; \ (000); \ C_{2x}, C_{2y}, T; \quad & R_1; \quad 1; 1, 1, 1; \\
& R_2; \quad 1; 1, -1, 1; \\
& R_3; \quad 1; -1, 1, 1; \\
& R_4; \quad 1; -1, -1, 1; \\
Y; \ (\frac{1}{2}00); \ C_{2x}, C_{2y}, T; \quad & R_1; \quad 1; 1, 1, 1; \\
& R_2; \quad 1; 1, -1, 1; \\
& R_3; \quad 1; -1, 1, 1; \\
& R_4; \quad 1; -1, -1, 1; \\
X; \ (0\frac{1}{2}0); \ C_{2x}, C_{2y}, T; \quad & R_1; \quad 1; 1, 1, 1; \\
& R_2; \quad 1; 1, -1, 1; \\
& R_3; \quad 1; -1, 1, 1; \\
& R_4; \quad 1; -1, -1, 1; \\
Z; \ (00\frac{1}{2}); \ C_{2x}, C_{2y}, T; \quad & R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-NS}_{ZUTR}; \\
U; \ (0\frac{1}{2}0); \ C_{2x}, C_{2y}, T; \quad & R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-NS}_{ZUTR}; \\
T; \ (\frac{1}{2}0\frac{1}{2}); \ C_{2x}, C_{2y}, T; \quad & R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-NS}_{ZUTR}; \\
S; \ (\frac{1}{2}0\frac{1}{2}); \ C_{2x}, C_{2y}, T; \quad & R_5; \quad 1; 1, 1, 1; \\
& R_2; \quad 1; 1, -1, 1; \\
& R_3; \quad 1; -1, 1, 1; \\
& R_4; \quad 1; -1, -1, 1; \\
R; \ (\frac{1}{2}0\frac{1}{2}); \ C_{2x}, C_{2y}, T; \quad & R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-NS}_{ZUTR}; \\
\Delta; \ \Gamma Y; \quad & C_{2y}, TC_{2x}; \quad R_1; \quad 1; 1, 1; \\
& R_2; \quad 1; -1, 1; \\
D; \ \Xi S; \quad & C_{2y}, TC_{2x}; \quad R_1; \quad 1; 1, 1; \\
& R_2; \quad 1; -1, 1; \\
P; \ \Pi R; \quad & C_{2y}, TC_{2x}; \quad \{R_1, R_2\}; \quad 2; \sigma_3, \sigma_1; \text{L-NS}_{ZUTR}; \\
B; \ \Xi T; \quad & C_{2y}, TC_{2x}; \quad \{R_1, R_2\}; \quad 2; \sigma_3, \sigma_1; \text{L-NS}_{ZUTR}; \\
\Sigma; \ \Gamma X; \quad & C_{2y}, TC_{2x}; \quad R_1; \quad 1; 1, 1; \\
& R_2; \quad 1; -1, 1; \\
C; \ \Upsilon S; \quad & C_{2y}, TC_{2x}; \quad R_1; \quad 1; 1, 1; \\
& R_2; \quad 1; -1, 1; \\
E; \ \Pi R; \quad & C_{2y}, TC_{2x}; \quad \{R_2, R_4\}; \quad 2; \sigma_3, -i\sigma_2; \text{L-NS}_{ZUTR}; \\
A; \ \Xi U; \quad & C_{2y}, TC_{2x}; \quad \{R_2, R_4\}; \quad 2; \sigma_3, -i\sigma_2; \text{L-NS}_{ZUTR}; \\
\Lambda; \ \Gamma Z; \quad & C_{2x}, TC_{2x}; \quad R_1; \quad 1; 1, 1; \\
& R_2; \quad 1; -1, 1; \\
H; \ \Xi Y; \quad & C_{2x}, TC_{2x}; \quad R_1; \quad 1; 1, 1; \\
& R_2; \quad 1; -1, 1; \\
Q; \ \Xi R; \quad & C_{2x}, TC_{2x}; \quad R_1; \quad 1; 1, 1; \\
& R_2; \quad 1; -1, 1; \\
G; \ \Xi U; \quad & C_{2x}, TC_{2x}; \quad R_1; \quad 1; 1, 1; \\
& R_2; \quad 1; -1, 1; 
\end{align*}
\]
$\Gamma_0$: \{C_2y|000\}, \{C_2y|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}, T; Non-Centrosymmetric; without SOC

\[ \begin{align*}
\Gamma: (000); & \quad C_{2x}, C_{2y}, T; \quad R_1; \quad 1; 1, 1, 1; \\
& \quad R_2; \quad 1; 1, -1, 1; \\
& \quad R_3; \quad 1; -1, 1, 1; \\
& \quad R_4; \quad 1; -1, -1, 1; \\
Y: \left(\frac{1}{2}00\right); & \quad C_{2y}, C_{2z}, T; \quad R_3; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-NS}_{YTSR}; \\
X: \left(0\frac{1}{2}0\right); & \quad C_{2x}, C_{2z}, T; \quad R_3; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-NS}_{XUSR}; \\
Z: \left(00\frac{1}{2}\right); & \quad C_{2x}, C_{2y}, T; \quad R_1; \quad 1; 1, 1, 1; \\
& \quad R_2; \quad 1; 1, -1, 1; \\
& \quad R_3; \quad 1; -1, 1, 1; \\
& \quad R_4; \quad 1; -1, -1, 1; \\
U: \left(0\frac{1}{2}\frac{1}{2}\right); & \quad C_{2x}, C_{2z}, T; \quad R_3; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-NS}_{XUSR}; \\
T: \left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); & \quad C_{2y}, C_{2z}, T; \quad R_3; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-NS}_{YTSR}; \\
S: \left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); & \quad C_{2y}, C_{2z}, T; \quad \{R_2, R_4\}; \quad 2; i\sigma_3, \sigma_0, \sigma_1; \quad \text{P-NS}; \\
& \quad \{R_6, R_8\}; \quad 2; i\sigma_3, -\sigma_0, \sigma_1; \quad \text{P-NS}; \\
R: \left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); & \quad C_{2y}, C_{2z}, T; \quad \{R_2, R_4\}; \quad 2; i\sigma_3, \sigma_0, \sigma_1; \quad \text{P-NS}; \\
& \quad \{R_6, R_8\}; \quad 2; i\sigma_3, -\sigma_0, \sigma_1; \quad \text{P-NS}; \\
\Delta: \Gamma Y; & \quad C_{2y}, TC_{2x}; \quad R_1; \quad 1; 1, 1; \\
& \quad R_2; \quad 1; -1, 1; \\
D: \Gamma X; & \quad C_{2y}, TC_{2x}; \quad \{R_2, R_4\}; \quad 2; \sigma_3, -i\sigma_2; \quad \text{L-NS}_{XUSR}; \\
P: UR; & \quad C_{2y}, TC_{2x}; \quad \{R_2, R_4\}; \quad 2; \sigma_3, -i\sigma_2; \quad \text{L-NS}_{XUSR}; \\
B: ZT; & \quad C_{2y}, TC_{2x}; \quad R_1; \quad 1; 1, 1; \\
& \quad R_2; \quad 1; -1, 1; \\
\Sigma: \Gamma X; & \quad C_{2x}, TC_{2z}; \quad R_1; \quad 1; 1, 1; \\
& \quad R_2; \quad 1; -1, 1; \\
C: YS; & \quad C_{2x}, TC_{2z}; \quad \{R_2, R_4\}; \quad 2; -\sigma_3, \sigma_1; \quad \text{L-NS}_{YTSR}; \\
E: TR; & \quad C_{2x}, TC_{2z}; \quad \{R_2, R_4\}; \quad 2; -\sigma_3, \sigma_1; \quad \text{L-NS}_{YTSR}; \\
A: ZU; & \quad C_{2x}, TC_{2z}; \quad R_1; \quad 1; 1, 1; \\
& \quad R_2; \quad 1; -1, 1; \\
\Lambda: \Gamma Z; & \quad C_{2x}, TC_{2z}; \quad R_1; \quad 1; 1, 1; \\
& \quad R_2; \quad 1; -1, 1; \\
H: YT; & \quad C_{2x}, TC_{2z}; \quad \{R_1, R_2\}; \quad 2; \sigma_3, \sigma_1; \quad \text{L-NS}_{YTSR}; \\
Q: SR; & \quad C_{2x}, TC_{2z}; \quad \{R_1, R_2\}; \quad 2; \sigma_0, -i\sigma_2; \quad \text{L-NS}; \\
& \quad \{R_2, R_3\}; \quad 2; -\sigma_0, -i\sigma_2; \quad \text{L-NS}; \\
G: XU; & \quad C_{2x}, TC_{2z}; \quad \{R_1, R_2\}; \quad 2; \sigma_3, -i\sigma_2; \quad \text{L-NS}_{XUSR}; \\
\end{align*} \]
\( \Gamma_0; \{ C_{2y} \mid \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ C_{2y} \mid \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, T; \) Non-Centrosymmetric; without SOC

\[
\Gamma; (000); C_{2x}, C_{2y}, T; \quad R_1; \quad 1; 1, 1, 1;
R_2; \quad 1; 1, -1, 1;
R_3; \quad 1; -1, 1, 1;
R_4; \quad 1; -1, -1, 1;
\]

\[ Y; \left( \frac{1}{2} 00 \right); C_{2y}, C_{2z}, T; \quad R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-NS}_{YTSR}; \]

\[ X; (0 \frac{1}{2} 0); C_{2x}, C_{2z}, T; \quad R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-NS}_{XUSR}; \]

\[ Z; (00 \frac{1}{2}); C_{2z}, C_{2x}, T; \quad R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-NS}_{ZUTR}; \]

\[ U; (0 \frac{1}{2} \frac{1}{2}); C_{2x}, C_{2y}, T; \quad \{ R_2, R_4 \}; \quad 2; i\sigma_3, \sigma_0, \sigma_1; \quad \text{P-NSs}; \]
\[ \{ R_6, R_{8} \}; \quad 2; i\sigma_3, -\sigma_0, \sigma_1; \quad \text{P-NSs}; \]

\[ T; \left( \frac{1}{2} 0 \frac{1}{2} \right); C_{2z}, C_{2y}, T; \quad \{ R_2, R_4 \}; \quad 2; i\sigma_3, \sigma_0, \sigma_1; \quad \text{P-NSs}; \]
\[ \{ R_6, R_{8} \}; \quad 2; i\sigma_3, -\sigma_0, \sigma_1; \quad \text{P-NSs}; \]

\[ S; \left( \frac{1}{2} \frac{1}{2} 0 \right); C_{2z}, C_{2x}, T; \quad \{ R_2, R_4 \}; \quad 2; i\sigma_3, \sigma_0, \sigma_1; \quad \text{P-NSs}; \]
\[ \{ R_6, R_{8} \}; \quad 2; i\sigma_3, -\sigma_0, \sigma_1; \quad \text{P-NSs}; \]

\[ R; \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); C_{2x}, C_{2y}, T; \quad \{ R_5, R_3 \}; \quad 4; i\Gamma_0, 2, i\Gamma_0, 1, -\Gamma_2, 2; \quad \text{C-2 DP}; \quad 2 \]

\[ \Delta; \Gamma Y; \quad C_{2y}, TC_{2x}; \quad R_1; \quad 1; 1, 1, 1; \]
\[ R_2; \quad 1; -1, 1; \]

\[ D; XS; \quad C_{2y}, TC_{2x}; \quad \{ R_2, R_4 \}; \quad 2; \sigma_3, -i\sigma_2; \quad \text{L-NS}_{XUSR}; \]

\[ P; UR; \quad C_{2y}, TC_{2x}; \quad \{ R_2, R_4 \}; \quad 2; \sigma_0, -i\sigma_2; \quad \text{L-NSs}; \]
\[ \{ R_4, R_6 \}; \quad 2; -\sigma_0, -i\sigma_2; \quad \text{L-NSs}; \]

\[ B; ZT; \quad C_{2y}, TC_{2x}; \quad \{ R_1, R_4 \}; \quad 2; \sigma_3, \sigma_1; \quad \text{L-NS}_{ZUTR}; \]

\[ \Sigma; \Gamma X; \quad C_{2x}, TC_{2x}; \quad R_1; \quad 1; 1, 1, 1; \]
\[ R_2; \quad 1; -1, 1; \]

\[ C; YS; \quad C_{2x}, TC_{2x}; \quad \{ R_1, R_3 \}; \quad 2; \sigma_3, \sigma_1; \quad \text{L-NS}_{YTSR}; \]

\[ E; TR; \quad C_{2x}, TC_{2x}; \quad \{ R_2, R_4 \}; \quad 2; \sigma_0, -i\sigma_2; \quad \text{L-NSs}; \]
\[ \{ R_4, R_6 \}; \quad 2; -\sigma_0, -i\sigma_2; \quad \text{L-NSs}; \]

\[ A; ZU; \quad C_{2x}, TC_{2x}; \quad \{ R_2, R_4 \}; \quad 2; \sigma_3, -i\sigma_2; \quad \text{L-NS}_{ZUTR}; \]

\[ \Lambda; \Gamma Z; \quad C_{2x}, TC_{2x}; \quad R_1; \quad 1; 1, 1, 1; \]
\[ R_2; \quad 1; -1, 1; \]

\[ H; YT; \quad C_{2x}, TC_{2x}; \quad \{ R_2, R_4 \}; \quad 2; -\sigma_3, \sigma_1; \quad \text{L-NS}_{YTSR}; \]

\[ Q; SR; \quad C_{2x}, TC_{2x}; \quad \{ R_2, R_4 \}; \quad 2; -\sigma_0, -i\sigma_2; \quad \text{L-NSs}; \]
\[ \{ R_4, R_6 \}; \quad 2; \sigma_0, -i\sigma_2; \quad \text{L-NSs}; \]

\[ G; XU; \quad C_{2x}, TC_{2x}; \quad \{ R_1, R_3 \}; \quad 2; \sigma_3, -i\sigma_2; \quad \text{L-NS}_{XUSR}; \]
\[ \Gamma_0; \{C_{2y}(00\frac{1}{2}), C_{2y}(00\frac{1}{2})\}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\[ \begin{align*}
\Gamma; (000); C_{2x}, C_{2y}, R_1; & \quad 1; 1, 1, 1; \\
R_2; & \quad 1; 1, -1, 1; \\
R_3; & \quad 1; -1, 1, 1; \\
R_4; & \quad 1; -1, -1, 1; \\
Y; (\frac{1}{2} \frac{1}{2} 0); C_{2x}, C_{2y}, R_1; & \quad 1; 1, 1, 1; \\
R_2; & \quad 1; 1, -1, 1; \\
R_3; & \quad 1; -1, 1, 1; \\
R_4; & \quad 1; -1, -1, 1; \\
Z; (00\frac{1}{2}); C_{2x}, C_{2x}, R_5; & \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-NSZTR}; \\
\mathcal{T}; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{2x}, C_{2x}, R_5; & \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-NSZTR}; \\
S; (0\frac{1}{2} 0); C_{2x}, \mathcal{T}; R_1; & \quad 1; 1, 1; \\
R_2; & \quad 1; -1, 1; \\
R; (0\frac{1}{2} \frac{1}{2}) \frac{1}{2}; C_{2x}, \mathcal{T}; \{R_2, R_4\}; & \quad 2; i\sigma_3, \sigma_1; \text{P-NSZTR}; \\
\Lambda; \Gamma Z; C_{2x}, T C_{2x}; R_1; & \quad 1; 1, 1; \\
R_2; & \quad 1; -1, 1; \\
H; YT; C_{2x}, T C_{2x}; R_1; & \quad 1; 1, 1; \\
R_2; & \quad 1; -1, 1; \\
D; SR; C_{2x}; R_1; & \quad 1; 1; \\
R_2; & \quad 1; -1; \\
A; ZT; C_{2x}, T C_{2x}; \{R_1, R_2\}; & \quad 2; \sigma_3, -i\sigma_2; \text{L-NSZTR}; \\
\Sigma; \Gamma Y; C_{2x}, T C_{2x}; R_1; & \quad 1; 1, 1; \\
R_2; & \quad 1; -1, 1; \\
\Delta; \Gamma \Delta; C_{2y}, T C_{2x}; R_1; & \quad 1; 1, 1; \\
R_2; & \quad 1; -1, 1; \\
B; ZB; C_{2y}, T C_{2x}; \{R_2, R_4\}; & \quad 2; \sigma_3, \sigma_1; \text{L-NSZTR}; \\
G; TG; C_{2y}, T C_{2x}; \{R_2, R_4\}; & \quad 2; \sigma_3, \sigma_1; \text{L-NSZTR}; \\
F; YF; C_{2y}, T C_{2x}; R_1; & \quad 1; 1, 1; \\
R_2; & \quad 1; -1, 1; \\
E; TE; C_{2x}, T C_{2x}; \{R_1, R_2\}; & \quad 2; \sigma_3, -i\sigma_2; \text{L-NSZTR}; \\
C; YC; C_{2x}, T C_{2x}; R_1; & \quad 1; 1, 1; \\
R_2; & \quad 1; -1, 1; \\
\end{align*} \]
SG 21

\( \Gamma_0^1 \); \{C_{2z}[000], \{C_{2y}[000], T\}; Non-Centrosymmetric; without SOC

\[ \Gamma; \ (000); \ C_{2z}, C_{2y}, T; \ R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ Y; \ (1 \frac{1}{2} \frac{1}{2} 0); \ C_{2z}, C_{2y}, T; \ R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ Z; \ (00 \frac{1}{2}); \ C_{2z}, C_{2y}, T; \ R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ T; \ (1 \frac{1}{2} \frac{1}{2} \frac{1}{2}); \ C_{2z}, C_{2y}, T; \ R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ S; \ (0 \frac{1}{2} 0); \ C_{2z}, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; 1, 1, 1; \]
\[ R_4; 1, -1, 1; \]
\[ \Lambda; \ \Gamma Z; \ C_{2z}, T C_{2z}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ H; \ \Gamma T; \ C_{2z}, T C_{2z}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ D; \ \Gamma R; \ C_{2z}; \]
\[ R_1; 1, 1; \]
\[ R_2; 1, -1; \]
\[ A; \ \Gamma Z T; \ C_{2z}, T C_{2z}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ \Sigma; \ \Gamma Y; \ C_{2z}, T C_{2z}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ \Delta; \ \Gamma \Delta; \ C_{2y}, T C_{2z}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ B; \ \Gamma Z B; \ C_{2y}, T C_{2z}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ G; \ \Gamma T G; \ C_{2y}, T C_{2z}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ F; \ \Gamma Y F; \ C_{2y}, T C_{2z}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ E; \ \Gamma T E; \ C_{2x}, T C_{2z}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ C; \ \Gamma Y C; \ C_{2x}, T C_{2z}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
| Point | Symmetry Operations | \( C_{2z} \) | \( C_{2y} \) | \( T \) |
|-------|--------------------|-------|-------|-----|
| \( \Gamma \): (000) | \( R_1 \): 1 | 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| | \( R_3 \): 1 | -1 | -1 | 1 |
| | \( R_4 \): 1 | 1 | 1 | -1 |
| \( Y \): (0\( \frac{1}{2} \)\( \frac{1}{2} \)) | \( R_1 \): 1 | 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| | \( R_3 \): 1 | 1 | -1 | 1 |
| | \( R_4 \): 1 | -1 | -1 | 1 |
| \( X \): (\( \frac{1}{2} \)0\( \frac{1}{2} \)) | \( R_1 \): 1 | 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| | \( R_3 \): 1 | 1 | -1 | 1 |
| | \( R_4 \): 1 | -1 | -1 | 1 |
| \( Z \): (\( \frac{1}{2} \)\( \frac{1}{2} \)0) | \( R_1 \): 1 | 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| | \( R_3 \): 1 | 1 | -1 | 1 |
| | \( R_4 \): 1 | -1 | -1 | 1 |
| \( L \): (\( \frac{1}{2} \)00) | \( E \), \( T \) | \( R_1 \): 1 | 1 | 1 |
| \( \Lambda \): \( \Gamma Z/\Gamma \Lambda \) | \( C_{2z}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( G \): \( X Z/XY \) | \( C_{2z}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( H \): \( YH/YZ \) | \( C_{2z}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( Q \): \( Z Q \) | \( C_{2z}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( \Sigma \): \( \Gamma X/\Gamma \Sigma \) | \( C_{2z}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( C \): \( YC/YZ \) | \( C_{2z}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( A \): \( ZA/ZY \) | \( C_{2z}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( U \): \( X U \) | \( C_{2z}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( \Delta \): \( \Gamma Y/\Gamma \Delta \) | \( C_{2y}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( D \): \( X D/XZ \) | \( C_{2y}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( B \): \( ZB/ZX \) | \( C_{2y}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
| \( R \): \( Y R \) | \( C_{2y}, TC_{2z} \) | \( R_1 \): 1 | 1 | 1 |
| | \( R_2 \): 1 | -1 | 1 | 1 |
\[ \Gamma_v; \{ C_{2z}|000 \}, \{ C_{2y}|000 \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \ (000); \ C_{2x}, C_{2y}, T; \ R_1; 1; 1, 1, 1; \]
\[ R_2; 1; -1, 1; \]
\[ R_3; 1; -1, 1, 1; \]
\[ R_4; 1; -1, -1, 1; \]

\[ X; \ \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); \ C_{2x}, C_{2y}, T; \ R_1; 1; 1, 1, 1; \]
\[ R_2; 1; -1, 1; \]
\[ R_3; 1; 1, 1, 1; \]
\[ R_4; 1; -1, -1, 1; \]

\[ R; \ \left( \frac{1}{2} \right) 0 0; \ C_{2y}, T; \ R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ S; \ \left( \frac{1}{2} \frac{1}{2} \right); \ C_{2x}, T; \ R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ T; \ \left( \frac{1}{2} \frac{1}{2} 0 \right); \ C_{2x}, T; \ R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ W; \ \left( \frac{3}{4} \frac{1}{4} \frac{1}{4} \right); \ C_{2x}, C_{2y}; \ R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]
\[ R_3; 1; -1, 1; \]
\[ R_4; 1; -1, -1; \]

\[ \Lambda; \ \Gamma \Lambda/\Gamma X; \ C_{2x}, TC_{2x}; \ R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ G; \ \text{XG}; \ C_{2x}, TC_{2x}; \ R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ P; \ \text{TW}; \ C_{2x}; \ R_1; 1; 1; \]
\[ R_2; 1; -1; \]

\[ \Sigma; \ \Gamma \Sigma/\Gamma X; \ C_{2x}, TC_{2x}; \ R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ F; \ \text{XF}; \ C_{2x}, TC_{2x}; \ R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ D; \ \text{SW}; \ C_{2x}; \ R_1; 1; 1; \]
\[ R_2; 1; -1; \]

\[ \Delta; \ \Gamma \Delta/\Gamma X; \ C_{2y}, TC_{2x}; \ R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ U; \ \text{XU}; \ C_{2y}, TC_{2x}; \ R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ Q; \ \text{RW}; \ C_{2y}; \ R_1; 1; 1; \]
\[ R_2; 1; -1; \]
\[
\begin{align*}
\Gamma' &\rightarrow \{C_{2z}|\frac{1}{2}0\frac{1}{2}\}, \{C_{2y}|\frac{1}{2}\frac{1}{2}0\}, T;\text{ Non-Centrosymmetric; without SOC} \\
\Gamma; & (000); \quad C_{2z}, C_{2y}, T; R_1; 1; 1, 1, 1; \quad R_2; 1; 1, -1, 1; \quad R_3; 1; -1, 1, 1; \quad R_4; 1; -1, -1, 1; \\
X; & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad C_{2z}, C_{2y}, T; R_1; 1; 1, 1, 1; \quad R_2; 1; 1, -1, 1; \quad R_3; 1; -1, 1, 1; \quad R_4; 1; -1, -1, 1; \\
R; & (\frac{1}{2}00); \quad C_{2y}, T; R_1; 1; 1, 1; \quad R_2; 1; -1, 1; \\
S; & (\frac{1}{2}0\frac{1}{2}); \quad C_{2z}, T; R_1; 1; 1, 1; \quad R_2; 1; -1, 1; \\
T; & (\frac{1}{2}\frac{1}{2}0); \quad C_{2z}, T; R_1; 1; 1, 1; \quad R_2; 1; -1, 1; \\
W; & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad E, C_{2z}, C_{2y}; R_9; 2; i\sigma_0, \sigma_1, \sigma_3; C-1 WP; 1 \\
\Lambda; & \Gamma\Lambda/\GammaX; \quad C_{2z}, T C_{2z}; R_1; 1; 1, 1; \quad R_2; 1; -1, 1; \quad R_2; 1; 1, 1; \\
G; & \Gamma\Lambda/\GammaX; \quad C_{2z}, T C_{2z}; R_1; 1; 1, 1; \quad R_2; 1; -1, 1; \quad R_2; 1; 1, 1; \\
P; & \Gamma\Lambda/\GammaX; \quad C_{2z}; R_2; 1; 1; \quad R_4; 1; -1; \\
\Sigma; & \Gamma\Lambda/\GammaX; \quad C_{2z}, T C_{2z}; R_1; 1; 1, 1; \quad R_2; 1; -1, 1; \quad R_2; 1; 1, 1; \\
F; & \Gamma\Lambda/\GammaX; \quad C_{2z}, T C_{2z}; R_1; 1; -1, 1; \quad R_2; 1; 1, 1; \quad R_2; 1; -1, 1; \\
D; & \Gamma\Lambda/\GammaX; \quad C_{2z}; R_2; 1; -1; \quad R_4; 1; 1; \\
\Delta; & \Gamma\Lambda/\GammaX; \quad C_{2y}, T C_{2z}; R_1; 1; 1, 1; \quad R_2; 1; -1, 1; \\
U; & \Gamma\Lambda/\GammaX; \quad C_{2y}, T C_{2z}; R_1; 1; 1, 1; \quad R_2; 1; -1, 1; \quad R_2; 1; 1, 1; \\
Q; & \Gamma\Lambda/\GammaX; \quad C_{2y}; R_2; 1; 1; \quad R_4; 1; -1; \\
\end{align*}
\]
\[ \Gamma_{0}; \{C_{2z}, \sigma_{y}, \mathcal{T}\}; \text{Non-Centrosymmetric; without SOC} \]

\[ \begin{array}{c|c|c|c|c} \hline \text{Γ}; \; (000); & C_{2z}, \sigma_{y}, \mathcal{T}; & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 & & R_{3}; & 1, -1, 1; \\
 & & R_{4}; & 1, -1, 1; \\
 \hline Y; \; (\frac{1}{2}00); & C_{2z}, \sigma_{y}, \mathcal{T}; & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 & & R_{3}; & 1, -1, 1; \\
 & & R_{4}; & 1, -1, 1; \\
 \hline X; \; (0\frac{1}{2}0); & C_{2z}, \sigma_{y}, \mathcal{T}; & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 & & R_{3}; & 1, -1, 1; \\
 & & R_{4}; & 1, -1, 1; \\
 \hline Z; \; (00\frac{1}{2}); & C_{2z}, \sigma_{y}, \mathcal{T}; & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 & & R_{3}; & 1, -1, 1; \\
 & & R_{4}; & 1, -1, 1; \\
 \hline U; \; (0\frac{1}{2}\frac{1}{2}); & C_{2z}, \sigma_{y}, \mathcal{T}; & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 & & R_{3}; & 1, -1, 1; \\
 & & R_{4}; & 1, -1, 1; \\
 \hline T; \; (\frac{1}{2}0\frac{1}{2}); & C_{2z}, \sigma_{y}, \mathcal{T}; & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 & & R_{3}; & 1, -1, 1; \\
 & & R_{4}; & 1, -1, 1; \\
 \hline S; \; (0\frac{1}{2}\frac{1}{2}); & C_{2z}, \sigma_{y}, \mathcal{T}; & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 & & R_{3}; & 1, -1, 1; \\
 & & R_{4}; & 1, -1, 1; \\
 \hline R; \; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & C_{2z}, \sigma_{y}, \mathcal{T}; & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 & & R_{3}; & 1, -1, 1; \\
 & & R_{4}; & 1, -1, 1; \\
 \hline \Delta; \; \Gamma Y; & \sigma_{y}, \mathcal{T}C_{2z}; & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 \hline D; \; \sigma_{y}, \mathcal{T}C_{2z}; & & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 \hline P; \; \sigma_{y}, \mathcal{T}C_{2z}; & & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 \hline B; \; \sigma_{y}, \mathcal{T}C_{2z}; & & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 \hline \Sigma; \; \Gamma X; & \sigma_{y}, \mathcal{T}\sigma_{z}; & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 \hline C; \; \sigma_{y}, \mathcal{T}\sigma_{z}; & & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 \hline E; \; \sigma_{y}, \mathcal{T}\sigma_{z}; & & R_{1}; & 1, 1, 1; \\
 & & R_{2}; & 1, -1, 1; \\
 \end{array} \]
| Group | Symmetry | \( R_1 \) | \( R_2 \) | \( R_3 \) | \( R_4 \) |
|-------|----------|----------|----------|----------|----------|
| \( A \); ZU; \( \sigma_y, T \sigma_x \) | \( R_1 \); 1, 1, 1; \( R_2 \); 1, -1, 1; \( R_3 \); 1, 1, 1; \( R_4 \); 1, -1, 1; |
| \( \Lambda \); \( \Gamma Z \); \( C_{2z}, \sigma_y \) | \( R_1 \); 1, 1, 1; \( R_2 \); 1, 1, -1; \( R_3 \); 1, -1, 1; \( R_4 \); 1, -1, -1; |
| \( H \); YT; \( C_{2x}, \sigma_y \) | \( R_1 \); 1, 1, 1; \( R_2 \); 1, 1, -1; \( R_3 \); 1, -1, 1; \( R_4 \); 1, -1, -1; |
| \( Q \); SR; \( C_{2x}, \sigma_y \) | \( R_1 \); 1, 1, 1; \( R_2 \); 1, 1, -1; \( R_3 \); 1, -1, 1; \( R_4 \); 1, -1, -1; |
| \( G \); XU; \( C_{2z}, \sigma_y \) | \( R_1 \); 1, 1, 1; \( R_2 \); 1, 1, -1; \( R_3 \); 1, 1, 1; \( R_4 \); 1, -1, -1; |
\( \Gamma_0; \{ C_{2z}[00\frac{1}{2}], \{ \sigma_y[00\frac{1}{2}] \}; T; \text{Non-Centrosymmetric; without SOC}\)
\begin{align*}
Q; & \text{ SR; } C_{2z, \sigma_y}; R_1; 1, 1; \\
& R_2; 1, 1, -1; \\
& R_3; 1, -1, 1; \\
& R_4; 1, -1, -1; \\
G; & \text{ XU; } C_{2z, \sigma_y}; R_1; 1, 1; \\
& R_2; 1, 1, -1; \\
& R_3; 1, -1, 1; \\
& R_4; 1, -1, -1;
\end{align*}
\[
\begin{array}{c|c|c|c}
\text{Symbol} & \Gamma' & \sigma_y, \sigma_z, T & \text{Notation} \\
\hline
\Gamma & (000) & C_{2v}, \sigma_y, T; & R_1; 1, 1, 1; \\
 & & R_2; 1, 1, -1, 1; \\
 & & R_3; 1, -1, 1, 1; \\
 & & R_4; 1, -1, -1, 1; \\
Y & (\frac{1}{2}00) & C_{2v}, \sigma_y, T; & R_1; 1, 1, 1; \\
 & & R_2; 1, 1, -1, 1; \\
 & & R_3; 1, -1, 1, 1; \\
 & & R_4; 1, -1, -1, 1; \\
X & (0\frac{1}{2}0) & C_{2v}, \sigma_y, T; & R_1; 1, 1, 1; \\
 & & R_2; 1, 1, -1, 1; \\
 & & R_3; 1, -1, 1, 1; \\
 & & R_4; 1, -1, -1, 1; \\
Z & (00\frac{1}{2}) & \sigma_y, C_{2v}, T; & \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{ P-WNLs;} \\
 & & \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{ P-WNLs;} \\
U & (0\frac{1}{2}\frac{1}{2}) & \sigma_y, C_{2v}, T; & \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{ P-WNLs;} \\
 & & \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{ P-WNLs;} \\
T & (\frac{1}{2}0\frac{1}{2}) & \sigma_y, C_{2v}, T; & \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{ P-WNLs;} \\
 & & \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{ P-WNLs;} \\
S & (\frac{1}{2}\frac{1}{2}0) & C_{2v}, \sigma_y, T; & R_1; 1, 1, 1; \\
 & & R_2; 1, 1, -1, 1; \\
 & & R_3; 1, -1, 1, 1; \\
 & & R_4; 1, -1, -1, 1; \\
R & (\frac{1}{2}\frac{1}{2}\frac{1}{2}) & \sigma_y, C_{2v}, T; & \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{ P-WNLs;} \\
 & & \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{ P-WNLs;} \\
\Delta & \text{GY} & \sigma_x, T C_{2z}; & R_1; 1, 1, 1; \\
 & & R_2; 1, -1, 1; \\
D & \text{XS} & \sigma_x, T C_{2z}; & R_1; 1, 1, 1; \\
 & & R_2; 1, -1, 1; \\
P & \text{UR} & \sigma_x, T C_{2z}; & \{R_1, R_2\}; 2; -i\sigma_3, \sigma_1; \text{ WNL; } \pi \\
B & \text{ZT} & \sigma_x, T C_{2z}; & \{R_1, R_2\}; 2; -i\sigma_3, \sigma_1; \text{ WNL; } \pi \\
\Sigma & \Gamma X & \sigma_y, T \sigma_x; & R_1; 1, 1, 1; \\
 & & R_2; 1, -1, 1; \\
C & \text{YS} & \sigma_y, T \sigma_x; & R_1; 1, 1, 1; \\
 & & R_2; 1, -1, 1; \\
E & \text{TR} & \sigma_y, T \sigma_x; & \{R_1, R_2\}; 2; -i\sigma_3, -i\sigma_2; \text{ WNL; } \pi \\
A & \text{ZU} & \sigma_y, T \sigma_x; & \{R_1, R_2\}; 2; -i\sigma_3, -i\sigma_2; \text{ WNL; } \pi \\
\Lambda & \Gamma Z & C_{2v}, \sigma_y; & R_1; 1, 1, 1; \\
 & & R_2; 1, 1, -1; \\
H & \text{YT} & C_{2v}, \sigma_y; & R_1; 1, 1, 1; \\
 & & R_2; 1, 1, -1; \\
\end{array}
\]
Q; SR; $C_{2z}, \sigma_y$; $R_1; 1, 1$;
   $R_2; 1, -1$;
   $R_3; -1, 1$;
   $R_4; -1, -1$

G; XU; $C_{2z}, \sigma_y$; $R_1; 1, 1$;
   $R_2; 1, -1$;
   $R_3; -1, 1$;
   $R_4; -1, -1$
\( \Gamma_0; \{ C_{2z}[\frac{1}{2}00], \{ \sigma_y[000], T \}; \) Non-Centrosymmetric; without SOC

\[
\begin{array}{ll}
\Gamma; (000); & C_{2z}, \sigma_y, T; R_1; \ 1, 1, 1; \\
& R_2; \ 1, 1, -1, 1; \\
& R_3; \ 1, -1, 1, 1; \\
& R_4; \ 1, -1, -1, 1; \\
Y; (\frac{1}{2}00); & \sigma_x, \sigma_y, T; R_5; \ 2; \ i\sigma_2, \sigma_3, -\sigma_0; P-WNLs; \\
X; (0\frac{1}{2}0); & C_{2z}, \sigma_y, T; R_1; \ 1, 1, 1; \\
& R_2; \ 1, 1, -1, 1; \\
& R_3; \ 1, -1, 1, 1; \\
& R_4; \ 1, -1, -1, 1; \\
Z; (00\frac{1}{2}); & C_{2z}, \sigma_y, T; R_1; \ 1, 1, 1; \\
& R_2; \ 1, 1, -1, 1; \\
& R_3; \ 1, -1, 1, 1; \\
& R_4; \ 1, -1, -1, 1; \\
U; (0\frac{1}{2}\frac{1}{2}); & C_{2z}, \sigma_y, T; R_1; \ 1, 1, 1; \\
& R_2; \ 1, 1, -1, 1; \\
& R_3; \ 1, -1, 1, 1; \\
& R_4; \ 1, -1, -1, 1; \\
T; (\frac{1}{2}0\frac{1}{2}); & \sigma_x, \sigma_y, T; R_5; \ 2; \ i\sigma_2, \sigma_3, -\sigma_0; P-WNLs; \\
S; (\frac{1}{2}\frac{1}{2}0); & \sigma_x, \sigma_y, T; R_5; \ 2; \ i\sigma_2, \sigma_3, -\sigma_0; P-WNLs; \\
R; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & \sigma_x, \sigma_y, T; R_5; \ 2; \ i\sigma_2, \sigma_3, -\sigma_0; P-WNLs; \\
\Delta; \Gamma_Y; & \sigma_x, T C_{2z}; R_1; \ 1, 1, 1; \\
& R_2; \ 1, -1, 1; \\
D; \ XS; & \sigma_x, T C_{2z}; R_1; \ 1, 1, 1; \\
& R_2; \ 1, -1, 1; \\
P; \ UR; & \sigma_x, T C_{2z}; R_1; \ 1, 1, 1; \\
& R_2; \ 1, -1, 1; \\
B; \ ZT; & \sigma_x, T C_{2z}; R_1; \ 1, 1, 1; \\
& R_2; \ 1, -1, 1; \\
\Sigma; \Gamma_X; & \sigma_y, T \sigma_x; R_1; \ 1, 1, 1; \\
& R_2; \ 1, -1, 1; \\
C; \ YS; & \sigma_y, T \sigma_x; \{ R_1, R_2 \}; \ 2; \ \sigma_3, -i\sigma_2; \ WNL; \ \pi \\
E; \ TR; & \sigma_y, T \sigma_x; \{ R_1, R_2 \}; \ 2; \ \sigma_3, -i\sigma_2; \ WNL; \ \pi \\
A; \ ZU; & \sigma_y, T \sigma_x; R_1; \ 1, 1, 1; \\
& R_2; \ 1, -1, 1; \\
\Lambda; \ \Gamma Z; & C_{2z}, \sigma_y; R_1; \ 1, 1, 1; \\
& R_2; \ 1, 1, -1; \\
& R_3; \ 1, -1, 1; \\
& R_4; \ 1, -1, -1; \\
H; \ YT; & C_{2z}, \sigma_y; R_5; \ 2; \ -\sigma_2, \sigma_3; \ WNL; \ \pi \\
Q; \ \ SR; & C_{2z}, \sigma_y; R_5; \ 2; \ -\sigma_2, \sigma_3; \ WNL; \ \pi \\
G; \ \ XU; & C_{2z}, \sigma_y; R_1; \ 1, 1, 1; \\
& R_2; \ 1, 1, -1; \\
& R_3; \ 1, -1, 1; \\
& R_4; \ 1, -1, -1; \\
\end{array}
\]
Γ; (000); \( C_{2z}, \sigma_y, T \); R_1; 1, 1, 1; R_2; 1, 1, -1, 1; R_3; 1, -1, 1, 1; R_4; 1, -1, -1, 1;

Y; \( (\frac{1}{2} \bar{0} 0) \); \( \sigma_z, C_{2z}, T \); R_5; 2; \( i \sigma_2, \sigma_3, -\sigma_0 \); P-WNLs;

X; (0\( \frac{1}{2} \bar{0} \)); \( C_{2z}, \sigma_y, T \); R_1; 1, 1, 1; R_2; 1, 1, -1, 1; R_3; 1, -1, 1, 1; R_4; 1, -1, -1, 1;

Z; (00\( \frac{1}{2} \)); \( C_{2z}, \sigma_z, T \); \( \{ R_2, R_4 \} \); 2; \( i \sigma_3, \sigma_0, \sigma_1 \); P-NSZUTR;

U; (0\( \frac{1}{2} \bar{2} \)); \( C_{2z}, \sigma_z, T \); \( \{ R_2, R_4 \} \); 2; \( i \sigma_3, \sigma_0, \sigma_1 \); P-NSZUTR;

T; (\( \frac{1}{2} \bar{0} 0 \)); \( C_{2z}, \sigma_y, T \); \( \{ R_5, R_3 \} \); 4; \( i \Gamma_0,2,i \Gamma_0,1,-\Gamma_2,2 \); DP; 0

S; \( \frac{1}{2} \bar{2} \bar{0} \); \( \sigma_z, C_{2z}, T \); R_5; 2; \( i \sigma_2, \sigma_3, -\sigma_0 \); P-WNLs;

\Delta; ΓY; \( \sigma_z, TC_{2z} \); R_1; 1, 1, 1; R_2; 1, -1, 1;

D; XS; \( \sigma_z, TC_{2z} \); R_1; 1, 1, 1; R_2; 1, -1, 1;

P; UR; \( \sigma_z, TC_{2z} \); \( \{ R_1, R_1 \} \); 2; \( \sigma_0, -i \sigma_2 \); L-NSZUTR;

B; ZT; \( \sigma_z, TC_{2z} \); \( \{ R_1, R_1 \} \); 2; \( \sigma_0, -i \sigma_2 \); L-NSZUTR;

Σ; ΓX; \( \sigma_y, TC_{2z} \); R_1; 1, 1, 1; R_2; 1, -1, 1;

C; YS; \( \sigma_y, TC_{2z} \); \( \{ R_1, R_2 \} \); 2; \( \sigma_3, -i \sigma_2 \); WNL; \( \pi \)

E; TR; \( \sigma_y, TC_{2z} \); \( \{ R_1, R_1 \} \); 2; \( -i \sigma_0, -i \sigma_2 \); L-NSZUTR;

A; ZU; \( \sigma_y, TC_{2z} \); \( \{ R_1, R_2 \} \); 2; \( -i \sigma_3, \sigma_1 \); L-NSZUTR;

A; ΓZ; \( C_{2z}, \sigma_y \); R_1; 1, 1, 1; R_2; 1, 1, -1; R_3; 1, -1, 1; R_4; 1, -1, -1;

H; YT; \( C_{2z}, \sigma_y \); R_5; 2; \( -\sigma_2, \sigma_3 \); WNL; \( \pi \)

Q; SR; \( C_{2z}, \sigma_y \); R_5; 2; \( -\sigma_2, \sigma_3 \); WNL; \( \pi \)

G; XU; \( C_{2z}, \sigma_y \); R_1; 1, 1, 1; R_2; 1, 1, -1; R_3; 1, -1, 1; R_4; 1, -1, -1;

Non-Centrosymmetric; without SOC
\(\Gamma_0; \{C_{2z}, \{200\}, \{\sigma_y|002\}\}; T; \text{Non-Centrosymmetric; without SOC}\)

| \(\Gamma\) | (000) | \(C_{2z}, \sigma_y, T; R_1\) | 1, 1, 1; |
| --- | --- | --- | --- |
| \(R_2\) | 1, 1, -1, 1; |
| \(R_3\) | 1, -1, 1, 1; |
| \(R_4\) | 1, -1, -1, 1; |
| \(Y\) | \(\{3/20\}\); \(\sigma_x, \sigma_y, T; R_5\) | 2; \(i\sigma_2, \sigma_3, -\sigma_0; \) P-WNLs; |
| \(X\) | (0 1/2 0); \(C_{2z}, \sigma_y, T; R_1\) | 1, 1, 1; |
| \(R_2\) | 1, 1, -1, 1; |
| \(R_3\) | 1, -1, 1, 1; |
| \(R_4\) | 1, -1, -1, 1; |
| \(Z\) | (0 0 1/2); \(\sigma_x, C_{2z}, T; \{R_2, R_4\}\); 2; \(i\sigma_3, \sigma_0, \sigma_1; \) P-WNLs; |
| \(\{R_6, R_8\}\); 2; \(i\sigma_3, -\sigma_0, \sigma_1; \) P-WNLs; |
| \(U\) | (0 1 1/2); \(\sigma_z, C_{2z}, T; \{R_2, R_4\}\); 2; \(i\sigma_3, \sigma_0, \sigma_1; \) P-WNLs; |
| \(\{R_6, R_8\}\); 2; \(i\sigma_3, -\sigma_0, \sigma_1; \) P-WNLs; |
| \(T\) | (1/2 0 1/2); \(\sigma_y, C_{2z}, T; R_5\) | 2; \(i\sigma_2, \sigma_3, -\sigma_0; \) P-WNLs; |
| \(S\) | (1/2 1/2 0); \(\sigma_x, \sigma_y, T; R_5\) | 2; \(i\sigma_2, \sigma_3, -\sigma_0; \) P-WNLs; |
| \(R\) | (1 1/2 1/2); \(\sigma_y, C_{2z}, T; R_5\) | 2; \(i\sigma_2, \sigma_3, -\sigma_0; \) P-WNLs; |
| \(\Delta\) | \(\Gamma Y; \sigma_x, TC_{2z}; R_1\) | 1, 1, 1; |
| \(R_2\) | 1, -1, 1; |
| \(D\) | \(X S; \sigma_x, TC_{2z}; R_1\) | 1, 1, 1; |
| \(R_2\) | 1, -1, 1; |
| \(P; UR; \sigma_x, TC_{2z}; \{R_1, R_2\}\); 2; \(-i\sigma_3, \sigma_1; \) WNL; \(\pi\) |
| \(B; Z T; \sigma_x, TC_{2z}; \{R_1, R_2\}\); 2; \(-i\sigma_3, \sigma_1; \) WNL; \(\pi\) |
| \(\Sigma; \Gamma X; \sigma_y, T\sigma_x; R_1\) | 1, 1, 1; |
| \(R_2\) | 1, -1, 1; |
| \(C; Y S; \sigma_y, T\sigma_x; \{R_1, R_2\}\); 2; \(\sigma_3, -i\sigma_2; \) WNL; \(\pi\) |
| \(E; TR; \sigma_y, T\sigma_x; R_1\) | 1, -i, 1; |
| \(R_2\) | 1, i, 1; |
| \(A; Z U; \sigma_y, T\sigma_x; \{R_1, R_2\}\); 2; \(-i\sigma_3, -i\sigma_2; \) WNL; \(\pi\) |
| \(\Lambda; \Gamma Z; C_{2z}, \sigma_y; R_1\) | 1, 1, 1; |
| \(R_2\) | 1, 1, -1; |
| \(R_3\) | 1, -1, 1; |
| \(R_4\) | 1, -1, -1; |
| \(H; YT; C_{2z}, \sigma_y; R_5\) | 2; \(-\sigma_2, \sigma_3; \) WNL; \(\pi\) |
| \(Q; SR; C_{2z}, \sigma_y; R_5\) | 2; \(-\sigma_2, \sigma_3; \) WNL; \(\pi\) |
| \(G; X U; C_{2z}, \sigma_y; R_1\) | 1, 1, 1; |
| \(R_2\) | 1, 1, -1; |
| \(R_3\) | 1, -1, 1; |
| \(R_4\) | 1, -1, -1; |
5. SG 31-40

SG 31
Γ₀; \{C_{2v}; \frac{1}{2}; \frac{1}{2} \}; \{σ₀|000\}; \text{T; Non-Centrosymmetric; without SOC}

Γ; (000); \(C_{2v};σ_y;T\); \(R_1\); 1; 1,1,1;
R₂; 1; 1,−1,1;
R₃; 1; −1,1,1;
R₄; 1; −1,−1,1;
Y; (\frac{1}{2};00); \(σ_z;σ_y;T\); \(R_5\); 2; \(iσ_2;σ_3;−σ_0\); P-WNLs;
X; (0\frac{1}{2};0); \(C_{2v};σ_y;T\); \(R_1\); 1; 1,1,1;
R₂; 1; 1,−1,1;
R₃; 1; −1,1,1;
R₄; 1; −1,−1,1;
Z; (00\frac{1}{2}); \(C_{2v};σ_y;T\); \(\{R_2;R_4\}\); 2; \(iσ_3;σ_0;σ_1\); P-NSZUTR;
\{R₀;R₈\}; 2; \(iσ_3;−σ₀;σ₁\); P-NSZUTR;
U; (0\frac{1}{2}\frac{1}{2}); \(C_{2v};σ_y;T\); \(\{R_2;R_4\}\); 2; \(iσ_3;σ_0;σ_1\); P-NSZUTR;
\{R₀;R₈\}; 2; \(iσ_3;−σ₀;σ₁\); P-NSZUTR;
T; (\frac{1}{2};0\frac{1}{2}); \(C_{2v};σ_y;T\); \(R_5\); 2; \(iσ_2;σ_3;−σ_0\); P-WNL/NS;
S; (\frac{1}{2};\frac{1}{2};0); \(σ_z;σ_y;T\); \(R_5\); 2; \(iσ_2;σ_3;−σ_0\); P-WNLs;
R; (\frac{1}{2};\frac{1}{2};\frac{1}{2}); \(C_{2v};σ_y;T\); \(R_5\); 2; \(iσ_2;σ_3;−σ_0\); P-WNL/NS;
Δ; ΓΥ; \(σ_z;TC_{2v}\); \(R_1\); 1; 1,1;
R₂; 1; −1,1;
D; XS; \(σ_z;TC_{2v}\); \(R_1\); 1; 1,1;
R₂; 1; −1,1;
P; UR; \(σ_z;TC_{2v}\); \(\{R_1;R_2\}\); 2; \(−iσ_3;−iσ_2\); L-NSZUTR;
B; ZT; \(σ_z;TC_{2v}\); \(\{R_1;R_2\}\); 2; \(−iσ_3;−iσ_2\); L-NSZUTR;
Σ; ΓΧ; \(σ_y;Tσ_z\); \(R_1\); 1; 1,1;
R₂; 1; −1,1;
C; YS; \(σ_y;Tσ_z\); \(\{R_1;R_2\}\); 2; \(σ_3;−iσ_2\); WNL; π
E; TR; \(σ_y;Tσ_z\); \(\{R_1;R_2\}\); 2; \(σ_3;σ_1\); L-NSZUTR;
A; ZU; \(σ_y;Tσ_z\); \(\{R_1;R_2\}\); 2; \(σ₀;−iσ_2\); L-NSZUTR;
\{R_2;R_2\}; 2; \(−σ₀;−iσ_2\); L-NSZUTR;
Λ; ΓΖ; \(C_{2v};σ_y\); \(R_1\); 1; 1,1;
R₂; 1; 1,−1;
R₃; 1; −1,1;
R₄; 1; −1,−1;
H; YT; \(C_{2v};σ_y\); \(R_5\); 2; \(−σ_2;σ_3\); WNL; π
Q; SR; \(C_{2v};σ_y\); \(R_5\); 2; \(−σ_2;σ_3\); WNL; π
G; XU; \(C_{2v};σ_y\); \(R_1\); 1; 1,1;
R₂; 1; 1,−1;
R₃; 1; −1,1;
R₄; 1; −1,−1;
$\Gamma_0; \{C_{2v}, |\frac{1}{2} \pm 0\}; \{\sigma_y | 0 \pm 0\}; \mathcal{T}; \text{Non-Centrosymmetric; without SOC}$

$\Gamma; (000); C_{2v}, \sigma_y, \mathcal{T}; R_1; 1, 1, 1;$
R_2; 1, 1, -1, 1;
R_3; 1, -1, 1, 1;
R_4; 1, -1, -1, 1;

Y; (0\frac{1}{2}00); \sigma_z, C_{2v}, \mathcal{T}; R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs};$

X; (0\frac{1}{2}00); \sigma_y, C_{2v}, \mathcal{T}; R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs};$

Z; (00\frac{1}{2}); C_{2v}, \sigma_y, \mathcal{T}; R_1; 1, 1, 1, 1;
R_2; 1, 1, 1, 1;
R_3; 1, -1, 1, 1;
R_4; 1, -1, -1, 1;

U; (0\frac{1}{2}0\frac{1}{2}); \sigma_y, C_{2v}, \mathcal{T}; R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs};$

T; (0\frac{1}{2}0\frac{1}{2}); \sigma_z, C_{2v}, \mathcal{T}; R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs};$

S; (\frac{1}{2}0\frac{1}{2}0); \sigma_z, C_{2v}, \mathcal{T}; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{P-WNLs};
\{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{P-WNLs};$

R; (\frac{1}{2}0\frac{1}{2}0); \sigma_z, C_{2v}, \mathcal{T}; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{P-WNLs};
\{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{P-WNLs};$

$\Delta; \Gamma Y; \sigma_z, T_{C_{2v}}; R_1; 1, 1, 1;
R_2; 1, -1, 1,$

D; XS; $\sigma_z, T_{C_{2v}}; \{R_1, R_2\}; 2; \sigma_3, \sigma_1; \text{WNL}; \pi$

P; UR; $\sigma_z, T_{C_{2v}}; \{R_1, R_2\}; 2; \sigma_3, \sigma_1; \text{WNL}; \pi$

B; ZT; $\sigma_z, T_{C_{2v}}; R_1; 1, 1, 1;
R_2; 1, -1, 1,$

$\Sigma; \Gamma X; \sigma_y, T_{\sigma_z}; R_1; 1, 1, 1;
R_2; 1, -1, 1,$

C; YS; $\sigma_y, T_{\sigma_z}; \{R_3, R_5\}; 2; \sigma_3, -i\sigma_2; \text{WNL}; \pi$

E; TR; $\sigma_y, T_{\sigma_z}; \{R_1, R_2\}; 2; \sigma_3, -i\sigma_2; \text{WNL}; \pi$

A; ZU; $\sigma_y, T_{\sigma_z}; R_1; 1, 1, 1;
R_2; 1, -1, 1,$

$\Lambda; \Gamma Z; C_{2v}, \sigma_y; R_1; 1, 1, 1;
R_2; 1, 1, -1,$
R_3; 1, -1, 1;
R_4; 1, -1, -1;

H; YT; $C_{2v}, \sigma_y; R_5; 2; -\sigma_2, \sigma_3; \text{WNL}; \pi$

Q; SR; $C_{2v}, \sigma_y, E; R_5; 1; 1, -i, 1;
R_6; 1, -1, -i, 1;
R_7; 1, 1, i, 1,$
R_8; 1, -1, i, 1;

G; XU; $C_{2v}, \sigma_y; R_5; 2; \sigma_2, -i\sigma_3; \text{WNL}; \pi$
Γ₀: \{C_{2z},\{\frac{1}{2}\{\frac{3}{2}\}\}\}, \{\sigma_y,0,\frac{1}{2}\}\}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC}

Γ; (000); \{C_{2z},\sigma_y,\mathcal{T}; R_1; \} 1, 1, 1;
R_2; 1, 1, -1, 1;
R_3; 1, -1, 1, 1;
R_4; 1, -1, -1, 1;
Y; (\frac{3}{2}00); \{C_{2z},\sigma_y,\mathcal{T}; R_5; \} 2; i\sigma_2,\sigma_3, -\sigma_0; \text{P-WNLs;}
X; (0\frac{3}{2}0); \{C_{2z},\sigma_y,\mathcal{T}; R_5; \} 2; i\sigma_2,\sigma_3, -\sigma_0; \text{P-WNLs;}
Z; (00\frac{3}{2}); \{C_{2z},\sigma_y,\mathcal{T}; \{R_2, R_4; \} 2; i\sigma_3,\sigma_0,\sigma_1; \text{P-NS}_{\text{ZUTR}}
\{R_6, R_8; \} 2; i\sigma_3, -\sigma_0,\sigma_1; \text{P-NS}_{\text{ZUTR}}
U; (0\frac{3}{2}1); \{C_{2z},\sigma_y,\mathcal{T}; R_5; \} 2; i\sigma_2,\sigma_3, -\sigma_0; \text{P-WNL/NS;}
T; (\frac{3}{2}0\frac{3}{2}); \{C_{2z},\sigma_y,\mathcal{T}; \{R_5, R_5; \} 4; i\Gamma_{0,2},i\Gamma_{0,1}, -\Gamma_{2,2}; \text{DP;}
S; (1\frac{3}{2}0); \{C_{2z},\sigma_y,\mathcal{T}; \{R_2, R_4; \} 2; i\sigma_3,\sigma_0,\sigma_1; \text{P-WNLs;}
\{R_6, R_8; \} 2; i\sigma_3, -\sigma_0,\sigma_1; \text{P-WNLs;}
R; (\frac{3}{2}2\frac{3}{2}); \{C_{2z},\sigma_y,\mathcal{T}; \{R_2, R_4; \} 2; i\sigma_3,\sigma_0,\sigma_1; \text{P-NS}_{\text{ZUTR}}
\{R_6, R_8; \} 2; i\sigma_3, -\sigma_0,\sigma_1; \text{P-NS}_{\text{ZUTR}}
Δ; \Gamma_Y; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, 1, 1;
\{R_2; 1, -1, 1; \}
\text{D; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, 1, 1; \}
\text{E; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, 1, -1; \}
\text{F; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\text{G; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, -1; \}
\text{H; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\text{I; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, -1; \}
\text{J; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\text{K; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, -1; \}
\text{L; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\text{M; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, -1; \}
\text{N; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\text{O; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, -1; \}
\text{P; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\text{Q; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, -1; \}
\text{R; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\text{S; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, -1; \}
\text{T; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\text{U; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, -1; \}
\text{V; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\text{W; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, -1; \}
\text{X; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\text{Y; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, -1; \}
\text{Z; \{C_{2z},\sigma_y,\mathcal{T}; \} 1, -1, 1; \}
\( \Gamma_0; \{ C_{2z}, \frac{1}{2} \frac{1}{2} \frac{0}{} \}, \{ \sigma_y | \frac{1}{2} \frac{1}{2} \frac{0}{} \} \); Non-Centrosymmetric; without SOC

\[ \begin{align*}
\Gamma; (000); & C_{2z}, \sigma_y, T; R_1; 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, 1, 1; \\
Y; (\frac{1}{2}00); & \sigma_z, C_{2z}, T; R_5; 2, i \sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs; } \pi \\
X; (0\frac{1}{2}0); & \sigma_y, C_{2z}, T; R_5; 2, i \sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs; } \pi \\
Z; (00\frac{1}{2}); & \sigma_y, C_{2z}, T; \{ R_2, R_4 \}; 2, i \sigma_3, \sigma_0, \sigma_1; \text{P-WNLs; } \pi \\
& \{ R_6, R_8 \}; 2, i \sigma_3, -\sigma_0, \sigma_1; \text{P-WNLs; } \pi \\
U; (0\frac{3}{2}0); & \sigma_z, C_{2z}, T; R_5; 2, i \sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs; } \pi \\
\Delta; \Gamma_Y; & \sigma_z, TC_{2z}; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, 1, 1; \\
D; X; & \sigma_z, TC_{2z}; \{ R_1, R_2 \}; 2, \sigma_3, \sigma_1; \text{WNL; } \pi \\
P; U; & \sigma_z, TC_{2z}; R_1; 1, -i, 1; \\
& R_2; 1, i, 1; \\
B; Z; & \sigma_z, TC_{2z}; \{ R_1, R_2 \}; 2, -i \sigma_3, -\sigma_2; \text{WNL; } \pi \\
\Sigma; \Gamma_X; & \sigma_y, T \sigma_z; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
C; Y; & \sigma_y, T \sigma_z; \{ R_1, R_2 \}; 2, \sigma_3, -i \sigma_2; \text{WNL; } \pi \\
E; T; & \sigma_y, T \sigma_z; R_1; 1, -i, 1; \\
& R_2; 1, i, 1; \\
A; Z; & \sigma_y, T \sigma_z; \{ R_1, R_2 \}; 2, -i \sigma_3, -i \sigma_2; \text{WNL; } \pi \\
\Lambda; \Gamma_Z; & C_{2z}, \sigma_y; R_1; 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, 1, 1; \\
H; Y; & C_{2z}, \sigma_y; R_5; 2, -\sigma_2, \sigma_3; \text{WNL; } \pi \\
Q; S; & C_{2z}, \sigma_y, E; R_5; 1, -i, 1, 1; \\
& R_6; 1, -1, -i, 1; \\
& R_7; 1, i, 1, 1; \\
& R_8; 1, -i, 1, 1; \\
G; X; & C_{2z}, \sigma_y; R_5; 2, \sigma_2, -i \sigma_3; \text{WNL; } \pi \\
\end{align*} \]
\[ \Gamma^0_0; \{ C_{2z}(000), \{ \sigma_y(000) \}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma; & (000); C_{2z}, \sigma_y, \mathcal{T}; R_1; 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
Y; & (1 \frac{1}{2} 0); C_{2z}, \sigma_y, \mathcal{T}; R_1; 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
Z; & (00 \frac{1}{2}); C_{2z}, \sigma_y, \mathcal{T}; R_1; 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
T; & (1 \frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{2z}, \sigma_y, \mathcal{T}; R_1; 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
S; & (0 \frac{1}{2} 0); C_{2z}, \mathcal{T}; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
R; & (0 \frac{1}{4} \frac{1}{4}); C_{2z}, \mathcal{T}; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
\Lambda; \Gamma Z; & C_{2z}, \sigma_y; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
& R_3; 1, -1, 1; \\
& R_4; 1, -1, -1; \\
H; YT; & C_{2z}, \sigma_y; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
& R_3; 1, -1, 1; \\
& R_4; 1, -1, -1; \\
D; SR; & C_{2z}; R_1; 1, 1; \\
& R_2; 1, -1; \\
A; ZT; & \sigma_y, \mathcal{T}, \sigma_z; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
\Sigma; \Gamma Y; & \sigma_y, \mathcal{T}, \sigma_z; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
\Delta; \Gamma \Delta; & \sigma_z, \mathcal{T} C_{2z}; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
B; ZB; & \sigma_z, \mathcal{T} C_{2z}; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
G; TG; & \sigma_z, \mathcal{T} C_{2z}; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
F; YF; & \sigma_z, \mathcal{T} C_{2z}; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
E; TE; & \sigma_y, \mathcal{T}, \sigma_z; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
C; YC; & \sigma_y, \mathcal{T}, \sigma_z; R_1; 1, 1, 1; \\
& R_2; 1, -1, 1;
\[ \Gamma^6; \{C_{2v},[00\frac{1}{2}1]\}, \{\sigma_y[000]\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma: (000); & \quad C_{2s},\sigma_y, T; \\
& R_1: 1,1,1; \\
& R_2: 1,1,-1; \\
& R_3: 1,-1,1; \\
& R_4: 1,-1,-1; \\
Y: (\frac{1}{2}\frac{1}{2}0); & \quad C_{2s},\sigma_y, T; \\
& R_1: 1,1,1; \\
& R_2: 1,1,-1; \\
& R_3: 1,-1,1; \\
& R_4: 1,-1,-1; \\
Z: (00\frac{1}{2}); & \quad C_{2s},\sigma_y, T; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \quad \text{P-NSZTR}; \\
& \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \quad \text{P-NSZTR}; \\
T: (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & \quad C_{2s},\sigma_y, T; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \quad \text{P-NSZTR}; \\
& \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \quad \text{P-NSZTR}; \\
S: (0\frac{1}{2}0); & \quad C_{2s}, T; \\
& R_1: 1,1; \\
& R_2: 1,-1; \\
R: (0\frac{1}{2}\frac{1}{2}); & \quad C_{2s}, T; \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \quad \text{P-NSZTR}; \\
A: \Gamma\Gamma; & \quad C_{2s}, \sigma_y; \\
& R_1: 1,1; \\
& R_2: 1,1,-1; \\
& R_3: 1,-1,1; \\
& R_4: 1,-1,-1; \\
H: \Gamma T; & \quad C_{2s}, \sigma_y; \\
& R_1: 1,1; \\
& R_2: 1,1,-1; \\
& R_3: 1,-1,1; \\
& R_4: 1,-1,-1; \\
D: \Gamma\Sigma; & \quad C_{2s}; \\
& R_1: 1,1; \\
& R_2: 1,-1; \\
A: \Gamma T; & \quad \sigma_y, T\sigma_z; \{R_1, R_1\}; 2; \sigma_0, -i\sigma_2; \quad \text{L-NSZTR}; \\
& \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \quad \text{L-NSZTR}; \\
\Sigma: \Gamma Y; & \quad \sigma_y, T\sigma_z; \\
& R_1: 1,1; \\
& R_2: 1,-1,1; \\
\Delta: \Gamma \Delta; & \quad \sigma_y, T\sigma_z; \\
& R_1: 1,1; \\
& R_2: 1,-1,1; \\
B: \Gamma Y; & \quad \sigma_y, T\sigma_z; \{R_1, R_2\}; 2; -i\sigma_3, -i\sigma_2; \quad \text{L-NSZTR}; \\
G: \Gamma T; & \quad \sigma_y, T\sigma_z; \{R_1, R_2\}; 2; -i\sigma_3, -i\sigma_2; \quad \text{L-NSZTR}; \\
F: \Gamma Y; & \quad \sigma_y, T\sigma_z; \\
& R_1: 1,1; \\
& R_2: 1,-1,1; \\
E: \Gamma T; & \quad \sigma_y, T\sigma_z; \{R_1, R_1\}; 2; \sigma_0, -i\sigma_2; \quad \text{L-NSZTR}; \\
& \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \quad \text{L-NSZTR}; \\
C: \Gamma Y; & \quad \sigma_y, T\sigma_z; \\
& R_1: 1,1; \\
& R_2: 1,-1,1; \\
\]
\[ \Gamma_0^\bullet; \{ C_{2z}(000), \sigma_y(00\frac{1}{2}) \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{array}{ll}
\Gamma; (000); \quad C_{2z}, \sigma_y, T; & R_1; 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
Y; (\frac{1}{2} \frac{1}{2} 0); \quad C_{2z}, \sigma_y, T; & R_1; 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
Z; (00 \frac{1}{2}); \quad \sigma_x, C_{2z}, T; & R_2, R_4; \{ 2; i \sigma_3, \sigma_0, \sigma_1 \}; \text{P-WNLs;} \\
& R_6, R_8; \{ 2; i \sigma_3, -\sigma_0, \sigma_1 \}; \text{P-WNLs;} \\
T; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad \sigma_x, C_{2z}, T; & R_2, R_4; \{ 2; i \sigma_3, \sigma_0, \sigma_1 \}; \text{P-WNLs;} \\
& R_6, R_8; \{ 2; i \sigma_3, -\sigma_0, \sigma_1 \}; \text{P-WNLs;} \\
S; (0 \frac{1}{2} 0); \quad C_{2z}, T; & R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
R; (0 \frac{1}{2} \frac{1}{2}); \quad C_{2z}, T; & R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
A; \Gamma Z; \quad C_{2z}, \sigma_y; & R_1; 1, 1, 1; \\
& R_2; 1, 1, -1; \\
& R_3; 1, -1, -1; \\
& R_4; 1, -1, -1; \\
H; \Gamma T; \quad C_{2z}, \sigma_y; & R_1; 1, 1, 1; \\
& R_2; 1, 1, -1; \\
& R_3; 1, -1, -1; \\
& R_4; 1, -1, -1; \\
D; \Gamma R; \quad C_{2z}; & R_1; 1, 1; \\
& R_2; 1, -1; \\
A; \Gamma T; \quad \sigma_y, T \sigma_x; & R_1, R_2; \{ 2; -i \sigma_3, -i \sigma_2 \}; \text{WNL;} \quad \pi \\
\Sigma; \Gamma Y; \quad \sigma_y, T \sigma_x; & R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
\Delta; \Gamma \Delta; \quad \sigma_x, T C_{2z}; & R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
B; \Gamma Z; \quad \sigma_x, T C_{2z}; & R_1, R_2; \{ 2; -i \sigma_3, \sigma_1 \}; \text{WNL;} \quad \pi \\
G; \Gamma T; \quad \sigma_x, T C_{2z}; & R_1, R_2; \{ 2; -i \sigma_3, \sigma_1 \}; \text{WNL;} \quad \pi \\
F; \Gamma \sigma; \quad \sigma_x, T C_{2z}; & R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
E; \Gamma \sigma; \quad \sigma_y, T \sigma_x; & R_1, R_2; \{ 2; -i \sigma_3, -i \sigma_2 \}; \text{WNL;} \quad \pi \\
C; \Gamma \sigma; \quad \sigma_y, T \sigma_x; & R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
\end{array}
\]
SG 38

Γ \text{b}; \{ \begin{array}{l} C_{2y}[000], \{ \sigma_x[000], T \} \end{array} \}; \text{Non-Centrosymmetric; without SOC}

| Point | Matrix Elements | R1 | R2 | R3 | R4 |
|-------|----------------|----|----|----|----|
| Γ | (000) | $C_{2y}, \sigma_x, T$ | 1, 1, 1 | 1, -1, 1 | -1, 1, 1 | -1, -1, 1 |
| Y | ($\frac{1}{2} \frac{1}{2} 0$) | $C_{2y}, \sigma_x, T$ | 1, 1, 1 | 1, -1, 1 | -1, 1, 1 | -1, -1, 1 |
| Z | (00 $\frac{1}{2}$) | $C_{2y}, \sigma_x, T$ | 1, 1, 1 | 1, -1, 1 | -1, 1, 1 | -1, -1, 1 |
| T | ($\frac{1}{2} \frac{1}{2} \frac{1}{2}$) | $C_{2y}, \sigma_x, T$ | 1, 1, 1 | 1, -1, 1 | -1, 1, 1 | -1, -1, 1 |
| S | (0 $\frac{1}{2} 0$) | $\sigma_x, T$ | 1, 1 | 1, -1 | -1, 1 |
| R | (0 $\frac{1}{2} \frac{1}{2}$) | $\sigma_x, T$ | 1, 1 | 1, -1 | -1, 1 |
| Λ | ΓZ | $\sigma_x, T \sigma_z$ | 1, 1 | 1, -1 | -1, 1 |
| H | YT | $\sigma_x, T \sigma_z$ | 1, 1 | 1, -1 | -1, 1 |
| D | SR | $E, T \sigma_z$ | 1, 1 | 1, -1 | -1, 1 |
| A | ZT | $\sigma_x, T C_{2y}$ | 1, 1 | 1, -1 | -1, 1 |
| Σ | ΓY | $\sigma_x, T C_{2y}$ | 1, 1 | 1, -1 | -1, 1 |
| Δ | ΓΔ | $C_{2y}, \sigma_z$ | 1, 1 | 1, -1 | -1, 1 |
| B | ZB | $C_{2y}, \sigma_z$ | 1, 1 | 1, -1 | -1, 1 |
| G | TG | $C_{2y}, \sigma_z$ | 1, 1 | 1, -1 | -1, 1 |
| F | YF | $C_{2y}, \sigma_z$ | 1, 1 | 1, -1 | -1, 1 |
\[ E; \text{TE}; \sigma_z, TC_2y; R_1; 1; 1,1; R_2; 1; -1,1; \]
\[ C; \text{YC}; \sigma_z, TC_2y; R_1; 1; 1,1; R_2; 1; -1,1; \]
\[ \Gamma_0^0; \{ C_{2y}|000\}, \{ \sigma_x|\frac{1}{2},\frac{1}{2}|0 \}; T; \text{Non-Centrosymmetric; without SOC} \]

| Γ; (000); \( C_{2y},\sigma_x,T \) | \( R_1 \); | 1; 1,1,1; |
| --- | --- | --- |
| \( R_2 \); | 1; 1, -1,1; |
| \( R_3 \); | 1; -1,1,1; |
| \( R_4 \); | 1; -1, -1,1; |
| Y; (\( \frac{1}{2},\frac{1}{2},0 \)); \( C_{2y},\sigma_x,T \) | \( R_1 \); | 1; 1,1,1; |
| \( R_2 \); | 1; 1, -1,1; |
| \( R_3 \); | 1; -1,1,1; |
| \( R_4 \); | 1; -1, -1,1; |
| Z; (00\( \frac{1}{2} \)); \( C_{2y},\sigma_x,T \) | \( R_1 \); | 1; 1,1,1; |
| \( R_2 \); | 1; 1, -1,1; |
| \( R_3 \); | 1; -1,1,1; |
| \( R_4 \); | 1; -1, -1,1; |
| T; (\( \frac{1}{2},\frac{1}{2},\frac{1}{2} \)); \( C_{2y},\sigma_x,T \) | \( R_1 \); | 1; 1,1,1; |
| \( R_2 \); | 1; 1, -1,1; |
| \( R_3 \); | 1; -1,1,1; |
| \( R_4 \); | 1; -1, -1,1; |
| S; (0\( \frac{1}{2} \)); \( \sigma_x,T \) | \{ \( R_2, R_3 \); \} | 2; \( i\sigma_3,\sigma_4 \); | P-WNL; |
| R; (0\( \frac{1}{2},\frac{1}{2} \)); \( \sigma_x,T \) | \{ \( R_2, R_3 \); \} | 2; \( i\sigma_3,\sigma_4 \); | P-WNL; |
| Λ; ΓZ; \( \sigma_z,T\sigma_z \) | \( R_1 \); | 1; 1,1; |
| \( R_2 \); | 1; -1,1; |
| H; YT; \( \sigma_z,T\sigma_z \) | \( R_1 \); | 1; 1,1; |
| \( R_2 \); | 1; -1,1; |
| D; SR; \( E,T\sigma_z \) | \{ \( R_1, R_1 \); \} | 2; \( \sigma_0,-i\sigma_2 \); WNL; \( \pi \) |
| A; ZT; \( \sigma_z,TC_{2y} \) | \( R_1 \); | 1; 1,1; |
| \( R_2 \); | 1; -1,1; |
| Σ; ΓY; \( \sigma_z,TC_{2y} \) | \( R_1 \); | 1; 1,1; |
| \( R_2 \); | 1; -1,1; |
| Δ; ΓΔ; \( C_{2y},\sigma_z \) | \( R_1 \); | 1; 1,1; |
| \( R_2 \); | 1; 1, -1; |
| \( R_3 \); | 1; -1,1; |
| \( R_4 \); | 1; -1, -1; |
| B; ZB; \( C_{2y},\sigma_z \) | \( R_1 \); | 1; 1,1; |
| \( R_2 \); | 1; 1, -1; |
| \( R_3 \); | 1; -1,1; |
| \( R_4 \); | 1; -1, -1; |
| G; TG; \( C_{2y},\sigma_z \) | \( R_1 \); | 1; 1,1; |
| \( R_2 \); | 1; 1,1; |
| \( R_3 \); | 1; -1,1; |
| \( R_4 \); | 1; -1,1; |
| F; YF; \( C_{2y},\sigma_z \) | \( R_1 \); | 1; 1,1; |
| \( R_2 \); | 1; 1,1; |
| \( R_3 \); | 1; -1, -1; |
| \( R_4 \); | 1; -1, -1; |
| E; TE; \( \sigma_z,TC_{2y} \) | \( R_1 \); | 1; 1,1; |
| \( R_2 \); | 1; -1,1; |
| C; YC; \( \sigma_z,TC_{2y} \) | \( R_1 \); | 1; 1,1; |
| \( R_2 \); | 1; -1,1; |
\( \Gamma^6; \{ C_{2y}[000], \sigma_x[00\frac{1}{2}] \}; T; \) Non-Centrosymmetric; without SOC

| \( \Gamma \); (000) | \( C_{2y}, \sigma_x, T \); \( \Gamma_1 \); | 1; 1,1; |
| \( C_{2y}, \sigma_x, T \); \( \Gamma_2 \); | 1; 1, -1,1; |
| \( C_{2y}, \sigma_x, T \); \( \Gamma_3 \); | 1; -1,1,1; |
| \( C_{2y}, \sigma_x, T \); \( \Gamma_4 \); | 1; -1, -1,1; |

| \( Y \); \( \frac{1}{2} \frac{1}{2} 0 \) | \( C_{2y}, \sigma_x, T \); \( \Gamma_1 \); | 1; 1,1; |
| \( C_{2y}, \sigma_x, T \); \( \Gamma_2 \); | 1; 1, -1,1; |
| \( C_{2y}, \sigma_x, T \); \( \Gamma_3 \); | 1; -1,1,1; |
| \( C_{2y}, \sigma_x, T \); \( \Gamma_4 \); | 1; -1, -1,1; |

| \( Z \); (00\frac{1}{2}) | \( \sigma_x, C_{2y}, T \); \( \Gamma_5 \); | 2; \( i\sigma_2, \sigma_3, -\sigma_0 \); P-WNLs; |
| \( T \); \( \frac{1}{2} \frac{1}{2} \frac{1}{2} \) | \( \sigma_x, C_{2y}, T \); \( \Gamma_5 \); | 2; \( i\sigma_2, \sigma_3, -\sigma_0 \); P-WNLs; |

| \( \Delta \); \( \Gamma Z \) | \( \sigma_x, T \sigma_z \); \( \Gamma_1 \); | 1; 1,1; |
| \( \sigma_x, T \sigma_z \); \( \Gamma_2 \); | 1; -1,1; |
| \( \sigma_x, T \sigma_z \); \( \Gamma_3 \); | 1; 1,1; |
| \( \sigma_x, T \sigma_z \); \( \Gamma_4 \); | 1; -1,1; |

| \( D \); \( \Sigma \) | \( E, T \sigma_z \); \( \Gamma_1 \); | 1; 1,1; |
| \( \sigma_x, T \sigma_z \); \( \Gamma_2 \); | 1; -1,1; |

| \( A \); \( ZT \) | \( \sigma_x, T C_{2y} \); \{\( \Gamma_2, \Gamma_4 \); | 2; \( \sigma_3, \sigma_1 \); WNL; \( \pi \) |

| \( \Sigma \); \( \Gamma Y \) | \( \sigma_x, T C_{2y} \); \( \Gamma_1 \); | 1; 1,1; |
| \( \sigma_x, T C_{2y} \); \( \Gamma_2 \); | 1; -1,1; |

| \( \Delta \); \( \Gamma \Delta \) | \( C_{2y}, \sigma_z \); \( \Gamma_1 \); | 1; 1,1; |
| \( C_{2y}, \sigma_z \); \( \Gamma_2 \); | 1; 1, -1; |
| \( C_{2y}, \sigma_z \); \( \Gamma_3 \); | 1; -1,1; |
| \( C_{2y}, \sigma_z \); \( \Gamma_4 \); | 1; -1, -1; |

| \( B \); \( ZB \) | \( \sigma_x, C_{2y} \); \( \Gamma_5 \); | 2; \( \sigma_2, \sigma_3 \); WNL; \( \pi \) |

| \( G \); \( TG \) | \( \sigma_x, C_{2y} \); \( \Gamma_5 \); | 2; \( \sigma_2, \sigma_3 \); WNL; \( \pi \) |

| \( F \); \( YF \) | \( C_{2y}, \sigma_x \); \( \Gamma_1 \); | 1; 1,1; |
| \( C_{2y}, \sigma_x \); \( \Gamma_2 \); | 1; 1, -1; |
| \( C_{2y}, \sigma_x \); \( \Gamma_3 \); | 1; -1,1; |
| \( C_{2y}, \sigma_x \); \( \Gamma_4 \); | 1; -1, -1; |

| \( E \); \( TE \) | \( \sigma_x, T C_{2y} \); \{\( \Gamma_2, \Gamma_4 \); | 2; \( \sigma_3, \sigma_1 \); WNL; \( \pi \) |

| \( C \); \( YC \) | \( \sigma_x, T C_{2y} \); \( \Gamma_1 \); | 1; 1,1; |
| \( \sigma_x, T C_{2y} \); \( \Gamma_2 \); | 1; -1,1; |
| Group | Notation | Description |
|-------|----------|-------------|
| Γ    | (000)    | $C_{2y}, \sigma_x, T$; $R_1: 1, 1, 1$; $R_2: 1, 1, -1, 1$; $R_3: 1, -1, 1, 1$; $R_4: 1, -1, -1, 1$; Non-Centrosymmetric; without SOC |
| Y    | $(\frac{1}{2} \frac{1}{2} 0)$ | $C_{2y}, \sigma_x, T$; $R_1: 1, 1, 1$; $R_2: 1, 1, -1, 1$; $R_3: 1, -1, 1, 1$; $R_4: 1, -1, -1, 1$; |
| Z    | $(00 \frac{1}{2})$ | $\sigma_z, C_{2y}, T$; $R_5: 2; i\sigma_2, \sigma_3, -\sigma_0$; P-WNLs; |
| T    | $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $\sigma_z, C_{2y}, T$; $R_5: 2; i\sigma_2, \sigma_3, -\sigma_0$; P-WNLs; |
| S    | $(0 \frac{1}{2} 0)$ | $\sigma_z, T$; $\{R_2, R_4\}: 2; i\sigma_3, \sigma_1$; P-WNLs; |
| R    | $(0 \frac{1}{2} \frac{1}{2})$ | $\sigma_z, T$; $\{R_2, R_4\}: 2; i\sigma_3, \sigma_1$; P-WNLs; |
| Δ    | ΓZ      | $\sigma_z, T \sigma_z$; $R_1: 1, 1, 1$; $R_2: 1, -1, 1$; |
| H    | YT      | $\sigma_z, T \sigma_z$; $R_1: 1, 1, 1$; $R_2: 1, -1, 1$; |
| D    | SR      | $E, T \sigma_z$; $\{R_1, R_3\}: 2; \sigma_0, -i\sigma_2$; WNL; π |
| A    | ZT      | $\sigma_z, T C_{2y}$; $\{R_2, R_4\}: 2; \sigma_3, \sigma_1$; WNL; π |
| Σ    | ΓY      | $\sigma_z, T C_{2y}$; $R_1: 1, 1, 1$; $R_2: 1, -1, 1$; |
| Δ    | ΓΔ      | $C_{2y}, \sigma_z$; $R_1: 1, 1, 1$; $R_2: 1, 1, -1$; $R_3: 1, -1, 1$; $R_4: 1, -1, -1$; |
| B    | ZB      | $\sigma_z, C_{2y}$; $R_5: 2; \sigma_2, \sigma_3$; WNL; π |
| G    | TG      | $\sigma_z, C_{2y}$; $R_5: 2; -\sigma_2, \sigma_3$; WNL; π |
| F    | YF      | $C_{2y}, \sigma_z$; $R_1: 1, 1, -1$; $R_2: 1, 1, 1$; $R_3: 1, -1, -1$; $R_4: 1, -1, 1$; |
| E    | TE      | $\sigma_z, T C_{2y}$; $\{R_2, R_4\}: 2; \sigma_3, \sigma_1$; WNL; π |
| C    | YC      | $\sigma_z, T C_{2y}$; $R_1: 1, 1, 1$; $R_2: 1, -1, 1$; |
\[ \Gamma_0; \{ C_2z|000\}, \{ \sigma_y|000\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (\mathbf{000}) \]:

\[ C_{2z}, \sigma_y, T; \]

- \[ R_1; 1, 1, 1, 1 \];
- \[ R_2; 1, 1, -1, 1 \];
- \[ R_3; 1, -1, 1, 1 \];
- \[ R_4; 1, -1, -1, 1 \];

\[ Y; (0\frac{1}{2} \frac{1}{2}) \]:

\[ C_{2z}, \sigma_y, T; \]

- \[ R_1; 1, 1, 1, 1 \];
- \[ R_2; 1, 1, -1, 1 \];
- \[ R_3; 1, -1, 1, 1 \];
- \[ R_4; 1, -1, -1, 1 \];

\[ X; (\frac{1}{4} 0 \frac{1}{4}) \]:

\[ C_{2z}, \sigma_y, T; \]

- \[ R_1; 1, 1, 1, 1 \];
- \[ R_2; 1, 1, -1, 1 \];
- \[ R_3; 1, -1, 1, 1 \];
- \[ R_4; 1, -1, -1, 1 \];

\[ Z; (\frac{1}{2} \frac{1}{2} 0) \]:

\[ C_{2z}, \sigma_y, T; \]

- \[ R_1; 1, 1, 1, 1 \];
- \[ R_2; 1, 1, -1, 1 \];
- \[ R_3; 1, -1, 1, 1 \];
- \[ R_4; 1, -1, -1, 1 \];

\[ L; (\frac{1}{4} 0 \frac{1}{4}) \]:

\[ E, T; \]

- \[ R_1; 1, 1, 1 \];

\[ \Lambda; \Gamma Z/\Gamma \Lambda; \]

\[ C_{2z}, \sigma_y; \]

- \[ R_1; 1, 1, 1 \];
- \[ R_2; 1, 1, -1 \];
- \[ R_3; 1, -1, 1 \];
- \[ R_4; 1, -1, -1 \];

\[ G; XG/XY; \]

\[ C_{2z}, \sigma_y; \]

- \[ R_1; 1, 1, 1 \];
- \[ R_2; 1, 1, -1 \];
- \[ R_3; 1, -1, 1 \];
- \[ R_4; 1, -1, -1 \];

\[ H; YH/YX; \]

\[ C_{2z}, \sigma_y; \]

- \[ R_1; 1, 1, 1 \];
- \[ R_2; 1, 1, -1 \];
- \[ R_3; 1, -1, 1 \];
- \[ R_4; 1, -1, -1 \];

\[ Q; ZQ; \]

\[ C_{2z}, \sigma_y; \]

- \[ R_1; 1, 1, 1 \];
- \[ R_2; 1, 1, -1 \];
- \[ R_3; 1, -1, 1 \];
- \[ R_4; 1, -1, -1 \];

\[ \Sigma; \Gamma X/\Gamma \Sigma; \] \[ \sigma_y, T \sigma_x; \]

- \[ R_1; 1, 1, 1 \];
- \[ R_2; 1, -1, 1 \];

\[ C; YC/YZ; \] \[ \sigma_y, T \sigma_x; \]

- \[ R_1; 1, 1, 1 \];
- \[ R_2; 1, -1, 1 \];

\[ A; ZA/ZY; \] \[ \sigma_y, T \sigma_x; \]

- \[ R_1; 1, 1, 1 \];
- \[ R_2; 1, -1, 1 \];

\[ U; XU; \] \[ \sigma_y, T \sigma_x; \]

- \[ R_1; 1, 1, 1 \];
- \[ R_2; 1, -1, 1 \];

\[ \Delta; \Gamma Y/\Gamma \Delta; \] \[ \sigma_x, T C_{2z}; \]

- \[ R_1; 1, 1, 1 \];
- \[ R_2; 1, -1, 1 \];
\( D; \) XD/XZ; \( \sigma_x, T C_{2z}; R_1; 1, 1, 1; \)
\( R_2; 1; -1, 1; \)
\( B; \) ZB/ZX; \( \sigma_x, T C_{2z}; R_1; 1, 1, 1; \)
\( R_2; 1; -1, 1; \)
\( R; \) YR; \( \sigma_x, T C_{2z}; R_1; 1, 1, 1; \)
\( R_2; 1; -1, 1; \)

\( \Gamma; (000); C_{2z}, \sigma_y, T; R_1; 1, 1, 1; \)
\( R_2; 1, 1, -1, 1; \)
\( R_3; 1, -1, 1, 1; \)
\( R_4; 1, -1, -1, 1; \)
\( Y; (01\frac{1}{2}0); \sigma_x, C_{2z}, T; R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; P\text{-WNLs}; \)
\( X; (\frac{1}{2}01); \sigma_y, C_{2z}, T; R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; P\text{-WNLs}; \)
\( Z; (\frac{1}{2}\frac{1}{2}0); \sigma_x, C_{2z}, T; \{R_2, R_4\}; 2, i\sigma_3, \sigma_0, \sigma_1; P\text{-WNLs}; \)
\( \{R_6, R_8\}; 2, i\sigma_3, -\sigma_0, \sigma_1; P\text{-WNLs}; \)
\( L; (\frac{1}{2}00); E, T; R_1; 1, 1, 1; \)
\( \Lambda; \Gamma Z/\Gamma A; C_{2z}, \sigma_y; R_1; 1, 1, 1; \)
\( R_2; 1, 1, -1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, -1; \)
\( G; \) XG/XY; \( C_{2z}, \sigma_y; R_5; 2; \sigma_2, -i\sigma_3; \text{WNL}; \pi \)
\( H; \) YH/YX; \( C_{2z}, \sigma_y; R_5; 2; -\sigma_2, \sigma_3; \text{WNL}; \pi \)
\( Q; \) ZQ; \( C_{2z}, \sigma_y, E; R_5; 1, 1, -i, 1; \)
\( R_6; 1, -1, -i, 1; \)
\( R_7; 1, 1, i, 1; \)
\( R_8; 1, -1, i, 1; \)
\( \Sigma; \) \( \Gamma X/\Gamma \Sigma; \sigma_y, T \sigma_x; R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( C; \) YC/YZ; \( \sigma_y, T \sigma_x; \{R_1, R_2\}; 2; \sigma_3, -i\sigma_2; \text{WNL}; \pi \)
\( A; \) ZA/ZY; \( \sigma_y, T \sigma_x; \{R_1, R_2\}; 2; -i\sigma_3, -i\sigma_2; \text{WNL}; \pi \)
\( U; \) XU; \( \sigma_y, T \sigma_x; R_1; 1, -i, 1; \)
\( R_2; 1, i, 1; \)
\( \Delta; \) \( \Gamma Y/\Gamma \Delta; \sigma_x, T C_{2z}; R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( D; \) XD/XZ; \( \sigma_x, T C_{2z}; \{R_1, R_2\}; 2; \sigma_3, \sigma_1; \text{WNL}; \pi \)
\( B; \) ZB/ZX; \( \sigma_x, T C_{2z}; \{R_1, R_2\}; 2; -i\sigma_3, \sigma_1; \text{WNL}; \pi \)
\( R; \) YR; \( \sigma_x, T C_{2z}; R_1; 1, -i, 1; \)
\( R_2; 1, i, 1; \)
\begin{equation*}
\Gamma; (000); \quad C_{2z}, \sigma_y, T; \quad R_1; 1, 1, 1, 1; \\
R_2; 1, 1, -1, 1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, -1, 1; \\
\end{equation*}

\begin{equation*}
\begin{array}{c}
X; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \\
C_{2z}, \sigma_y, T; \\
R_1; 1, 1, 1; \\
R_2; 1, 1, -1, 1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, -1, 1; \\
\end{array}
\end{equation*}

\begin{equation*}
R; (\frac{1}{2} 00); \quad \sigma_y, T; \\
R_1; 1, 1; \\
R_2; 1, -1, 1; \\
\end{equation*}

\begin{equation*}
S; (\frac{1}{2} 0 \frac{1}{2}); \quad \sigma_x, T; \\
R_1; 1, 1, 1; \\
R_2; 1, -1, 1; \\
\end{equation*}

\begin{equation*}
T; (\frac{1}{2} \frac{1}{2} 0); \quad C_{2z}, T; \\
R_1; 1, 1, 1; \\
R_2; 1, -1, 1; \\
\end{equation*}

\begin{equation*}
W; (\frac{3}{4} \frac{1}{4} \frac{3}{4}); \quad C_{2z}, T \sigma_x; \\
R_1; 1, 1, 1; \\
R_2; 1, -1, 1; \\
\end{equation*}

\begin{equation*}
\Lambda; \Gamma \Lambda / \Gamma X; \quad C_{2z}, \sigma_y; \\
R_1; 1, 1, 1; \\
R_2; 1, 1, -1; \\
R_3; 1, -1, 1; \\
R_4; 1, -1, -1; \\
\end{equation*}

\begin{equation*}
G; X G; \quad C_{2z}, \sigma_y; \\
R_1; 1, 1, 1; \\
R_2; 1, 1, -1; \\
R_3; 1, -1, 1; \\
R_4; 1, -1, -1; \\
\end{equation*}

\begin{equation*}
P; T W; \quad C_{2z}; \\
R_1; 1, 1; \\
R_2; 1, -1; \\
\end{equation*}

\begin{equation*}
\Sigma; \Gamma \Sigma / \Gamma X; \quad \sigma_y, T \sigma_x; \\
R_1; 1, 1, 1; \\
R_2; 1, -1, 1; \\
\end{equation*}

\begin{equation*}
F; X F; \quad \sigma_y, T \sigma_x; \\
R_1; 1, 1, 1; \\
R_2; 1, -1, 1; \\
\end{equation*}

\begin{equation*}
D; S W; \quad E, T \sigma_x; \\
R_1; 1, 1, 1; \\
\end{equation*}

\begin{equation*}
\Delta; \Gamma \Delta / \Gamma X; \quad \sigma_x, T C_{2z}; \\
R_1; 1, 1, 1; \\
R_2; 1, -1, 1; \\
\end{equation*}

\begin{equation*}
U; X U; \quad \sigma_x, T C_{2z}; \\
R_1; 1, 1, 1; \\
R_2; 1, -1, 1; \\
\end{equation*}

\begin{equation*}
Q; R W; \quad E, T \sigma_y; \\
R_1; 1, 1, 1; \\
\end{equation*}
$\Gamma; (000); \quad C_{2z}, \sigma_y, T; \quad R_1; \quad 1; 1, 1, 1;
R_2; \quad 1; 1, -1, 1;
R_3; \quad 1; -1, 1, 1;
R_4; \quad 1; -1, -1, 1;

X; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad C_{2z}, \sigma_y, T; \quad R_1; \quad 1; 1, 1, 1;
R_2; \quad 1; 1, -1, 1;
R_3; \quad 1; -1, 1, 1;
R_4; \quad 1; -1, -1, 1;

R; (\frac{1}{2}00); \quad \sigma_y, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, \sigma_1; \quad \text{P-WNLs};

S; (\frac{3}{4}0\frac{1}{4}); \quad \sigma_y, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, \sigma_1; \quad \text{P-WNLs};

T; (\frac{1}{4}0\frac{1}{4}); \quad C_{2z}, T; \quad R_1; \quad 1; 1, 1;
R_2; \quad 1; -1, 1;

W; (\frac{1}{2}\frac{3}{4}\frac{3}{4}); \quad C_{2z}, T_{\sigma_y}; \quad \{R_1, R_1\}; \quad 2; \quad \sigma_0, -i\sigma_2; \quad \text{P-WNLs};
\quad \{R_2, R_2\}; \quad 2; \quad -\sigma_0, -i\sigma_2; \quad \text{P-WNLs};

\Lambda; \quad \Gamma \Lambda/\Gamma X; \quad C_{2z}, \sigma_y; \quad R_1; \quad 1; 1, 1;
R_2; \quad 1; 1, -1;
R_3; \quad 1; -1, 1;
R_4; \quad 1; -1, -1;

G; \quad XG; \quad C_{2z}, \sigma_y; \quad R_1; \quad 1; 1, 1;
R_2; \quad 1; 1, -1;
R_3; \quad 1; -1, 1;
R_4; \quad 1; -1, -1;

P; \quad TW; \quad C_{2z}; \quad R_1; \quad 1; 1;
R_2; \quad 1; -1;

\Sigma; \quad \Gamma \Sigma/\Gamma X; \quad \sigma_y, T\sigma_x; \quad R_1; \quad 1; 1, 1;
R_2; \quad 1; -1, 1;

F; \quad XF; \quad \sigma_y, T\sigma_x; \quad R_1; \quad 1; 1, 1;
R_2; \quad 1; -1, 1;

D; \quad SW; \quad E, T\sigma_x; \quad \{R_1, R_1\}; \quad 2; \quad \sigma_0, -i\sigma_2; \quad \text{WNL}; \quad \pi

\Delta; \quad \Gamma \Delta/\Gamma X; \quad \sigma_y, TC_{2z}; \quad R_1; \quad 1; 1, 1;
R_2; \quad 1; -1, 1;

U; \quad XU; \quad \sigma_x, TC_{2z}; \quad R_1; \quad 1; 1, 1;
R_2; \quad 1; -1, 1;

Q; \quad RW; \quad E, T\sigma_y; \quad \{R_1, R_1\}; \quad 2; \quad \sigma_0, -i\sigma_2; \quad \text{WNL}; \quad \pi
\( \Gamma_0^s \); \( \{ C_{2z} | 000 \}, \{ \sigma_y | 0^{1\frac{1}{2}} \} \); \( T \); Non-Centrosymmetric; without SOC

\begin{align*}
\Gamma; & \; (000); \quad C_{2z}, \sigma_y, T; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, 1, -1, 1; \\
& \quad R_3; \quad 1, -1, 1, 1; \\
& \quad R_4; \quad 1, -1, -1, 1; \\
X; & \; (1\frac{1}{2}, \frac{1}{2}); \quad C_{2z}, \sigma_y, T; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, 1, -1, 1; \\
& \quad R_3; \quad 1, -1, 1, 1; \\
& \quad R_4; \quad 1, -1, -1, 1; \\
R; & \; (\frac{1}{2}, 00); \quad \sigma_y, T; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, -1, 1; \\
S; & \; (\frac{1}{2}, 0\frac{1}{2}); \quad \sigma_x, T; \quad \{ R_2, R_4 \}; \quad 2; i\sigma_3, \sigma_1; \quad \text{P-WNLs}; \\
T; & \; (\frac{1}{2}, 10); \quad C_{2z}, T; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, -1, 1; \\
W; & \; (\frac{1}{2}, 1\frac{1}{2}); \quad C_{2z}, T\sigma_x; \quad \{ R_1, R_2 \}; \quad 2; \sigma_3, -i\sigma_2; \quad \text{P-WNL}; \\
\Lambda; & \; \Gamma\Lambda/\Gamma X; \quad C_{2z}, \sigma_y; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, 1, -1; \\
& \quad R_3; \quad 1, -1, 1; \\
& \quad R_4; \quad 1, -1, -1; \\
G; & \; XG; \quad C_{2z}, \sigma_y; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, 1, -1; \\
& \quad R_3; \quad 1, -1, 1; \\
& \quad R_4; \quad 1, -1, -1; \\
P; & \; TW; \quad C_{2z}; \quad R_1; \quad 1, 1; \\
& \quad R_2; \quad 1, -1; \\
\Sigma; & \; \Gamma\Sigma/\Gamma X; \quad \sigma_y, T\sigma_x; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, -1, 1; \\
F; & \; XF; \quad \sigma_y, T\sigma_x; \quad R_1; \quad 1, -1, 1; \\
& \quad R_2; \quad 1, 1, 1; \\
D; & \; SW; \quad E, T\sigma_x; \quad \{ R_1, R_1 \}; \quad 2; \sigma_0, -i\sigma_2; \quad \text{WNL}; \quad \pi \\
\Delta; & \; \Gamma\Delta/\Gamma X; \quad \sigma_x, TC_{2z}; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, -1, 1; \\
U; & \; XU; \quad \sigma_x, TC_{2z}; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, -1, 1; \\
Q; & \; RW; \quad E, T\sigma_y; \quad R_1; \quad 1, 1, 1; 
\end{align*}
\(\Gamma_0; \{C_2z, 000\}, \{C_2y, 000\}, \{I, 000\}, T; \text{Centrosymmetric; without SOC}\)

\(\Gamma; \langle 000 \rangle; C_{2z}, C_{2y}, I, T; R_1; 1, 1, 1, 1;\)
\(R_2; 1, -1, 1, 1;\)
\(R_3; 1, -1, 1, 1;\)
\(R_4; 1, -1, -1, 1;\)
\(R_5; 1, 1, -1, 1;\)
\(R_6; 1, -1, -1, 1;\)
\(R_7; 1, -1, -1, 1;\)
\(R_8; 1, -1, -1, 1;\)

\(Y; \langle \frac{1}{2} 00 \rangle; C_{2z}, C_{2y}, I, T; R_1; 1, 1, 1, 1;\)
\(R_2; 1, -1, 1, 1;\)
\(R_3; 1, -1, 1, 1;\)
\(R_4; 1, -1, -1, 1;\)
\(R_5; 1, 1, -1, 1;\)
\(R_6; 1, -1, -1, 1;\)
\(R_7; 1, -1, -1, 1;\)
\(R_8; 1, -1, -1, 1;\)

\(X; \langle 0 \frac{1}{2} 0 \rangle; C_{2z}, C_{2y}, I, T; R_1; 1, 1, 1, 1;\)
\(R_2; 1, -1, 1, 1;\)
\(R_3; 1, -1, 1, 1;\)
\(R_4; 1, -1, -1, 1;\)
\(R_5; 1, 1, -1, 1;\)
\(R_6; 1, -1, -1, 1;\)
\(R_7; 1, -1, -1, 1;\)
\(R_8; 1, -1, -1, 1;\)

\(Z; \langle 0 0 \frac{1}{2} \rangle; C_{2z}, C_{2y}, I, T; R_1; 1, 1, 1, 1;\)
\(R_2; 1, -1, 1, 1;\)
\(R_3; 1, -1, 1, 1;\)
\(R_4; 1, -1, -1, 1;\)
\(R_5; 1, 1, -1, 1;\)
\(R_6; 1, -1, -1, 1;\)
\(R_7; 1, -1, -1, 1;\)
\(R_8; 1, -1, -1, 1;\)

\(U; \langle 0 \frac{1}{2} \frac{1}{2} \rangle; C_{2z}, C_{2y}, I, T; R_1; 1, 1, 1, 1;\)
\(R_2; 1, -1, 1, 1;\)
\(R_3; 1, -1, 1, 1;\)
\(R_4; 1, -1, -1, 1;\)
\(R_5; 1, 1, -1, 1;\)
\(R_6; 1, -1, -1, 1;\)
\(R_7; 1, -1, -1, 1;\)
\(R_8; 1, -1, -1, 1;\)
\( T: \left( \frac{1}{2} \frac{0}{2} \right) \); \( C_{2y}, C_{2y}, I, T \);
\( R_1; 1; 1, 1, 1, 1; \)
\( R_2; 1; -1, 1, 1, 1; \)
\( R_3; 1; 1, -1, 1, 1; \)
\( R_4; 1; -1, -1, 1, 1; \)
\( R_5; 1; 1, 1, -1, 1; \)
\( R_6; 1; -1, 1, -1, 1; \)
\( R_7; 1; 1, -1, -1, 1; \)
\( R_8; 1; -1, -1, -1, 1; \)

\( S: \left( \frac{1}{2} \frac{1}{2} 0 \right) \); \( C_{2y}, C_{2y}, I, T \);
\( R_1; 1; 1, 1, 1, 1; \)
\( R_2; 1; -1, 1, 1, 1; \)
\( R_3; 1; 1, -1, 1, 1; \)
\( R_4; 1; -1, -1, 1, 1; \)
\( R_5; 1; 1, 1, -1, 1; \)
\( R_6; 1; -1, 1, -1, 1; \)
\( R_7; 1; 1, -1, -1, 1; \)
\( R_8; 1; -1, -1, -1, 1; \)

\( R: \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right) \); \( C_{2y}, C_{2y}, I, T \);
\( R_1; 1; 1, 1, 1, 1; \)
\( R_2; 1; -1, 1, 1, 1; \)
\( R_3; 1; 1, -1, 1, 1; \)
\( R_4; 1; -1, -1, 1, 1; \)
\( R_5; 1; 1, 1, -1, 1; \)
\( R_6; 1; -1, 1, -1, 1; \)
\( R_7; 1; 1, -1, -1, 1; \)
\( R_8; 1; -1, -1, -1, 1; \)

\( \Delta; \Gamma Y \); \( C_{2y}, \sigma_x, I, T \);
\( R_1; 1; 1, 1, 1; \)
\( R_2; 1; 1, -1, 1; \)
\( R_3; 1; -1, 1, 1; \)
\( R_4; 1; -1, -1, 1; \)

\( D; \Xi S \); \( C_{2y}, \sigma_x, I, T \);
\( R_1; 1; 1, 1, 1; \)
\( R_2; 1; 1, -1, 1; \)
\( R_3; 1; -1, 1, 1; \)
\( R_4; 1; -1, -1, 1; \)

\( P; \Upsilon R \); \( C_{2y}, \sigma_x, I, T \);
\( R_1; 1; 1, 1, 1; \)
\( R_2; 1; 1, -1, 1; \)
\( R_3; 1; -1, 1, 1; \)
\( R_4; 1; -1, -1, 1; \)

\( B; \Xi T \); \( C_{2y}, \sigma_x, I, T \);
\( R_1; 1; 1, 1, 1; \)
\( R_2; 1; 1, -1, 1; \)
\( R_3; 1; -1, 1, 1; \)
\( R_4; 1; -1, -1, 1; \)

\( \Sigma; \Gamma X \); \( C_{2y}, \sigma_z, I, T \);
\( R_1; 1; 1, 1, 1; \)
\( R_2; 1; 1, -1, 1; \)
\( R_3; 1; -1, 1, 1; \)
\( R_4; 1; -1, -1, 1; \)

\( C; \Xi S \); \( C_{2y}, \sigma_z, I, T \);
\( R_1; 1; 1, 1, 1; \)
\( R_2; 1; 1, -1, 1; \)
\( R_3; 1; -1, 1, 1; \)
\( R_4; 1; -1, -1, 1; \)
E; TR; \( C_{2x,\sigma_z,IT} \); \( R_1 \); 1; 1, 1, 1;
   \( R_2 \); 1; 1, -1, 1;
   \( R_3 \); 1; -1, 1, 1;
   \( R_4 \); 1; -1, -1, 1;
A; ZU; \( C_{2x,\sigma_z,IT} \); \( R_1 \); 1; 1, 1, 1;
   \( R_2 \); 1; 1, -1, 1;
   \( R_3 \); 1; -1, 1, 1;
   \( R_4 \); 1; -1, -1, 1;
\( \Lambda \); \( \Gamma Z \); \( C_{2z,\sigma_y,IT} \); \( R_1 \); 1; 1, 1, 1;
   \( R_2 \); 1; 1, -1, 1;
   \( R_3 \); 1; -1, 1, 1;
   \( R_4 \); 1; -1, -1, 1;
H; YT; \( C_{2z,\sigma_y,IT} \); \( R_1 \); 1; 1, 1, 1;
   \( R_2 \); 1; 1, -1, 1;
   \( R_3 \); 1; -1, 1, 1;
   \( R_4 \); 1; -1, -1, 1;
Q; SR; \( C_{2z,\sigma_y,IT} \); \( R_1 \); 1; 1, 1, 1;
   \( R_2 \); 1; 1, -1, 1;
   \( R_3 \); 1; -1, 1, 1;
   \( R_4 \); 1; -1, -1, 1;
G; XU; \( C_{2z,\sigma_y,IT} \); \( R_1 \); 1; 1, 1, 1;
   \( R_2 \); 1; 1, -1, 1;
   \( R_3 \); 1; -1, 1, 1;
   \( R_4 \); 1; -1, -1, 1;
\( \Gamma_0; \{ C_{2z}|000 \}, \{ C_{2y}|000 \}, \{ I \}|\frac{1}{2}\frac{1}{2}\frac{1}{2} \}; \mathcal{T}; \text{Centrosymmetric; without SOC} \)

\( \Gamma; \ (000); C_{2x},C_{2y},I,\mathcal{T}; R_1; 1; 1,1,1,1; \)
\( R_2; 1; -1,1,1,1; \)
\( R_3; 1; 1,-1,1,1; \)
\( R_4; 1; -1,-1,1,1; \)
\( R_5; 1; 1,1,-1,1; \)
\( R_6; 1; -1,1,-1,1; \)
\( R_7; 1; 1,-1,-1,1; \)
\( R_8; 1; -1,-1,-1,1; \)

\( Y; \ (\frac{1}{2}00); \sigma_z,I,C_{2y},\mathcal{T}; R_5; 2; i\sigma_2,\sigma_3,\sigma_0,-\sigma_0; \text{P-WNLs}; \)
\( R_{10}; 2; i\sigma_2,\sigma_3,-\sigma_0,-\sigma_0; \text{P-WNLs}; \)

\( X; \ (0\frac{1}{2}0); \sigma_y,I,C_{2x},\mathcal{T}; R_5; 2; i\sigma_2,\sigma_3,\sigma_0,-\sigma_0; \text{P-WNLs}; \)
\( R_{10}; 2; i\sigma_2,\sigma_3,-\sigma_0,-\sigma_0; \text{P-WNLs}; \)

\( Z; \ (00\frac{1}{2}); \sigma_x,I,C_{2x},\mathcal{T}; R_5; 2; i\sigma_2,\sigma_3,\sigma_0,-\sigma_0; \text{P-WNLs}; \)
\( R_{10}; 2; i\sigma_2,\sigma_3,-\sigma_0,-\sigma_0; \text{P-WNLs}; \)

\( U; \ (0\frac{1}{2}\frac{1}{2}); \sigma_z,I,C_{2y},\mathcal{T}; R_5; 2; i\sigma_2,\sigma_3,\sigma_0,-\sigma_0; \text{P-WNLs}; \)
\( R_{10}; 2; i\sigma_2,\sigma_3,-\sigma_0,-\sigma_0; \text{P-WNLs}; \)

\( T; \ (\frac{1}{2}0\frac{1}{2}); \sigma_y,I,C_{2x},\mathcal{T}; R_5; 2; i\sigma_2,\sigma_3,\sigma_0,-\sigma_0; \text{P-WNLs}; \)
\( R_{10}; 2; i\sigma_2,\sigma_3,-\sigma_0,-\sigma_0; \text{P-WNLs}; \)

\( S; \ (\frac{1}{2}\frac{1}{2}0); \sigma_x,I,C_{2x},\mathcal{T}; R_5; 2; i\sigma_2,\sigma_3,\sigma_0,-\sigma_0; \text{P-WNLs}; \)
\( R_{10}; 2; i\sigma_2,\sigma_3,-\sigma_0,-\sigma_0; \text{P-WNLs}; \)

\( R; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{2x},C_{2y},I,\mathcal{T}; R_1; 1; 1,1,1,1; \)
\( R_2; 1; -1,1,1,1; \)
\( R_3; 1; 1,-1,1,1; \)
\( R_4; 1; -1,-1,1,1; \)
\( R_5; 1; 1,1,-1,1; \)
\( R_6; 1; -1,1,-1,1; \)
\( R_7; 1; 1,-1,-1,1; \)
\( R_8; 1; -1,-1,-1,1; \)

\( \Delta; \Gamma Y; \ C_{2y},\sigma_x,\mathcal{I}; R_1; 1; 1,1,1; \)
\( R_2; 1; 1,-1,1; \)
\( R_3; 1; 1,1,1; \)
\( R_4; 1; 1,-1,1; \)

\( D;\ X S; \ \sigma_x,C_{2y},\mathcal{I}; R_5; 2; \sigma_2,\sigma_3,-i\sigma_1; \text{WNL}; \ \pi \)
\( P; \ U R; \ \sigma_x,C_{2y},\mathcal{I}; R_2; 1; -i,1,1; \)
\( R_4; 1; i,1,1; \)
\( R_6; 1; -i,-1,1; \)
\( R_8; 1; i,-1,1; \)

\( B; \ Z T; \ \sigma_x,C_{2y},\mathcal{I}; R_5; 2; \sigma_2,\sigma_3,-i\sigma_1; \text{WNL}; \ \pi \)
\( \Sigma; \ G X; \ C_{2x},\sigma_y,\mathcal{I}; R_1; 1; 1,1,1; \)
\( R_2; 1; 1,-1,1; \)
\( R_3; 1; 1,1,1; \)
\( R_4; 1; 1,-1,1; \)

\( C; \ Y S; \ \sigma_y,C_{2x},\mathcal{I}; R_5; 2; -\sigma_2,\sigma_3,-i\sigma_1; \text{WNL}; \ \pi \)
E; TR; \sigma_z, C_2x, IT; R_2; 1; i, 1, 1;
R_4; 1; -i, 1, 1;
R_6; 1; i, -1, 1;
R_8; 1; -i, -1, 1;

A; ZU; \sigma_z, C_2x, IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \text{ WNL; } \pi

\Lambda; \Gamma Z; C_2x, \sigma_y, IT; R_1; 1, 1, 1;
R_2; 1; 1, -1, 1;
R_3; 1; -1, 1, 1;
R_4; 1; -1, -1, 1;

H; YT; \sigma_y, C_2x, IT; R_5; 2; -\sigma_2, \sigma_3, -i\sigma_1; \text{ WNL; } \pi

Q; SR; \sigma_x, C_2z, IT; R_2; 1; i, 1, 1;
R_4; 1; -i, 1, 1;
R_6; 1; i, -1, 1;
R_8; 1; -i, -1, 1;

G; XU; \sigma_x, C_2z, IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \text{ WNL; } \pi
\( \Gamma: (000) \): \( C_{2x}, C_{2y}, I, T; R_1; 1; 1, 1, 1; \)
\( R_2; 1; -1, 1, 1; \)
\( R_3; 1; 1, -1, 1; \)
\( R_4; 1; -1, -1, 1; \)
\( R_5; 1; 1, 1, -1; \)
\( R_6; 1; -1, 1, -1; \)
\( R_7; 1; 1, -1, -1; \)
\( R_8; 1; -1, 1, -1; \)

\( Y: (\frac{1}{2}00) \): \( C_{2x}, C_{2y}, I, T; R_1; 1; 1, 1, 1; \)
\( R_2; 1; -1, 1, 1; \)
\( R_3; 1; 1, -1, 1; \)
\( R_4; 1; -1, -1, 1; \)
\( R_5; 1; 1, 1, -1; \)
\( R_6; 1; -1, 1, -1; \)
\( R_7; 1; 1, -1, -1; \)
\( R_8; 1; -1, 1, -1; \)

\( X: (0\frac{1}{2}0) \): \( C_{2x}, C_{2y}, I, T; R_1; 1; 1, 1, 1; \)
\( R_2; 1; -1, 1, 1; \)
\( R_3; 1; 1, -1, 1; \)
\( R_4; 1; -1, -1, 1; \)
\( R_5; 1; 1, 1, -1; \)
\( R_6; 1; -1, 1, -1; \)
\( R_7; 1; 1, -1, -1; \)
\( R_8; 1; -1, 1, -1; \)

\( Z: (00\frac{1}{2}) \): \( \sigma_x, I, C_{2x}, T; R_5; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; P\text{-WNLs}; \)
\( R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; P\text{-WNLs}; \)

\( U: (0\frac{1}{2}\frac{1}{2}) \): \( \sigma_x, I, C_{2x}, T; R_5; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; P\text{-WNLs}; \)
\( R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; P\text{-WNLs}; \)

\( T: (\frac{1}{2}0\frac{1}{2}) \): \( \sigma_x, I, C_{2x}, T; R_5; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; P\text{-WNLs}; \)
\( R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; P\text{-WNLs}; \)

\( S: (\frac{1}{2}\frac{1}{2}0) \): \( C_{2x}, C_{2y}, I, T; R_1; 1; 1, 1, 1; \)
\( R_2; 1; -1, 1, 1; \)
\( R_3; 1; 1, -1, 1; \)
\( R_4; 1; -1, -1, 1; \)
\( R_5; 1; 1, 1, -1; \)
\( R_6; 1; -1, 1, -1; \)
\( R_7; 1; 1, -1, -1; \)
\( R_8; 1; -1, 1, -1; \)

\( R: (\frac{1}{2}\frac{1}{2}\frac{1}{2}) \): \( \sigma_x, I, C_{2x}, T; R_5; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; P\text{-WNLs}; \)
\( R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; P\text{-WNLs}; \)

\( \Delta: \Gamma Y; C_{2y}, \sigma_x, I, T; R_1; 1; 1, 1, 1; \)
\( R_2; 1; 1, -1, 1; \)
\( R_3; 1; -1, 1, 1; \)
\( R_4; 1; -1, -1, 1; \)
D: XS; $C_{2y,\sigma_x,IT}$; $R_1$: 1; 1, 1, 1;  
$R_2$: 1; 1, -1, 1;  
$R_3$: 1; -1, 1, 1;  
$R_4$: 1; -1, -1, 1;  
$P$: UR; $\sigma_z, C_{2y,IT}$; $R_5$: 2; $\sigma_2, \sigma_3, -i\sigma_1$; WNL; $\pi$  
$B$: ZT; $\sigma_z, C_{2y,IT}$; $R_5$: 2; $\sigma_2, \sigma_3, -i\sigma_1$; WNL; $\pi$  
$\Sigma$: $\Gamma X$; $C_{2x,\sigma_z,IT}$; $R_1$: 1; 1, 1, 1;  
$R_2$: 1; 1, -1, 1;  
$R_3$: 1; -1, 1, 1;  
$R_4$: 1; -1, -1, 1;  
$C$: YS; $C_{2x,\sigma_z,IT}$; $R_1$: 1; 1, 1, 1;  
$R_2$: 1; 1, -1, 1;  
$R_3$: 1; -1, 1, 1;  
$R_4$: 1; -1, -1, 1;  
$E$: TR; $\sigma_z, C_{2x,IT}$; $R_5$: 2; $\sigma_2, \sigma_3, -i\sigma_1$; WNL; $\pi$  
$A$: ZU; $\sigma_z, C_{2x,IT}$; $R_5$: 2; $\sigma_2, \sigma_3, -i\sigma_1$; WNL; $\pi$  
$\Lambda$: $\Gamma Z$; $C_{2z,\sigma_y,IT}$; $R_1$: 1; 1, 1, 1;  
$R_2$: 1; 1, -1, 1;  
$R_3$: 1; -1, 1, 1;  
$R_4$: 1; -1, -1, 1;  
$H$: YT; $C_{2z,\sigma_y,IT}$; $R_1$: 1; 1, 1, 1;  
$R_2$: 1; 1, -1, 1;  
$R_3$: 1; -1, 1, 1;  
$R_4$: 1; -1, -1, 1;  
$Q$: SR; $C_{2z,\sigma_y,IT}$; $R_1$: 1; 1, 1, 1;  
$R_2$: 1; 1, -1, 1;  
$R_3$: 1; -1, 1, 1;  
$R_4$: 1; -1, -1, 1;  
$G$: XU; $C_{2z,\sigma_y,IT}$; $R_1$: 1; 1, 1, 1;  
$R_2$: 1; 1, -1, 1;  
$R_3$: 1; -1, 1, 1;  
$R_4$: 1; -1, -1, 1;
Γ: (000): \[ C_{2\gamma}, \mathcal{I}, \mathcal{T}; \quad R_{1}: 1; 1, 1, 1, 1; \]
\[ R_{2}: 1; -1, 1, 1, 1; \]
\[ R_{3}: 1; 1, -1, 1, 1; \]
\[ R_{4}: 1; -1, -1, 1, 1; \]
\[ R_{5}: 1; 1, 1, -1, 1; \]
\[ R_{6}: 1; -1, 1, -1, 1; \]
\[ R_{7}: 1; 1, -1, -1, 1; \]
\[ R_{8}: 1; -1, -1, -1, 1; \]
\[ Y: \left(\frac{1}{2}00\right); \quad \sigma_{x}, \mathcal{I}, C_{2\gamma}, \mathcal{T}; \quad R_{5}: 2; i\sigma_{2}, \sigma_{3}, \sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ R_{10}: 2; i\sigma_{2}, \sigma_{3}, -\sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ X: \left(0\frac{1}{2}0\right); \quad \sigma_{x}, \mathcal{I}, C_{2\gamma}, \mathcal{T}; \quad R_{5}: 2; i\sigma_{2}, \sigma_{3}, \sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ R_{10}: 2; i\sigma_{2}, \sigma_{3}, -\sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ Z: \left(00\frac{1}{2}\right); \quad C_{2\gamma}, C_{2\gamma}, \mathcal{I}, \mathcal{T}; \quad R_{1}: 1; 1, 1, 1, 1; \]
\[ R_{2}: 1; -1, 1, 1, 1; \]
\[ R_{3}: 1; 1, -1, 1, 1; \]
\[ R_{4}: 1; -1, -1, 1, 1; \]
\[ R_{5}: 1; 1, 1, -1, 1; \]
\[ R_{6}: 1; -1, 1, -1, 1; \]
\[ R_{7}: 1; 1, -1, -1, 1; \]
\[ R_{8}: 1; -1, -1, -1, 1; \]
\[ U: \left(0\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); \quad \sigma_{x}, \mathcal{I}, C_{2\gamma}, \mathcal{T}; \quad R_{5}: 2; i\sigma_{2}, \sigma_{3}, \sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ R_{10}: 2; i\sigma_{2}, \sigma_{3}, -\sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ T: \left(\frac{1}{2}0\frac{1}{2}\frac{1}{2}\right); \quad \sigma_{x}, \mathcal{I}, C_{2\gamma}, \mathcal{T}; \quad R_{5}: 2; i\sigma_{2}, \sigma_{3}, \sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ R_{10}: 2; i\sigma_{2}, \sigma_{3}, -\sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ S: \left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); \quad \sigma_{x}, \mathcal{I}, C_{2\gamma}, \mathcal{T}; \quad R_{5}: 2; i\sigma_{2}, \sigma_{3}, \sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ R_{10}: 2; i\sigma_{2}, \sigma_{3}, -\sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ R: \left(\frac{1}{2}\frac{3}{2}\frac{3}{2}\frac{3}{2}\right); \quad \sigma_{x}, \mathcal{I}, C_{2\gamma}, \mathcal{T}; \quad R_{5}: 2; i\sigma_{2}, \sigma_{3}, \sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ R_{10}: 2; i\sigma_{2}, \sigma_{3}, -\sigma_{0}, -\sigma_{0}; \quad \text{P-WNLs}; \]
\[ \Delta; \quad \mathcal{Y}: \quad C_{2\gamma}, \sigma_{x}, \mathcal{I}, \mathcal{T}; \quad R_{1}: 1; 1, 1, 1; \]
\[ R_{2}: 1; 1, -1, 1; \]
\[ R_{3}: 1; -1, 1, 1; \]
\[ R_{4}: 1; -1, -1, 1; \]
\[ D; \quad \mathcal{X}: \quad \sigma_{x}, C_{2\gamma}, \mathcal{I}, \mathcal{T}; \quad R_{5}: 2; \sigma_{2}, \sigma_{3}, -i\sigma_{1}; \quad \text{WNL}; \quad \pi \]
\[ P; \quad \mathcal{U}: \quad \sigma_{x}, C_{2\gamma}, \mathcal{I}, \mathcal{T}; \quad R_{5}: 2; \sigma_{2}, \sigma_{3}, -i\sigma_{1}; \quad \text{WNL}; \quad \pi \]
\[ B; \quad \mathcal{Z}: \quad C_{2\gamma}, \sigma_{x}, \mathcal{I}, \mathcal{T}; \quad R_{1}: 1; 1, 1, 1; \]
\[ R_{2}: 1; 1, -1, 1; \]
\[ R_{3}: 1; -1, 1, 1; \]
\[ R_{4}: 1; -1, -1, 1; \]
\[ \Sigma; \quad \mathcal{X}: \quad C_{2\gamma}, \sigma_{x}, \mathcal{I}, \mathcal{T}; \quad R_{1}: 1; 1, 1, 1; \]
\[ R_{2}: 1; 1, -1, 1; \]
\[ R_{3}: 1; -1, 1, 1; \]
\[ R_{4}: 1; -1, -1, 1; \]
\[ C; \quad \mathcal{Y}: \quad \sigma_{y}, C_{2\gamma}, \mathcal{I}, \mathcal{T}; \quad R_{5}: 2; -\sigma_{2}, \sigma_{3}, -i\sigma_{1}; \quad \text{WNL}; \quad \pi \]
\[ E; \quad \mathcal{R}: \quad \sigma_{y}, C_{2\gamma}, \mathcal{I}, \mathcal{T}; \quad R_{5}: 2; -\sigma_{2}, \sigma_{3}, -i\sigma_{1}; \quad \text{WNL}; \quad \pi \]
$A; \ ZU; \ C_{2x,\sigma_z, IT}; \ R_1; \ 1; 1,1,1;$$\ R_2; \ 1; 1,-1,1;$$\ R_3; \ 1; -1,1,1;$$\ R_4; \ 1; -1,-1,1;$$\ \ \ \ \ \ Λ; \ ΓZ; \ C_{2z,\sigma_y, IT}; \ R_1; \ 1; 1,1,1;$$\ R_2; \ 1; 1,-1,1;$$\ R_3; \ 1; -1,1,1;$$\ R_4; \ 1; -1,-1,1;$$\ H; \ YT; \ σ_y,C_{2x, IT}; \ R_5; \ 1; \ σ_2,σ_3,-iσ_1; \ WNL; \ π$$\ Q; \ SR; \ σ_y,C_{2x, IT}; \ R_2; \ 1; i,1,1;$$\ R_4; \ 1; -i,1,1;$$\ R_6; \ 1; i,-1,1;$$\ R_8; \ 1; -i,-1,1;$$\ G; \ XU; \ σ_z,C_{2x, IT}; \ R_5; \ 2; σ_2,σ_3,-iσ_1; \ WNL; \ π$
7. SG 51

Γ₀: \{C_{2z}\{00\frac{1}{2}\}, \{C_{2y}\{000\}, \{I\{000\}, T; Centrosymmetric; without SOC

Γ: \{(000): C_{2z}, C_{2y}, I; T; R₁; 1; 1, 1, 1, 1;
R₂; 1; -1, 1, 1, 1;
R₃; 1; 1, -1, 1, 1;
R₄; 1; -1, -1, 1, 1;
R₅; 1; 1, 1, -1, 1;
R₆; 1; -1, -1, -1, 1;
R₇; 1; 1, -1, -1, 1;
R₈; 1; -1, -1, -1, 1;

Y: (\frac{5}{2}00); C_{2z}, C_{2y}, I; T; R₁; 1; 1, 1, 1, 1;
R₂; 1; -1, 1, 1, 1;
R₃; 1; 1, -1, 1, 1;
R₄; 1; -1, -1, 1, 1;
R₅; 1; 1, 1, -1, 1;
R₆; 1; -1, 1, -1, 1;
R₇; 1; 1, -1, -1, 1;
R₈; 1; -1, -1, -1, 1;

X: (0\frac{1}{2}0); C_{2z}, C_{2y}, I; T; R₁; 1; 1, 1, 1, 1;
R₂; 1; -1, 1, 1, 1;
R₃; 1; 1, -1, 1, 1;
R₄; 1; -1, -1, 1, 1;
R₅; 1; 1, 1, -1, 1;
R₆; 1; -1, 1, -1, 1;
R₇; 1; 1, -1, -1, 1;
R₈; 1; -1, -1, -1, 1;

Z: (00\frac{1}{2}); C_{2z}, I; σ_y, T; R₅; 2; iσ₂, σ₃, σ₀, -σ₀; P-NSZUTR;
R₁₀; 2; iσ₂, σ₃, -σ₀, -σ₀; P-NSZUTR;

U: (0\frac{1}{2}\frac{1}{2}); C_{2z}, I; σ_y, T; R₅; 2; iσ₂, σ₃, σ₀, -σ₀; P-NSZUTR;
R₁₀; 2; iσ₂, σ₃, -σ₀, -σ₀; P-NSZUTR;

T: (\frac{5}{2}0\frac{1}{2}); C_{2z}, I; σ_y, T; R₅; 2; iσ₂, σ₃, σ₀, -σ₀; P-NSZUTR;
R₁₀; 2; iσ₂, σ₃, -σ₀, -σ₀; P-NSZUTR;

S: (\frac{5}{2}\frac{1}{2}0); C_{2z}, C_{2y}, I; T; R₁; 1; 1, 1, 1, 1;
R₂; 1; -1, 1, 1, 1;
R₃; 1; 1, -1, 1, 1;
R₄; 1; -1, -1, 1, 1;
R₅; 1; 1, 1, -1, 1;
R₆; 1; -1, -1, -1, 1;
R₇; 1; 1, -1, -1, 1;
R₈; 1; -1, -1, -1, 1;

R: (\frac{5}{2}\frac{1}{2}\frac{1}{2}); C_{2z}, I; σ_y, T; R₅; 2; iσ₂, σ₃, σ₀, -σ₀; P-NSZUTR;
R₁₀; 2; iσ₂, σ₃, -σ₀, -σ₀; P-NSZUTR;
Δ; ΓY; C_{2y, \sigma_x, IT}; R_i; 1; 1, 1, 1;
  R_2; 1; 1, -1, 1;
  R_3; 1; -1, 1, 1;
  R_4; 1; -1, -1, 1;

D; XS; C_{2y, \sigma_x, IT}; R_i; 1; 1, 1, 1;
  R_2; 1; 1, -1, 1;
  R_3; 1; -1, 1, 1;
  R_4; 1; -1, -1, 1;

P; UR; \sigma_x, C_{2y, IT}; R_i; 2; \sigma_2, \sigma_3, -\sigma_0; \text{L-NS}_{ZUTR};

G; XU; C_{2x, \sigma_y, IT}; R_i; 1; 1, 1, 1;
  R_2; 1; 1, -1, 1;
  R_3; 1; -1, 1, 1;
  R_4; 1; -1, -1, 1;

E; TR; C_{2x, \sigma_y, IT}; \{ R_2, R_4 \}; 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}_{ZUTR};
  \{ R_6, R_8 \}; 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NS}_{ZUTR};

A; ZU; C_{2x, \sigma_y, IT}; \{ R_2, R_4 \}; 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}_{ZUTR};
  \{ R_6, R_8 \}; 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NS}_{ZUTR};

Λ; ΓZ; C_{2x, \sigma_y, IT}; R_i; 1; 1, 1, 1;
  R_2; 1; 1, -1, 1;
  R_3; 1; -1, 1, 1;
  R_4; 1; -1, -1, 1;

H; YT; C_{2x, \sigma_y, IT}; R_i; 1; 1, 1, 1;
  R_2; 1; 1, -1, 1;
  R_3; 1; -1, 1, 1;
  R_4; 1; -1, -1, 1;

Q; SR; C_{2x, \sigma_y, IT}; R_i; 1; 1, 1, 1;
  R_2; 1; 1, -1, 1;
  R_3; 1; -1, 1, 1;
  R_4; 1; -1, -1, 1;
\[ \Gamma_0; \{ C_{2v}(00\frac{1}{2}), C_{2v}(000), \{ I, 1 \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, T; \text{Centrosymmetric; without SOC} \}

\begin{align*}
\Gamma; (000); & C_{2x}, C_{2y}, I, T; \{ R_1, 1; 1, 1, 1, 1; \\
R_2; & 1, -1, 1, 1; \\
R_3; & 1, 1, -1, 1; \\
R_4; & 1, -1, -1, 1; \\
R_5; & 1, 1, 1, 1; \\
R_6; & 1, -1, -1, 1; \\
R_7; & 1, 1, -1, 1; \\
R_8; & 1, -1, -1, 1; \\
Y; (\frac{1}{2}00); & \sigma_x, I, C_{2y}, T; \{ R_5, 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-WNLs; R}_{10}; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-WNLs;}
\end{align*}

\begin{align*}
X; (0\frac{1}{2}0); & \sigma_y, I, C_{2x}, T; \{ R_5, 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-WNLs; R}_{10}; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-WNLs;}
\end{align*}

\begin{align*}
Z; (00\frac{1}{2}); & \sigma_x, I, \sigma_y, T; \{ R_5, 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-NS}_{\text{ZUTR}}; R}_{10}; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-NS}_{\text{ZUTR}};
\end{align*}

\begin{align*}
U; (0\frac{1}{2}\frac{1}{2}); & \sigma_x, C_{2y}, I, T; \{ R_9, R_{10}; 4; i\Gamma_3, 0, \Gamma_0, 1, \Gamma_0, 3, \Gamma_1, 0; \} \text{DP; 0 }
\end{align*}

\begin{align*}
T; (\frac{1}{2}0\frac{1}{2}); & \sigma_z, I, \sigma_y, T; \{ R_5, 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-WNL/NS; R}_{10}; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-WNL/NS;}
\end{align*}

\begin{align*}
S; (\frac{1}{2}\frac{1}{2}0); & \sigma_x, I, C_{2z}, T; \{ R_5, 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-WNLs; R}_{10}; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-WNLs;}
\end{align*}

\begin{align*}
R; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & \sigma_y, I, \sigma_z, T; \{ R_5, 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-NS}_{\text{ZUTR}}; R}_{10}; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \} \text{P-NS}_{\text{ZUTR}};
\end{align*}

\begin{align*}
\Delta; \Gamma Y; & C_{2y}, \sigma_z, I, T; \{ R_1, 1, 1, 1, 1; \\
R_2; & 1, 1, 1; \\
R_3; & 1, -1, 1; \\
R_4; & 1, -1, 1; \\
D; \Gamma X; & \sigma_z, C_{2y}, I, T; \{ R_5, 2; \sigma_2, \sigma_3, -i\sigma_1; \} \text{WNL; WNL; } \pi
\end{align*}

\begin{align*}
P; \ caracteres; & \sigma_z, C_{2y}, I, T; \{ R_2, R_8; 2; -i\sigma_3, \sigma_3, \sigma_3; \} \text{L-NS}_{\text{ZUTR}}; \\
\{ R_4, R_5; 2; i\sigma_3, \sigma_3, \sigma_1; \} \text{L-NS}_{\text{ZUTR}};
\end{align*}

\begin{align*}
B; \ ZT; & \sigma_z, C_{2y}, I, T; \{ R_5, 2; \sigma_2, \sigma_3, -\sigma_0; \} \text{L-NS}_{\text{ZUTR}};
\end{align*}

\begin{align*}
\Sigma; \Gamma X; & C_{2x}, \sigma_z, I, T; \{ R_1, 1, 1, 1, 1; \\
R_2; & 1, 1, 1; \\
R_3; & 1, -1, 1; \\
R_4; & 1, -1, 1; \\
C; \ YS; & \sigma_y, C_{2x}, I, T; \{ R_5, 2; -\sigma_2, \sigma_3, -i\sigma_1; \} \text{WNL; } \pi
\end{align*}

\begin{align*}
E; \ TR; & \sigma_y, \sigma_z, I, T; \{ R_5, 2; -\sigma_2, i\sigma_1, -i\sigma_3; \} \text{L-NS}_{\text{ZUTR}};
\end{align*}

\begin{align*}
A; \ ZU; & C_{2x}, \sigma_y, I, T; \{ R_2, R_4; 2; \sigma_3, \sigma_0, \sigma_1; \} \text{L-NS}_{\text{ZUTR}}; \\
\{ R_6, R_8; 2; \sigma_3, -\sigma_0, \sigma_1; \} \text{L-NS}_{\text{ZUTR}};
\end{align*}

\begin{align*}
\Delta; \Gamma Z; & C_{2x}, \sigma_y, I, T; \{ R_1, 1, 1, 1, 1; \\
R_2; & 1, 1, 1; \\
R_3; & 1, -1, 1; \\
R_4; & 1, -1, 1; \\
H; \ YT; & \sigma_y, C_{2x}, I, T; \{ R_5, 2; -\sigma_2, \sigma_3, -i\sigma_1; \} \text{WNL; } \pi
\end{align*}
\(Q; \text{SR}; \sigma_y, C_{2z}, IT; R_2; 1; i, 1, 1;\)
\(R_4; 1; -i, 1, 1;\)
\(R_6; 1; i, -1, 1;\)
\(R_8; 1; -i, -1, 1;\)
\(G; \text{XU}; \sigma_x, C_{2z}, IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL}; \pi\)
Γ: (000): \( C_{2z}, C_{2y}, I, T; R_1; 1, 1, 1, 1; \)
   \( R_2; 1, -1, 1, 1; \)
   \( R_3; 1, 1, -1, 1; \)
   \( R_4; 1, -1, -1, 1; \)
   \( R_5; 1, 1, 1, 1; \)
   \( R_6; 1, -1, 1, 1; \)
   \( R_7; 1, 1, -1, 1; \)
   \( R_8; 1, -1, -1, 1; \)

\( \Gamma; \) (000): \( C_{2z}, C_{2y}, I, T; R_1; 1, 1, 1, 1; \)
   \( R_2; 1, -1, 1, 1; \)
   \( R_3; 1, 1, -1, 1; \)
   \( R_4; 1, -1, -1, 1; \)
   \( R_5; 1, 1, 1, 1; \)
   \( R_6; 1, -1, 1, 1; \)
   \( R_7; 1, 1, -1, 1; \)
   \( R_8; 1, -1, -1, 1; \)

Y: (001): \( \sigma_z, I, C_{2y}, T; R_5; 2, \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-WNLs;
   \( R_{10}; 2, \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \) P-WNLs;

X: (00\frac{1}{2}): \( C_{2z}, C_{2y}, I, T; R_1; 1, 1, 1, 1; \)
   \( R_2; 1, -1, 1, 1; \)
   \( R_3; 1, 1, -1, 1; \)
   \( R_4; 1, -1, -1, 1; \)
   \( R_5; 1, 1, 1, 1; \)
   \( R_6; 1, -1, 1, 1; \)
   \( R_7; 1, 1, -1, 1; \)
   \( R_8; 1, -1, -1, 1; \)

Z: (00\frac{1}{2}): \( C_{2z}, I, \sigma_y, T; R_5; 2, \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-WNLs;
   \( R_{10}; 2, \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \) P-WNLs;

U: (0\frac{1}{2}1): \( C_{2z}, I, \sigma_y, T; R_5; 2, \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-WNLs;
   \( R_{10}; 2, \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \) P-WNLs;

T: (\frac{1}{2}01): \( C_{2z}, \sigma_y, I, T; R_5; 2, \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-WNLs;
   \( R_{10}; 2, \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \) P-WNLs;

S: (\frac{1}{2}\frac{1}{2}0): \( \sigma_z, I, C_{2y}, T; R_5; 2, \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-WNLs;
   \( R_{10}; 2, \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \) P-WNLs;

R: (\frac{1}{2}\frac{1}{2}\frac{1}{2}): \( C_{2z}, \sigma_y, I, T; R_5; 2, \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-WNLs;
   \( R_{10}; 2, \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \) P-WNLs;

\Delta; \Gamma Y: \( C_{2y}, \sigma_x, I, T; R_1; 1, 1, 1, 1; \)
   \( R_2; 1, -1, 1, 1; \)
   \( R_3; 1, -1, 1, 1; \)
   \( R_4; 1, 1, -1, 1; \)

D: XS: \( C_{2y}, \sigma_x, I, T; R_1; 1, 1, 1, 1; \)
   \( R_2; 1, -1, 1, 1; \)
   \( R_3; 1, -1, 1, 1; \)
   \( R_4; 1, 1, -1, 1; \)

P: UR: \( \sigma_z, C_{2y}, I, T; R_5; 2, \sigma_2, \sigma_3, -\sigma_0; \) P-WNLs;

B: ZT: \( \sigma_z, C_{2y}, I, T; R_5; 2, \sigma_2, \sigma_3, -\sigma_0; \) P-WNLs;

\Sigma: \Gamma X: \( C_{2z}, \sigma_x, I, T; R_1; 1, 1, 1, 1; \)
   \( R_2; 1, 1, -1, 1; \)
   \( R_3; 1, 1, -1, 1; \)
   \( R_4; 1, -1, -1, 1; \)

C: YS: \( \sigma_y, C_{2x}, I, T; R_5; 2, -\sigma_2, \sigma_3, -\sigma_1; \) WNL; \pi

E: TR: \( \sigma_y, C_{2x}, I, T; R_5; 2, -\sigma_2, \sigma_1, -\sigma_1; \) L-NSZUTR;
| Symbol | Label | 3D Symmetry | 2D Symmetry |
|--------|-------|-------------|-------------|
| \( R_1 \) | \( \Gamma Z \, C_{2x} \sigma_y \, IT \) | 1, 1, 1; | \( R_5 \); \( -\sigma_2, \sigma_3, i\sigma_1 \); L-NS \( ZUTR \); \( \pi \) |
| \( R_2 \) | \( \Lambda \, C_{2x} \sigma_y \, IT \) | 1, -1, 1; | \( R_6 \); \( R_7 \); \( \sigma_3, -\sigma_0, \sigma_1 \); L-NS \( ZUTR \); \( \pi \) |
| \( R_3 \) | \( \Lambda \, \sigma_y \, \sigma_y \, IT \) | -1, 1, 1; | \( R_8 \); \( R_9 \); \( \sigma_3, \sigma_0, \sigma_1 \); L-NS \( ZUTR \); \( \pi \) |
| \( R_4 \) | \( \Lambda \, \sigma_y \, \sigma_y \, IT \) | -1, -1, 1; | \( R_{10} \); \( R_{11} \); \( \sigma_3, \sigma_0, \sigma_1 \); L-NS \( ZUTR \); \( \pi \) |
Γ₀; \{C_{2x}[00\frac{1}{2}], C_{2y}[000], I[0\frac{1}{2}0]\}, T; Centrosymmetric; without SOC

Γ; (000); \text{C}_{2x}, \text{C}_{2y}, I, T; R₁; \ 1; 1, 1, 1;
  R₂; \ 1; -1, 1, 1;
  R₃; \ 1; 1, -1, 1;
  R₄; \ 1; -1, -1, 1;
  R₅; \ 1; 1, 1, -1;
  R₆; \ 1; -1, 1, -1;
  R₇; \ 1; -1, -1, 1;
  R₈; \ 1; -1, -1, -1;

Y; \left(\frac{1}{2}00\right); \text{C}_{2x}, \text{C}_{2y}, I, T; R₁; \ 1; 1, 1, 1;
  R₂; \ 1; -1, 1, 1;
  R₃; \ 1; 1, -1, 1;
  R₄; \ 1; -1, -1, 1;
  R₅; \ 1; 1, 1, -1;
  R₆; \ 1; -1, 1, -1;
  R₇; \ 1; -1, -1, 1;
  R₈; \ 1; -1, -1, -1;

X; \left(\frac{1}{2}0\right); \sigma_y, I, \text{C}_{2x}, T; R₅; \ 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-WNLs};
  R₁₀; \ 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNLs};

Z; \left(0\frac{1}{2}\right); \text{C}_{2x}, I, \sigma_y, T; R₅; \ 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NS}_{ZUTR};
  R₁₀; \ 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NS}_{ZUTR};

U; \left(0\frac{1}{2}\right); \sigma_x, \text{C}_{2y}, I, T; \{R₉, R₁₀\}; 4; i\Gamma_{3,0}, \Gamma_{0,1}, \Gamma_{0,3}, \Gamma_{1,0}; \text{DP}; \ 0

T; \left(\frac{1}{2}0\right); \text{C}_{2x}, I, \sigma_y, T; R₅; \ 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NS}_{ZUTR};
  R₁₀; \ 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NS}_{ZUTR};

S; \left(\frac{1}{2}\frac{1}{2}\right); \sigma_y, I, \text{C}_{2x}, T; R₅; \ 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-WNLs};
  R₁₀; \ 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNLs};

R; \left(\frac{1}{2}\frac{1}{2}\right); \sigma_x, \text{C}_{2y}, I, T; \{R₉, R₁₀\}; 4; i\Gamma_{3,0}, \Gamma_{0,1}, \Gamma_{0,3}, \Gamma_{1,0}; \text{DP}; \ 0

Δ; ΓY; \text{C}_{2y}, \sigma_x, IT; R₁; \ 1; 1, 1, 1;
  R₂; \ 1; 1, -1, 1;
  R₃; \ 1; -1, 1, 1;
  R₄; \ 1; -1, -1, 1;

D; XS; \sigma_x, \text{C}_{2y}, IT; R₅; \ 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL}; \ 0

P; UR; \sigma_x, \text{C}_{2y}, IT; \{R₂, R₆\}; 2; -i\sigma_0, \sigma_3, \sigma_1; \text{L-NS}_{ZUTR};
 \{R₄, R₆\}; 2; i\sigma_0, \sigma_3, \sigma_1; \text{L-NS}_{ZUTR};

B; ZT; \sigma_x, \text{C}_{2y}, IT; R₅; \ 2; \sigma_2, \sigma_3, -\sigma_0; \text{L-NS}_{ZUTR};

Σ; ΓX; \text{C}_{2x}, \sigma_x, IT; R₁; \ 1; 1, 1, 1;
  R₂; \ 1; 1, -1, 1;
  R₃; \ 1; -1, 1, 1;
  R₄; \ 1; -1, -1, 1;

C; YS; \text{C}_{2x}, \sigma_z, IT; R₁; \ 1; 1, 1, 1;
  R₂; \ 1; 1, -1, 1;
  R₃; \ 1; -1, 1, 1;
  R₄; \ 1; -1, -1, 1;

E; TR; \text{C}_{2x}, \sigma_y, IT; \{R₂, R₆\}; 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}_{ZUTR};
 \{R₆, R₆\}; 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NS}_{ZUTR};

A; ZU; \text{C}_{2x}, \sigma_y, IT; \{R₂, R₆\}; 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}_{ZUTR};
 \{R₆, R₆\}; 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NS}_{ZUTR};
| ΓZ | $C_{2z}, \sigma_y, IT$ | $R_1$ | 1, 1, 1 |
|----|-----------------|------|--------|
|    | $R_2$           | 1, -1, 1 |
|    | $R_3$           | -1, 1, 1 |
|    | $R_4$           | -1, -1, 1 |
| H  | $YT$            | $C_{2z}, \sigma_y, IT$ | $R_1$ | 1, 1, 1 |
|    | $R_2$           | 1, -1, 1 |
|    | $R_3$           | -1, 1, 1 |
|    | $R_4$           | -1, -1, 1 |
| Q  | $SR$            | $\sigma_x, C_{2z}, IT$ | $R_5$ | 2, $\sigma_2, \sigma_3, -i\sigma_1$ | WNL: π |
| G  | $XU$            | $\sigma_x, C_{2z}, IT$ | $R_5$ | 2, $\sigma_2, \sigma_3, -i\sigma_1$ | WNL: π |
\[ \Gamma_0; \{C_{2z}, I(000)\}, \{C_{2y}, \frac{1}{2} 0 0\}, \{I, 000\}, T \}; \text{Centrosymmetric; without SOC} \]

| \( \Gamma \); (000) | \( C_{2z}, C_{2y}, I, T \); | \( R \); | \( 1 \); |
|---|---|---|---|
| \( R_1 \); | 1; 1, 1, 1, 1; |
| \( R_2 \); | 1; -1, 1, 1, 1; |
| \( R_3 \); | 1; -1, -1, 1, 1; |
| \( R_4 \); | 1; -1, 1, 1, 1; |
| \( R_5 \); | 1; 1, -1, 1, 1; |
| \( R_6 \); | 1; -1, 1, -1, 1; |
| \( R_7 \); | 1; -1, -1, 1, 1; |
| \( R_8 \); | 1; -1, -1, -1, 1; |

| \( Y; (\frac{1}{2}, 0, 0) \); | \( \sigma_z, I, \sigma_z, T \); | \( R \); | \( 2 \); |
|---|---|---|---|
| \( R_5 \); | \( i\sigma_2, \sigma_3, \sigma_0, -\sigma_0 \); |
| \( R_{10} \); | \( i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0 \); |

| \( X; (0, \frac{1}{2}, 0) \); | \( \sigma_y, I, \sigma_z, T \); | \( R \); | \( 2 \); |
|---|---|---|---|
| \( R_5 \); | \( i\sigma_2, \sigma_3, \sigma_0, -\sigma_0 \); |
| \( R_{10} \); | \( i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0 \); |

| \( Z; (00, \frac{1}{2}) \); | \( C_{2z}, C_{2y}, I, T \); | \( R \); | \( 1 \); |
|---|---|---|---|
| \( R_1 \); | 1, 1, 1, 1; |
| \( R_2 \); | 1, -1, 1, 1; |
| \( R_3 \); | 1, -1, -1, 1; |
| \( R_4 \); | 1, -1, 1, 1; |
| \( R_5 \); | 1, 1, -1, 1; |
| \( R_6 \); | 1, -1, -1, 1; |
| \( R_7 \); | 1, -1, -1, 1; |
| \( R_8 \); | 1, -1, -1, -1, 1; |

| \( U; (0, \frac{1}{2}, \frac{1}{2}) \); | \( \sigma_y, I, \sigma_z, T \); | \( R \); | \( 2 \); |
|---|---|---|---|
| \( R_5 \); | \( i\sigma_2, \sigma_3, \sigma_0, -\sigma_0 \); |
| \( R_{10} \); | \( i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0 \); |

| \( T; (\frac{1}{2}, 0, \frac{1}{2}) \); | \( \sigma_z, I, \sigma_z, T \); | \( R \); | \( 2 \); |
|---|---|---|---|
| \( R_5 \); | \( i\sigma_2, \sigma_3, \sigma_0, -\sigma_0 \); |
| \( R_{10} \); | \( i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0 \); |

| \( S; (\frac{1}{2}, \frac{1}{2}, 0) \); | \( C_{2z}, C_{2y}, I, T \); | \( \{R_2, R_4\} \); | \( 2 \); |
|---|---|---|---|
| \( \{R_6, R_8\} \); | \( i\sigma_3, \sigma_0, \sigma_0, \sigma_1 \); |
| \( \{R_{10}, R_{12}\} \); | \( i\sigma_3, -\sigma_0, \sigma_0, \sigma_1 \); |
| \( \{R_{14}, R_{16}\} \); | \( i\sigma_3, -\sigma_0, -\sigma_0, \sigma_1 \); |

| \( R; (\frac{1}{2}, \frac{1}{2}, 0) \); | \( C_{2z}, C_{2y}, I, T \); | \( \{R_2, R_4\} \); | \( 2 \); |
|---|---|---|---|
| \( \{R_6, R_8\} \); | \( i\sigma_3, \sigma_0, \sigma_0, \sigma_1 \); |
| \( \{R_{10}, R_{12}\} \); | \( i\sigma_3, -\sigma_0, \sigma_0, \sigma_1 \); |
| \( \{R_{14}, R_{16}\} \); | \( i\sigma_3, -\sigma_0, -\sigma_0, \sigma_1 \); |

| \( \Delta; \Gamma Y \); | \( C_{2y}, \sigma_x, I, T \); | \( R \); | \( 1 \); |
|---|---|---|---|
| \( R_1 \); | 1, 1, 1, 1; |
| \( R_2 \); | 1, 1, -1, 1; |
| \( R_3 \); | 1, -1, 1, 1; |
| \( R_4 \); | 1, -1, -1, 1; |

| \( D; X S \); | \( C_{2y}, \sigma_z, I, T \); | \( \{R_2, R_4\} \); | \( 2 \); |
|---|---|---|---|
| \( \{R_6, R_8\} \); | \( \sigma_3, \sigma_0, \sigma_1 \); |
| \( \{R_{10}, R_{12}\} \); | \( \sigma_3, -\sigma_0, \sigma_1 \); |

| \( P; U R \); | \( C_{2y}, \sigma_z, I, T \); | \( \{R_2, R_4\} \); | \( 2 \); |
|---|---|---|---|
| \( \{R_6, R_8\} \); | \( \sigma_3, \sigma_0, \sigma_1 \); |
| \( \{R_{10}, R_{12}\} \); | \( \sigma_3, -\sigma_0, \sigma_1 \); |

| \( B; Z T \); | \( C_{2y}, \sigma_z, I, T \); | \( R \); | \( 1 \); |
|---|---|---|---|
| \( R_1 \); | 1, 1, 1, 1; |
| \( R_2 \); | 1, 1, -1, 1; |
| \( R_3 \); | 1, -1, 1, 1; |
| \( R_4 \); | 1, -1, -1, 1; |
Σ: ΓX; $C_{2x, \sigma_z, IT}; R_1; 1; 1,1,1;$
$R_2; 1; 1,-1,1;$
$R_3; 1; -1,1,1;$
$R_4; 1; -1,-1,1;$

C: YS; $C_{2x, \sigma_{z}, IT}; \{R_2, R_4\}; 2; -\sigma_3, \sigma_0, \sigma_1; L-NS_{YTSR}$;
$\{R_6, R_8\}; 2; -\sigma_3, -\sigma_0, \sigma_1; L-NS_{YTSR}$;

E: TR; $C_{2x, \sigma_{z}, IT}; \{R_2, R_4\}; 2; -\sigma_3, \sigma_0, \sigma_1; L-NS_{YTSR}$;
$\{R_6, R_8\}; 2; -\sigma_3, -\sigma_0, \sigma_1; L-NS_{YTSR}$;

A: ZU; $C_{2x, \sigma_{z}, IT}; R_1; 1; 1,1,1;$
$R_2; 1; 1,-1,1;$
$R_3; 1; -1,1,1;$
$R_4; 1; -1,-1,1;$

Λ: ΓZ; $C_{2x, \sigma_y, IT}; R_1; 1; 1,1,1;$
$R_2; 1; 1,-1,1;$
$R_3; 1; -1,1,1;$
$R_4; 1; -1,-1,1;$

H: YT; $\sigma_y, C_{2x, IT}; R_5; 2; -\sigma_2, \sigma_3, -\sigma_0; L-NS_{YTSR}$;

Q: SR; $\sigma_y, C_{2x, IT}; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; L-NSs$;
$\{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; L-NSs$;

G: XU; $\sigma_{x}, C_{2x, IT}; R_5; 2; \sigma_2, \sigma_3, -\sigma_0; L-NS_{XUSR}$;
Γ₀: \{C₂\{000\}, \{C₂y\{\frac{1}{2}\frac{1}{2}\}\}, \{I\{\frac{1}{2}\frac{1}{2}\}\}\}; Centrosymmetric; without SOC

Γ: (000): \begin{align*}
C_{2x}, C_{2y}, I, T; R₁; & 1, 1, 1, 1; \\
R₂; & 1, −1, 1, 1; \\
R₃; & 1, −1, 1, 1; \\
R₄; & 1, −1, 1, 1; \\
R₅; & 1, 1, −1, 1; \\
R₆; & 1, −1, 1, 1; \\
R₇; & 1, −1, −1, 1; \\
R₈; & 1, −1, −1, 1; \\
\end{align*}

Y: \{\frac{1}{2}00\}; \begin{align*}
σₓ, I, σₓ, T; R₅; & 2; iσ₂, σ₃, σ₀, −σ₀; \quad \text{P-NS}_{YTSR}; \\
R₁₀; & 2; iσ₂, σ₃, −σ₀, −σ₀; \quad \text{P-NS}_{YTSR}; \\
\end{align*}

X: (0\frac{1}{2}0); \begin{align*}
σₓ, I, σᵧ, T; R₅; & 2; iσ₂, σ₃, σ₀, −σ₀; \quad \text{P-NS}_{XUSR}; \\
R₁₀; & 2; iσ₂, σ₃, −σ₀, −σ₀; \quad \text{P-NS}_{XUSR}; \\
\end{align*}

Z: (00\frac{1}{2}); \begin{align*}
σₓ, I, C₂z, T; R₅; & 2; iσ₂, σ₃, σ₀, −σ₀; \quad \text{P-WNLs}; \\
R₁₀; & 2; iσ₂, σ₃, −σ₀, −σ₀; \quad \text{P-WNLs}; \\
\end{align*}

U: \{\frac{1}{2}\frac{1}{2}0\}; \begin{align*}
σₓ, C₂x, I, T; \{R₉, R₁₀\}; & 4; iΓ₃, 0,Γ₀, 1, Γ₀, 3; Γ₁, 0, 1, 0; \quad \text{DP}; \quad 0 \\
\end{align*}

T: \{\frac{1}{2}\frac{1}{2}\frac{1}{2}\}; \begin{align*}
σₓ, C₂x, I, T; \{R₉, R₁₀\}; & 4; iΓ₃, 0,Γ₀, 1, Γ₀, 3; Γ₁, 0, 1, 0; \quad \text{DP}; \quad 0 \\
\end{align*}

S: \{\frac{1}{2}\frac{1}{2}\frac{1}{2}\}; \begin{align*}
C₂y, I, C₂z, T; R₅; & 2; iσ₂, σ₃, σ₀, −σ₀; \quad \text{P-NS}; \\
R₁₀; & 2; iσ₂, σ₃, −σ₀, −σ₀; \quad \text{P-NS}; \\
\end{align*}

R: \{\frac{1}{2}\frac{1}{2}\frac{1}{2}\}; \begin{align*}
C₂x, C₂z, I, T; \{R₂, R₄\}; & 2; iσ₃, σ₀, σ₀, σ₁; \quad \text{P-NS}; \\
\{R₀, R₈\}; & 2; iσ₃, −σ₀, σ₀, σ₁; \quad \text{P-NS}; \\
\{R₁₀, R₁₂\}; & 2; iσ₃, σ₀, −σ₀, σ₁; \quad \text{P-NS}; \\
\{R₁₄, R₁₆\}; & 2; iσ₃, −σ₀, −σ₀, σ₁; \quad \text{P-NS}; \\
\end{align*}

Δ: ΓY; \begin{align*}
C₂y, σₓ, I, T; & R₁; 1, 1, 1, 1; \\
R₂; & 1, −1, 1, 1; \\
R₃; & 1, −1, 1, 1; \\
R₄; & 1, −1, −1, 1; \\
\end{align*}

D: XS; \begin{align*}
C₂y, σₓ, I, T; & R₅; 2; σ₂, σ₃, −iσ₁; \quad \text{L-NS}_{XUSR}; \\
\end{align*}

P: UR; \begin{align*}
C₂y, σₓ, I, T; \{R₂, R₈\}; & 2; σ₃, −iσ₃, σ₁; \quad \text{L-NS}_{XUSR}; \\
\{R₄, R₆\}; & 2; −σ₃, −iσ₃, σ₁; \quad \text{L-NS}_{XUSR}; \\
\end{align*}

B: ZT; \begin{align*}
σₓ, C₂y, I, T; & R₅; 2; σ₂, σ₃, −iσ₁; \quad \text{WNL}; \quad π \\
\end{align*}

Σ: ΓX; \begin{align*}
C₂x, σₓ, I, T; & R₁; 1, 1, 1, 1; \\
R₂; & 1, −1, 1, 1; \\
R₃; & 1, −1, 1, 1; \\
R₄; & 1, −1, −1, 1; \\
\end{align*}

C: YS; \begin{align*}
C₂x, σₓ, I, T; & R₅; 2; −σ₂, iσ₃, −iσ₃; \quad \text{L-NS}_{YTSR}; \\
\end{align*}

E: TR; \begin{align*}
C₂x, σᵧ, I, T; \{R₂, R₆\}; & 2; −σ₃, −iσ₃, σ₁; \quad \text{L-NS}_{YTSR}; \\
\{R₄, R₆\}; & 2; σ₃, −iσ₃, σ₁; \quad \text{L-NS}_{YTSR}; \\
\end{align*}

A: ZU; \begin{align*}
σₓ, C₂x, I, T; & R₅; 2; σ₂, σ₃, −iσ₁; \quad \text{WNL}; \quad π \\
\end{align*}

Λ: ΓZ; \begin{align*}
C₂x, σᵧ, I, T; & R₁; 1, 1, 1, 1; \\
R₂; & 1, −1, 1, 1; \\
R₃; & 1, −1, 1, 1; \\
R₄; & 1, −1, −1, 1; \\
\end{align*}

H: YT; \begin{align*}
C₂x, σᵧ, I, T; \{R₁, R₄\}; & 2; σ₃, σ₄, σ₁; \quad \text{L-NS}_{YTSR}; \\
\{R₂, R₃\}; & 2; σ₃, −σ₃, σ₁; \quad \text{L-NS}_{YTSR}; \\
\end{align*}
$Q; SR; C_{2z}, \sigma_y, IT; \{R_1, R_2\}; 2; \sigma_0, \sigma_3, \sigma_1; L-\text{NSS};$

$\{R_3, R_4\}; 2; -\sigma_0, \sigma_3, \sigma_1; L-\text{NSS};$

$G; XU; C_{2z}, \sigma_y, IT; \{R_1, R_3\}; 2; \sigma_3, \sigma_0, \sigma_1; L-\text{NS}_{XUSR};$

$\{R_2, R_4\}; 2; \sigma_3, -\sigma_0, \sigma_1; L-\text{NS}_{XUSR};$
\[ \Gamma; \{C_{2y}[000]\}, \{C_{2y}[\frac{1}{2}\frac{1}{2}0]\}, \{I[0\frac{1}{2}\frac{1}{2}]\}; \text{Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma; \ (000); & \quad C_{2x}, C_{2y}, I, T; \\
R_1; & \quad 1; 1, 1, 1; \\
R_2; & \quad 1; -1, 1, 1; \\
R_3; & \quad 1; 1, -1, 1; \\
R_4; & \quad 1; -1, 1, 1; \\
R_5; & \quad 1; 1, -1, 1; \\
R_6; & \quad 1; -1, 1, -1; \\
R_7; & \quad 1; 1, -1, 1; \\
R_8; & \quad 1; -1, -1, 1; \\
Y; \ (\frac{1}{2}00); & \quad \sigma_x, I, \sigma_z, T; \\
R_5; & \quad 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-NSYTSR}; \\
R_{10}; & \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-NSYTSR}; \\
X; \ (0\frac{1}{2}0); & \quad \sigma_x, I, \sigma_y, T; \\
R_5; & \quad 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-NSXUSR}; \\
R_{10}; & \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-NSXUSR}; \\
Z; \ (00\frac{1}{2}); & \quad C_{2x}, C_{2y}, I, T; \\
R_1; & \quad 1; 1, 1, 1; \\
R_2; & \quad 1; -1, 1, 1; \\
R_3; & \quad 1; 1, -1, 1; \\
R_4; & \quad 1; -1, 1, 1; \\
R_5; & \quad 1; 1, -1, 1; \\
R_6; & \quad 1; -1, -1, 1; \\
R_7; & \quad 1; 1, -1, 1; \\
R_8; & \quad 1; -1, -1, 1; \\
U; \ (0\frac{1}{2}\frac{1}{2}); & \quad \sigma_x, I, \sigma_y, T; \\
R_5; & \quad 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-NSXUSR}; \\
R_{10}; & \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-NSXUSR}; \\
T; \ (\frac{1}{2}0\frac{1}{2}); & \quad \sigma_x, I, \sigma_z, T; \\
R_5; & \quad 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-NSYTSR}; \\
R_{10}; & \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-NSYTSR}; \\
S; \ (\frac{1}{2}\frac{1}{2}0); & \quad C_{2x}, C_{2y}, I, T; \{R_9, R_{10}\}; 4; i\Gamma_3, \Gamma_0, \Gamma_0, \Gamma_0; \Gamma_1, \Gamma_0; \text{P-DNLSR}; \\
R; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & \quad C_{2x}, C_{2y}, I, T; \{R_9, R_{10}\}; 4; i\Gamma_3, \Gamma_0, \Gamma_0, \Gamma_0, \Gamma_1, \Gamma_0; \text{P-DNLSR}; \\
\Delta; \ \Gamma_Y; & \quad C_{2y}, \sigma_x, I, T; \\
R_1; & \quad 1; 1, 1, 1; \\
R_2; & \quad 1; 1, -1, 1; \\
R_3; & \quad 1; -1, 1, 1; \\
R_4; & \quad 1; -1, -1, 1; \\
D; \ \Gamma_X; & \quad C_{2y}, \sigma_x, I, T; \\
R_5; & \quad 2; \sigma_2, \sigma_3, -i\sigma_1; \quad \text{L-NSXUSR}; \\
P; \ \Gamma_U; & \quad C_{2y}, \sigma_x, I, T; \\
R_5; & \quad 2; \sigma_2, \sigma_3, -i\sigma_1; \quad \text{L-NSXUSR}; \\
B; \ \Gamma_T; & \quad C_{2y}, \sigma_x, I, T; \\
R_1; & \quad 1; 1, 1, 1; \\
R_2; & \quad 1; 1, -1, 1; \\
R_3; & \quad 1; -1, 1, 1; \\
R_4; & \quad 1; -1, -1, 1; \\
\Sigma; \ \Gamma_X; & \quad C_{2x}, \sigma_z, I, T; \\
R_1; & \quad 1; 1, 1, 1; \\
R_2; & \quad 1; 1, -1, 1; \\
R_3; & \quad 1; -1, 1, 1; \\
R_4; & \quad 1; -1, -1, 1; \\
C; \ \Gamma_Y; & \quad C_{2x}, \sigma_z, I, T; \{R_2, R_3\}; 2; -\sigma_3, \sigma_0, \sigma_1; \quad \text{L-NSYTSR}; \\
\{R_6, R_8\}; 2; -\sigma_3, -\sigma_0, \sigma_1; \quad \text{L-NSYTSR}; \\
E; \ \Gamma_T; & \quad C_{2x}, \sigma_z, I, T; \{R_2, R_3\}; 2; -\sigma_3, \sigma_0, \sigma_1; \quad \text{L-NSYTSR}; \\
\{R_6, R_8\}; 2; -\sigma_3, -\sigma_0, \sigma_1; \quad \text{L-NSYTSR};
\]
A; ZU; $C_{2x}, \sigma_z, IT$; \( R_1 \): \( 1, 1, 1 \);
\( R_2 \): \( 1, -1, 1 \);
\( R_3 \): \( -1, 1, 1 \);
\( R_4 \): \( -1, -1, 1 \);

Λ; ΓZ; $C_{2z}, \sigma_y, IT$; \( R_1 \): \( 1, 1, 1 \);
\( R_2 \): \( 1, -1, 1 \);
\( R_3 \): \( -1, 1, 1 \);
\( R_4 \): \( -1, -1, 1 \);

H; YT; $\sigma_y, C_{2x}, IT$; \( R_5 \): \( 2; -\sigma_3, \sigma_3, -\sigma_0 \); L-NS_{YTSR};

Q; SR; $\sigma_y, C_{2x}, IT$; \( \{ R_5, R_3 \} \): \( 4; -\Gamma_{0,2}, \Gamma_{0,3}, -\Gamma_{2,2} \); DNL; 0

G; XU; $C_{2x}, \sigma_y, IT$; \( \{ R_1, R_3 \} \): \( 2; \sigma_3, \sigma_0, \sigma_1 \); L-NS_{XUSR};
\( \{ R_2, R_4 \} \): \( 2; \sigma_3, -\sigma_0, \sigma_1 \); L-NS_{XUSR};
\[ \Gamma; \{C_2(000), \{C_2y\frac{1}{2}\frac{1}{2}\}, \{I\frac{1}{2}\frac{1}{2}\}\}, T; \text{Centrosymmetric; without SOC} \]

| \( \Gamma \) | \( (000) \) | \( C_{2x}, C_{2y}, I, T \) | \( R_1 \) | \( 1, 1, 1, 1 \) |
|-----------|----------------|----------------|------------|---------|
| \( R_2 \) | \( 1, -1, 1, 1 \) |
| \( R_3 \) | \( 1, -1, 1, 1 \) |
| \( R_4 \) | \( 1, -1, 1, 1 \) |
| \( R_5 \) | \( 1, 1, -1, 1 \) |
| \( R_6 \) | \( 1, -1, 1, 1 \) |
| \( R_7 \) | \( 1, -1, -1, 1 \) |
| \( R_8 \) | \( 1, -1, -1, 1 \) |

| \( Y; \left( \frac{1}{2} \frac{1}{2} \right) \) | \( \sigma_x, I, \sigma_z, T \) | \( R_5 \) | \( 2; \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NS}\) |
| \( R_{10} \) | \( 2; \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NS} \) |

| \( X; \left( 0 \frac{1}{2} \frac{1}{2} \right) \) | \( \sigma_y, I, \sigma_z, T \) | \( R_5 \) | \( 2; \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NS} \) |
| \( R_{10} \) | \( 2; \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NS} \) |

| \( Z; \left( 0 0 \frac{1}{2} \right) \) | \( \sigma_x, I, C_{2z}, T \) | \( R_5 \) | \( 2; \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-WNL}\) |
| \( R_{10} \) | \( 2; \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNL} \) |

| \( U; \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right) \) | \( \sigma_x, C_{2z}, I, T \) | \( R_5 \) | \( 2; \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-WNL/NS}\) |
| \( R_{10} \) | \( 2; \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNL/NS} \) |

| \( T; \left( \frac{1}{2} 0 \frac{1}{2} \right) \) | \( \sigma_y, C_{2z}, I, T \) | \( R_5 \) | \( 2; \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-WNL/NS}\) |
| \( R_{10} \) | \( 2; \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNL/NS} \) |

| \( S; \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right) \) | \( \sigma_x, C_{2z}, I, T \) | \( \{R_2, R_4\} \) | \( 2; \sigma_3, \sigma_0, \sigma_0, \sigma_1; \text{P-NS}\) |
| \( \{R_6, R_8\} \) | \( 2; \sigma_3, -\sigma_0, \sigma_0, \sigma_1; \text{P-NS} \) |
| \( \{R_{10}, R_{12}\} \) | \( 2; \sigma_3, \sigma_0, -\sigma_0, \sigma_1; \text{P-NS} \) |
| \( \{R_{14}, R_{16}\} \) | \( 2; \sigma_3, -\sigma_0, -\sigma_0, \sigma_1; \text{P-NS} \) |

| \( R; \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right) \) | \( C_{2y}, I, C_{2z}, T \) | \( R_5 \) | \( 2; \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NS}\) |
| \( R_{10} \) | \( 2; \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NS} \) |

| \( \Delta; \Gamma Y; \) | \( C_{2y}, \sigma_z, I, T \) | \( \{R_2, R_4\} \) | \( 1; 1, 1, 1 \) |
| \( \{R_6, R_8\} \) | \( 1; 1, -1, 1 \) |
| \( \{R_{10}, R_{12}\} \) | \( 1; -1, 1, 1 \) |
| \( \{R_{14}, R_{16}\} \) | \( 1; -1, -1, 1 \) |

| \( D; \) | \( \) | \( C_{2y}, \sigma_z, I, T \) | \( \{R_2, R_4\} \) | \( 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}\) |
| \( \) | \( \{R_6, R_8\} \) | \( 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NS} \) |

| \( P; \) | \( \) | \( C_{2y}, \sigma_z, I, T \) | \( R_5 \) | \( 2; \sigma_2, \sigma_1, -i\sigma_1; \text{L-NS}\) |

| \( B; \) | \( \) | \( \sigma_z, C_{2y}, I, T \) | \( R_5 \) | \( 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL}\) |

| \( \Sigma; \Gamma X; \) | \( C_{2x}, \sigma_z, I, T \) | \( R_5 \) | \( 1; 1, 1, 1 \) |
| \( R_2 \) | \( 1; 1, -1, 1 \) |
| \( R_3 \) | \( 1; -1, 1, 1 \) |
| \( R_4 \) | \( 1; -1, -1, 1 \) |

| \( C; \) | \( \) | \( C_{2x}, \sigma_z, I, T \) | \( \{R_2, R_4\} \) | \( 2; -\sigma_3, \sigma_0, \sigma_1; \text{L-NS}\) |
| \( \) | \( \{R_6, R_8\} \) | \( 2; -\sigma_3, -\sigma_0, \sigma_1; \text{L-NS} \) |

| \( E; \) | \( \) | \( C_{2x}, \sigma_z, I, T \) | \( R_5 \) | \( 2; -\sigma_2, \sigma_1, -i\sigma_1; \text{L-NS}\) |

| \( A; \) | \( \) | \( \sigma_z, C_{2x}, I, T \) | \( R_5 \) | \( 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL}\) |

| \( \Lambda; \Gamma Z; \) | \( C_{2x}, \sigma_y, I, T \) | \( R_5 \) | \( 1; 1, 1, 1 \) |
| \( R_2 \) | \( 1; 1, -1, 1 \) |
| \( R_3 \) | \( 1; -1, 1, 1 \) |
| \( R_4 \) | \( 1; -1, -1, 1 \) |
\( H; YT; \sigma_y, C_{2z}, IT; R_5; 2; -\sigma_2, \sigma_3, -\sigma_0; \text{L-NS}_{YTSR}; \)
\( Q; SR; \sigma_y, C_{2z}, IT; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{L-NSs}; \)
\( \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{L-NSs}; \)
\( G; XU; \sigma_x, C_{2z}, IT; R_5; 2; \sigma_2, \sigma_3, -\sigma_0; \text{L-NS}_{XUSR}; \)
SG 59

\[ \Gamma_0; \{C_{2z}|000\}, \{C_{2y}|\frac{1}{2}\frac{1}{2}0\}, \{I|\frac{1}{2}\frac{1}{2}0\}, T; \text{Centrosymmetric; without SOC} \]

\( \Gamma; (000): C_{2z}, C_{2y}, I, T; \)
- \( R_1: 1, 1, 1, 1; \)
- \( R_2: 1, -1, 1, 1; \)
- \( R_3: 1, 1, -1, 1; \)
- \( R_4: 1, -1, 1, 1; \)
- \( R_5: 1, 1, 1, 1; \)
- \( R_6: 1, -1, 1, 1; \)
- \( R_7: 1, -1, 1, 1; \)
- \( R_8: 1, -1, -1, 1; \)

\( Y; (\frac{1}{2}00); \sigma_z, I, \sigma_z, T; \)
- \( R_5: 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NSYTSR}; \)
- \( R_{10}: 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NSYTSR}; \)

\( X; (0\frac{1}{2}0); \sigma_x, I, \sigma_y, T; \)
- \( R_5: 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NSXUSR}; \)
- \( R_{10}: 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NSXUSR}; \)

\( Z; (00\frac{1}{2}); C_{2z}, C_{2y}, I, T; \)
- \( R_1: 1, 1, 1, 1; \)
- \( R_2: 1, -1, 1, 1; \)
- \( R_3: 1, 1, -1, 1; \)
- \( R_4: 1, -1, 1, 1; \)
- \( R_5: 1, 1, 1, 1; \)
- \( R_6: 1, -1, 1, 1; \)
- \( R_7: 1, -1, -1, 1; \)
- \( R_8: 1, -1, -1, 1; \)

\( U; (0\frac{1}{2}\frac{1}{2}); \sigma_z, I, \sigma_y, T; \)
- \( R_5: 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NSXUSR}; \)
- \( R_{10}: 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NSXUSR}; \)

\( T; (\frac{1}{2}0\frac{1}{2}); \sigma_z, I, \sigma_z, T; \)
- \( R_5: 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NSYTSR}; \)
- \( R_{10}: 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NSYTSR}; \)

\( S; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{2z}, I, C_{2z}, T; \)
- \( R_5: 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NSS}; \)
- \( R_{10}: 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NSS}; \)

\( R; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{2z}, I, C_{2z}, T; \)
- \( R_5: 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NSS}; \)
- \( R_{10}: 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NSS}; \)

\( \Delta; \Gamma Y; C_{2y}, \sigma_x, I, T; \)
- \( R_1: 1, 1, 1, 1; \)
- \( R_2: 1, 1, -1, 1; \)
- \( R_3: 1, -1, 1, 1; \)
- \( R_4: 1, -1, -1, 1; \)

\( D; \Gamma X; C_{2y}, \sigma_z, I, T; \)
- \( R_5: 2, \sigma_2, \sigma_3, -i\sigma_1; \text{L-NSXUSR}; \)

\( P; \Gamma R; C_{2y}, \sigma_x, I, T; \)
- \( R_5: 2, \sigma_2, \sigma_3, -i\sigma_1; \text{L-NSXUSR}; \)

\( B; \Gamma T; C_{2y}, \sigma_y, I, T; \)
- \( R_1: 1, 1, 1, 1; \)
- \( R_2: 1, 1, -1, 1; \)
- \( R_3: 1, -1, 1, 1; \)
- \( R_4: 1, -1, -1, 1; \)

\( \Sigma; \Gamma Z; C_{2x}, \sigma_z, I, T; \)
- \( R_1: 1, 1, 1, 1; \)
- \( R_2: 1, 1, -1, 1; \)
- \( R_3: 1, -1, 1, 1; \)
- \( R_4: 1, -1, -1, 1; \)

\( C; \Gamma S; C_{2x}, \sigma_z, I, T; \)
- \( R_5: 2, -\sigma_2, i\sigma_3, -i\sigma_3; \text{P-NSYTSR}; \)

\( E; \Gamma T; C_{2x}, \sigma_z, I, T; \)
- \( R_5: 2, -\sigma_2, i\sigma_3, -i\sigma_3; \text{P-NSYTSR}; \)
\[ A; ZU; C_{2x}, \sigma_z, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ \Lambda; \Gamma Z; C_{2z}, \sigma_y, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ H; YT; C_{2x}, \sigma_y, IT; \{ R_1, R_4 \}; 2; \sigma_3, \sigma_3, \sigma_1; \text{P-NS}_{YTSR}; \]
\[ \{ R_2, R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_1; \text{P-NS}_{YTSR}; \]

\[ Q; SR; C_{2x}, \sigma_y, IT; \{ R_1, R_2 \}; 2; \sigma_0, \sigma_3, \sigma_1; \text{L-NSs}; \]
\[ \{ R_3, R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_1; \text{L-NSs}; \]

\[ G; XU; C_{2x}, \sigma_y, IT; \{ R_1, R_3 \}; 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}_{XUSR}; \]
\[ \{ R_2, R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NS}_{XUSR}; \]
\( \Gamma_0; \{C_{2v}[000], C_{2v}[\frac{1}{2}, \frac{1}{2}, 0], I[\frac{1}{2}, \frac{1}{2}, 0]\}; \ T; \text{Centrosymmetric; without SOC} \)

\[ \begin{array}{llllllllll}
\Gamma & \text{ (000); } & C_{2v}, C_{2v}, I, T; & R_1; & \Gamma_0, & 1; & 1, 1, 1, 1; & \\
& & R_2; & \Gamma_0, & 1; & -1, 1, 1, 1; & \\
& & R_3; & \Gamma_0, & 1; & 1, -1, 1, 1; & \\
& & R_4; & \Gamma_0, & 1; & -1, -1, 1, 1; & \\
& & R_5; & \Gamma_0, & 1; & 1, 1, -1, 1; & \\
& & R_6; & \Gamma_0, & 1; & -1, 1, -1, 1; & \\
& & R_7; & \Gamma_0, & 1; & -1, -1, -1, 1; & \\
& & R_8; & \Gamma_0, & 1; & -1, -1, -1, 1; & \\
\end{array} \]

\[ \begin{array}{llll}
Y; \left( \frac{1}{2} \ 0 \ 0 \right); & \sigma_x, \sigma_z, T; & R_5; & 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; & \text{P-NSYTSR;} \\
& R_{10}; & 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; & \text{P-NSYTSR;} \\
X; \left( 0 \frac{1}{2} 0 \right); & \sigma_y, \sigma_z, T; & R_5; & 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; & \text{P-NSXUSR;} \\
& R_{10}; & 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; & \text{P-NSXUSR;} \\
Z; \left( 0 0 \frac{1}{2} \right); & \sigma_x, I, C_{2v}, T; & R_5; & 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; & \text{P-WNLs;} \\
& R_{10}; & 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; & \text{P-WNLs;} \\
U; \left( 0 \frac{1}{2} \frac{1}{2} \right); & \sigma_x, C_{2v}, I, T; & R_5; & 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; & \text{P-WNL/NS;} \\
& R_{10}; & 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; & \text{P-WNL/NS;} \\
T; \left( \frac{1}{2} 0 \ 0 \right); & \sigma_y, C_{2v}, I, T; \{R_0, R_{10}\}; & 4; i\Gamma_3, \Gamma_0, \Gamma_0, \Gamma_1, \Gamma_1; & \text{DP;} & 0 \\
S; \left( \frac{1}{2} \frac{1}{2} 0 \right); & C_{2v}, C_{2v}, I, T; \{R_0, R_{10}\}; & 4; i\Gamma_3, \Gamma_0, \Gamma_0, \Gamma_0, \Gamma_1; & \text{P-DNLYSR;} \\
R; \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); & C_{2v}, C_{2v}, I, T; \{R_0, R_{10}\}; & 4; i\Gamma_3, \Gamma_0, \Gamma_0, \Gamma_0, \Gamma_1; & \text{P-DNLYSR;} \\
\Delta; \gamma Y; & C_{2v}, \sigma_x, I, T; & R_1; & 1; & 1, 1, 1; & \\
& R_2; & 1; & 1, -1, 1; & \\
& R_3; & 1; & -1, 1, 1; & \\
& R_4; & 1; & -1, -1, 1; & \\
D; \gamma X; & C_{2v}, \sigma_x, I, T; \{R_2, R_4\}; & 2; \sigma_3, \sigma_0, \sigma_1; & \text{L-NSXUSR;} & \\
& \{R_6, R_8\}; & 2; \sigma_3, -\sigma_0, \sigma_1; & \text{L-NSXUSR;} & \\
P; \gamma UR; & C_{2v}, \sigma_x, I, T; & R_5; & 2; \sigma_2, -i\sigma_1, -i\sigma_3; & \text{L-NSXUSR;} & \\
B; \gamma ZT; & \sigma_x, C_{2v}, I, T; & R_5; & 2; \sigma_2, \sigma_3, -i\sigma_1; & \text{WNL;} & \pi \\
\Sigma; \gamma GX; & C_{2v}, \sigma_x, I, T; & R_1; & 1; & 1, 1, 1; & \\
& R_2; & 1; & 1, -1, 1; & \\
& R_3; & 1; & -1, 1, 1; & \\
& R_4; & 1; & -1, -1, 1; & \\
C; \gamma YS; & C_{2v}, \sigma_x, I, T; & R_5; & 2; -\sigma_2, i\sigma_3, -i\sigma_3; & \text{L-NSYTSR;} & \\
E; \gamma TR; & C_{2v}, \sigma_y, I, T; \{R_2, R_8\}; & 2; -\sigma_3, -i\sigma_3, \sigma_1; & \text{L-NSYTSR;} & \\
& \{R_4, R_8\}; & 2; \sigma_3, -i\sigma_3, \sigma_1; & \text{L-NSYTSR;} & \\
A; \gamma ZU; & \sigma_x, C_{2v}, I, T; & R_5; & 2; \sigma_2, \sigma_3, -i\sigma_1; & \text{WNL;} & \pi \\
\Lambda; \gamma GZ; & C_{2v}, \sigma_y, I, T; & R_1; & 1; & 1, 1, 1; & \\
& R_2; & 1; & 1, -1, 1; & \\
& R_3; & 1; & -1, 1, 1; & \\
& R_4; & 1; & -1, -1, 1; & \\
H; \gamma YT; & C_{2v}, \sigma_y, I, T; \{R_1, R_4\}; & 2; \sigma_3, \sigma_3, \sigma_1; & \text{L-NSYTSR;} & \\
& \{R_2, R_3\}; & 2; \sigma_3, -\sigma_3, \sigma_1; & \text{L-NSYTSR;} & \\
Q; \gamma SR; & \sigma_z, C_{2v}, I, T; \{R_5, R_5\}; & 4; \Gamma_0, \Gamma_0, \Gamma_0, \Gamma_2; & \text{DNL;} & 0 \\
G; \gamma XU; & \sigma_z, C_{2v}, I, T; & R_5; & 2; \sigma_2, \sigma_3, -\sigma_0; & \text{L-NSXUSR;} & \\
\end{array} \]

SG 60
\( \Gamma_0; \{ C_{2z} \}, \{ \frac{1}{2} \} \), \{ I(000) \}, T; \text{Centrosymmetric; without SOC}\\
\Gamma; (000); C_{2z}, C_{2y}, I; T; R_1; 1, 1, 1, 1;\\
R_2; 1, -1, 1, 1;\\
R_3; 1, -1, 1, 1;\\
R_4; 1, -1, 1, 1;\\
R_5; 1, 1, -1, 1;\\
R_6; 1, -1, 1, 1;\\
R_7; 1, 1, -1, 1;\\
R_8; 1, -1, -1, 1;\\
Y; (\frac{1}{2} 00); \sigma_x, I, \sigma_z, T; R_5; 2; \sigma_2, \sigma_3, \sigma_0, -\sigma_0; -\text{PNSYTSR};\\
\sigma_{10}; 2; \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; -\text{PNSYTSR};\\
X; (0 \frac{1}{2} 0); \sigma_y, I, \sigma_z, T; R_5; 2; \sigma_2, \sigma_3, \sigma_0, -\sigma_0; -\text{PNSXUSR};\\
\sigma_{10}; 2; \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; -\text{PNSXUSR};\\
Z; (0 0 \frac{1}{2}); \sigma_z, I, \sigma_y, T; R_5; 2; \sigma_2, \sigma_3, \sigma_0, -\sigma_0; -\text{PNSZUTR};\\
\sigma_{10}; 2; \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; -\text{PNSZUTR};\\
U; (0 \frac{1}{2} \frac{1}{2}); C_{2z}, C_{2y}, I; T; \{ R_0, R_{10} \}; 4; \Gamma_3, \Gamma_0, 1, \Gamma_0, 0, \Gamma_1, 0; -\text{PDNLEUR};\\
T; (\frac{1}{2} 0 \frac{1}{2}); C_{2z}, C_{2y}, I; T; \{ R_9, R_{10} \}; 4; \Gamma_3, \Gamma_0, \Gamma_0, \Gamma_0, \Gamma_1, 0; -\text{PDNLTEUR};\\
S; (\frac{1}{2} \frac{1}{2} 0); C_{2y}, C_{2z}, I; T; \{ R_0, R_{10} \}; 4; \Gamma_3, \Gamma_0, \Gamma_0, \Gamma_0, \Gamma_1, 0; -\text{PDNLS};\\
R; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{2z}, C_{2y}, I; T; \{ R_5, R_6 \}; 4; \Gamma_0, \Gamma_0, \Gamma_0, -\Gamma_2, 2; -\text{PDNLS};\\
\Gamma_Y; \{ C_{2y}, \sigma_x, I; T \}; R_1; 1, 1, 1, 1;\\
R_2; 1, -1, 1;\\
R_3; 1, -1, 1, 1;\\
R_4; 1, -1, 1, 1;\\
D; XS; \sigma_x, \sigma_z, I; T; \{ R_2, R_4 \}; 2; \sigma_3, \sigma_0, \sigma_1; -\text{LNSXUSR};\\
\sigma_{10}; 2; \sigma_3, -\sigma_0, \sigma_1; -\text{LNSXUSR};\\
P; UR; \sigma_x, \sigma_y, I; T; \{ R_5, R_6 \}; 4; \Gamma_0, 2, -\Gamma_0, 1, -\Gamma_2, 2; -\text{DNL}; 0;\\
B; ZT; \sigma_x, C_{2y}, I; T; R_5; 2; \sigma_2, \sigma_3, -\sigma_0; -\text{LNSZUTR};\\
\Sigma; \Gamma X; \sigma_x, \sigma_x, I; T; R_1; 1, 1, 1, 1;\\
R_2; 1, -1, 1;\\
R_3; 1, -1, 1, 1;\\
R_4; 1, -1, 1, 1;\\
C; YS; \sigma_y, C_{2z}, I; T; R_5; 2; -\sigma_2, \sigma_3, -\sigma_0; -\text{PNSYTSR};\\
E; TR; \sigma_x, \sigma_z, I; T; \{ R_5, R_9 \}; 4; \Gamma_0, 2, i\Gamma_0, 1, -\Gamma_2, 2; -\text{DNL}; 0;\\
A; ZU; \sigma_x, \sigma_y, I; T; \{ R_2, R_4 \}; 2; \sigma_3, \sigma_0, \sigma_1; -\text{LNSZUTR};\\
\sigma_{10}; 2; \sigma_3, -\sigma_0, \sigma_1; -\text{LNSZUTR};\\
\Lambda; \Gamma Z; \sigma_x, \sigma_y, I; T; R_1; 1, 1, 1, 1;\\
R_2; 1, 1, -1, 1;\\
R_3; 1, -1, 1, 1;\\
R_4; 1, -1, 1, 1;\\
H; YT; \sigma_x, \sigma_z, I; T; \{ R_2, R_4 \}; 2; -\sigma_3, \sigma_0, \sigma_1; -\text{PNSYTSR};\\
\sigma_{10}; 2; -\sigma_3, -\sigma_0, \sigma_1; -\text{PNSYTSR};\\
Q; SR; \sigma_x, \sigma_y, I; T; \{ R_5, R_6 \}; 4; -\Gamma_0, 2, \Gamma_0, 1, -\Gamma_2, 2; -\text{DNL}; 0;\\
G; XU; \sigma_x, C_{2z}, I; T; R_5; 2; \sigma_2, \sigma_3, -\sigma_0; -\text{PNSXUSR};
\[
\begin{array}{c|c|c}
\Gamma_0: & \{C_{2z}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2} \}, \{C_{2y}, \frac{1}{2}, \frac{1}{2} \}, \{I, \frac{1}{2}, \frac{1}{2} \}, \mathcal{T}; \text{Centrosymmetric; without SOC} \\
\hline
\Gamma; & (000); C_{2x}, C_{2y}, I, \mathcal{T}; & R_1: 1, 1, 1, 1; \\
\hline
\hline
R_2: & 1; -1, 1, 1, 1; \\
R_3: & 1; 1, -1, 1, 1; \\
R_4: & 1; -1, -1, 1, 1; \\
R_5: & 1; 1, 1, -1, 1; \\
R_6: & 1; -1, 1, -1, 1; \\
R_7: & 1; -1, 1, -1, 1; \\
R_8: & 1; -1, -1, -1, 1; \\
\hline
Y; & \left( \frac{1}{2}, 0, 0 \right); \sigma_x, I, \sigma_x, \mathcal{T}; & R_5: 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NSYSTUR}; \\
\hline
R_{10}: & 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NSYSTUR}; \\
\hline
X; & \left( 0, \frac{1}{2}, 0 \right); \sigma_x, I, \sigma_y, \mathcal{T}; & R_5: 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NSYSTUR}; \\
\hline
R_{10}: & 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NSYSTUR}; \\
\hline
Z; & \left( 0, 0, \frac{1}{2} \right); \sigma_x, I, \sigma_y, \mathcal{T}; & R_5: 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NSYSTUR}; \\
\hline
R_{10}: & 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NSYSTUR}; \\
\hline
U; & \left( 0, \frac{1}{2}, \frac{1}{2} \right); C_{2x}, C_{2y}, I, \mathcal{T}; & \{R_2, R_4\}: 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \text{P-NSS}; \\
\hline
\{R_6, R_8\}: 2; i\sigma_3, -\sigma_0, \sigma_0, \sigma_1; \text{P-NSS}; \\
\{R_{10}, R_{12}\}: 2; i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \text{P-NSS}; \\
\{R_{14}, R_{16}\}: 2; i\sigma_3, -\sigma_0, -\sigma_0, \sigma_1; \text{P-NSS}; \\
\hline
T; & \left( \frac{1}{2}, 0, \frac{1}{2} \right); C_{2y}, I, C_{2x}, \mathcal{T}; & R_5: 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NSS}; \\
\hline
R_{10}: & 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NSS}; \\
\hline
S; & \left( \frac{1}{2}, \frac{1}{2}, 0 \right); C_{2x}, \sigma_y, I, \mathcal{T}; & \{R_9, R_{10}\}: 4; i\Gamma_{3.0}, \Gamma_{0.1}, \Gamma_{0.3}, \Gamma_{1.0}; \text{P-DNL}_{\mathcal{S}}; \\
\hline
R; & \left( \frac{1}{2}, \frac{1}{2}, \frac{1}{2} \right); \sigma_x, \sigma_y, I, \mathcal{T}; & \{R_9, R_{10}\}: 4; i\Gamma_{3.0}, \Gamma_{0.1}, \Gamma_{0.3}, \Gamma_{1.0}; \text{P-DNL}_{\mathcal{S}}; \\
\hline
\Delta; \Gamma Y; & C_{2y}, \sigma_x, I, \mathcal{T}; & R_1: 1; 1, 1, 1; \\
\hline
R_2: & 1; -1, 1, 1; \\
R_3: & 1; -1, 1, 1; \\
R_4: & 1; -1, -1, 1; \\
\hline
D; \Gamma X; & C_{2y}, \sigma_x, I, \mathcal{T}; & R_5: 2; \sigma_2, \sigma_3, -i\sigma_1; \text{L-NSYSTUR}; \\
\hline
P; \Gamma Y; & C_{2y}, \sigma_x, I, \mathcal{T}; & \{R_2, R_6\}: 2; \sigma_0, -i\sigma_3, \sigma_1; \text{L-NSS}; \\
\hline
\{R_4, R_8\}: 2; -\sigma_0, -i\sigma_3, \sigma_1; \text{L-NSS}; \\
\hline
B; \Gamma Z; & \sigma_x, C_{2y}, I, \mathcal{T}; & R_5: 2; \sigma_2, \sigma_3, -\sigma_0; \text{L-NSYSTUR}; \\
\hline
\Sigma; \Gamma X; & C_{2y}, \sigma_x, I, \mathcal{T}; & R_1: 1; 1, 1, 1; \\
\hline
R_2: & 1; -1, 1, 1; \\
R_3: & 1; -1, 1, 1; \\
R_4: & 1; -1, -1, 1; \\
\hline
C; \Gamma Y; & C_{2x}, \sigma_x, I, \mathcal{T}; & \{R_1, R_3\}: 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NSYSTUR}; \\
\hline
\{R_2, R_4\}: 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NSYSTUR}; \\
\hline
E; \Gamma T; & C_{2x}, \sigma_y, I, \mathcal{T}; & \{R_2, R_6\}: 2; \sigma_0, \sigma_3, \sigma_1; \text{L-NSS}; \\
\hline
\{R_4, R_8\}: 2; -\sigma_0, \sigma_3, \sigma_1; \text{L-NSS}; \\
\hline
A; \Gamma U; & C_{2x}, \sigma_y, I, \mathcal{T}; & \{R_2, R_4\}: 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NSYSTUR}; \\
\hline
\{R_6, R_8\}: 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NSYSTUR}; \\
\hline
\Lambda; \Gamma Z; & C_{2x}, \sigma_y, I, \mathcal{T}; & R_1: 1; 1, 1, 1; \\
\hline
R_2: & 1; -1, 1, 1; \\
R_3: & 1; -1, 1, 1; \\
R_4: & 1; -1, -1, 1; \\
\end{array}
\]
$H; YT; C_{2z}, \sigma_y, IT; \{R_5\}; 2; -\sigma_2, \sigma_3, -i\sigma_1; L-NS_YTSR$

$Q; SR; C_{2z}, \sigma_y, IT; \{\{R_5, R_5\}\}; 4; -\Gamma_{0,2}, \Gamma_{0,3}, -\Gamma_{2,2}; DNL; 0$

$G; XU; C_{2z}, \sigma_y, IT; \{\{R_1, R_3\}\}; 2; \sigma_3, \sigma_0, \sigma_1; L-NS_{XUSR}$

$\{R_2, R_4\}; 2; \sigma_3, -\sigma_0, \sigma_1; L-NS_{XUSR}$
\( \Gamma^6_0; \{C_2, [00\frac{1}{2}], \{C_2y[00\frac{1}{2}], \{[0|000]\}, T; \} \text{ Centrosymmetric; without SOC} \)

\[ \Gamma; (000); C_{2z}, C_{2y}, I, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, -1, 1, 1; \]
\[ R_3; 1, 1, -1, 1; \]
\[ R_4; 1, -1, 1, 1; \]
\[ R_5; 1, 1, 1, 1; \]
\[ R_6; 1, -1, 1, -1; \]
\[ R_7; 1, -1, -1, 1; \]
\[ R_8; 1, -1, -1, -1; \]

\[ Y; (\frac{1}{2} \frac{1}{2} 0); C_{2z}, C_{2y}, I, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, -1, 1, 1; \]
\[ R_3; 1, 1, -1, 1; \]
\[ R_4; 1, -1, 1, 1; \]
\[ R_5; 1, 1, 1, 1; \]
\[ R_6; 1, -1, -1, 1; \]
\[ R_7; 1, -1, -1, 1; \]
\[ R_8; 1, -1, -1, -1; \]

\[ Z; (00\frac{1}{2}); C_{2z}, I, \sigma_x, T; \]
\[ R_5; 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \]
\[ R_{10}; 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \]

\[ T; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{2z}, I, \sigma_x, T; \]
\[ R_5; 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \]
\[ R_{10}; 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \]

\[ S; (0\frac{1}{2} 0); C_{2z}, I, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, -1, 1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, 1, -1, 1; \]

\[ R; (0\frac{1}{2} \frac{1}{2}); C_{2z}, I, T; \]
\[ R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; \]

\[ \Lambda; \Gamma Z; C_{2z}, \sigma_y, I T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ H; \Gamma Y; C_{2z}, \sigma_y, I T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ D; \Gamma R; C_{2z}, I T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]

\[ A; \Gamma Z; \sigma_x, C_{2z}, I T; \]
\[ R_5; 2, \sigma_2, \sigma_3, -\sigma_0; \]

\[ \Sigma; \Gamma Y; C_{2z}, \sigma_z, I T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ \Delta; \Gamma \Delta; C_{2y}, \sigma_x, I T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
$B; \ ZB; \ C_{2y, \sigma_x, IT}; \ \{R_2, R_4\}; \ 2; \ \sigma_3, \sigma_0, \sigma_1; \ \text{L-NSZTR;}$

$\{R_6, R_8\}; \ 2; \ \sigma_3, -\sigma_0, \sigma_1; \ \text{L-NSZTR;}$

$G; \ TG; \ C_{2y, \sigma_x, IT}; \ \{R_2, R_4\}; \ 2; \ \sigma_3, \sigma_0, \sigma_1; \ \text{L-NSZTR;}$

$\{R_6, R_8\}; \ 2; \ \sigma_3, -\sigma_0, \sigma_1; \ \text{L-NSZTR;}$

$F; \ YF; \ C_{2y, \sigma_x, IT}; \ \begin{array}{l}
R_1; \ 1, 1, 1; \\
R_2; \ 1, 1, -1, 1; \\
R_3; \ 1, -1, 1, 1; \\
R_4; \ 1, -1, -1, 1;
\end{array}$

$E; \ TE; \ \sigma_z, C_{2x, IT}; \ \begin{array}{l}
R_5; \ 2; \ \sigma_2, \sigma_3, -\sigma_0; \ \text{L-NSZTR;} \\
\end{array}$

$C; \ YC; \ C_{2x, \sigma_z, IT}; \ \begin{array}{l}
R_1; \ 1, 1, 1; \\
R_2; \ 1, 1, -1, 1; \\
R_3; \ 1, -1, 1, 1; \\
R_4; \ 1, -1, -1, 1;
\end{array}$
\begin{align*}
\Gamma_0^b: & \{C_{2z}(00\frac{1}{2}), \{C_{2y}(00\frac{1}{2})\}, \{I\frac{1}{2}\frac{1}{2}0\}, T; \text{Centrosymmetric; without SOC} \\
\Gamma: & (000); C_{2z}, C_{2y}, I, T; R_1; 1; 1, 1, 1; \\
& R_2; 1; -1, 1, 1; \\
& R_3; 1; 1, -1, 1; \\
& R_4; 1; -1, -1, 1; \\
& R_5; 1; 1, 1, -1; \\
& R_6; 1; -1, 1, -1; \\
& R_7; 1; 1, -1, -1; \\
& R_8; 1; -1, -1, -1; \\
\gamma: & (\frac{1}{2}\frac{1}{2}0); C_{2z}, C_{2y}, I, T; R_1; 1; 1, 1, 1; \\
& R_2; 1; -1, 1, 1; \\
& R_3; 1; 1, -1, 1; \\
& R_4; 1; -1, -1, 1; \\
& R_5; 1; 1, 1, -1; \\
& R_6; 1; -1, 1, -1; \\
& R_7; 1; 1, -1, -1; \\
& R_8; 1; -1, -1, -1; \\
\zeta: & (00\frac{1}{2}); C_{2z}, I, \sigma_y, T; R_5; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NS}_{ZTR}; \\
& R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NS}_{ZTR}; \\
\tau: & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{2z}, I, \sigma_y, T; R_5; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{P-NS}_{ZTR}; \\
& R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-NS}_{ZTR}; \\
\sigma: & (0\frac{1}{2}0); \sigma_z, I, T; R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNL}_{SR}; \\
\rho: & (0\frac{1}{2}\frac{1}{2}); \sigma_z, I, T; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{P-WNL/NS}; \\
& \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{P-WNL/NS}; \\
\lambda: & \Gamma\zeta; C_{2z}, \sigma_y, I; T; R_1; 1, 1, 1; \\
& R_2; 1, 1, -1; \\
& R_3; 1, -1, 1; \\
& R_4; 1, -1, -1; \\
\eta: & \gamma\tau; C_{2z}, \sigma_y, I; T; R_1; 1, 1, 1; \\
& R_2; 1, 1, -1; \\
& R_3; 1, -1, 1; \\
& R_4; 1, -1, -1; \\
\nu: & \delta\Delta; C_{2y}, \sigma_z, I; T; R_1; 1, 1, 1; \\
& R_2; 1, 1, -1; \\
& R_3; 1, -1, 1; \\
& R_4; 1, -1, -1; \\
\beta: & \beta\zeta; C_{2y}, \sigma_z, I; T; \{R_2, R_4\}; 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}_{ZTR}; \\
& \{R_6, R_8\}; 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}_{ZTR}; \\
\gamma: & \Gamma\gamma; C_{2y}, \sigma_z, I; T; \{R_2, R_4\}; 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NS}_{ZTR}; \\
& \{R_6, R_8\}; 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}_{ZTR};
\end{align*}
\( F; \ YF; \ C_{2y}, \sigma_z, \sigma_x, \IT; \ R_1; 1; 1, -1, 1; \)
\( R_2; 1; 1, 1, 1; \)
\( R_3; 1; -1, -1, 1; \)
\( R_4; 1; -1, 1, 1; \)

\( E; \ TE; \sigma_z, \sigma_x, \sigma_y, \IT; \ R_5; 2; \sigma_2, \sigma_3, -\sigma_0; \text{L-NS}_{ZTR}; \)

\( C; \ YC; \ C_{2x}, \sigma_z, \IT; \ R_1; 1; 1, 1, 1; \)
\( R_2; 1; 1, -1, 1; \)
\( R_3; 1; -1, 1, 1; \)
\( R_4; 1; -1, -1, 1; \)
Γ\(^6\); \{C\(_2\),[000]\}, \{C\(_2\)\_y,[000]\}, \{I\}[000]; \(T\); Centrosymmetric; without SOC

\(\Gamma\); (000): \(C\(_{2z}\),\(C\(_{2y}\),\(I\),\(T\); \(R\(_1\); 1; 1,1,1,1;
\(R\(_2\); 1; -1,1,1,1;
\(R\(_3\); 1; 1,1,1,1;
\(R\(_4\); 1; -1,1,1,1;
\(R\(_5\); 1; 1,1,1,1;
\(R\(_6\); 1; -1,1,1,1;
\(R\(_7\); 1; 1,1,1,1;
\(R\(_8\); 1; -1,1,1,1;

\(\Lambda\); (00\(\frac{1}{2}\)); \(C\(_{2z}\),\(C\(_{2y}\),\(I\),\(T\); \(R\(_1\); 1; 1,1,1,1;
\(R\(_2\); 1; -1,1,1,1;
\(R\(_3\); 1; 1,1,1,1;
\(R\(_4\); 1; -1,1,1,1;
\(R\(_5\); 1; 1,1,1,1;
\(R\(_6\); 1; -1,1,1,1;
\(R\(_7\); 1; 1,1,1,1;
\(R\(_8\); 1; -1,1,1,1;

\(T\); (00\(\frac{1}{2}\)); \(C\(_{2z}\),\(C\(_{2y}\),\(I\),\(T\); \(R\(_1\); 1; 1,1,1,1;
\(R\(_2\); 1; -1,1,1,1;
\(R\(_3\); 1; 1,1,1,1;
\(R\(_4\); 1; -1,1,1,1;
\(R\(_5\); 1; 1,1,1,1;
\(R\(_6\); 1; -1,1,1,1;
\(R\(_7\); 1; 1,1,1,1;
\(R\(_8\); 1; -1,1,1,1;

\(S\); (0\(\frac{1}{2}\)0): \(C\(_{2z}\),\(I\),\(T\); \(R\(_1\); 1; 1,1,1,1;
\(R\(_2\); 1; -1,1,1,1;
\(R\(_3\); 1; 1,1,1,1;
\(R\(_4\); 1; -1,1,1,1;

\(R\); (0\(\frac{1}{2}\)0): \(C\(_{2z}\),\(I\),\(T\); \(R\(_1\); 1; 1,1,1,1;
\(R\(_2\); 1; -1,1,1,1;
\(R\(_3\); 1; 1,1,1,1;
\(R\(_4\); 1; -1,1,1,1;

\(\Sigma\); (0\(\frac{1}{2}\)\(\frac{1}{2}\)): \(C\(_{2z}\),\(\sigma\_y\),\(I\),\(T\); \(R\(_1\); 1; 1,1,1,1;
\(R\(_2\); 1; -1,1,1,1;
\(R\(_3\); 1; 1,1,1,1;
\(R\(_4\); 1; -1,1,1,1;
\[ H; YT; C_{2z, \sigma_y, IT}; R_1; 1, 1, 1; \\
R_2; 1, -1, -1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, -1, 1; \\
\]
\[ D; SR; C_{2z, IT}; R_1; 1, 1, 1; \\
R_2; 1, -1, 1; \\
\]
\[ A; ZT; C_{2x, \sigma_z, IT}; R_1; 1, 1, 1, 1; \\
R_2; 1, -1, 1, 1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, -1, 1; \\
\]
\[ \Sigma; \Gamma_Y; C_{2z, \sigma_y, IT}; R_1; 1, 1, 1, 1; \\
R_2; 1, -1, 1, 1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, -1, 1; \\
\]
\[ \Delta; \Gamma_\Delta; C_{2y, \sigma_x, IT}; R_1; 1, 1, 1, 1; \\
R_2; 1, -1, 1, 1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, -1, 1; \\
\]
\[ B; ZB; C_{2y, \sigma_x, IT}; R_1; 1, 1, 1, 1; \\
R_2; 1, 1, -1, 1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, -1, 1; \\
\]
\[ G; TG; C_{2y, \sigma_x, IT}; R_1; 1, 1, 1, 1; \\
R_2; 1, -1, 1, 1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, -1, 1; \\
\]
\[ F; YF; C_{2y, \sigma_x, IT}; R_1; 1, 1, 1, 1; \\
R_2; 1, 1, -1, 1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, -1, 1; \\
\]
\[ E; TE; C_{2x, \sigma_z, IT}; R_1; 1, 1, 1, 1; \\
R_2; 1, -1, -1, 1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, 1, 1; \\
\]
\[ C; YC; C_{2x, \sigma_z, IT}; R_1; 1, 1, 1, 1; \\
R_2; 1, 1, -1, 1; \\
R_3; 1, -1, 1, 1; \\
R_4; 1, -1, -1, 1; \]
Γ°: \{C_2z[000], C_2y[000], I[000\frac{1}{2}]\}; Centrosymmetric; without SOC

Γ; (000): \(C_{2x}, C_{2y}, I, T\);
\[ R_1: 1; 1, 1, 1, 1; \]
\[ R_2: 1; -1, 1, 1, 1; \]
\[ R_3: 1; 1, -1, 1, 1; \]
\[ R_4: 1; -1, -1, 1, 1; \]
\[ R_5: 1; 1, 1, -1, 1; \]
\[ R_6: 1; -1, 1, -1, 1; \]
\[ R_7: 1; -1, -1, 1, 1; \]
\[ R_8: 1; -1, -1, 1, 1; \]

Y: \left(\frac{1}{2} \frac{1}{2} 0\right): \(C_{2x}, C_{2y}, I, T\);
\[ R_1: 1; 1, 1, 1, 1; \]
\[ R_2: 1; -1, 1, 1, 1; \]
\[ R_3: 1; 1, -1, 1, 1; \]
\[ R_4: 1; -1, -1, 1, 1; \]
\[ R_5: 1; 1, 1, -1, 1; \]
\[ R_6: 1; -1, 1, -1, 1; \]
\[ R_7: 1; -1, -1, 1, 1; \]
\[ R_8: 1; -1, -1, 1, 1; \]

Z; (00\frac{1}{2}): \(\sigma_x, I, C_{2z}, T\);
\[ R_5: 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_{10}: 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs} \]

T; \left(\frac{3}{2} \frac{3}{2} \frac{3}{2}\right): \(\sigma_x, I, C_{2z}, T\);
\[ R_5: 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_{10}: 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs} \]

S; \left(0 \frac{1}{2} 0\right): \(C_{2z}, I, T\);
\[ R_1: 1; 1, 1, 1; \]
\[ R_2: 1; 1, -1, 1; \]
\[ R_3: 1; -1, 1, 1; \]
\[ R_4: 1; -1, -1, 1; \]

R; \left(0 \frac{1}{2} \frac{1}{2}\right): \(C_{2z}, I, T\);
\[ R_1: 1; 1, 1, 1; \]
\[ R_2: 1; 1, -1, 1; \]
\[ R_3: 1; -1, 1, 1; \]
\[ R_4: 1; -1, -1, 1; \]

Λ; ΓZ: \(C_{2z}, \sigma_y, I, T\);
\[ R_1: 1; 1, 1, 1; \]
\[ R_2: 1; 1, -1, 1; \]
\[ R_3: 1; -1, 1, 1; \]
\[ R_4: 1; -1, -1, 1; \]

H; YT: \(C_{2z}, \sigma_y, I, T\);
\[ R_1: 1; 1, 1, 1; \]
\[ R_2: 1; 1, -1, 1; \]
\[ R_3: 1; -1, 1, 1; \]
\[ R_4: 1; -1, -1, 1; \]

D; SR: \(C_{2z}, I, T\);
\[ R_1: 1; 1, 1; \]
\[ R_2: 1; -1, 1; \]

A; ZT: \(\sigma_z, C_{2z}, I, T\);
\[ R_5: 2; \sigma_2, \sigma_3, -i\sigma_1; \quad \text{WNL}; \pi \]

Σ; ΓY: \(C_{2z}, \sigma_z, I, T\);
\[ R_1: 1; 1, 1, 1; \]
\[ R_2: 1; 1, -1, 1; \]
\[ R_3: 1; -1, 1, 1; \]
\[ R_4: 1; -1, -1, 1; \]

Δ; ΓΔ: \(C_{2y}, \sigma_z, I, T\);
\[ R_1: 1; 1, 1, 1; \]
\[ R_2: 1; 1, -1, 1; \]
\[ R_3: 1; -1, 1, 1; \]
\[ R_4: 1; -1, -1, 1; \]
B; ZB; \( \sigma_z, C_{2y}, IT \); \( R_5 \); 2; \( \sigma_2, \sigma_3, -i\sigma_1 \); WNL; \( \pi \)

G; TG; \( \sigma_z, C_{2y}, IT \); \( R_5 \); 2; \( \sigma_2, \sigma_3, -i\sigma_1 \); WNL; \( \pi \)

F; YF; \( C_{2y}, \sigma_x, IT \); \( R_1 \); 1, 1, 1;
  \( R_2 \); 1, 1, -1, 1;
  \( R_3 \); 1, -1, 1, 1;
  \( R_4 \); 1, -1, -1, 1;

E; TE; \( \sigma_z, C_{2x}, IT \); \( R_5 \); 2; \( \sigma_2, \sigma_3, -i\sigma_1 \); WNL; \( \pi \)

C; YC; \( C_{2x}, \sigma_z, IT \); \( R_1 \); 1, 1, 1;
  \( R_2 \); 1, 1, -1, 1;
  \( R_3 \); 1, -1, 1, 1;
  \( R_4 \); 1, -1, -1, 1;
Γ; (000); \( C_{2v}, C_{2y}, I, T \); \( R_1 \): 1; 1, 1, 1;

\( R_2 \): 1; -1, 1, 1;

\( R_3 \): 1; 1, -1, 1;

\( R_4 \): 1; -1, -1, 1;

\( R_5 \): 1; 1, 1, -1;

\( R_6 \): 1; -1, 1, -1;

\( R_7 \): 1; 1, -1, -1;

\( R_8 \): 1; -1, -1, -1;

\( Y; (\frac{1}{2} \frac{1}{2} 0); C_{2v}, C_{2y}, I, T; R_1 \); 1; 1, 1, 1;

\( R_2 \): 1; -1, 1, 1;

\( R_3 \): 1; 1, -1, 1;

\( R_4 \): 1; -1, -1, 1;

\( R_5 \): 1; 1, 1, -1;

\( R_6 \): 1; -1, 1, -1;

\( R_7 \): 1; 1, -1, -1;

\( R_8 \): 1; -1, -1, -1;

\( Z; (00 \frac{1}{2}); C_{2v}, C_{2y}, I, T; R_1 \); 1; 1, 1, 1;

\( R_2 \): 1; -1, 1, 1;

\( R_3 \): 1; 1, -1, 1;

\( R_4 \): 1; -1, -1, 1;

\( R_5 \): 1; 1, 1, -1;

\( R_6 \): 1; -1, 1, -1;

\( R_7 \): 1; 1, -1, -1;

\( R_8 \): 1; -1, -1, -1;

\( T; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{2v}, C_{2y}, I, T; R_1 \); 1; 1, 1, 1;

\( R_2 \): 1; -1, 1, 1;

\( R_3 \): 1; 1, -1, 1;

\( R_4 \): 1; -1, -1, 1;

\( R_5 \): 1; 1, 1, -1;

\( R_6 \): 1; -1, 1, -1;

\( R_7 \): 1; 1, -1, -1;

\( R_8 \): 1; -1, -1, -1;

\( S; (0 \frac{1}{2} 0); \sigma_x, I, T; R_5 \); 2; \( i \sigma_2, \sigma_3, -\sigma_0 \); P-WNLs;

\( R_2 \); (0 \frac{1}{2} \frac{1}{2}); \sigma_z, I, T; R_5 \); 2; \( i \sigma_2, \sigma_3, -\sigma_0 \); P-WNLs;

\( \Lambda; \Gamma Z; \quad C_{2v}, \sigma_y, I T; R_1 \); 1; 1, 1, 1;

\( R_2 \); 1; 1, -1, 1;

\( R_3 \); 1; -1, 1, 1;

\( R_4 \); 1; -1, -1, 1;

\( H; YT; \quad C_{2v}, \sigma_y, I T; R_1 \); 1; 1, 1, 1;

\( R_2 \); 1; 1, -1, 1;

\( R_3 \); 1; -1, 1, 1;

\( R_4 \); 1; -1, -1, 1;

\( D; SR; \quad C_{2v}, I T; \{R_1, R_2\}; 2; \sigma_3, \sigma_1 \); WNL; \( \pi \)

\( A; ZT; \quad C_{2v}, \sigma_z, I T; R_1 \); 1; 1, 1, 1;

\( R_2 \); 1; 1, -1, 1;

\( R_3 \); 1; -1, 1, 1;

\( R_4 \); 1; -1, -1, 1;
\[
\begin{align*}
\Sigma; \Gamma Y; \ C_{2x, \sigma_x, IT}; R_1: & \ 1, 1, 1; \\
& R_2: \ 1, -1, 1; \\
& R_3: \ 1, -1, 1; \\
& R_4: \ 1, -1, -1; \\
\Delta; \Gamma \Delta; \ C_{2y, \sigma_x, IT}; R_1: & \ 1, 1, 1; \\
& R_2: \ 1, -1, 1; \\
& R_3: \ 1, -1, 1; \\
& R_4: \ 1, -1, -1; \\
B; ZB; \ C_{2y, \sigma_x, IT}; R_1: & \ 1, 1, 1; \\
& R_2: \ 1, -1, 1; \\
& R_3: \ 1, -1, 1; \\
& R_4: \ 1, -1, -1; \\
G; TG; \ C_{2y, \sigma_x, IT}; R_1: & \ 1, -1, 1; \\
& R_2: \ 1, 1, 1; \\
& R_3: \ 1, -1, -1; \\
& R_4: \ 1, -1, 1; \\
F; YF; \ C_{2y, \sigma_x, IT}; R_1: & \ 1, -1, 1; \\
& R_2: \ 1, 1, 1; \\
& R_3: \ 1, -1, -1; \\
& R_4: \ 1, -1, 1; \\
E; TE; \ C_{2x, \sigma_x, IT}; R_1: & \ 1, 1, 1; \\
& R_2: \ 1, -1, 1; \\
& R_3: \ 1, -1, 1; \\
& R_4: \ 1, -1, -1; \\
C; YC; \ C_{2x, \sigma_x, IT}; R_1: & \ 1, 1, 1; \\
& R_2: \ 1, -1, 1; \\
& R_3: \ 1, -1, 1; \\
& R_4: \ 1, -1, -1; 
\end{align*}
\]
\[\Gamma_v^\delta; \{C_2_z|000\}, \{C_2_y|000\}, \{I|\frac{1}{2} \frac{1}{2} \frac{1}{2}\}; T;\text{ Centrosymmetric; without SOC}\]

\[\Gamma; (000)\; C_{2z}, C_{2y}, I, T; R_1; 1; 1,1,1;\]
\[R_2; 1; -1,1,1;\]
\[R_3; 1; 1, -1,1;\]
\[R_4; 1; -1, -1,1;\]
\[R_5; 1; 1,1, -1;\]
\[R_6; 1; -1,1, -1;\]
\[R_7; 1; 1, -1, -1;\]
\[R_8; 1; -1, -1, -1;\]

\[Y; (\frac{1}{2} \frac{1}{2} 0)\; C_{2z}, C_{2y}, I, T; R_1; 1; 1,1,1;\]
\[R_2; 1; -1,1,1;\]
\[R_3; 1; 1, -1,1;\]
\[R_4; 1; -1, -1,1;\]
\[R_5; 1; 1,1, -1;\]
\[R_6; 1; -1,1, -1;\]
\[R_7; 1; 1, -1, -1;\]
\[R_8; 1; -1, -1, -1;\]

\[Z; (00\frac{1}{2})\; \sigma_z, I, C_{2z}, T; R_5; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0;\text{ P-WNLs}\]
\[R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0;\text{ P-WNLs}\]

\[T; (\frac{1}{2} \frac{1}{2} \frac{1}{2})\; \sigma_z, I, C_{2z}, T; R_5; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0;\text{ P-WNLs}\]
\[R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0;\text{ P-WNLs}\]

\[S; (0\frac{1}{2} 0)\; \sigma_z, I, T; R_5; 2; i\sigma_2, \sigma_3, -\sigma_0;\text{ P-WNLs}\]
\[R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0;\text{ P-WNLs}\]

\[\Lambda; \Gamma Z; C_{2z}, \sigma_y, IT; R_1; 1; 1,1,1;\]
\[R_2; 1; 1, -1,1;\]
\[R_3; 1; -1,1,1;\]
\[R_4; 1; -1, -1,1;\]

\[H; YT; C_{2z}, \sigma_y, IT; R_1; 1; 1,1,1;\]
\[R_2; 1; 1, -1,1;\]
\[R_3; 1; -1,1,1;\]
\[R_4; 1; -1, -1,1;\]

\[D; SR; C_{2z}, IT; \{R_3, R_4\}; 2; \sigma_3, \sigma_1;\text{ WNL}; \pi\]

\[A; ZT; \sigma_z, C_{2z}, IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1;\text{ WNL}; \pi\]

\[\Sigma; \Gamma Y; C_{2z}, \sigma_z, IT; R_1; 1; 1,1,1;\]
\[R_2; 1; 1, -1,1;\]
\[R_3; 1; -1,1,1;\]
\[R_4; 1; -1, -1,1;\]

\[\Delta; \Gamma \Delta; C_{2y}, \sigma_x, IT; R_1; 1; 1,1,1;\]
\[R_2; 1; 1, -1,1;\]
\[R_3; 1; -1,1,1;\]
\[R_4; 1; -1, -1,1;\]

\[B; ZB; \sigma_z, C_{2y}, IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1;\text{ WNL}; \pi\]

\[G; TG; \sigma_z, C_{2y}, IT; R_5; 2; -\sigma_2, \sigma_3, -i\sigma_1;\text{ WNL}; \pi\]

\[F; YF; C_{2y}, \sigma_x, IT; R_1; 1; 1,1,1;\]
\[R_2; 1; 1,1,1;\]
\[R_3; 1; -1,1,1;\]
\[R_4; 1; -1,1,1;\]
\[ E; \ \text{TE}; \ \sigma_z, C_2x, IT; \ R_5; 2; \ \sigma_2, \sigma_3, -i\sigma_1; \ \text{WNL}; \ \pi \]
\[
C; \ \text{YC}; \ C_2x, \sigma_z, IT; \ R_1; 1; 1, 1, 1;
\]
\[
R_2; 1; 1, -1, 1;
\]
\[
R_3; 1; -1, 1, 1;
\]
\[
R_4; 1; -1, -1, 1;
\]
Γ: \( (000) \) \( C_{2z}, C_{2y}, I, T \): 
- \( R_1 \): 1, 1, 1, 1; 
- \( R_2 \): 1, -1, 1, 1; 
- \( R_3 \): 1, -1, 1, 1; 
- \( R_4 \): 1, -1, -1, 1; 
- \( R_5 \): 1, 1, -1, 1; 
- \( R_6 \): 1, -1, 1, -1; 
- \( R_7 \): 1, -1, -1, 1; 
- \( R_8 \): 1, -1, -1, -1;

\( Y: \left(0\frac{1}{2}\frac{1}{2}\right)\) \( C_{2z}, C_{2y}, I, T \): 
- \( R_1 \): 1, 1, 1, 1; 
- \( R_2 \): 1, -1, 1, 1; 
- \( R_3 \): 1, -1, 1, 1; 
- \( R_4 \): 1, -1, -1, 1; 
- \( R_5 \): 1, 1, -1, 1; 
- \( R_6 \): 1, -1, -1, 1; 
- \( R_7 \): 1, -1, -1, 1; 
- \( R_8 \): 1, -1, -1, -1;

\( X: \left(\frac{1}{2}0\frac{1}{2}\right)\) \( C_{2z}, C_{2y}, I, T \): 
- \( R_1 \): 1, 1, 1, 1; 
- \( R_2 \): 1, -1, 1, 1; 
- \( R_3 \): 1, -1, 1, 1; 
- \( R_4 \): 1, -1, -1, 1; 
- \( R_5 \): 1, 1, -1, 1; 
- \( R_6 \): 1, -1, -1, 1; 
- \( R_7 \): 1, -1, -1, 1; 
- \( R_8 \): 1, -1, -1, -1;

\( Z: \left(\frac{1}{2}\frac{1}{2}0\right)\) \( C_{2z}, C_{2y}, I, T \): 
- \( R_1 \): 1, 1, 1, 1; 
- \( R_2 \): 1, -1, 1, 1; 
- \( R_3 \): 1, -1, 1, 1; 
- \( R_4 \): 1, -1, -1, 1; 
- \( R_5 \): 1, 1, -1, 1; 
- \( R_6 \): 1, -1, -1, 1; 
- \( R_7 \): 1, -1, -1, 1; 
- \( R_8 \): 1, -1, -1, -1;

\( L: \left(\frac{1}{2}00\right)\) \( I, T \): 
- \( R_1 \): 1, 1, 1; 
- \( R_2 \): 1, -1, 1;

\( A: \Gamma Z/\Gamma A\) \( C_{2z}, \sigma_y, I, T \): 
- \( R_1 \): 1, 1, 1; 
- \( R_2 \): 1, -1, 1; 
- \( R_3 \): 1, -1, 1; 
- \( R_4 \): 1, -1, -1; 

\( G: XG/XY\) \( C_{2z}, \sigma_y, I, T \): 
- \( R_1 \): 1, 1, 1; 
- \( R_2 \): 1, -1, 1; 
- \( R_3 \): 1, -1, 1; 
- \( R_4 \): 1, -1, -1; 

\( H: YH/YX\) \( C_{2z}, \sigma_y, I, T \): 
- \( R_1 \): 1, 1, 1; 
- \( R_2 \): 1, -1, 1; 
- \( R_3 \): 1, -1, 1; 
- \( R_4 \): 1, -1, -1;
|  |  |  |
|---|---|---|
| Q; ZQ; | $C_{2z\sigma_y IT}$; | $R_1$; 1, 1, 1;  
R2; 1, 1, 1, 1;  
R3; 1, 1, 1, 1;  
R4; 1, 1, 1, 1;  

| Σ; ΓX/ΓΣ; | $C_{2z\sigma_x IT}$; | $R_1$; 1, 1, 1;  
R2; 1, 1, 1, 1;  
R3; 1, 1, 1, 1;  
R4; 1, 1, 1, 1;  

| C; YC/YZ; | $C_{2z\sigma_x IT}$; | $R_1$; 1, 1, 1;  
R2; 1, 1, 1, 1;  
R3; 1, 1, 1, 1;  
R4; 1, 1, 1, 1;  

| A; ZA/ZY; | $C_{2z\sigma_y IT}$; | $R_1$; 1, 1, 1;  
R2; 1, 1, 1, 1;  
R3; 1, 1, 1, 1;  
R4; 1, 1, 1, 1;  

| U; XU; | $C_{2z\sigma_x IT}$; | $R_1$; 1, 1, 1;  
R2; 1, 1, 1, 1;  
R3; 1, 1, 1, 1;  
R4; 1, 1, 1, 1;  

| Δ; ΓY/ΓΔ; | $C_{2y\sigma_x IT}$; | $R_1$; 1, 1, 1;  
R2; 1, 1, 1, 1;  
R3; 1, 1, 1, 1;  
R4; 1, 1, 1, 1;  

| D; XD/XZ; | $C_{2y\sigma_x IT}$; | $R_1$; 1, 1, 1;  
R2; 1, 1, 1, 1;  
R3; 1, 1, 1, 1;  
R4; 1, 1, 1, 1;  

| B; ZB/ZX; | $C_{2y\sigma_x IT}$; | $R_1$; 1, 1, 1;  
R2; 1, 1, 1, 1;  
R3; 1, 1, 1, 1;  
R4; 1, 1, 1, 1;  

| R; YR; | $C_{2y\sigma_x IT}$; | $R_1$; 1, 1, 1;  
R2; 1, 1, 1, 1;  
R3; 1, 1, 1, 1;  
R4; 1, 1, 1, 1;  

|  |  |  |
\[ \Gamma_0^1; \{C_{2v}[000], \{C_{2v}[000], \{I[\frac{1}{2} \frac{1}{2} 0]\}, T; \text{Centrosymmetric; without SOC}\]  

\[ \Gamma; (000); C_{2x}C_{2y}I, T; R_1; 1, 1, 1, 1; \]  
\[ R_2; 1, -1, 1, 1; \]  
\[ R_3; 1, 1, 1, 1; \]  
\[ R_4; 1, -1, 1, 1; \]  
\[ R_5; 1, 1, -1, 1; \]  
\[ R_6; 1, -1, 1, 1; \]  
\[ R_7; 1, -1, 1, 1; \]  
\[ R_8; 1, 1, 1, 1; \]  

\[ Y; (0 \frac{1}{2} \frac{1}{2} \frac{1}{2}); \sigma_xI, C_{2y}T; R_5; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNLs}; \]  
\[ R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNLs}; \]  

\[ X; (\frac{1}{2} 0 \frac{1}{2}); \sigma_xI, C_{2x}T; R_5; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNLs}; \]  
\[ R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNLs}; \]  

\[ Z; (\frac{1}{2} \frac{1}{2} 0); \sigma_yI, C_{2z}T; R_5; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNLs}; \]  
\[ R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{P-WNLs}; \]  

\[ L; (\frac{1}{2} 00); I, T; R_1; 1, 1, 1; \]  
\[ R_2; 1, -1, 1; \]  

\[ \Lambda; \Gamma Z/\Gamma A; C_{2z} \sigma_y IT; R_1; 1, 1, 1, 1; \]  
\[ R_2; 1, 1, -1, 1; \]  
\[ R_3; 1, 1, 1, 1; \]  
\[ R_4; 1, -1, 1, 1; \]  

\[ G; XG/XY; \sigma_xC_{2z}IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL; } \pi \]  
\[ H; YH/YX; \sigma_yC_{2z}IT; R_5; 2; -\sigma_2, \sigma_3, -i\sigma_1; \text{WNL; } \pi \]  

\[ Q; ZQ; \sigma_yC_{2z}IT; R_5; 2; i, 1, 1; \]  
\[ R_1; 1, 1, 1; \]  
\[ R_4; 1, -1, 1; \]  
\[ R_6; 1, 1, -1; \]  
\[ R_8; 1, -1, 1; \]  

\[ \Sigma; \Gamma X/\Gamma \Sigma; C_{2z} \sigma_x IT; R_1; 1, 1, 1, 1; \]  
\[ R_2; 1, 1, -1, 1; \]  
\[ R_3; 1, 1, 1, 1; \]  
\[ R_4; 1, -1, 1, 1; \]  

\[ C; YC/YZ; \sigma_yC_{2z}IT; R_5; 2; -\sigma_2, \sigma_3, -i\sigma_1; \text{WNL; } \pi \]  
\[ A; ZA/ZY; \sigma_xC_{2z}IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL; } \pi \]  

\[ U; XU; \sigma_yC_{2z}IT; R_5; 2; i, 1, 1; \]  
\[ R_4; 1, 1, 1; \]  
\[ R_6; 1, -1, 1; \]  
\[ R_8; 1, -1, 1; \]  

\[ \Delta; \Gamma Y/\Gamma \Delta; C_{2y} \sigma_z IT; R_1; 1, 1, 1, 1; \]  
\[ R_2; 1, 1, -1, 1; \]  
\[ R_3; 1, 1, 1, 1; \]  
\[ R_4; 1, -1, 1, 1; \]  

\[ D; XD/XZ; \sigma_xC_{2y}IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL; } \pi \]  
\[ B; ZB/ZX; \sigma_xC_{2y}IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL; } \pi \]  

\[ R; YR; \sigma_xC_{2y}IT; R_5; 2; -i, 1, 1; \]  
\[ R_4; 1, 1, 1; \]  
\[ R_6; 1, -1, 1; \]  
\[ R_8; 1, -1, 1; \]
SG 71

Γ<sup>o</sup>: \{C<sub>2z</sub>[000], \{C<sub>2y</sub>[000], \{I[000], T; Centrosymmetric; without SOC

Γ: (000); C<sub>2z</sub>,C<sub>2y</sub>,I,T; R<sub>1</sub>; 1; 1,1,1;
R<sub>2</sub>; 1; −1,1,1,1;
R<sub>3</sub>; 1; 1,−1,1,1;
R<sub>4</sub>; 1; −1,−1,1,1;
R<sub>5</sub>; 1; 1,−1,1,1;
R<sub>6</sub>; 1; −1,−1,−1,1;
R<sub>7</sub>; 1; 1,−1,−1,1;
R<sub>8</sub>; 1; −1,−1,−1,1;

X: (110); C<sub>2z</sub>,C<sub>2y</sub>,I,T; R<sub>1</sub>; 1; 1,1,1,1;
R<sub>2</sub>; 1; −1,1,1,1;
R<sub>3</sub>; 1; 1,−1,1,1;
R<sub>4</sub>; 1; −1,−1,1,1;
R<sub>5</sub>; 1; 1,−1,1,1;
R<sub>6</sub>; 1; −1,−1,−1,1;
R<sub>7</sub>; 1; 1,−1,−1,1;
R<sub>8</sub>; 1; −1,−1,−1,1;

R: (100); C<sub>2y</sub>,I,T; R<sub>1</sub>; 1; 1,1,1,1;
R<sub>2</sub>; 1; 1,−1,1;
R<sub>3</sub>; 1; −1,1,1;
R<sub>4</sub>; 1; −1,−1,1;

S: (100); C<sub>2z</sub>,I,T; R<sub>1</sub>; 1; 1,1,1;
R<sub>2</sub>; 1; 1,−1,1;
R<sub>3</sub>; 1; −1,1,1;
R<sub>4</sub>; 1; −1,−1,1;

T: (110); C<sub>2z</sub>,I,T; R<sub>1</sub>; 1; 1,1,1,1;
R<sub>2</sub>; 1; 1,−1,1,1;
R<sub>3</sub>; 1; −1,1,1,1;
R<sub>4</sub>; 1; −1,−1,1,1;

W: (111); C<sub>2z</sub>,C<sub>2y</sub>,IT; R<sub>1</sub>; 1; 1,1,1,1;
R<sub>2</sub>; 1; 1,−1,1,1;
R<sub>3</sub>; 1; −1,1,1,1;
R<sub>4</sub>; 1; −1,−1,1,1;

A; ΓA/ΓX; C<sub>2z</sub>,σ<sub>y</sub>,IT; R<sub>1</sub>; 1; 1,1,1,1;
R<sub>2</sub>; 1; 1,−1,1,1;
R<sub>3</sub>; 1; −1,1,1,1;
R<sub>4</sub>; 1; −1,−1,1,1;

G; XG; C<sub>2z</sub>,σ<sub>y</sub>,IT; R<sub>1</sub>; 1; 1,1,1,1;
R<sub>2</sub>; 1; 1,−1,1,1;
R<sub>3</sub>; 1; −1,1,1,1;
R<sub>4</sub>; 1; −1,−1,1,1;

P; TW; C<sub>2z</sub>,IT; R<sub>1</sub>; 1; 1,1,1;
R<sub>2</sub>; 1; −1,1,1;
|   |   |   |   |
|---|---|---|---|
| $\Sigma$: $\Gamma\Sigma/\Gamma X$: $C_{2x,\sigma_z,IT}$: $R_1$: 1, 1, 1; $R_2$: 1, 1, 1; $R_3$: 1, −1, 1; $R_4$: 1, −1, 1; |
| $F$: $XF$: $C_{2x,\sigma_z,IT}$: $R_1$: 1, 1, 1; $R_2$: 1, 1, 1; $R_3$: 1, −1, 1; $R_4$: 1, −1, 1; |
| $D$: $SW$: $C_{2x,IT}$: $R_1$: 1, 1, 1; $R_2$: 1, 1, 1; |
| $\Delta$: $\Gamma\Delta/\Gamma X$: $C_{2y,\sigma_x,IT}$: $R_1$: 1, 1, 1; $R_2$: 1, 1, 1; $R_3$: 1, −1, 1; $R_4$: 1, −1, 1; |
| $U$: $XU$: $C_{2y,\sigma_z,IT}$: $R_1$: 1, 1, 1; $R_2$: 1, 1, 1; $R_3$: 1, −1, 1; $R_4$: 1, −1, 1; |
| $Q$: $RW$: $C_{2y,IT}$: $R_1$: 1, 1, 1; $R_2$: 1, −1, 1; |
Γ°; \{C_{2v}[000], C_{2v}[000], \{T\frac{1}{2} [000]\}; \text{Centrosymmetric; without SOC}

Γ; (000); \ C_{2v}, C_{2y}, I, T; \ R_1; \ 1; 1, 1, 1;
R_2; \ 1; -1, 1, 1;
R_3; \ 1; 1, -1, 1;
R_4; \ 1; -1, -1, 1;
R_5; \ 1; 1, 1, -1;
R_6; \ 1; 1, -1, -1;
R_7; \ 1; -1, 1, -1;
R_8; \ 1; -1, -1, -1;
X; \ (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ C_{2v}, C_{2y}, I, T; \ R_1; \ 1; 1, 1, 1;
R_2; \ 1; -1, 1, 1;
R_3; \ 1; 1, -1, 1;
R_4; \ 1; -1, -1, 1;
R_5; \ 1; 1, 1, -1;
R_6; \ 1; 1, -1, -1;
R_7; \ 1; -1, 1, -1;
R_8; \ 1; -1, -1, -1;
R; \ (\frac{1}{4} 0 0); \ \sigma_y, I, T; \ R_5; \ 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs;}
S; \ (\frac{1}{4} 0 \frac{1}{2}); \ \sigma_x, I, T; \ R_5; \ 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs;}
T; \ (\frac{1}{2} \frac{1}{2} 0); \ C_{2z}, I, T; \ R_1; \ 1; 1, 1, 1;
R_2; \ 1; 1, -1, 1;
R_3; \ 1; -1, 1, 1;
R_4; \ 1; -1, -1, 1;
W; \ (\frac{3}{4} \frac{3}{4} \frac{3}{4}); \ C_{2z}, C_{2y}, I, T; \ \{R_1, R_2\}; \ 2; \sigma_0, \sigma_3, \sigma_1; \text{P-WNLs;}
\{R_3, R_4\}; \ 2; -\sigma_0, \sigma_3, \sigma_1; \text{P-WNLs;}
Λ; \ \Gamma\Lambda/\Gamma\chi; \ C_{2z}, \sigma_y, I, T; \ R_1; \ 1; 1, 1, 1;
R_2; \ 1; 1, -1, 1;
R_3; \ 1; -1, 1, 1;
R_4; \ 1; -1, -1, 1;
G; \ \Xi\chi; \ C_{2z}, \sigma_y, I, T; \ R_1; \ 1; 1, 1, 1;
R_2; \ 1; 1, -1, 1;
R_3; \ 1; -1, 1, 1;
R_4; \ 1; -1, -1, 1;
P; \ \Theta\chi/\Theta\chi; \ C_{2z}, \sigma_z, I, T; \ R_1; \ 1; 1, 1, 1;
R_2; \ 1; 1, -1, 1;
R_3; \ 1; -1, 1, 1;
R_4; \ 1; -1, -1, 1;
Sigma; \ \Gamma\Sigma/\Gamma\Sigma; \ C_{2z}, \sigma_z, I, T; \ R_1; \ 1; 1, 1, 1;
R_2; \ 1; 1, -1, 1;
R_3; \ 1; -1, 1, 1;
R_4; \ 1; -1, -1, 1;
F; \ \Xi\chi; \ C_{2z}, \sigma_z, I, T; \ R_1; \ 1; 1, 1, 1;
R_2; \ 1; 1, -1, 1;
R_3; \ 1; -1, 1, 1;
R_4; \ 1; -1, -1, 1;
D; \ \Omega\omega; \ C_{2z}, I, T; \ \{R_1, R_2\}; \ 2; \sigma_3, \sigma_1; \text{WNL; \pi}
\[
\begin{align*}
\Delta; \Gamma \Delta / \Gamma X; \ C_{2y}, \sigma_x, IT; & \quad R_1; \quad 1; 1,1,1; \\
& \quad R_2; \quad 1; 1,-1,1; \\
& \quad R_3; \quad 1; -1,1,1; \\
& \quad R_4; \quad 1; -1,-1,1; \\
U; \ XU; \ C_{2y}, \sigma_x, IT; & \quad R_1; \quad 1; 1,1,1; \\
& \quad R_2; \quad 1; 1,-1,1; \\
& \quad R_3; \quad 1; -1,1,1; \\
& \quad R_4; \quad 1; -1,-1,1; \\
Q; \ RW; \ C_{2y}, IT; & \quad \{R_1, R_2\}; \quad 2; \sigma_3, \sigma_1; \quad \text{WNL}; \ \pi
\end{align*}
\]
\( \Gamma_0^\prime; \{C_{2z} | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{C_{2y} | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{I|000\}, T; \) Centrosymmetric; without SOC

\[\begin{array}{l}
\Gamma; (000); C_{2x}, C_{2y}, I, T; \\
R_1; 1; 1, 1, 1, 1; \\
R_2; 1; -1, 1, 1, 1; \\
R_3; 1; 1, -1, 1, 1; \\
R_4; 1; -1, -1, 1, 1; \\
R_5; 1; 1, 1, -1, 1; \\
R_6; 1; -1, 1, -1, 1; \\
R_7; 1; 1, -1, -1, 1; \\
R_8; 1; -1, -1, -1, 1; \\
R; (\frac{1}{4} 0 0); \sigma_y, I, T; \\
R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs}; \\
S; (\frac{1}{4} 0 \frac{1}{2}); \sigma_z, I, T; \\
R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs}; \\
T; (\frac{1}{2} \frac{1}{2} 0); \sigma_z, I, T; \\
R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNLs}; \\
W; (\frac{3}{4} \frac{1}{4} \frac{3}{4}); E, C_{2x}, C_{2y}, I; T; \{R_9, R_0\}; 4; \Gamma_0, \Gamma_0, \Gamma_0, \Gamma_0, -\Gamma_2, 2; \text{DP}; \text{WNL}; \pi \\
\Lambda; \Gamma \Delta / \Gamma X; C_{2x}, \sigma_y, I, T; \\
R_1; 1; 1, 1, 1; \\
R_2; 1; 1, -1, 1; \\
R_3; 1; -1, 1, 1; \\
R_4; 1; -1, -1, 1; \\
G; X G; C_{2x}, \sigma_y, I, T; \\
R_1; 1; -1, 1, 1; \\
R_2; 1; -1, -1, 1; \\
R_3; 1; 1, 1, 1; \\
R_4; 1; 1, -1, 1; \\
P; T W; C_{2x}, I, T; \\
\{R_2, R_4\}; 2; \sigma_3, \sigma_1; \text{WNL}; \pi \\
\Sigma; \Gamma \Sigma / \Gamma X; C_{2x}, \sigma_z, I, T; \\
R_1; 1; 1, 1, 1; \\
R_2; 1; 1, -1, 1; \\
R_3; 1; -1, 1, 1; \\
R_4; 1; -1, -1, 1; \\
F; X F; C_{2x}, \sigma_z, I, T; \\
R_1; 1; -1, 1, 1; \\
R_2; 1; -1, -1, 1; \\
R_3; 1; 1, 1, 1; \\
R_4; 1; 1, -1, 1; \\
D; S W; C_{2x}, I, T; \\
\{R_2, R_4\}; 2; -\sigma_3, \sigma_1; \text{WNL}; \pi \\
\Delta; \Gamma \Delta / \Gamma X; C_{2y}, \sigma_z, I, T; \\
R_1; 1; 1, 1, 1; \\
R_2; 1; 1, -1, 1; \\
R_3; 1; -1, 1, 1; \\
R_4; 1; -1, -1, 1; \\
U; X U; C_{2y}, \sigma_z, I, T; \\
R_1; 1; 1, 1, 1; \\
R_2; 1; 1, -1, 1; \\
R_3; 1; -1, 1, 1; \\
R_4; 1; -1, -1, 1; \\
Q; R W; C_{2y}, I, T; \\
\{R_2, R_4\}; 2; \sigma_3, \sigma_1; \text{WNL}; \pi 
\end{array}\]
SG 74

\[ \Gamma'_{v} \cap \{ C_{2x} | \frac{1}{2} 0 \frac{1}{2} \}, \{ C_{2y} | \frac{1}{2} \frac{1}{2} 0 \}, \{ I | \frac{1}{2} \frac{1}{2} 0 \}, T; \text{Centrosymmetric; without SOC} \]

|\( \Gamma; (000) \) | \( C_{2x}, C_{2y}, I, T; \) | \( R_{3}; \) | 1; 1, 1, 1; |
|---|---|---|---|
| \( R_{2}; \) | 1; -1, 1, 1; |
| \( R_{5}; \) | 1; 1, -1, 1; |
| \( R_{4}; \) | 1; -1, -1, 1; |
| \( R_{5}; \) | 1; 1, 1, -1; |
| \( R_{6}; \) | 1; -1, 1, -1; |
| \( \sigma_{z}; \) | 1; 1, -1, -1; |
| \( R_{8}; \) | 1; -1, -1, -1; |

|\( X; (\frac{1}{2} \frac{1}{2} \frac{1}{2}) \) | \( C_{2x}, C_{2y}, I, T; \) | \( R_{3}; \) | 1; 1, 1, 1; |
|---|---|---|---|
| \( R_{2}; \) | 1; -1, 1, 1; |
| \( R_{5}; \) | 1; 1, -1, 1; |
| \( R_{4}; \) | 1; -1, -1, 1; |
| \( R_{5}; \) | 1; 1, 1, -1; |
| \( R_{6}; \) | 1; -1, 1, -1; |
| \( \sigma_{z}; \) | 1; 1, -1, -1; |
| \( \pi; \) | 1; 1, -1, -1; |

|\( R; (\frac{1}{2} 0 0) \) | \( C_{2y}, I, T; \) | \( R_{3}; \) | 1; 1, 1, 1; |
|---|---|---|---|
| \( R_{2}; \) | 1; 1, -1, 1; |
| \( R_{5}; \) | 1; -1, 1, 1; |
| \( R_{4}; \) | 1; -1, -1, 1; |
| \( \sigma_{z}; \) | 1; 1, 1, 1; |
| \( \pi; \) | 1; 1, 1, 1; |

|\( S; (\frac{1}{2} 0 \frac{1}{2}) \) | \( C_{2x}, I, T; \) | \( R_{3}; \) | 1; 1, 1, 1; |
|---|---|---|---|
| \( R_{2}; \) | 1; 1, -1, 1; |
| \( R_{5}; \) | 1; -1, 1, 1; |
| \( R_{4}; \) | 1; -1, -1, 1; |
| \( \sigma_{z}; \) | 1; 1, 1, 1; |
| \( \pi; \) | 1; 1, 1, 1; |

|\( T; (\frac{1}{2} \frac{1}{2} 0) \) | \( \sigma_{z}, I, T; \) | \( R_{5}; \) | 2; 1\( \sigma_{2}, \sigma_{3}, -\sigma_{0} \); P-WNLs; |

|\( W; (\frac{3}{4} \frac{1}{4} \frac{1}{4}) \) | \( E, C_{2x}, C_{2y}, I, T; \) | \( R_{5}; \) | 2; 1\( \sigma_{2}, \sigma_{3}, -\sigma_{3} \); P-WNL_{TW}; |

|\( \Lambda; \Gamma \Lambda/\Gamma X; \) | \( C_{2x}, \sigma_{y}, I, T; \) | \( R_{3}; \) | 1; 1, 1, 1; |
|---|---|---|---|
| \( R_{2}; \) | 1; 1, -1, 1; |
| \( R_{5}; \) | 1; -1, 1, 1; |
| \( R_{4}; \) | 1; -1, -1, 1; |
| \( \sigma_{y}; \) | 1; 1, 1, 1; |
| \( \pi; \) | 1; 1, 1, 1; |

|\( G; X G; \) | \( C_{2x}, \sigma_{y}, I, T; \) | \( R_{3}; \) | 1; 1, 1, 1; |
|---|---|---|---|
| \( R_{2}; \) | 1; 1, -1, 1; |
| \( R_{5}; \) | 1; -1, 1, 1; |
| \( R_{4}; \) | 1; -1, -1, 1; |
| \( \sigma_{y}; \) | 1; 1, 1, 1; |
| \( \pi; \) | 1; 1, 1, 1; |

|\( P; T W; \) | \( C_{2x}, I, T; \) | \( \{ R_{2}, R_{4} \}; \) | 2; 1\( \sigma_{2}, \sigma_{1} \); WNL; \( \pi \); |

|\( \Sigma; \Gamma \Sigma/\Gamma X; \) | \( C_{2x}, \sigma_{z}, I, T; \) | \( R_{3}; \) | 1; 1, 1, 1; |
|---|---|---|---|
| \( R_{2}; \) | 1; 1, -1, 1; |
| \( R_{5}; \) | 1; -1, 1, 1; |
| \( R_{4}; \) | 1; -1, -1, 1; |
| \( \sigma_{z}; \) | 1; 1, 1, 1; |
| \( \pi; \) | 1; 1, 1, 1; |

|\( F; X F; \) | \( C_{2x}, \sigma_{z}, I, T; \) | \( R_{3}; \) | 1; 1, 1, 1; |
|---|---|---|---|
| \( R_{2}; \) | 1; 1, -1, 1; |
| \( R_{5}; \) | 1; -1, 1, 1; |
| \( R_{4}; \) | 1; -1, -1, 1; |
| \( \sigma_{z}; \) | 1; 1, 1, 1; |
| \( \pi; \) | 1; 1, 1, 1; |

|\( D; S W; \) | \( C_{2x}, I, T; \) | \( R_{2}; \) | 1; 1, 1; |
|---|---|---|---|
| \( R_{4}; \) | 1; 1, 1; |
\[ \Delta; \Gamma\Delta/\Gamma X; \ C_{2y, \sigma_x, IT}; \ R_1; 1; 1, 1, 1; \]
\[ R_2; 1; 1, -1, 1; \]
\[ R_3; 1; -1, 1, 1; \]
\[ R_4; 1; -1, -1, 1; \]

\[ U; XU; \ C_{2y, \sigma_x, IT}; \ R_1; 1; 1, -1, 1; \]
\[ R_2; 1; 1, 1, 1; \]
\[ R_3; 1; -1, -1, 1; \]
\[ R_4; 1; -1, 1, 1; \]

\[ Q; RW; \ C_{2y, IT}; \ R_2; 1; 1, 1; \]
\[ R_4; 1; -1, 1; \]
\[ \Gamma_q; \{ C_{4z}^+ | 000 \}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (000); C_{4z}^+, \mathcal{T}; \]
\[ R_1; 1, 1, 1; \]
\[ \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_1; \text{C-2 WP; 2} \]
\[ R_3; 1; -1, 1; \]

\[ M; (\frac{1}{2} \frac{1}{2} 0); C_{4z}^+, \mathcal{T}; \]
\[ R_1; 1, 1, 1; \]
\[ \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_1; \text{C-2 WP; 2} \]
\[ R_3; 1; -1, 1; \]

\[ Z; (00 \frac{1}{2}); C_{4z}^+, \mathcal{T}; \]
\[ R_1; 1, 1, 1; \]
\[ \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_1; \text{C-2 WP; 2} \]
\[ R_3; 1; -1, 1; \]

\[ A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{4z}^+, \mathcal{T}; \]
\[ R_1; 1, 1, 1; \]
\[ \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_1; \text{C-2 WP; 2} \]
\[ R_3; 1; -1, 1; \]

\[ R; (0 \frac{1}{2} \frac{1}{2}); C_{2z}, \mathcal{T}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ X; (0 \frac{1}{2} 0); C_{2z}, \mathcal{T}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ \Delta; \Gamma X; E, TC_{2z}; R_1; 1, 1, 1; \]
\[ U; ZR; E, TC_{2z}; R_1; 1, 1, 1; \]
\[ \Lambda; \Gamma Z; C_{4z}^+; \]
\[ R_1; 1, 1; \]
\[ R_2; 1; i; \]
\[ R_3; 1; -1; \]
\[ R_4; 1; -i; \]

\[ V; \text{MA}; C_{4z}^+; \]
\[ R_1; 1, 1; \]
\[ R_2; 1; i; \]
\[ R_3; 1; -1; \]
\[ R_4; 1; -i; \]

\[ \Sigma; \Gamma M; E, TC_{2z}; R_1; 1, 1, 1; \]
\[ S; \text{ZA}; E, TC_{2z}; R_1; 1, 1, 1; \]
\[ Y; \text{XM}; E, TC_{2z}; R_1; 1, 1, 1; \]
\[ T; \text{RA}; E, TC_{2z}; R_1; 1, 1, 1; \]
\[ W; \text{XR}; C_{2z}; R_1; 1, 1; \]
\[ R_2; 1; -1; \]
| Point | Zone | Orbits | Symmetry | Character |
|-------|------|--------|----------|-----------|
| \(\Gamma\) | \(000\) | \(C_{4v}^+\) | Non-Centrosymmetric; without SOC | 2 |
| \(M\) | \(1 \frac{1}{2} 0\) | \(C_{4v}^+\) | 2 |
| \(Z\) | \(00 \frac{1}{2}\) | \(C_{4v}^+\) | \(\sigma_0, -i\sigma_2\); P-NS \(ZAR\) | |
| \(A\) | \(1 \frac{1}{2} 0\) | \(C_{4v}^+\) | \(\sigma_0, i\sigma_2\); P-NS \(ZAR\) | |
| \(R\) | \(0 \frac{1}{2} 0\) | \(C_{2v}\) | \(\sigma_0, -i\sigma_2\); L-NS \(ZAR\) | |
| \( \Delta \) | \( \Gamma X \) | \(E, TC_{2v}\) | 2 |
| \(U\) | \(Z\) | \(E, TC_{2v}\) | \(\sigma_0, -i\sigma_2\); L-NS \(ZAR\) | |
| \( \Lambda \) | \( \Gamma Z \) | \(C_{4v}^+\) | 1 |
| \(V\) | \(M\) | \(C_{2v}\) | \(\sigma_0, -i\sigma_2\); L-NS \(ZAR\) | |
| \(S\) | \(ZA\) | \(E, TC_{2v}\) | 2 |
| \(Y\) | \(XM\) | \(E, TC_{2v}\) | 2 |
| \(T\) | \(RA\) | \(E, TC_{2v}\) | 2 |
| \(W\) | \(XR\) | \(C_{2v}\) | 1 |
\[ \Gamma; \{ C_{4v}^+ | 001 \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (000); C_{4v}^+, T; \]
\[ R_1; 1, 1, 1; \]
\[ \{ R_2, R_4 \}; 2; i \sigma_3, \sigma_1; \text{C-2 WP; 2} \]
\[ R_3; 1; -1, 1; \]

\[ M; (1 \frac{1}{2} 0); C_{4v}^+, T; \]
\[ R_1; 1, 1, 1; \]
\[ \{ R_2, R_4 \}; 2; i \sigma_3, \sigma_1; \text{C-2 WP; 2} \]
\[ R_3; 1; -1, 1; \]

\[ Z; (00 \frac{1}{2}); C_{4v}^+, T; \]
\[ R_1; 1, 1, 1; \]
\[ \{ R_2, R_4 \}; 2; i \sigma_3, \sigma_1; \text{C-2 WP; 2} \]
\[ R_3; 1; -1, 1; \]

\[ A; (1 \frac{1}{2} 2 \frac{1}{2}); C_{4v}^+, T; \]
\[ R_1; 1, 1, 1; \]
\[ \{ R_2, R_4 \}; 2; i \sigma_3, \sigma_1; \text{C-2 WP; 2} \]
\[ R_3; 1; -1, 1; \]

\[ R; (0 \frac{1}{2} 1); C_{2v}, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_3; 1; -1, 1; \]

\[ X; (0 \frac{1}{2} 0); C_{2v}, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1; -1, 1; \]

\[ \Delta; \Gamma X; E, T C_{2v}; R_1; 1, 1, 1; \]

\[ U; Z R; E, T C_{2v}; R_1; 1, 1, 1; \]

\[ \Lambda; \Gamma Z; C_{4v}^+; \]
\[ R_1; 1, 1; \]
\[ R_2; 1; i; \]
\[ R_3; 1; -1; \]
\[ R_4; 1; -i; \]

\[ V; M A; C_{4v}^+; \]
\[ R_1; 1, 1; \]
\[ R_2; 1; i; \]
\[ R_3; 1; -1; \]
\[ R_4; 1; -i; \]

\[ \Sigma; \Gamma M; E, T C_{2v}; R_1; 1, 1, 1; \]

\[ S; Z A; E, T C_{2v}; R_1; 1, 1, 1; \]

\[ Y; X M; E, T C_{2v}; R_1; 1, 1, 1; \]

\[ T; R A; E, T C_{2v}; R_1; 1, 1, 1; \]

\[ W; X R; C_{2v}; R_1; 1, 1; \]
\[ R_2; 1; -1; \]
\( \Gamma_q; \{ C_{4z}^+|00\frac{3}{2}\}, T; \) Non-Centrosymmetric; without SOC

\[ \begin{align*}
\Gamma &; (000); \; C_{4z}^+, T; \; R_1; \; 1, 1, 1; \\
& \quad \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_1; \; \text{C-2 WP; 2} \\
R_3 &; 1; -1, 1; \\
M &; (\frac{1}{2} \frac{1}{2} 0); \; C_{4z}^+, T; \; R_1; \; 1, 1, 1; \\
& \quad \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_1; \; \text{C-2 WP; 2} \\
R_3 &; 1; -1, 1; \\
Z &; (00\frac{1}{2}); \; C_{4z}^+, T; \; \{ R_2, R_3 \}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_1; \; \text{P-NSZAR;} \\
& \quad \{ R_4, R_6 \}; 2; -\frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_1; \; \text{P-NSZAR;} \\
A &; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \; C_{4z}^+, T; \; \{ R_2, R_3 \}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_1; \; \text{P-NSZAR;} \\
& \quad \{ R_4, R_6 \}; 2; -\frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_1; \; \text{P-NSZAR;} \\
R &; (0\frac{1}{2} \frac{1}{2}); \; C_{2z}, T; \; \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_1; \; \text{P-NSZAR;} \\
X &; (0 \frac{1}{2} 0); \; C_{2z}, T; \; R_1; \; 1, 1, 1; \\
& \quad R_2; 1; -1, 1; \\
\Delta &; \Gamma X; \; E, TC_{2z}; \; R_1; \; 1, 1, 1; \\
U &; ZR; \; E, TC_{2z}; \; \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \; \text{L-NSZAR;} \\
\Lambda &; \Gamma Z; \; C_{4z}^+; \; R_1; \; 1, 1; \\
& \quad R_2; 1; i; \\
& \quad R_3; 1; -1; \\
& \quad R_4; 1; -i; \\
V &; MA; \; C_{4z}^+; \; R_1; \; 1, 1; \\
& \quad R_2; 1; i; \\
& \quad R_3; 1; -1; \\
& \quad R_4; 1; -i; \\
\Sigma &; \Gamma M; \; E, TC_{2z}; \; R_1; \; 1, 1, 1; \\
S &; ZA; \; E, TC_{2z}; \; \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \; \text{L-NSZAR;} \\
Y &; XM; \; E, TC_{2z}; \; R_1; \; 1, 1, 1; \\
T &; RA; \; E, TC_{2z}; \; \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \; \text{L-NSZAR;} \\
W &; XR; \; C_{2z}; \; R_1; \; 1, 1; \\
& \quad R_2; 1; -1; \\
\]
\[ \Gamma^v; \{ C_{4v}^+ |000 \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma; & (000); \quad C_{4v}^+; T; \quad R_1; \quad 1; 1,1; \\
& \{ R_2, R_4 \}; \quad 2; \quad i\sigma_3, \sigma_1; \quad \text{C-2 WP; 2} \\
& R_3; \quad 1; -1,1; \\
N; & (0\frac{1}{2}0); \quad E, T; \quad R_1; \quad 1; 1,1; \\
X; & (00\frac{1}{2}); \quad C_{2z}, T; \quad R_1; \quad 1; 1,1; \\
& R_2; \quad 1; -1,1; \\
Z; & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad C_{4z}^+; T; \quad R_1; \quad 1; 1,1; \\
& \{ R_2, R_4 \}; \quad 2; \quad i\sigma_3, \sigma_1; \quad \text{C-2 WP; 2} \\
& R_3; \quad 1; -1,1; \\
P; & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad C_{4z}, C_{4z}^+ T; \quad R_1; \quad 1; 1,1; \\
& \{ R_2, R_2 \}; \quad 2; \quad -\sigma_0, -i\sigma_2; \quad \text{C-2 WP; 2} \\
\Lambda; & \Gamma\Lambda/\Gamma Z; \quad C_{4z}^+; \quad R_1; \quad 1; 1; \\
& R_2; \quad 1; i; \\
& R_3; \quad 1; -1; \\
& R_4; \quad 1; -i; \\
V; & ZV; \quad C_{4z}^+; \quad R_1; \quad 1; 1; \\
& R_2; \quad 1; i; \\
& R_3; \quad 1; -1; \\
& R_4; \quad 1; -i; \\
W; & XP; \quad C_{4z}; \quad R_1; \quad 1; 1; \\
& R_2; \quad 1; -1; \\
\Sigma; & \Gamma Z/\Gamma \Sigma; \quad E, T C_{2z}; \quad R_1; \quad 1; 1,1; \\
F; & ZF; \quad E, T C_{2z}; \quad R_1; \quad 1; 1,1; \\
Q; & NP; \quad E; \quad R_1; \quad 1; 1; \\
\Delta; & \Gamma X; \quad E, T C_{2z}; \quad R_1; \quad 1; 1,1; \\
U; & ZU; \quad E, T C_{2z}; \quad R_1; \quad 1; 1,1; \\
Y; & X Z/X Y; \quad E, T C_{2z}; \quad R_1; \quad 1; 1,1; 
\end{align*}
\]
\[ \Gamma_0'\{C_{4z}^+; 3\frac{1}{2} \frac{1}{2} \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (000); C_{4z}; T; R_1; 1; 1,1; \]
\[ \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \text{C-2 WP; 2} \]
\[ R_3; 1; -1,1; \]

\[ N; (0\frac{1}{2}0); E, T; R_1; 1; 1,1; \]

\[ X; (00\frac{1}{2}); C_{2z}, T; R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]

\[ Z; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{4z}^+, T; R_1; 1; 1,1; \]
\[ \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \text{C-2 WP; 2} \]
\[ R_3; 1; -1,1; \]

\[ P; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{2z}, C_{4z}^+, T; \{R_1, R_2\}; 2; \sigma_3, e^{-\frac{i\pi}{2} \frac{(\sigma_1+\sigma_2)}{\sqrt{2}}}; \text{C-1 WP; 1} \]

\[ \Lambda; \Gamma\Lambda/TZ; C_{4z}^+; R_1; 1; 1; \]
\[ R_2; 1; i; \]
\[ R_3; 1; -1; \]
\[ R_4; 1; -i; \]

\[ V; ZV; C_{4z}^+, E; R_5; 1; 1,1; \]
\[ R_6; 1; i,1; \]
\[ R_7; 1; -1,1; \]
\[ R_8; 1; -i,1; \]

\[ W; XP; C_{2z}; R_1; 1; 1; \]
\[ R_2; 1; -1; \]

\[ \Sigma; \Gamma Z/TZ; E, TC_{2z}; R_1; 1; 1,1; \]

\[ F; ZF; E, TC_{2z}; R_1; 1; 1,1; \]

\[ Q; NP; E; R_1; 1; 1; \]

\[ \Delta; \Gamma X; E, TC_{2z}; R_1; 1; 1,1; \]

\[ U; ZU; E, TC_{2z}; R_1; 1; 1,1; \]

\[ Y; XZ/XY; E, TC_{2z}; R_1; 1; 1,1; \]
| Point | Symmetry | Operations | Label | Matsubara Points | Quasiparticle Labels |
|-------|----------|------------|-------|------------------|---------------------|
| \(\Gamma\) | \(0,0,0\) | \(S_{4z}^+ T\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(M\) | \(\frac{1}{2}, \frac{1}{2}, 0\) | \(S_{4z}^+ T\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(Z\) | \(0,0, \frac{1}{2}\) | \(S_{4z}^+ T\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(A\) | \(\frac{1}{2}, \frac{1}{2}, \frac{1}{2}\) | \(S_{4z}^+ T\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(R\) | \(0, \frac{1}{2}, \frac{1}{2}\) | \(C_{2z} T\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(X\) | \(0, \frac{1}{2}, 0\) | \(C_{2z} T\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(\Delta\) | \(\Gamma X\) | \(E, TC_{2z}\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(U\) | \(Z R\) | \(E, TC_{2z}\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(\Lambda\) | \(\Gamma Z\) | \(C_{2z} S_{4z}^+ T\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(V\) | \(M A\) | \(C_{2z} S_{4z}^+ T\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(\Sigma\) | \(\Gamma M\) | \(E, TC_{2z}\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(S\) | \(Z A\) | \(E, TC_{2z}\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(Y\) | \(X M\) | \(E, TC_{2z}\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(T\) | \(R A\) | \(E, TC_{2z}\) | \(R_1\) | 1, 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| \(W\) | \(X R\) | \(C_{2z}\) | \(R_1\) | 1, 1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
| | | | \(R_2\) | 1, -1 | P-QNL_{FG}; \(\{R_2, R_4\}; 2, \sigma_3, \sigma_1; \) |
Γ
\{S_4^+|000\}; T; Non-Centrosymmetric; without SOC

Γ; (000); S_4^+, T; R_1; 1; 1,1;  
\{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \text{P-NL}_{\Gamma Z};  
R_3; 1; -1,1;  
N; (0\frac{1}{2}0); E, T; R_1; 1; 1,1;  
X; (00\frac{1}{2}); C_2, T; R_1; 1; 1,1;  
R_2; 1; -1,1;  
Z; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); S_4^+, T; R_1; 1; 1,1;  
\{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \text{P-NL}_{\Gamma Z};  
R_3; 1; -1,1;  
P; (\frac{1}{4}\frac{1}{4}\frac{1}{4}); S_4^+, T; R_1; 1; 1;  
R_2; 1; i;  
R_3; 1; -1;  
R_4; 1; -i;  
Λ; ΓA/ΓZ; C_2, S_4^+, T; R_1; 1; 1,1;  
\{R_2, R_4\}; 2; -\sigma_0, -i\sigma_2; \text{QNL}; 0  
V; ZV; C_2, S_4^+, T; R_1; 1; 1,1;  
\{R_2, R_4\}; 2; -\sigma_0, -i\sigma_2; \text{QNL}; 0  
W; XP; C_2; R_1; 1; 1;  
R_2; 1; -1;  
Σ; ΓZ/ΓΣ; E, TC_2; R_1; 1; 1,1;  
F; ZF; E, TC_2; R_1; 1; 1,1;  
Q; NP; E; R_1; 1; 1;  
Δ; ΓX; E, TC_2; R_1; 1; 1,1;  
U; ZU; E, TC_2; R_1; 1; 1,1;  
Y; XZ/XY; E, TC_2; R_1; 1; 1,1;
Γ; (000); $C_{4v}^+$, $I$, $T$; 1, 1, 1;
{R_2, R_4}; 2; \sigma_3, \sigma_0, \sigma_1; \text{P-QNL}_{\Gamma Z};$
R_3; 1; −1, 1, 1;
R_5; 1; 1, −1, 1;
{R_6, R_8}; 2; \sigma_3, −\sigma_0, \sigma_1; \text{P-QNL}_{\Gamma Z};$
R_7; 1; −1, −1, 1;

M; (1\frac{1}{2} 0); $C_{4v}^+$, $I$, $T$; 1, 1, 1;
{R_2, R_4}; 2; \sigma_3, \sigma_0, \sigma_1; \text{P-QNL}_{MA};$
R_3; 1; −1, 1, 1;
R_5; 1; 1, −1, 1;
{R_6, R_8}; 2; \sigma_3, −\sigma_0, \sigma_1; \text{P-QNL}_{\Gamma Z};$
R_7; 1; −1, −1, 1;

Z; (00\frac{1}{2}); $C_{4v}^+$, $I$, $T$; 1, 1, 1;
{R_2, R_4}; 2; \sigma_3, \sigma_0, \sigma_1; \text{P-QNL}_{\Gamma Z};$
R_3; 1; −1, 1, 1;
R_5; 1; 1, −1, 1;
{R_6, R_8}; 2; \sigma_3, −\sigma_0, \sigma_1; \text{P-QNL}_{\Gamma Z};$
R_7; 1; −1, −1, 1;

A; (1\frac{1}{2} 1\frac{1}{2}); $C_{4v}^+$, $I$, $T$; 1, 1, 1;
{R_2, R_4}; 2; \sigma_3, \sigma_0, \sigma_1; \text{P-QNL}_{MA};$
R_3; 1; −1, 1, 1;
R_5; 1; 1, −1, 1;
{R_6, R_8}; 2; \sigma_3, −\sigma_0, \sigma_1; \text{P-QNL}_{MA};$
R_7; 1; −1, −1, 1;

R; (0\frac{1}{2} \frac{1}{2}); $C_{2v}, I$, $T$; 1, 1, 1;
{R_2, R_4}; 1; 1, −1, 1;
R_3; 1; −1, 1, 1;
R_4; 1; −1, −1, 1;

X; (0\frac{1}{2} 0); $C_{2v}, I$, $T$; 1, 1, 1;
{R_2, R_4}; 1; 1, −1, 1;
R_3; 1; −1, 1, 1;
R_4; 1; −1, −1, 1;

Δ; ΓX; $\sigma_z$, $IT$; 1, 1, 1;
{R_2, R_4}; 1; −1, 1, 1;
R_3; 1; −1, 1, 1;

U; ZR; $\sigma_z$, $IT$; 1, 1, 1;
{R_2, R_4}; 1; −1, 1, 1;

Λ; ΓZ; $C_{4v}^+$, $I$, $T$; 1, 1, 1;
{R_2, R_4}; 2; \sigma_3, \sigma_1; \text{QNL}; 0$
R_3; 1; −1, 1;

V; MA; $C_{4v}^+$, $I$, $T$; 1, 1, 1;
{R_2, R_4}; 2; \sigma_3, \sigma_1; \text{QNL}; 0$
R_3; 1; −1, 1;
| Symbol | Group | Subgroup | $R_1$ | $R_2$ |
|-------|-------|----------|-------|-------|
| $\Sigma$ | $\Gamma M$ | $\sigma_z$, $I$ | 1, 1, 1 | 1, $-1$, 1 |
| $S$ | $ZA$ | $\sigma_z$, $I$ | 1, 1, 1 | 1, $-1$, 1 |
| $Y$ | $XM$ | $\sigma_z$, $I$ | 1, 1, 1 | 1, $-1$, 1 |
| $T$ | $RA$ | $\sigma_z$, $I$ | 1, 1, 1 | 1, $-1$, 1 |
| $W$ | $XR$ | $C_{2z}$, $I$ | 1, 1, 1 | 1, $-1$, 1 |
$$\Gamma; \{ C^{+}_{4v} | 00 \frac{1}{2} \}, \{ T | 00 \frac{1}{2} \}; T; \text{Centrosymmetric; without SOC}$$

| $\Gamma$; (000); $C^{+}_{4v}, I, T$; | $R_1$; 1; 1,1,1; |
| --- | --- |
| $\{ R_2, R_4 \}$; 2; $i\sigma_3, \sigma_0, \sigma_1$; | P-QNL_{Gamma}; |
| $R_3$; 1; $-1,1,1$; |
| $R_5$; 1; $1,-1,1$; |

| $\{ R_6, R_8 \}$; 2; $i\sigma_3, -\sigma_0, \sigma_1$; | P-QNL_{Gamma}; |
| $R_7$; 1; $-1,-1,1$; |

| $M; (\frac{1}{2} \frac{1}{2} 0); C^{+}_{4v}, I, T$; | $R_1$; 1; 1,1,1; |
| --- | --- |
| $\{ R_2, R_4 \}$; 2; $i\sigma_3, \sigma_0, \sigma_1$; | P-QNL_{MA}; |
| $R_3$; 1; $-1,1,1$; |
| $R_5$; 1; $1,-1,1$; |

| $\{ R_6, R_8 \}$; 2; $i\sigma_3, -\sigma_0, \sigma_1$; | P-QNL_{MA}; |
| $R_7$; 1; $-1,-1,1$; |

| $Z; (00 \frac{1}{2}); C^{+}_{4v}, E, I, T$; | $R_9$; 2; $\sigma_1, -\sigma_0, \sigma_3, -\sigma_0$; | P-WNLs; |
| $R_{10}$; 2; $i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0$; | P-WNLs; |

| $A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C^{+}_{4v}, E, I, T$; | $R_9$; 2; $\sigma_1, -\sigma_0, \sigma_3, -\sigma_0$; | P-WNLs; |
| $R_{10}$; 2; $i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0$; | P-WNLs; |

| $R; (0 \frac{1}{2} \frac{1}{2}); C_{2v}, I, T$; | $R_1$; 1; 1,1,1; |
| $R_2$; 1; $1,-1,1$; |
| $R_3$; 1; $-1,1,1$; |
| $R_4$; 1; $-1,-1,1$; |

| $X; (0 \frac{1}{2} 0); C_{2v}, I, T$; | $R_1$; 1; 1,1,1; |
| $R_2$; 1; $1,-1,1$; |
| $R_3$; 1; $-1,1,1$; |
| $R_4$; 1; $-1,-1,1$; |

| $\Delta; \Gamma X$; | $\sigma_2, I, T$; | $R_1$; 1; 1,1; |
| $R_2$; 1; $-1,1$; |

| $U; \Gamma R$; | $\sigma_2, I, T$; | $R_2$; 1; 1,1; |
| $R_3$; 1; $-1,1$; |

| $\Lambda; \Gamma Z$; | $C^{+}_{4v}, I, T$; | $R_1$; 1; 1,1; |
| $\{ R_2, R_4 \}$; 2; $i\sigma_3, \sigma_1$; | QNL; 0 |
| $R_3$; 1; $-1,1$; |

| $V; \Gamma A$; | $C^{+}_{4v}, I, T$; | $R_1$; 1; 1,1; |
| $\{ R_2, R_4 \}$; 2; $i\sigma_3, \sigma_1$; | QNL; 0 |
| $R_3$; 1; $-1,1$; |

| $\Sigma; \Gamma M$; | $\sigma_2, I, T$; | $R_1$; 1; 1,1; |
| $R_2$; 1; $-1,1$; |

| $S; \Gamma A$; | $\sigma_2, I, T$; | $R_2$; 1; 1,1; |
| $R_4$; 1; $-1,1$; |

| $Y; \Gamma M$; | $\sigma_2, I, T$; | $R_1$; 1; 1,1; |
| $R_2$; 1; $-1,1$; |

| $T; \Gamma A$; | $\sigma_2, I, T$; | $R_2$; 1; 1,1; |
| $R_4$; 1; $-1,1$; |

| $W; \Gamma R$; | $C_{2v}, I, T$; | $R_1$; 1; 1,1; |
| $R_2$; 1; $-1,1$; |
$\Gamma_\eta; \{C_{4v}^+; 1 \frac{1}{2}; 0\}, \{I; 1 \frac{1}{2}; 0\}, T; \text{Centrosymmetric; without SOC}$

| Γ; (000) | $C_{4v}^+; I, T$ | $R_1$ | 1; 1,1,1; |
| --- | --- | --- | --- |
| | | $(R_2, R_4)$; 2; $i\sigma_3, \sigma_0, \sigma_1$; | P-QNL $\Gamma_2$; |
| | | $R_3$; 1; $-1,1,1$; |
| | | $R_5$; 1; 1, $-1,1$; |
| | | $(R_6, R_8)$; 2; $i\sigma_3, -\sigma_0, \sigma_1$; | P-QNL $\Gamma_2$; |
| | | $R_7$; 1; $-1,1,1$; |
| $M; (1 \frac{1}{2}; 0)$ | $C_{4v}^+; E, I, T$ | $R_9$; 2; $\sigma_1, -\sigma_0, \sigma_3, -\sigma_0$; | P-WNLs; |
| | | $R_{10}$; 2; $i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0$; | P-WNLs; |
| $Z; (00 \frac{1}{2})$ | $C_{4v}^+; I, T$ | $R_1$; 1; 1,1,1; |
| | | $(R_2, R_4)$; 2; $i\sigma_3, \sigma_0, \sigma_1$; | P-QNL $\Gamma_2$; |
| | | $R_3$; 1; $-1,1,1$; |
| | | $R_5$; 1; 1, $-1,1$; |
| | | $(R_6, R_8)$; 2; $i\sigma_3, -\sigma_0, \sigma_1$; | P-QNL $\Gamma_2$; |
| | | $R_7$; 1; $-1,1,1$; |
| $A; (1 \frac{1}{2}; \frac{1}{2})$ | $C_{4v}^+; E, I, T$ | $R_9$; 2; $\sigma_1, -\sigma_0, \sigma_3, -\sigma_0$; | P-WNLs; |
| | | $R_{10}$; 2; $i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0$; | P-WNLs; |
| $R; (0 \frac{1}{2}; \frac{1}{2})$ | $\sigma_x; I, T$ | $R_5$; 2; $i\sigma_2, \sigma_3, -\sigma_0$; | P-WNLs; |
| $X; (0 \frac{1}{2}; 0)$ | $\sigma_x; I, T$ | $R_5$; 2; $i\sigma_2, \sigma_3, -\sigma_0$; | P-WNLs; |
| $\Delta; \Gamma X$ | $\sigma_x; I, T$ | $R_1$; 1; 1,1; |
| | | $R_2$; 1; $-1,1$; |
| $U; ZR$ | $\sigma_z; I, T$ | $R_1$; 1; 1,1; |
| | | $R_2$; 1; $-1,1$; |
| $\Lambda; \Gamma Z$ | $C_{4v}^+; I, T$ | $R_1$; 1; 1,1; |
| | | $(R_2, R_4)$; 2; $i\sigma_3, \sigma_1$; | QNL; 0 |
| | | $R_3$; 1; $-1,1$; |
| $V; MA$ | $C_{4v}^+; E, I, T$ | $(R_5, R_7)$; 2; $-\sigma_3, \sigma_0, \sigma_1$; | QNL; 0 |
| | | $R_6$; 1; $-i,1,1$; |
| | | $R_8$; 1; $i,1,1$; |
| $\Sigma; \Gamma M$ | $\sigma_z; I, T$ | $R_1$; 1; 1,1; |
| | | $R_2$; 1; $-1,1$; |
| $S; ZA$ | $\sigma_z; I, T$ | $R_1$; 1; 1,1; |
| | | $R_2$; 1; $-1,1$; |
| $Y; XM$ | $\sigma_z; I, T$ | $R_1$; 1; $-i,1$; |
| | | $R_2$; 1; $i,1$; |
| $T; RA$ | $\sigma_z; I, T$ | $R_1$; 1; $-i,1$; |
| | | $R_2$; 1; $i,1$; |
| $W; XR$ | $C_{2v}; I, T$ | $(R_1, R_2)$; 2; $\sigma_3, \sigma_1$; | WNL; $\pi$ |
\( \Gamma \): \( \{ C_{4v}^+ \} \), \( \{ l_{\text{centrosymmetric}} \} \), \( T \); Centrosymmetric; without SOC

\[ \Gamma; (000); C_{4v}^+, I, T; \]

\[ R_1; 1, 1, 1; \]

\[ \{ R_2, R_4 \}; 2; i \sigma_3, \sigma_0, \sigma_1; \text{ P-QNL}_{\Gamma Z}; \]

\[ R_3; 1, -1, 1; \]

\[ R_5; 1, 1, -1; \]

\[ \{ R_6, R_8 \}; 2; i \sigma_3, -\sigma_0, \sigma_1; \text{ P-QNL}_{\Gamma Z}; \]

\[ R_7; 1, -1, 1; \]

\[ M; \left( \frac{1}{2} \right); C_{4v}^+, E, I, T; \]

\[ R_9; 2; \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \text{ P-WNLs}; \]

\[ R_{10}; 2; i \sigma_2, -\sigma_0, \sigma_3, -\sigma_0; \text{ P-WNLs}; \]

\[ Z; (00\frac{1}{2}); C_{4v}^+, E, I, T; \]

\[ R_9; 2; \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \text{ P-WNLs}; \]

\[ R_{10}; 2; i \sigma_2, -\sigma_0, \sigma_3, -\sigma_0; \text{ P-WNLs}; \]

\[ A; \left( \frac{1}{2} \right); C_{4v}^+; I, T; \]

\[ R_3; 1, 1, 1; \]

\[ \{ R_2, R_4 \}; 2; i \sigma_3, \sigma_0, \sigma_1; \text{ P-QNL}_{MA}; \]

\[ R_5; 1, -1, 1; \]

\[ R_7; 1, -1, 1; \]

\[ R_5; 1, -1, 1; \]

\[ \{ R_6, R_8 \}; 2; i \sigma_3, -\sigma_0, \sigma_1; \text{ P-QNL}_{MA}; \]

\[ R_7; 1, -1, 1; \]

\[ R; \left( \frac{1}{2} \right); \sigma_2, I, T; \]

\[ R_5; 2; i \sigma_2, \sigma_3, -\sigma_0; \text{ P-WNLs}; \]

\[ X; \left( \frac{1}{2} \right); \sigma_2, I, T; \]

\[ R_5; 2; i \sigma_2, \sigma_3, -\sigma_0; \text{ P-WNLs}; \]

\[ \Delta; \Gamma X; \sigma_2, I, T; \]

\[ R_3; 1, 1, 1; \]

\[ R_2; 1, -1, 1; \]

\[ R_4; 1, -1, 1; \]

\[ U; \Gamma Z; \sigma_2, I, T; \]

\[ R_3; 1, 1, 1; \]

\[ R_2; 1, -1, 1; \]

\[ R_4; 1, -1, 1; \]

\[ \Lambda; \Gamma Z; C_{4v}^+; I, T; \]

\[ R_3; 1, 1, 1; \]

\[ \{ R_2, R_4 \}; 2; i \sigma_3, \sigma_1; \text{ QNL}; 0 \]

\[ R_3; 1, -1, 1; \]

\[ V; \Gamma A; C_{4v}^+, E, I, T; \]

\[ \{ R_5, R_7 \}; 2; -\sigma_3, \sigma_0, \sigma_1; \text{ QNL}; 0 \]

\[ R_6; 1, -i, 1, 1; \]

\[ R_8; 1, i, 1, 1; \]

\[ \Sigma; \Gamma M; \sigma_2, I, T; \]

\[ R_3; 1, 1, 1; \]

\[ R_2; 1, -1, 1; \]

\[ S; \Gamma A; \sigma_2, I, T; \]

\[ R_3; 1, 1, 1; \]

\[ R_2; 1, -1, 1; \]

\[ Y; \Gamma M; \sigma_2, I, T; \]

\[ R_3; 1, -i, 1; \]

\[ R_2; 1, i, 1; \]

\[ T; \Gamma A; \sigma_2, I, T; \]

\[ R_3; 1, -i, 1; \]

\[ R_4; 1, i, 1; \]

\[ W; \Gamma R; C_{2v}^+; \]
\( \Gamma \); \( \{C_{4z}^+\{000\}, \{I\{000\}, T\} \}; \) Centrosymmetric; without SOC

\( \Gamma \); (000); \( C_{4z}^+, I, T \); \( R_3; \) 1, 1, 1;
\{\( R_2, R_4 \); \} 2; \( i\sigma_3, \sigma_0, \sigma_1 \); P-QNL\( \Gamma Z \);
\( R_3; \) 1; -1, 1, 1;
\( R_5; \) 1; 1, -1, 1;
\{\( R_6, R_8 \); \} 2; \( i\sigma_3, -\sigma_0, \sigma_1 \); P-QNL\( \Gamma Z \);
\( R_7; \) 1; -1, -1, 1;

\( N \); (0\( \frac{1}{2} \)0); \( I, T \); \( R_4; \) 1, 1, 1;
\( R_2; \) 1, -1, 1;

\( X \); (00\( \frac{1}{2} \)); \( C_{2z}, I, T \); \( R_4; \) 1, 1, 1, 1;
\( R_2; \) 1, 1, -1, 1;
\( R_3; \) 1, -1, 1, 1;
\( R_4; \) 1, -1, -1, 1;

\( Z \); (\( \frac{1}{2} \\frac{1}{2} \\frac{1}{2} \)); \( C_{4z}^+, I, T \); \( R_4; \) 1, 1, 1, 1;
\{\( R_2, R_4 \); \} 2; \( i\sigma_3, \sigma_0, \sigma_1 \); P-QNL\( \Gamma Z \);
\( R_3; \) 1; -1, 1, 1;
\( R_5; \) 1; 1, -1, 1;
\{\( R_6, R_8 \); \} 2; \( i\sigma_3, -\sigma_0, \sigma_1 \); P-QNL\( \Gamma Z \);
\( R_7; \) 1; -1, -1, 1;

\( P \); (\( \frac{1}{2} \\frac{1}{2} \frac{1}{2} \)); \( S_{4z}^+, I, T \); \( R_4; \) 1, 1, 1;
\{\( R_2, R_4 \); \} 2; \( i\sigma_3, \sigma_1 \); P-WNLs;
\( R_3; \) 1; -1, 1;

\( \Lambda \); \( \Gamma \Lambda / \Gamma Z \); \( C_{4z}^+, I, T \); \( R_4; \) 1, 1, 1;
\{\( R_2, R_4 \); \} 2; \( i\sigma_3, \sigma_1 \); QNL; 0
\( R_3; \) 1; -1, 1;

\( V \); \( Z \Lambda \); \( C_{4z}^+, I, T \); \( R_4; \) 1, 1, 1;
\{\( R_2, R_4 \); \} 2; \( i\sigma_3, \sigma_1 \); QNL; 0
\( R_3; \) 1; -1, 1;

\( W \); \( X \Lambda \); \( C_{4z}^+, I, T \); \( R_4; \) 1, 1, 1;
\( R_2; \) 1, -1, 1;
\( \Sigma \); \( \Gamma Z / \Gamma \Sigma \); \( \sigma_2, I, T \); \( R_4; \) 1, 1, 1;
\( R_2; \) 1, -1, 1;
\( F \); \( Z \Sigma \); \( \sigma_2, I, T \); \( R_4; \) 1, 1, 1;
\( R_2; \) 1, -1, 1;
\( Q \); \( N \Lambda \); \( E, I, T \); \( R_4; \) 1, 1, 1;
\( \Delta \); \( \Gamma X \); \( \sigma_2, I, T \); \( R_4; \) 1, 1, 1;
\( R_2; \) 1, -1, 1;
\( U \); \( Z \Sigma \); \( \sigma_2, I, T \); \( R_4; \) 1, 1, 1;
\( R_2; \) 1, -1, 1;
\( Y \); \( X \Sigma / X Y \); \( \sigma_2, I, T \); \( R_4; \) 1, 1, 1;
\( R_2; \) 1, -1, 1;
\[ \Gamma^v; \{ C_{4z}^{\pm \frac{3}{4} \pm \frac{1}{4}} \}, \{ I_{\pm \frac{3}{4} \pm \frac{1}{4}} \}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; (000); C_{4z}^{\pm \frac{3}{4}}, I, T; \]

| \[ R_1 \] | 1, 1, 1; |
| \[ R_2, R_3 \] | 2; \( i\sigma_3, \sigma_0, \sigma_1 \); P-QNL_{\Gamma Z}; |
| \[ R_4 \] | 1; \(-1, 1, 1\); |
| \[ R_5 \] | 1; 1, \(-1, 1\); |
| \[ R_6, R_8 \] | 2; \( i\sigma_3, -\sigma_0, \sigma_1 \); P-QNL_{\Gamma Z}; |
| \[ R_7 \] | 1; \(-1, -1, 1\); |

\[ N; (0\frac{1}{2}0); I, T; \]

| \[ R_1 \] | 1, 1, 1; |
| \[ R_2 \] | 1; \(-1, 1, 1\); |

\[ X; (00\frac{1}{2}); \sigma_z, I, T; \]

| \[ R_5 \] | 2; \( i\sigma_2, \sigma_3, -\sigma_0 \); P-WNLs; |

\[ Z; (\frac{1}{2} \pm \frac{3}{2}); C_{4z}^{\pm \frac{3}{4}}, E, I, T; \]

| \[ R_9 \] | 2; \sigma_1, -\sigma_0, \sigma_3, -\sigma_0 \); P-WNLs; |
| \[ R_{10} \] | 2; \( i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0 \); P-WNLs; |
| \[ R_2, R_3 \] | 2; \( \left( \frac{1}{2} - \frac{i}{2} \right)(\sigma_0 + i\sigma_3), \sigma_1 \); P-WNL_{XP}; |
| \[ R_2, R_3 \] | 2; \( \left( -\frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_1 \); P-WNL_{XP}; |

\[ \Lambda; \Gamma\Lambda/\Gamma Z; C_{4z}^{\pm \frac{3}{4}}, I, T; \]

| \[ R_1 \] | 1, 1, 1; |
| \[ R_2, R_4 \] | 2; \( i\sigma_3, \sigma_1 \); QNL; 0 |
| \[ R_3 \] | 1; \(-1, 1, 1\); |

\[ V; ZV; C_{4z}^{\pm \frac{3}{4}}, E, I, T; \]

| \[ R_5, R_7 \] | 2; \sigma_3, \sigma_0, \sigma_1 \); QNL; 0 |
| \[ R_6 \] | 1; \( i, 1, 1\); |
| \[ R_8 \] | 1; \(-i, 1, 1\); |

\[ W; XP; C_{2z}, I, T; \]

| \[ R_1, R_2 \] | 2; \sigma_3, \sigma_1 \); WNL; \( \pi \) |
| \[ R_3 \] | 1; \( -i, 1, 1\); |

\[ \Sigma; \Gamma Z/\Sigma; \sigma_z, I, T; \]

| \[ R_1 \] | 1, 1, 1; |
| \[ R_2 \] | 1; \(-1, 1, 1\); |

\[ F; ZF; \sigma_z, I, T; \]

| \[ R_2 \] | 1; 1, 1; |
| \[ R_4 \] | 1; \(-1, 1, 1\); |

\[ Q; NP; E, I, T; \]

| \[ R_1 \] | 1, 1, 1; |

\[ \Delta; \Gamma X; \sigma_z, I, T; \]

| \[ R_1 \] | 1, 1, 1; |
| \[ R_2 \] | 1; \(-1, 1, 1\); |

\[ U; ZU; \sigma_z, I, T; \]

| \[ R_2 \] | 1, 1, 1; |
| \[ R_4 \] | 1; \(-1, 1, 1\); |

\[ Y; XZ/XY; \sigma_z, I, T; \]

| \[ R_1 \] | 1; \(-i, 1, 1\); |
| \[ R_2 \] | 1; \( i, 1\); |
\( \Gamma \); \((000)\): \(C_{4x}^+, C_{2x}, T\); \(R_1\): \(1, 1, 1, 1\);
\( R_2\): \(1, -1, 1, 1\);
\( R_3\): \(-1, 1, 1, 1\);
\( R_4\): \(-1, -1, 1, 1\);
\( R_5\): \(2; i\sigma_2, \sigma_3, -\sigma_0\); C-2 WP; 2

\( M \); \((\frac{1}{2}\frac{1}{2}0)\): \(C_{4x}^+, C_{2x}, T\); \(R_1\): \(1, 1, 1, 1\);
\( R_2\): \(1, -1, 1, 1\);
\( R_3\): \(-1, 1, 1, 1\);
\( R_4\): \(-1, -1, 1, 1\);
\( R_5\): \(2; i\sigma_2, \sigma_3, -\sigma_0\); C-2 WP; 2

\( Z \); \((00\frac{1}{2})\): \(C_{4x}^+, C_{2x}, T\); \(R_1\): \(1, 1, 1, 1\);
\( R_2\): \(1, -1, 1, 1\);
\( R_3\): \(-1, 1, 1, 1\);
\( R_4\): \(-1, -1, 1, 1\);
\( R_5\): \(2; i\sigma_2, \sigma_3, -\sigma_0\); C-2 WP; 2

\( A \); \((\frac{1}{2}\frac{1}{2}\frac{1}{2})\): \(C_{4x}^+, C_{2x}, T\); \(R_1\): \(1, 1, 1, 1\);
\( R_2\): \(1, -1, 1, 1\);
\( R_3\): \(-1, 1, 1, 1\);
\( R_4\): \(-1, -1, 1, 1\);
\( R_5\): \(2; i\sigma_2, \sigma_3, -\sigma_0\); C-2 WP; 2

\( R \); \((0\frac{1}{2}\frac{1}{2})\): \(C_{2x}, C_{2y}, T\); \(R_1\): \(1, 1, 1, 1\);
\( R_2\): \(1, -1, 1, 1\);
\( R_3\): \(-1, 1, 1, 1\);
\( R_4\): \(-1, -1, 1, 1\);

\( X \); \((0\frac{1}{2}0)\): \(C_{2x}, C_{2y}, T\); \(R_1\): \(1, 1, 1, 1\);
\( R_2\): \(1, -1, 1, 1\);
\( R_3\): \(-1, 1, 1, 1\);
\( R_4\): \(-1, -1, 1, 1\);

\( \Delta \); \(\Gamma X\); \(C_{2y}, TC_{2z}\); \(R_1\): \(1, 1, 1\);
\( R_2\): \(-1, -1, 1\);

\( U \); \(Z R\); \(C_{2y}, TC_{2z}\); \(R_1\): \(1, 1, 1\);
\( R_2\): \(-1, -1, 1\);

\( \Lambda \); \(\Gamma Z\); \(C_{4x}^+, C_{2b}T\); \(R_1\): \(1, 1, 1\);
\( R_2\): \(i, 1, 1\);
\( R_3\): \(-1, 1, 1\);
\( R_4\): \(-i, 1, 1\);

\( V \); \(M A\); \(C_{4x}^+, C_{2b}T\); \(R_1\): \(1, 1, 1\);
\( R_2\): \(i, 1, 1\);
\( R_3\): \(-1, 1, 1\);
\( R_4\): \(-i, 1, 1\);

\( \Sigma \); \(\Gamma M\); \(C_{2a}, C_{2b}T\); \(R_1\): \(1, 1, 1\);
\( R_2\): \(-1, -1, 1\);

\( S \); \(ZA\); \(C_{2a}, C_{2b}T\); \(R_1\): \(1, 1, 1\);
\( R_2\): \(-1, -1, 1\);
Y; XM; \(C_{2x,T}C_{2y}\); \(R_1\); 1; 1; 1;
\(R_2\); 1; 1; -1, 1;

T; RA; \(C_{2x,T}C_{2y}\); \(R_1\); 1; 1, 1;
\(R_2\); 1; 1, 1;

W; XR; \(C_{2z,T}C_{2y}\); \(R_1\); 1; 1, 1;
\(R_2\); 1; 1, 1;

SG 90
\[ \Gamma_q; \{C_{4z}^+\[000\], \{C_{2x}\[\frac{1}{2}\frac{1}{2}\]0\}\}; \] Non-Centrosymmetric; without SOC

\[ \Gamma; (000); C_{4z}^+; C_{2x,T}; \]
\(R_1\); 1; 1, 1, 1;
\(R_2\); 1; 1, 1,
\(R_3\); 1; 1, 1, 1;
\(R_4\); 1; 1, 1, 1;
\(R_5\); 2; \(i\sigma_2, \sigma_3, -\sigma_0\); C-2 WP; 2

\(M; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{4z}^+; C_{2x,C_{20},T}; \{R_5, R_6\}; 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \) P-NSs;
\(R_7, R_8\); 2; \(-i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \) P-NSs;
\(R_9\); 2; \(\sigma_1, \sigma_0, \sigma_2, -\sigma_0; \) P-NS;

\(Z; (00\frac{1}{2}); C_{4z}^+; C_{2x,T}; \]
\(R_1\); 1; 1, 1, 1;
\(R_2\); 1; 1, 1, 1;
\(R_3\); 1; 1, 1, 1;
\(R_4\); 1; 1, 1, 1;
\(R_5\); 2; \(i\sigma_2, \sigma_3, -\sigma_0; \) C-2 WP; 2

\(A; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{4z}^+; C_{2x,C_{20},T}; \{R_5, R_6\}; 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \) P-NSs;
\(R_7, R_8\); 2; \(-i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \) P-NSs;
\(R_9\); 2; \(\sigma_1, -\sigma_0, \sigma_2, -\sigma_0; \) P-NS;

\(R; (0\frac{1}{2}\frac{1}{2}); C_{2y,C_{2x,T}}; \]
\(R_5\); 2; \(i\sigma_2, \sigma_3, -\sigma_0; \) P-\(\text{NS}_{\text{MARX}}\);

\(X; (0\frac{1}{2}\frac{1}{2}); C_{2y,C_{2x,T}}; \]
\(R_5\); 2; \(i\sigma_2, \sigma_3, -\sigma_0; \) P-\(\text{NS}_{\text{MARX}}\);

\(\Delta; \Gamma X; C_{2y,T}C_{2z}; \]
\(R_1\); 1; 1, 1;
\(R_2\); 1; 1, 1;

\(U; ZR; C_{2y,T}C_{2z}; \]
\(R_1\); 1; 1, 1;
\(R_2\); 1; 1, 1;

\(\Lambda; \Gamma Z; C_{4z}^+; C_{20,T}; \]
\(R_1\); 1; 1, 1;
\(R_2\); 1, 1, 1;
\(R_3\); 1; 1, 1;
\(R_4\); 1; 1, 1;

\(V; \Lambda A; C_{4z}^+; C_{20,T}; \{R_1, R_2\}; 2; \sigma_3, -\sigma_2; \) L-\(\text{NS}s\);
\{\(R_2, R_3\); 2, \(\sigma_3, \sigma_1; \) L-\(\text{NS}s\);

\(\Sigma; \Gamma M; C_{2a,C_{20,T}}; \]
\(R_1\); 1; 1, 1;
\(R_2\); 1, 1, 1;

\(S; \Lambda A; C_{2a,C_{20,T}}; \]
\(R_1\); 1, 1, 1;
\(R_2); 1; 1, 1;

\(Y; X M; C_{2x,T}C_{2y}; \{R_2, R_2\}; 2; \sigma_3, -i\sigma_2; \) L-\(\text{NS}_{\text{MARX}}\);

\(T; RA; C_{2x,T}C_{2y}; \{R_2, R_4\}; 2; \sigma_3, -i\sigma_2; \) L-\(\text{NS}_{\text{MARX}}\);

\(W; XR; C_{2z,T}C_{2y}; \{R_1, R_2\}; 2; \sigma_3, -i\sigma_2; \) L-\(\text{NS}_{\text{MARX}}\);
11. SG 91-100

\[ \Gamma = \{ C_{4z}^{+}, C_{2z}, T \}; Non-Centrosymmetric; without SOC \]

\[ \Gamma; \ (000); \ C_{4z}^{+}, C_{2z}, T; \]
\[ R_1; \ 1, 1, 1; \]
\[ R_2; \ 1, 1, -1, 1; \]
\[ R_3; \ 1, -1, 1, 1; \]
\[ R_4; \ 1, -1, -1, 1; \]
\[ R_5; \ 2, i\sigma_2, \sigma_3, -\sigma_0; \ C-2 \ WP; \ 2 \]

\[ M; \ (1\frac{1}{2} 0); \ C_{4z}^{+}, C_{2z}, T; \]
\[ R_1; \ 1, 1, 1; \]
\[ R_2; \ 1, 1, -1, 1; \]
\[ R_3; \ 1, -1, 1, 1; \]
\[ R_4; \ 1, -1, -1, 1; \]
\[ R_5; \ 2, i\sigma_2, \sigma_3, -\sigma_0; \ C-2 \ WP; \ 2 \]

\[ Z; \ (00\frac{1}{2}); \ C_{4z}^{+}, C_{2z}, T; \]
\[ R_6; \ 2, \ \frac{2\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_3, -\sigma_0; \ P-NS_{ZAR}; \]
\[ R_7; \ 2, \ \frac{2\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_3, -\sigma_0; \ P-NS_{ZAR}; \]

\[ A; \ (1\frac{1}{2} 1\frac{1}{2}); \ C_{4z}^{+}, C_{2z}, T; \]
\[ R_6; \ 2, \ \frac{2\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_3, -\sigma_0; \ P-NS_{ZAR}; \]
\[ R_7; \ 2, \ \frac{2\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_3, -\sigma_0; \ P-NS_{ZAR}; \]

\[ R; \ (0\frac{1}{2} \frac{1}{2}); \ C_{2z}, C_{2z}, T; \]
\[ R_5; \ 2, i\sigma_2, \sigma_3, -\sigma_0; \ P-NS_{ZAR}; \]

\[ X; \ (0\frac{1}{2}0); \ C_{2z}, C_{2z}, T; \]
\[ R_1; \ 1, 1, 1, 1; \]
\[ R_2; \ 1, 1, -1, 1; \]
\[ R_3; \ 1, -1, 1, 1; \]
\[ R_4; \ 1, -1, -1, 1; \]

\[ \Delta; \ \Gamma X; \ C_{2z}, TC_{2z}; \]
\[ R_1; \ 1, 1; \]
\[ R_2; \ 1, -1, 1; \]

\[ \Upsilon; \ ZR; \ C_{2z}, TC_{2z}; \ {R_2, R_4}; \ 2, \sigma_3, -i\sigma_2; \ L-NS_{ZAR}; \]

\[ \Lambda; \ \Gamma Z; \ C_{4z}^{+}, C_{2z}, T; \]
\[ R_1; \ 1, 1, 1; \]
\[ R_2; \ i, 1; \]
\[ R_3; \ 1, -1, 1; \]
\[ R_4; \ 1, i, 1; \]

\[ \nu; \ MA; \ C_{4z}^{+}, C_{2z}, T; \]
\[ R_1; \ 1, 1, 1; \]
\[ R_2; \ i, 1; \]
\[ R_3; \ 1, -1, 1; \]
\[ R_4; \ 1, i, 1; \]

\[ \Sigma; \ \Gamma M; \ C_{2z}, C_{2z}, T; \]
\[ R_1; \ 1, 1, 1; \]
\[ R_2; \ 1, -1, 1; \]

\[ \sigma; \ ZA; \ C_{2z}, C_{2z}, T; \ {R_2, R_6}; \ 2, \sigma_3, \sigma_1; \ L-NS_{ZAR}; \]

\[ \chi; \ XM; \ C_{2z}, TC_{2z}; \]
\[ R_1; \ 1, 1, 1; \]
\[ R_2; \ 1, -1, 1; \]

\[ \tau; \ RA; \ C_{2z}, TC_{2z}; \ {R_1, R_2}; \ 2, \sigma_3, \sigma_1; \ L-NS_{ZAR}; \]

\[ \omega; \ XR; \ C_{2z}, TC_{2z}; \]
\[ R_1; \ 1, 1, 1; \]
\[ R_2; \ 1, -1, 1; \]
Γ: (000); $C_{4v}^+, C_{2v}, T$; $R_1$: 1, 1, $\sigma_1$
$R_2$: 1, 1, $-\sigma_1$
$R_3$: 1, $-\sigma_1$
$R_4$: 1, $-\sigma_1$
$R_5$: 2, $i\sigma_2, \sigma_3, -\sigma_0$; C-2 WP; 2

M: ($\frac{1}{2} \frac{1}{2} 0$); $C_{4v}^+, C_{2v}, C_{2x}, T$; 
{R_5, R_6}: 2, $i\sigma_3, \sigma_0, \sigma_0, \sigma_1$; P-NSS;
{R_7, R_8}: 2, $-i\sigma_3, \sigma_0, -\sigma_0, \sigma_1$; P-NSS;
R_9: 2, $\sigma_1, -\sigma_0, \sigma_3, -\sigma_0$; P-NSS;

Z: (00 $\frac{1}{2}$); $C_{4v}^+, C_{2x}, T$; $R_6$: 2, $\frac{2\sigma_0+\sigma_3}{\sqrt{2}}, \sigma_3, -\sigma_0$; P-NSS;
R_7: 2, $-\frac{2\sigma_0-\sigma_3}{\sqrt{2}}, \sigma_3, -\sigma_0$; P-NSS;

A: ($\frac{1}{2} \frac{1}{2} \frac{1}{2}$); $C_{4v}^+, C_{2a}, T$; 
{R_6, R_7}: 4, $\Gamma_{0,1,3,0}, \Gamma_{0,3,0}, \Gamma_{1,0}$; C-2 DP;

R: ($0 \frac{1}{2} \frac{1}{2}$); $C_{2a}, T$; $R_2$: 2, $i\sigma_3, \sigma_0, \sigma_1$; P-NSS;
{R_6, R_7}: 2, $i\sigma_3, -\sigma_0, \sigma_1$; P-NSS;

Δ; ΓX; $C_{2y}, T$; $R_2$: 1, $-1, 1$; U; ZR; $C_{2y}, T$; $R_2$: 2, $\sigma_3, -i\sigma_2$; L-NSS;

Λ; ΓZ; $C_{4v}, C_{2b}, T$; $R_1$: 1, 1, 1;
R_2: 1, 1, 1;
R_3: 1, $-1, 1$;
R_4: 1, $-1, 1$;

V; MA; $C_{4v}, C_{2b}, T$; 
{R_1, R_3}: 2, $\sigma_3, \sigma_1$; L-NSS;
{R_2, R_4}: 2, $i\sigma_3, \sigma_1$; L-NSS;

Σ; ΓM; $C_{2a}, C_{2b}, T$; $R_1$: 1, 1, 1;
R_2: 1, $-1, 1$;

S; ZA; $C_{2a}, C_{2b}, T$; 
{R_2, R_3}: 2, $\sigma_3, \sigma_1$; L-NSS;

Y; XM; $C_{2a}, T$; $R_2$: 2, $\sigma_3, -i\sigma_2$; L-NSS;

T; RA; $C_{2a}, T$; $R_2$: 2, $\sigma_0, -i\sigma_2$; L-NSS;
R_4: 2, $-\sigma_0, -i\sigma_2$; L-NSS;

W; XR; $C_{2a}, T$; $R_1$: 2, $\sigma_3, -i\sigma_2$; L-NSS;
\[ \Gamma; (000); \ C^+_4, C_{2a}, T; \ R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; \ C-2 \ WP; 2 \]

\[ M; (\frac{1}{2} \frac{1}{2} 0); \ C^+_4, C_{2a}, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; \ C-2 \ WP; 2 \]

\[ Z; (00 \frac{1}{2}); \ C^+_4, C_{2a}, C_{2a}, T; \]
\[ R_6; 1, 1, 1, -1, 1; \]
\[ R_7; 1, 1, -1, -1, 1; \]
\[ R_8; 1, -1, 1, -1, 1; \]
\[ R_9; 1, -1, -1, -1, 1; \]
\[ R_5; 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \ C-2 \ WP; 2 \]

\[ A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ C^+_4, C_{2a}, C_{2a}, T; \]
\[ R_6; 1, 1, 1, -1, 1; \]
\[ R_7; 1, 1, -1, -1, 1; \]
\[ R_8; 1, -1, 1, -1, 1; \]
\[ R_9; 1, -1, -1, -1, 1; \]
\[ R_5; 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \ C-2 \ WP; 2 \]

\[ R; (0 \frac{1}{2} \frac{1}{2}); \ C_{2a}, C_{2b}, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ X; (0 \frac{1}{2} 0); \ C_{2a}, C_{2b}, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ \Delta; \ \Gamma X; \ C_{2b}, TC_{2a}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]

\[ U; \ ZR; \ C_{2b}, TC_{2a}; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]

\[ \Lambda; \ \Gamma Z; \ C^+_4, C_{2b}, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, i, 1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -i, 1; \]

\[ V; \ MA; \ C^+_4, C_{2b}, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, i, 1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -i, 1; \]

\[ \Sigma; \ \Gamma M; \ C_{2a}, C_{2b}, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]

\[ S; \ ZA; \ C_{2a}, C_{2b}, T; \]
\[ R_2; 1, 1, 1; \]
\[ R_4; 1, -1, 1; \]
\[
\begin{array}{c|c}
\Gamma & (000) \quad C^{+}_{4z},C_{T} \quad R_{1} \quad 1; 1,1,1; \\
\Gamma & (000) \quad R_{2} \quad 1; 1,1,1; \\
\Gamma & (000) \quad R_{3} \quad 1; 1,1,1; \\
\Gamma & (000) \quad R_{4} \quad 1; 1,1,1; \\
\Gamma & (000) \quad R_{5} \quad 2; i\sigma_{2},\sigma_{3}, -\sigma_{0}; \quad C-2 \quad WP; \quad 2 \\
M & (1\frac{1}{2}0) \quad C^{+}_{4z},C_{T} \quad \{R_{5}, R_{6}\} \quad 2; i\sigma_{3},\sigma_{0},\sigma_{0},\sigma_{1}; \quad P-\text{NSs}; \\
M & (1\frac{1}{2}0) \quad \{R_{7}, R_{8}\} \quad 2; -i\sigma_{3},\sigma_{0},-\sigma_{0},\sigma_{1}; \quad P-\text{NSs}; \\
M & (1\frac{1}{2}0) \quad R_{9} \quad 2; \sigma_{1},-\sigma_{0},\sigma_{3}, -\sigma_{0}; \quad P-\text{NSs}; \\
Z & (00\frac{1}{2}) \quad C^{+}_{4z},C_{T} \quad R_{5} \quad 2; i\sigma_{2},\sigma_{3},\sigma_{0},-\sigma_{0}; \quad C-2 \quad WP; \quad 2 \\
Z & (00\frac{1}{2}) \quad R_{6} \quad 1; 1,1,1; \\
Z & (00\frac{1}{2}) \quad R_{7} \quad 1; 1,1,1; \\
Z & (00\frac{1}{2}) \quad R_{8} \quad 1; 1,1,1; \\
Z & (00\frac{1}{2}) \quad R_{9} \quad 1; 1,1,1; \\
A & (1\frac{1}{2}1) \quad C^{+}_{4z},C_{T} \quad \{R_{5}, R_{6}\} \quad 2; i\sigma_{3},\sigma_{0},\sigma_{0},\sigma_{1}; \quad P-\text{NSs}; \\
A & (1\frac{1}{2}1) \quad \{R_{7}, R_{8}\} \quad 2; -i\sigma_{3},\sigma_{0},-\sigma_{0},\sigma_{1}; \quad P-\text{NSs}; \\
A & (1\frac{1}{2}1) \quad R_{9} \quad 2; \sigma_{1},-\sigma_{0},\sigma_{3}, -\sigma_{0}; \quad P-\text{NSs}; \\
R & (0\frac{1}{2}\frac{1}{2}) \quad C_{T} \quad R_{5} \quad 2; i\sigma_{2},\sigma_{3}, -\sigma_{0}; \quad \text{P-NS}_{\text{MARX}}; \\
X & (0\frac{1}{2}0) \quad C_{T} \quad R_{5} \quad 2; i\sigma_{2},\sigma_{3}, -\sigma_{0}; \quad \text{P-NS}_{\text{MARX}}; \\
\Delta \quad \Gamma \chi \quad R_{1} \quad 1; 1,1; \\
\Delta \quad \Gamma \chi \quad R_{2} \quad 1; 1,1; \\
U \quad \Gamma \chi \quad R_{2} \quad 1; 1,1; \\
\Delta \quad \Gamma \chi \quad R_{3} \quad 1; 1,1; \\
\Delta \quad \Gamma \chi \quad R_{4} \quad 1; 1,1; \\
V \quad \Gamma \chi \quad R_{5} \quad 2; \sigma_{3}, -\sigma_{2}; \quad \text{L-NSs}; \\
\Sigma \quad \Gamma \chi \quad R_{5} \quad 2; \sigma_{3}, -\sigma_{2}; \quad \text{L-NSs}; \\
S \quad \Gamma \chi \quad R_{2} \quad 1; 1,1; \\
S \quad \Gamma \chi \quad R_{4} \quad 1; 1,1; \\
Y \quad \Gamma \chi \quad R_{2} \quad 1; 1,1; \\
Y \quad \Gamma \chi \quad R_{4} \quad 1; 1,1; \\
T \quad \Gamma \chi \quad R_{2} \quad 1; 1,1; \\
T \quad \Gamma \chi \quad R_{4} \quad 1; 1,1; \\
W \quad \Gamma \chi \quad R_{2} \quad 1; 1,1; \\
W \quad \Gamma \chi \quad R_{4} \quad 1; 1,1; \\
\end{array}
\]
\[ \Gamma \; (000); \quad C_{4\iota}, C_2, T; \quad R_i; \quad 1, 1, 1; \]
\[ R_2; \quad 1, 1, -1, 1; \]
\[ R_3; \quad 1, -1, 1, 1; \]
\[ R_4; \quad 1, -1, -1, 1; \]
\[ R_5; \quad 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{C-2 WP}; \quad 2 \]
\[ M; \; (\frac{1}{2} 0 0); \quad C_{4\iota}, C_2, T; \quad R_i; \quad 1, 1, 1, 1; \]
\[ R_2; \quad 1, 1, -1, 1; \]
\[ R_3; \quad 1, -1, 1, 1; \]
\[ R_4; \quad 1, -1, -1, 1; \]
\[ R_5; \quad 2, \sigma_2, \sigma_3, -\sigma_0; \quad \text{C-2 WP}; \quad 2 \]
\[ Z; \; (00 \frac{1}{2}); \quad C_{4\iota}, C_2, T; \quad R_6; \quad 2, \frac{\frac{\sigma+\sigma_0}{\sqrt{2}}, \sigma_3, -\sigma_0}{P-NS_ZAR}; \]
\[ R_7; \quad 2, \frac{\frac{\sigma-\sigma_0}{\sqrt{2}}, \sigma_3, -\sigma_0}{P-NS_ZAR}; \]
\[ A; \; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad C_{4\iota}, C_2, T; \quad R_6; \quad 2, \frac{\frac{\sigma+\sigma_0}{\sqrt{2}}, \sigma_3, -\sigma_0}{P-NS_ZAR}; \]
\[ R_7; \quad 2, \frac{\frac{\sigma-\sigma_0}{\sqrt{2}}, \sigma_3, -\sigma_0}{P-NS_ZAR}; \]
\[ R; \; (0 \frac{1}{2} \frac{1}{2}); \quad C_2, C_2, T; \quad R_5; \quad 2, \sigma_2, \sigma_3, -\sigma_0; \quad \text{P-NS_ZAR}; \]
\[ X; \; (0 \frac{1}{2} 0); \quad C_2, C_2, C_2; \quad R_i; \quad 1, 1, 1, 1; \]
\[ R_2; \quad 1, 1, -1, 1; \]
\[ R_3; \quad 1, -1, 1, 1; \]
\[ R_4; \quad 1, -1, -1, 1; \]
\[ \Delta; \; \Gamma X; \quad C_2, T C_2; \quad R_i; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ U; \; Z R; \quad C_2, T C_2; \quad \{ R_2, R_4 \}; \quad 2, \sigma_3, -i\sigma_2; \quad \text{L-NS_ZAR}; \]
\[ \Lambda; \; \Gamma Z; \quad C_{4\iota}, C_2; \quad R_i; \quad 1, 1, 1; \]
\[ R_2; \quad 1, i, i; \]
\[ R_3; \quad 1, -1, 1; \]
\[ R_4; \quad 1, -i, 1; \]
\[ V; \; MA; \quad C_{4\iota}, C_2; \quad R_i; \quad 1, 1, 1; \]
\[ R_2; \quad 1, i, 1; \]
\[ R_3; \quad 1, -1, 1; \]
\[ R_4; \quad 1, -i, 1; \]
\[ \Sigma; \; \Gamma M; \quad C_2, C_2; \quad R_i; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ S; \; Z A; \quad C_2, C_2; \quad \{ R_4, R_8 \}; \quad 2, \sigma_3, \sigma_1; \quad \text{L-NS_ZAR}; \]
\[ Y; \; XM; \quad C_2, T C_2; \quad R_i; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ T; \; RA; \quad C_2, T C_2; \quad \{ R_1, R_2 \}; \quad 2, \sigma_3, \sigma_1; \quad \text{L-NS_ZAR}; \]
\[ W; \; XR; \quad C_2, T C_2; \quad R_i; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\( \Gamma_q; \{C_{4v}^+|00\frac{3}{2}\}, \{C_{2v}|\frac{1}{2}\frac{1}{2}\}; T; \text{Non-Centrosymmetric; without SOC} \)

| \( \Gamma \) | \( (000) \) | \( C_{4v}^+, C_{2v}, T \) |
|---|---|---|
| \( R_1 \) | 1, 1, 1 |
| \( R_2 \) | 1, 1, -1, 1 |
| \( R_3 \) | 1, -1, 1, 1 |
| \( R_4 \) | 1, -1, -1, 1 |
| \( R_5 \) | 2, \( i\sigma_2, \sigma_3, -\sigma_0 \); C-2 WP; 2 |

| \( M; (\frac{1}{2}\frac{1}{2}0) \) | \( C_{4v}^+, C_{2v}, C_{2h}, T \) |
|---|---|
| \( \{R_6, R_8\} \) | 2, \( i\sigma_3, \sigma_0, \sigma_1 \); P-NSS; |
| \( R_7 \) | 2, \( -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1 \); P-NSS; |
| \( R_9 \) | 2, \( \sigma_1, -\sigma_0, \sigma_3, -\sigma_0 \); P-NSS; |

| \( Z; (00\frac{1}{2}) \) | \( C_{4v}^+, C_{2v}, T \) |
|---|---|
| \( R_6 \) | 2, \( \frac{\alpha + \sqrt{3}}{\sqrt{2}}, \sigma_3, -\sigma_0 \); P-NSS; |
| \( R_7 \) | 2, \( -\frac{\alpha - i\sigma_2}{\sqrt{2}}, \sigma_3, -\sigma_0 \); P-NSS; |

| \( A; (\frac{1}{2}\frac{1}{2}\frac{1}{2}) \) | \( C_{4v}^+, C_{2v}, T \) |
|---|---|
| \( \{R_6, R_7\} \) | 4, \( \Gamma_{0.4}^{\frac{1}{2}}, \Gamma_{0.3}^{\frac{1}{2}}, \Gamma_{1.0}^{\frac{1}{2}}, \Gamma_{1.0}^{\frac{1}{2}} \); C-2 DP; 2 |

| \( R; (0\frac{1}{2}\frac{1}{2}) \) | \( C_{2v}, C_{2h}, T \) |
|---|---|
| \( \{R_2, R_4\} \) | 2, \( i\sigma_3, \sigma_0, \sigma_1 \); P-NSS; |
| \( R_6 \) | 2, \( i\sigma_3, -\sigma_0, \sigma_1 \); P-NSS; |

| \( X; (0\frac{1}{2}0) \) | \( C_{2v}, C_{2h}, T \) |
|---|---|
| \( R_5 \) | 2, \( i\sigma_2, \sigma_3, -\sigma_0 \); P-NSS; |

| \( \Delta; \Gamma_X \) | \( C_{2v}, T \) |
|---|---|
| \( R_1 \) | 1, 1, 1 |
| \( R_2 \) | 1, -1, 1 |

| \( U; ZR \) | \( C_{2v}, T \) |
|---|---|
| \( \{R_2, R_4\} \) | 2, \( \sigma_3, -i\sigma_2 \); L-NSS; |

| \( \Lambda; \Gamma_Z \) | \( C_{4v}^+, C_{2v}, T \) |
|---|---|
| \( R_1 \) | 1, 1, 1 |
| \( R_2 \) | 1, i, 1 |
| \( R_3 \) | 1, -1, 1 |
| \( R_4 \) | 1, -i, 1 |

| \( V; MA \) | \( C_{4v}^+, C_{2v}, T \) |
|---|---|
| \( \{R_1, R_3\} \) | 2, \( \sigma_3, \sigma_1 \); L-NSS; |
| \( \{R_2, R_4\} \) | 2, \( i\sigma_3, \sigma_1 \); L-NSS; |

| \( \Sigma; \Gamma_M \) | \( C_{2v}, C_{2h}, T \) |
|---|---|
| \( R_1 \) | 1, 1, 1 |
| \( R_2 \) | 1, -1, 1 |

| \( S; ZA \) | \( C_{2v}, C_{2h}, T \) |
|---|---|
| \( \{R_4, R_8\} \) | 2, \( \sigma_3, \sigma_1 \); L-NSS; |

| \( Y; XM \) | \( C_{2v}, T \) |
|---|---|
| \( \{R_2, R_4\} \) | 2, \( \sigma_3, -i\sigma_2 \); L-NSS; |

| \( T; RA \) | \( C_{2v}, T \) |
|---|---|
| \( \{R_2, R_4\} \) | 2, \( \sigma_0, -i\sigma_2 \); L-NSS; |

| \( W; XR \) | \( C_{2v}, T \) |
|---|---|
| \( \{R_1, R_3\} \) | 2, \( \sigma_3, -i\sigma_2 \); L-NSS; |
$\Gamma_v^0; \{C_{4v}^{+}[000], \langle C_2 \rangle[000], T\};$ Non-Centrosymmetric; without SOC

| Point | Group | $\Gamma$ | $\{C_4^+\}$, $\langle C_2 \rangle$, $T$; | $R_1$ | $R_2$ | $R_3$ | $R_4$ | $R_5$ |
|-------|-------|----------|--------------------------|-------|-------|-------|-------|-------|
| $\Gamma$ | (000) | $C_{4v}^+$, $C_2$, $T$; | | 1; 1, 1; | 1; 1, -1, 1; | 1; -1, 1, 1; | 1; -1, -1, 1; | 2; $i\sigma_2, \sigma_3, -\sigma_0$; C-2 WP; 2 |
| $N$ | $(0\frac{1}{2}0)$ | $C_{2y}, T$; | | 1; 1, 1; | 1; -1, 1; |
| $X$ | $(00\frac{1}{2})$ | $C_{2z}, C_{20}, T$; | | 1; 1, 1, 1; | 1; 1, -1, 1; | 1; -1, 1, 1; | 1; -1, -1, 1; |
| $Z$ | $(\frac{1}{2}\frac{1}{2}\frac{1}{2})$ | $C_{4y}^+$, $C_{2z}, T$; | | 1; 1, 1, 1; | 1; 1, -1, 1; | 1; -1, 1, 1; | 1; -1, -1, 1; | 2; $i\sigma_2, \sigma_3, -\sigma_0$; C-2 WP; 2 |
| $P$ | $(\frac{1}{2}\frac{1}{2}\frac{1}{2})$ | $C_{2z}, C_{2y}, C_{20} T$; | | 1; 1, 1, 1; | 1; 1, -1, 1; | 1; -1, 1, 1; | 1; -1, -1, 1; | 2; $-\sigma_0, \sigma_3, \sigma_1$; C-2 WP; 2 |
| $\Lambda$ | $\Gamma \Lambda / \Gamma Z$ | $C_{4y}^+$, $C_{20} T$; | | 1; 1, 1; | 1; $i$, 1; | 1; -1, 1; | 1; -$i$, 1; |
| $V$ | $ZV$ | $C_{4y}^+$, $C_{20} T$; | | 1; 1, 1; | 1; $i$, 1; | 1; -1, 1; | 1; -$i$, 1; |
| $W$ | $XP$ | $C_{2z}, C_{20} T$; | | 1; 1, 1; | 1; -1, 1; |
| $\Sigma$ | $\Gamma Z / \Gamma \Sigma$ | $C_{2z}, TC_{2y}$; | | 1; 1, 1; | 1; -1, 1; |
| $F$ | $ZF$ | $C_{2z}, TC_{2y}$; | | 1; 1, 1; | 1; -1, 1; |
| $Q$ | $NP$ | $C_{2y}$; | | 1; 1; | 1; -1; |
| $\Delta$ | $\Gamma X$ | $C_{2a}, C_{2b} T$; | | 1; 1, 1; | 1; -1, 1; |
| $U$ | $ZU$ | $C_{2a}, C_{2b} T$; | | 1; 1, 1; | 1; -1, 1; |
| $Y$ | $XZ / XY$ | $C_{2z}, TC_{2z}$; | | 1; 1, 1; | 1; -1, 1; |
\[ \Gamma_v: \{ C_{4v}^{-1}\frac{\sqrt{3}}{2} \}, \{ C_{2z} | 0 \frac{\sqrt{3}}{2} \}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

| Point | Symmetry | \( C_{4v} \), \( C_{2z}, \mathcal{T} \) |
|-------|----------|----------------------------------|
| \( \Gamma \): (000) | \( R_1 \): 1; 1,1,1; \( R_2 \): 1; 1,1,1; \( R_3 \): 1; 1,1,1; \( R_4 \): 1; 1,1,1; \( R_5 \): 2; \( i\sigma_2, \sigma_3, -\sigma_0 \); C-2 WP; 2 |
| \( N \): (0\( \frac{1}{2} \)) | \( R_1 \): 1; 1,1; \( R_2 \): 1; -1,1; |
| \( X \): (00\( \frac{1}{2} \)) | \( R_1 \): 1; 1,1,1; \( R_2 \): 1; 1,1,1; \( R_3 \): 1; 1,1,1; \( R_4 \): 1; 1,1,1; |
| \( Z \): (\( \frac{1}{2} \frac{1}{2} \)) | \( R_1 \): 1; 1,1,1; \( R_2 \): 1; 1,1,1; \( R_3 \): 1; 1,1,1; \( R_4 \): 1; 1,1,1; \( R_5 \): 2; \( i\sigma_2, \sigma_3, -\sigma_0 \); C-2 WP; 2 |
| \( P \): (\( \frac{1}{2} \frac{1}{2} \)) | \( E, C_{2z}, C_{2y}, C_{2b}\mathcal{T}; \) \( R_{10} \): 2; \( -i\sigma_0, \sigma_1, \sigma_3, \frac{\sigma_s \pm \sigma_2}{\sqrt{2}} \); C-1 WP; 1 |
| \( \Lambda \): \( \Gamma \Lambda/\Gamma Z \) | \( C_{4v}^{-1}, C_{2b}\mathcal{T} \) |
| \( V \): \( ZV \) | \( C_{4v}^-, E, C_{2b}\mathcal{T} \) |
| \( W \): \( XP \) | \( C_{2z}, C_{2b}\mathcal{T} \) |
| \( \Sigma \): \( \Gamma Z/\Gamma \Sigma \) | \( C_{2z}, \mathcal{T} C_{2y} \) |
| \( F \): \( ZF \) | \( C_{2z}, \mathcal{T} C_{2y} \) |
| \( Q \): \( NP \) | \( C_{2y} \) |
| \( \Delta \): \( \Gamma X \) | \( C_{2a}, C_{2b}\mathcal{T} \) |
| \( U \): \( ZU \) | \( C_{2a}, C_{2b}\mathcal{T} \) |
| \( Y \): \( XZ/XY \) | \( C_{2b}, \mathcal{T} C_{2z} \) |
\[ \Gamma_q; \{ C_{4z}^{+}\{000\}, \sigma_y\{000\}, T \}; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (000); C_{4z}^{+}, \sigma_y, T; R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{\Gamma^Z}; \]

\[ M; (1210); C_{4z}^{+}, \sigma_y, T; R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{MA}; \]

\[ Z; (00 \frac{1}{2}); C_{4z}^{+}, \sigma_y, T; R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{\Gamma^Z}; \]

\[ A; (12 \frac{1}{2}); C_{4z}^{+}, \sigma_y, T; R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{MA}; \]

\[ R; (01 \frac{1}{2}); C_{2x}, \sigma_y, T; R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ X; (0 \frac{1}{2}0); C_{2x}, \sigma_y, T; R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ \Delta; \Gamma X; \sigma_x, TC_{2z}; R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]

\[ U; \text{ZR}; \sigma_x, TC_{2z}; R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]

\[ \Lambda; \Gamma Z; C_{4z}^{+}, \sigma_y; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, -1; \]
\[ R_5; 2, i\sigma_2, \sigma_3; \text{QLN}; 0 \]

\[ V; \text{MA}; C_{4z}^{+}, \sigma_y; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, -1; \]
\[ R_5; 2, i\sigma_2, \sigma_3; \text{QLN}; 0 \]

\[ \Sigma; \Gamma M; \sigma_{db}, TC_{do}; R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
S; ZA; $\sigma_{db}, T \sigma_{da}$; $R_1$; 1; 1; 1;
$R_2$; 1; −1, 1;

Y; XM; $\sigma_y, T \sigma_x$; $R_1$; 1; 1; 1;
$R_2$; 1; −1, 1;

T; RA; $\sigma_y, T \sigma_x$; $R_1$; 1; 1; 1;
$R_2$; 1; −1, 1;

W; XR; $C_{2z}, \sigma_y$; $R_1$; 1; 1; 1;
$R_2$; 1; 1, −1;
$R_3$; 1; −1, 1;
$R_4$; 1; −1, −1;
\[\Gamma; (000); C^+_{4s}\sigma_y; T; R_1; 1, 1, 1;\]
\[R_2; 1, 1, -1, 1;\]
\[R_3; 1, -1, 1, 1;\]
\[R_4; 1, -1, 1, 1;\]
\[R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; P-QNL_\Gamma Z;\]
\[M; (1 \frac{1}{2} 0); C^+_{4s}, C_{2s}, \sigma_{db}; T; \{R_5, R_6\}; 2, i\sigma_3, \sigma_0, \sigma_1; P-WNLs;\]
\[\{R_7, R_8\}; 2, -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; P-WNLs;\]
\[R_9; 2, \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; P-WNLs;\]
\[Z; (00 \frac{1}{2}); C^+_{4s}\sigma_y; T; \]
\[R_1; 1, 1, 1;\]
\[R_2; 1, 1, -1, 1;\]
\[R_3; 1, -1, 1, 1;\]
\[R_4; 1, -1, 1, 1;\]
\[R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; P-QNL_\Gamma Z;\]
\[A; (1 \frac{1}{2} \frac{1}{2}); C^+_{4s}, C_{2s}, \sigma_{db}; T; \{R_5, R_6\}; 2, i\sigma_3, \sigma_0, \sigma_1; P-WNLs;\]
\[\{R_7, R_8\}; 2, -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; P-WNLs;\]
\[R_9; 2, \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; P-WNLs;\]
\[\Delta; \Gamma X; \sigma_x, TC_{2s}; \]
\[R_1; 1, 1, 1;\]
\[R_2; 1, -1, 1;\]
\[U; ZR; \sigma_x, TC_{2s}; \]
\[R_1; 1, 1, 1;\]
\[R_2; 1, -1, 1;\]
\[\Lambda; \Gamma Z; C^+_{4s}\sigma_y; \]
\[R_1; 1, 1, 1;\]
\[R_2; 1, -1, 1;\]
\[R_3; 1, -1, 1;\]
\[R_4; 1, -1, 1;\]
\[R_5; 2, i\sigma_2, \sigma_3; QNL; 0;\]
\[V; MA; C^+_{4s}, C_{2s}, \sigma_{db}; \]
\[R_5; 1, i, -1, -1;\]
\[R_6; 1, -i, -1, -1;\]
\[R_7; 1, -i, -1, 1;\]
\[R_8; 1, i, -1, 1;\]
\[R_9; 2, \sigma_1, \sigma_0, -\sigma_3; QNL; 0;\]
\[\Sigma; \Gamma M; \sigma_{db}, T\sigma_{da}; \]
\[R_1; 1, 1, 1;\]
\[R_2; 1, -1, 1;\]
\[S; ZA; \sigma_{db}, T\sigma_{da}; \]
\[R_1; 1, 1, 1;\]
\[R_2; 1, -1, 1;\]
\[Y; XM; \sigma_y, T\sigma_z; \{R_2, R_4\}; 2, \sigma_3, -i\sigma_2; WNL; \pi;\]
\[T; RA; \sigma_y, T\sigma_z; \{R_2, R_4\}; 2, \sigma_3, -i\sigma_2; WNL; \pi;\]
\[W; XR; \sigma_y, C_{2s}; \]
\[R_5; 2, \sigma_2, \sigma_3; WNL; \pi;\]
### SG 101

Γ; \{C_4^+; |00\frac{1}{2}\}; \{\sigma_y; |00\frac{1}{2}\}; \mathcal{T}; Non-Centrosymmetric; without SOC

| \Gamma; (000); C_4^+; \sigma_y; \mathcal{T}; | R_1; 1; 1,1,1; | R_2; 1; 1,-1,1; | R_3; 1; -1,1,1; | R_4; 1; -1,-1,1; | R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; P-QNL_{\frac{1}{2}Z}; |
| M; (\frac{1}{2} \frac{1}{2} 0); C_4^+; \sigma_y; \mathcal{T}; | R_1; 1; 1,1,1; | R_2; 1; 1,-1,1; | R_3; 1; -1,1,1; | R_4; 1; -1,-1,1; | R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; P-QNL_{MA}; |
| Z; (00\frac{1}{2}); C_{4z}; C_{2z}; \sigma_{db}, \mathcal{T}; \{R_5, R_6\}; | R_5; 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; P-WNLs; | R_6; 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; P-WNLs; |
| A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{4z}; C_{2z}; \sigma_{db}, \mathcal{T}; \{R_5, R_6\}; | R_5; 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; P-WNLs; | R_6; 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; P-WNLs; |
| R; (0 \frac{1}{2} 0); \sigma_z; C_{2z}; \mathcal{T}; \{R_2, R_4\}; | R_2; 2; i\sigma_3, \sigma_0, \sigma_1; P-WNLs; | R_4; 2; i\sigma_3, -\sigma_0, \sigma_1; P-WNLs; |
| X; (0 \frac{1}{2} 0); C_{2z}; \sigma_y; \mathcal{T}; | R_1; 1; 1,1,1; | R_2; 1; 1,-1,1; | R_3; 1; -1,1,1; | R_4; 1; -1,-1,1; |
| \Delta; \Gamma X; \sigma_z; TC_{2z}; | R_1; 1; 1,1; | R_2; 1; -1,1; |
| U; ZR; \sigma_z; TC_{2z}; | \{R_1, R_2\}; 2; -i\sigma_3, \sigma_1; WNL; \pi |
| \Lambda; \Gamma Z; C_{4z}; \sigma_y; | R_1; 1; 1,1; | R_2; 1; 1,-1; | R_3; 1; -1,1; | R_4; 1; -1,-1; | R_5; 2; i\sigma_2, \sigma_3; QNL; 0 |
| V; MA; C_{4z}; \sigma_y; | R_1; 1; 1,1; | R_2; 1; 1,-1; | R_3; 1; -1,1; | R_4; 1; -1,-1; | R_5; 2; i\sigma_2, \sigma_3; QNL; 0 |
| \Sigma; \Gamma M; \sigma_{db}, \mathcal{T}; \sigma_{da}; | R_1; 1; 1,1; | R_2; 1; -1,1; |
| S; ZA; \sigma_{db}, \mathcal{T}; \sigma_{da}; | R_1; 1; 1,1; | R_2; 1; -1,1; |
| Y; XM; \sigma_y; \mathcal{T}; \sigma_z; | R_1; 1; 1,1; | R_2; 1; -1,1; |
\[T; \ RA; \sigma_y, T \sigma_x; \{R_1, R_2\}; 2; -i\sigma_3, -i\sigma_2; \text{WNL}; \pi \]

\[W; \ XR; \ C_{2z}, \sigma_y; \begin{array}{c} R_1; 1, 1, 1; \\
R_2; 1, 1, -1; \\
R_3; 1, -1, 1; \\
R_4; 1, -1, -1; \end{array} \]
\[ \Gamma_q; \{ C_{4z}^+ \{00\} \}, \{ \sigma_y \{ \frac{1}{2} \frac{1}{2} \} \}, T; \text{Non-Centrosymmetric; without SOC} \]

| \( \Gamma \) | \( \Lambda \) | \( \Sigma \) | \( V \) | \( S \) | \( Y \) | \( T \) | \( W \) |
|---|---|---|---|---|---|---|---|
| \( \Gamma \); (000); \( C_{4z}^+, \sigma_y, T \); | \( R_1 \); 1, 1, 1; | \( R_2 \); 1, 1, 1; | \( R_3 \); 1, 1, 1; | \( R_4 \); 1, 1, 1; | \( R_5 \); \( i\sigma_2, \sigma_3, -\sigma_0 \); P-QNL; \( Z \); | \( R_6 \); 1, 1, 1; | \( R_7 \); 1, 1, 1; |
| \( M \); \( \{ \frac{1}{2} \frac{1}{2} \} \); \( C_{4z}^+, C_{2z}, \sigma_{db}, T \); \( \{ R_5, R_6 \} \); | \( R_8 \); \( i\sigma_2, \sigma_3, -\sigma_0, \sigma_1 \); P-WNLs; | \( R_9 \); \( \sigma_1, -\sigma_0, \sigma_3, -\sigma_0 \); P-WNLs; |
| \( Z \); \( \{ \frac{1}{2} \frac{1}{2} \} \); \( C_{4z}^+, C_{2z}, \sigma_{db}, T \); \( \{ R_5, R_6 \} \); | \( R_7 \); \( i\sigma_2, \sigma_3, -\sigma_0, \sigma_1 \); P-WNLs; | \( R_8 \); \( \sigma_1, -\sigma_0, \sigma_3, -\sigma_0 \); P-WNLs; |
| \( A \); \( \{ \frac{1}{2} \frac{1}{2} \} \); \( C_{4z}^+, \sigma_{db}, T \); | \( R_1 \); 1, 1, 1; | \( R_2 \); 1, 1, 1; | \( R_3 \); 1, 1, 1; | \( R_4 \); 1, 1, 1; | \( R_5 \); \( i\sigma_2, \sigma_3 \); QNL; 0 |
| \( R \); \( \{ \frac{1}{2} \frac{1}{2} \} \); \( \sigma_y, C_{2z}, T \); | \( R_5 \); \( i\sigma_2, \sigma_3 \); QNL; 0 | | | | |
| \( X \); \( \{ 0 \frac{1}{2} \} \); \( \sigma_x, C_{2z}, T \); | \( R_5 \); \( i\sigma_2, \sigma_3 \); QNL; 0 |
| \( \Delta \); \( \Gamma \chi \); \( \sigma_x, T C_{2z} \); | \( R_1 \); 1, 1; | \( R_2 \); 1, 1; | | | |
| \( U \); \( ZR \); \( \sigma_x, T C_{2z} \); \( \{ R_1, R_2 \} \); | \( R_5 \); \( i\sigma_3, \sigma_1 \); WNL; | | |
| \( \Lambda \); \( \Gamma \chi \); \( C_{4z}^+, \sigma_y \); | \( R_1 \); 1, 1; | \( R_2 \); 1, 1; | \( R_3 \); 1, 1; | \( R_4 \); 1, 1; | | |
| \( \Sigma \); \( \Gamma \chi \); \( \sigma_{db}, T \sigma_{da} \); | \( R_1 \); 1, 1; | \( R_2 \); 1, 1; | | | | |
| \( V \); \( \Gamma \chi \); \( \sigma_{da}, T \sigma_{da} \); | \( R_5 \); \( i, -1, -1 \); | \( R_6 \); \( -i, -1, -1 \); | \( R_7 \); \( i, -1, -1 \); | \( R_8 \); \( i, -1, 1 \); | | |
| \( S \); \( \Gamma \chi \); \( \sigma_{db}, T \sigma_{da} \); | \( R_1 \); 1, 1; | \( R_2 \); 1, 1; | | | | |
| \( Y \); \( \Gamma \chi \); \( \sigma_y, T \sigma_z \); \( \{ R_2, R_4 \} \); | \( R_3 \); \( \sigma_3, -i\sigma_2 \); WNL; | | | | |
| \( T \); \( \Gamma \chi \); \( \sigma_y, T \sigma_z \); | \( R_2 \); \( i, -1 \); | | | | |
| \( W \); \( \Gamma \chi \); \( \sigma_y, C_{2z} \); | \( R_5 \); 2, \( \sigma_2, \sigma_1 \); WNL; | | | | |
\[\Gamma_q \{C_{4v}^+|000\}, \{\sigma_y|00\}_y, T; \text{Non-Centrosymmetric; without SOC}\]

\[
\begin{array}{ll}
\Gamma; (000): & C_{4v}^+; \sigma_y, T; R_1: 1; 1, 1, 1; \\
& R_2: 1; 1, -1, 1; \\
& R_3: 1; 1, 1, 1; \\
& R_4: 1; -1, -1, 1; \\
& R_5: 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{\Gamma Z}; \\
\end{array}
\]

\[
\begin{array}{ll}
M; (\frac{1}{2} \frac{1}{2} 0): & C_{4v}^+; \sigma_y, T; R_1: 1; 1, 1, 1; \\
& R_2: 1; 1, -1, 1; \\
& R_3: 1; -1, -1, 1; \\
& R_4: 1; 1, -1, 1; \\
& R_5: 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{MA}; \\
\end{array}
\]

\[
\begin{array}{ll}
Z; (00 \frac{1}{2}): & C_{4v}^+; \sigma_y, T; \{R_0, R_6\}: 2; -\sigma_0, i\sigma_3, \sigma_1; \text{P-WNLs}; \\
& \{R_2, R_8\}: 2; \sigma_0, -i\sigma_3, \sigma_1; \text{P-WNLs}; \\
& \{R_{10}, R_{10}\}: 4; i\Gamma_{0,3}, i\Gamma_{0,2}, -\Gamma_{2,2}; \text{DP}; \\
\end{array}
\]

\[
\begin{array}{ll}
A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}): & C_{4v}^+; \sigma_y, T; \{R_0, R_6\}: 2; -\sigma_0, i\sigma_3, \sigma_1; \text{P-WNLs}; \\
& \{R_2, R_8\}: 2; \sigma_0, -i\sigma_3, \sigma_1; \text{P-WNLs}; \\
& \{R_{10}, R_{10}\}: 4; i\Gamma_{0,3}, i\Gamma_{0,2}, -\Gamma_{2,2}; \text{DP}; \\
\end{array}
\]

\[
\begin{array}{ll}
R; (0 \frac{1}{2} \frac{1}{2}): & \sigma_y; C_{2v}, T; \{R_2, R_4\}: 2; i\sigma_3, \sigma_0, \sigma_1; \text{P-WNLs}; \\
& \{R_0, R_8\}: 2; i\sigma_3, -\sigma_0, \sigma_1; \text{P-WNLs}; \\
\end{array}
\]

\[
\begin{array}{ll}
X; (0 \frac{1}{2} 0): & C_{2v}, \sigma_y, T; R_1: 1; 1, 1, 1; \\
& R_2: 1; 1, -1, 1; \\
& R_3: 1; -1, -1, 1; \\
& R_4: 1; -1, 1, 1; \\
\end{array}
\]

\[
\begin{array}{ll}
\Delta; \Gamma X: & \sigma_y, T C_{2v}; R_1: 1; 1, 1; \\
& R_2: 1; -1, 1; \\
\end{array}
\]

\[
\begin{array}{ll}
U; ZR: & \sigma_y, T C_{2v}; \{R_1, R_2\}: 2; -i\sigma_3, \sigma_1; \text{WNL}; \\
\end{array}
\]

\[
\begin{array}{ll}
\Lambda; \Gamma Z: & C_{4v}^+; \sigma_y; R_1: 1; 1, 1; \\
& R_2: 1; 1, -1; \\
& R_3: 1; -1, 1; \\
& R_4: 1; -1, -1; \\
& R_5: 2; i\sigma_2, \sigma_3; \text{QNL}; \\
\end{array}
\]

\[
\begin{array}{ll}
V; MA: & C_{4v}^+; \sigma_y; R_1: 1; 1, 1; \\
& R_2: 1; 1, -1; \\
& R_3: 1; -1, 1; \\
& R_4: 1; -1, -1; \\
& R_5: 2; i\sigma_2, \sigma_3; \text{QNL}; \\
\end{array}
\]

\[
\begin{array}{ll}
\Sigma; \Gamma M: & \sigma_{db}, T \sigma_{da}; R_1: 1; 1, 1; \\
& R_2: 1; -1, 1; \\
\end{array}
\]

\[
\begin{array}{ll}
S; ZA: & \sigma_{db}, T \sigma_{da}; \{R_1, R_2\}: 2; -i\sigma_3, -i\sigma_2; \text{WNL}; \\
\end{array}
\]

\[
\begin{array}{ll}
Y; XM: & \sigma_y, T \sigma_x; R_1: 1; 1, 1; \\
& R_2: 1; -1, 1; \\
\end{array}
\]

\[
\begin{array}{ll}
T; RA: & \sigma_y, T \sigma_x; \{R_1, R_2\}: 2; -i\sigma_3, -i\sigma_2; \text{WNL}; \\
\end{array}
\]

\[
\begin{array}{ll}
W; XR: & C_{2v}, \sigma_y; R_1: 1; 1, 1; \\
& R_2: 1; 1, -1; \\
& R_3: 1; -1, 1; \\
& R_4: 1; -1, -1; \\
\end{array}
\]
\( \Gamma \); \{C_4^+ \{000\}, \{\sigma_y \{001\}\}\}; Non-Centrosymmetric; without SOC

\( \Gamma \); (000); \( C_4^+ \sigma_y, T \):

- \( R_1 \): 1, 1, 1;
- \( R_2 \): 1, -1, 1;
- \( R_3 \): 1, -1, 1;
- \( R_4 \): 1, -1, 1;
- \( R_5 \): 2, \( i\sigma_2, \sigma_3, -\sigma_0 \);
- P-QNL; Z;

\( M \); (1110); \( C_4^+ C_2, \sigma_{db}, T \):

- \( \{R_5, R_6\} \): 2, \( i\sigma_3, \sigma_0, \sigma_0, \sigma_1 \);
- P-WNLs;
- \{R_7, R_8\}:
  - 2, \(-i\sigma_3, \sigma_0, -\sigma_0, \sigma_1 \);
  - P-WNLs;
- \( R_9 \):
  - 2, \( \sigma_1, -\sigma_0, \sigma_3, -\sigma_0 \);
  - P-WNLs;

\( Z \); (001/2);

- \( \{R_5, R_6\} \): 2, \(-\sigma_0, i\sigma_3, \sigma_1 \);
- P-WNLs;
- \{R_7, R_8\}:
  - 2, \( \sigma_0, -i\sigma_3, \sigma_1 \);
  - P-WNLs;
- \{R_{10}, R_{10}\}:
  - 4, \( i\Gamma_{0, 3}, i\Gamma_{0, 2}, -\Gamma_{2, 2} \);
  - DP; 0

\( A \); (111/2);

- \( \{R_5, R_6\} \): 2, \( i\sigma_3, \sigma_0, \sigma_0, \sigma_1 \);
- P-WNLs;
- \{R_7, R_8\}:
  - 2, \(-i\sigma_3, \sigma_0, -\sigma_0, \sigma_1 \);
  - P-WNLs;
- \( R_9 \):
  - 2, \( \sigma_1, -\sigma_0, \sigma_3, -\sigma_0 \);
  - P-WNLs;

\( R \); (011/2);

- \( \sigma_y, C_2, T \):
  - \( R_5 \):
    - 2, \( \sigma_2, \sigma_3, -\sigma_0 \);
    - P-WNLs;

\( X \); (011/2);

- \( \sigma_z, C_2, T \):
  - \( R_5 \):
    - 2, \( \sigma_3, -\sigma_0 \); P-WNLs;

\( \Delta \); \( \Gamma \chi; \sigma_z, T \); \( C_{2z} \):

- \( R_1 \):
  - 1, 1, 1;
- \( R_2 \):
  - 1, -1, 1;

\( U \); \( Z \gamma; \sigma_z, T, C_{2z} \):

- \( \{R_1, R_2\} \): 2, \(-i\sigma_3, \sigma_1 \);
- WNL; 0

\( \Lambda \); \( \Gamma \zeta; C_4^+ \sigma_y \):

- \( R_1 \):
  - 1, 1, 1;
- \( R_2 \):
  - 1, -1, 1;
- \( R_3 \):
  - 1, 1, 1;
- \( R_4 \):
  - 1, -1, 1;
- \( R_5 \):
  - 2, \( i\sigma_2, \sigma_3 \);
  - QNL; 0

\( V \); \( M \alpha; C_4^+ C_2, \sigma_{da} \):

- \( R_5 \):
  - 1, \(-i, -1, -1 \);
- \( R_6 \):
  - 1, \(-i, -1, -1 \);
- \( R_7 \):
  - 1, \(-i, -1, 1 \);
- \( R_8 \):
  - 1, \(-i, 1, 1 \);
- \( R_9 \):
  - 2, \( \sigma_1, \sigma_0, -\sigma_3 \);
  - QNL; 0

\( \Sigma \); \( \Gamma \mu; \sigma_{db}, T, \sigma_{da} \):

- \( R_1 \):
  - 1, 1, 1;
- \( R_2 \):
  - 1, -1, 1;

\( S \); \( Z \alpha; \sigma_{db}, T, \sigma_{da} \):

- \( \{R_1, R_2\} \): 2, \(-i\sigma_3, -i\sigma_2 \);
- WNL; 0

\( Y \); \( X \mu; \sigma_y, T, \sigma_z \):

- \( \{R_2, R_4\} \): 2, \( \sigma_3, -i\sigma_2 \);
- WNL; 0

\( T \); \( R \alpha; \sigma_y, T, \sigma_z \):

- \( R_2 \):
  - 1, -1, 1;
- \( R_4 \):
  - 1, 1, 1;

\( W \); \( X \rho; \sigma_y, C_2z \):

- \( R_5 \):
  - 2, \( \sigma_2, \sigma_3 \);
  - WNL; 0

(\(*)\)

\( \alpha \):

- \( \lambda \)
\( \Gamma; (000); C_{4v}^{+}, \sigma_y, T; \) 
\( R_1; 1, 1, 1; \)
\( R_2; 1, 1, 1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, 1, 1; \)
\( R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \) P-QLM; Z

\( M; (1\frac{1}{2}10); C_{4v}^{+}, \sigma_y, T; \) 
\( R_1; 1, 1, 1; \)
\( R_2; 1, 1, 1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, 1, 1; \)
\( R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \) P-QLM; A

\( \phi; (00\frac{1}{2}); C_{4v}, C_{2z}, \sigma_x, T; \) 
\( \{R_5, R_6\}; 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \) P-WNLs; 
\( \{R_7, R_8\}; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \) P-WNLs;

\( \phi; (1\frac{1}{2}1\frac{1}{2}); C_{4v}, C_{2z}, \sigma_x, T; \) 
\( \{R_5, R_6\}; 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \) P-WNLs; 
\( \{R_7, R_8\}; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \) P-WNLs;

\( \phi; (0\frac{1}{2}1); C_{2z}, \sigma_y, T; \) 
\( R_1; 1, 1, 1; \)
\( R_2; 1, 1, 1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, 1, 1; \)

\( X; (0\frac{1}{2}0); C_{2z}, \sigma_y, T; \) 
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, 1, 1; \)

\( \Delta; \phi; \sigma_x, \mathcal{T}C_{2z}; \) 
\( R_1; 1, 1; \)
\( R_2; 1, -1, 1; \)

\( \psi; \phi; \sigma_x, \mathcal{T}C_{2z}; \) 
\( R_1; 1, 1; \)
\( R_2; 1, -1, 1; \)

\( \Lambda; \phi; C_{4v}^{+}, \sigma_y; \) 
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, 1; \)
\( R_5; 2; i\sigma_2, \sigma_3; \) QNL; 0

\( V; \phi; C_{4v}^{+}, \sigma_y; \) 
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, 1; \)
\( R_5; 2; i\sigma_2, \sigma_3; \) QNL; 0

\( \Sigma; \phi; \sigma_{db}, \mathcal{T}\sigma_{da}; \) 
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)

\( S; \phi; \sigma_{db}, \mathcal{T}\sigma_{da}; \) 
\( \{R_1, R_2\}; 2; -i\sigma_3, -i\sigma_2; \) WNL; \( \pi \)

\( Y; \phi; \sigma_y, \mathcal{T}\sigma_z; \) 
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
$T$: RA, $\sigma_y, T \sigma_x$; $R_4$: 1, 1, 1; 
$R_2$: 1, -1, 1; 
$W$: XR, $C_2z, \sigma_y$; $R_4$: 1, 1, 1; 
$R_2$: 1, 1, -1; 
$R_3$: 1, -1, 1; 
$R_4$: 1, -1, -1;
\[
\begin{align*}
\Gamma &; (000); \quad C_{4x}^+, \sigma_y, T; \\
R_1 &; 1, 1, 1; \\
R_2 &; 1, -1, 1; \\
R_3 &; 1, -1, 1; \\
R_4 &; 1, -1, 1; \\
R_5 &; 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{T, 2}; \\
M &; (110); \quad C_{4x}^+, C_{2z}, \sigma_y, T; \\
\{R_5, R_6\} &; 2, i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNLs}; \\
\{R_7, R_8\} &; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-WNLs}; \\
R_9 &; 2, \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \\
Z &; (000); \quad C_{4x}^+, C_{2z}, \sigma_y, T; \\
\{R_5, R_6\} &; 2, i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNLs}; \\
\{R_7, R_8\} &; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-WNLs}; \\
R_9 &; 2, \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \\
A &; (11\frac{1}{2}); \quad C_{4x}^+, \sigma_y, T; \\
\{R_5, R_6\} &; 2, -\sigma_0, i\sigma_3, \sigma_1; \quad \text{P-WNLs}; \\
\{R_7, R_8\} &; 2, \sigma_0, -i\sigma_3, \sigma_1; \quad \text{P-WNLs}; \\
\{R_{10}, R_{10}\} &; 4, \Gamma_{0, 3}, \Gamma_{0, 2}, -\Gamma_{2, 2}; \quad \text{QDP}; \quad 0 \\
R &; (0\frac{1}{2}); \quad \sigma_z, C_{2z}, T; \\
R_5 &; 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \\
X &; (0\frac{1}{2}); \quad \sigma_z, C_{2z}, T; \\
R_5 &; 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \\
\Delta &; \Gamma X; \quad \sigma_z, TC_{2z}; \\
R_1 &; 1, 1, 1; \\
R_2 &; 1, -1, 1; \\
U &; \Gamma Z; \quad \sigma_z, TC_{2z}; \\
R_1 &; 1, 1, 1; \\
R_2 &; 1, -1, 1; \\
\Lambda &; \Delta Z; \quad C_{4z}^+, \sigma_y; \\
R_1 &; 1, 1, 1; \\
R_2 &; 1, -1, 1; \\
R_3 &; 1, -1, 1; \\
R_4 &; 1, -1, 1; \\
R_5 &; 2, i\sigma_2, \sigma_3; \quad \text{QNL}; \quad 0 \\
V &; M A; \quad C_{4z}^+, C_{2z}, \sigma_y, T; \\
R_5 &; 1, i, -1, -1; \\
R_6 &; -i, -1, -1; \\
R_7 &; -i, -1, -1; \\
R_8 &; 1, i, -1, 1; \\
R_9 &; 2, \sigma_1, \sigma_0, -\sigma_3; \quad \text{QNL}; \quad 0 \\
\Sigma &; \Gamma M; \quad \sigma_y, \sigma_0, \sigma_3, \sigma_1; \\
R_1 &; 1, 1, 1; \\
R_2 &; 1, -1, 1; \\
S &; Z A; \quad \sigma_y, \sigma_0, \sigma_3, \sigma_1; \\
\{R_1, R_2\} &; -i\sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \\
Y &; X M; \quad \sigma_y, \sigma_0, \sigma_3, \sigma_1; \\
\{R_1, R_4\} &; 2, \sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \\
T &; R A; \quad \sigma_y, \sigma_0, \sigma_3, \sigma_1; \\
\{R_2, R_4\} &; 2, \sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \\
W &; X R; \quad \sigma_y, \sigma_0, \sigma_3, \sigma_1; \\
R_5 &; 2, \sigma_2, \sigma_3; \quad \text{WNL}; \quad \pi
\end{align*}
\]
Γ: (000); \( C_{4z}^+; \sigma_y, T; \)
\begin{align*}
R_1: & \quad 1; 1,1,1; \\
R_2: & \quad 1; 1,-1,1; \\
R_3: & \quad 1; -1,1,1; \\
R_4: & \quad 1; -1,-1,1; \\
R_5: & \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{ P-QNL}_{PZ}; \\
\end{align*}

N: \((0\frac{1}{2}0)\); \( \sigma_y, T; \)
\begin{align*}
R_1: & \quad 1; 1,1; \\
R_2: & \quad 1; -1,1; \\
\end{align*}

X: \((00\frac{1}{2})\); \( C_{2z}, \sigma_{db}, T; \)
\begin{align*}
R_1: & \quad 1; 1,1,1; \\
R_2: & \quad 1; 1,-1,1; \\
R_3: & \quad 1; -1,1,1; \\
R_4: & \quad 1; -1,-1,1; \\
R_5: & \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \text{ P-QNL}_{PZ}; \\
\end{align*}

Z: \((\frac{1}{2}\frac{1}{2}\frac{1}{2})\); \( C_{4z}^+; \sigma_y, T; \)
\begin{align*}
R_1: & \quad 1; 1,1,1; \\
R_2: & \quad 1; 1,-1,1; \\
R_3: & \quad 1; -1,1,1; \\
R_4: & \quad 1; -1,-1,1; \\
R_5: & \quad 2; i\sigma_2, \sigma_3; \text{ QNL}; 0 \\
\end{align*}

P: \((\frac{1}{2}\frac{1}{2}\frac{1}{2})\); \( C_{2z}, \sigma_{db}, C_{4z}^+ T; \)
\begin{align*}
R_1: & \quad 1; 1,1,1; \\
R_2: & \quad 1; 1,-1,1; \\
\{R_3, R_4\}: & \quad 2; -\sigma_0, \sigma_3, -i\sigma_2; \text{ P-WNLs}; \\
\end{align*}

Λ: ΓΛ/ΓZ; \( C_{4z}^+; \sigma_y; \)
\begin{align*}
R_1: & \quad 1; 1,1; \\
R_2: & \quad 1; 1,-1; \\
R_3: & \quad 1; -1,1; \\
R_4: & \quad 1; -1,-1; \\
R_5: & \quad 2; i\sigma_2, \sigma_3; \text{ QNL}; 0 \\
\end{align*}

V: ZV; \( C_{4z}^+; \sigma_y; \)
\begin{align*}
R_1: & \quad 1; 1,1; \\
R_2: & \quad 1; 1,-1; \\
R_3: & \quad 1; -1,1; \\
R_4: & \quad 1; -1,-1; \\
R_5: & \quad 2; i\sigma_2, \sigma_3; \text{ QNL}; 0 \\
\end{align*}

W: XP; \( C_{2z}, \sigma_{db}; \)
\begin{align*}
R_1: & \quad 1; 1,1; \\
R_2: & \quad 1; 1,-1; \\
R_3: & \quad 1; -1,1; \\
R_4: & \quad 1; -1,-1; \\
\end{align*}

Σ: ΓZ/ΓΣ; \( \sigma_y, T\sigma_z; \)
\begin{align*}
R_1: & \quad 1; 1,1; \\
R_2: & \quad 1; -1,1; \\
\end{align*}

F: ZF; \( \sigma_y, T\sigma_z; \)
\begin{align*}
R_1: & \quad 1; 1,1; \\
R_2: & \quad 1; -1,1; \\
\end{align*}

Q: NP; \( E, T\sigma_y; \)
\begin{align*}
R_1: & \quad 1; 1,1; \\
\end{align*}

Δ: ΓX; \( \sigma_{db}, T\sigma_{da}; \)
\begin{align*}
R_1: & \quad 1; 1,1; \\
R_2: & \quad 1; -1,1; \\
\end{align*}

U: ZU; \( \sigma_{db}, T\sigma_{da}; \)
\begin{align*}
R_1: & \quad 1; 1,1; \\
R_2: & \quad 1; -1,1; \\
\end{align*}

Y: XZ/XY; \( \sigma_{da}, TC_{2z}; \)
\begin{align*}
R_1: & \quad 1; 1,1; \\
R_2: & \quad 1; -1,1; \\
\end{align*}
\[ \Gamma_{\mathcal{V}}^v; \{C_4^+_y[000], \sigma_y[\frac{1}{2}\frac{1}{2}0]\}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{array}{ll}
\Gamma; (000); C_4^+_y, \sigma_y, \mathcal{T}; & R_1; 1, 1, 1; \\
 & R_2; 1, 1, -1, 1; \\
 & R_3; 1, -1, 1, 1; \\
 & R_4; 1, -1, -1, 1; \\
 & R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{ P-QNL}_{\mathcal{V}Z}; \\
N; (0\frac{1}{2}0); \sigma_y, \mathcal{T}; & \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \text{ P-WNLs}; \\
X; (00\frac{1}{2}); C_{2z}, \sigma_{db}, \mathcal{T}; & R_1; 1, 1, 1; \\
 & R_2; 1, 1, -1, 1; \\
 & R_3; 1, -1, 1, 1; \\
 & R_4; 1, -1, -1, 1; \\
Z; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_4^+_z, \sigma_y, \mathcal{T}; & R_1; 1, 1, 1; \\
 & R_2; 1, 1, -1, 1; \\
 & R_3; 1, -1, 1, 1; \\
 & R_4; 1, -1, -1, 1; \\
 & R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{ P-QNL}_{\mathcal{V}Z}; \\
P; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \sigma_{db}, C_{2z}, C_4^+_z, \mathcal{T}; \{R_1, R_3\}; 2; \sigma_3, \sigma_0, \sigma_1; \text{ P-WNLs}; \\
 & \{R_2, R_4\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \text{ P-WNLs}; \\
 & \{R_4, R_1\}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \text{ P-WNLs}; \\
\Lambda; \Gamma\Lambda/\Gamma\Sigma; C_4^+_z, \sigma_y; & R_1; 1, 1, 1; \\
 & R_2; 1, 1, -1; \\
 & R_3; 1, -1, 1; \\
 & R_4; 1, -1, -1; \\
 & R_5; 2; i\sigma_2, \sigma_3; \text{ QNL}; 0 \\
V; \Sigma/\Gamma\Sigma; C_4^+_z, \sigma_y; & R_1; 1, 1, 1; \\
 & R_2; 1, 1, -1; \\
 & R_3; 1, -1, 1; \\
 & R_4; 1, -1, -1; \\
 & R_5; 2; i\sigma_2, \sigma_3; \text{ QNL}; 0 \\
W; \Gamma\Sigma/\Gamma\Sigma; C_2z, \sigma_{db}; & R_1; 1, 1, 1; \\
 & R_2; 1, 1, -1; \\
 & R_3; 1, -1, 1; \\
 & R_4; 1, -1, -1; \\
\Sigma; \Gamma\Sigma/\Gamma\Sigma; \sigma_y, \mathcal{T}\sigma_x; & R_1; 1, 1, 1; \\
 & R_2; 1, -1, 1; \\
\Phi; \Sigma/\Gamma\Sigma; \sigma_y, \mathcal{T}\sigma_x; & R_1; 1, -1, 1; \\
 & R_2; 1, 1, 1; \\
Q; \Gamma\Sigma/\Gamma\Sigma; E, \mathcal{T}\sigma_y; \{R_1, R_1\}; 2; \sigma_0, -i\sigma_2; \text{ WNL}; \pi \\
\Delta; \Gamma\Sigma/\Gamma\Sigma; \sigma_{db}, \mathcal{T}\sigma_{da}; & R_1; 1, 1, 1; \\
 & R_2; 1, -1, 1; \\
\Upsilon; \Sigma/\Gamma\Sigma; \sigma_{db}, \mathcal{T}\sigma_{da}; & R_1; 1, -1, 1; \\
 & R_2; 1, 1, 1; \\
\Psi; \Sigma/\Gamma\Sigma; \sigma_{da}, \mathcal{T}\sigma_{2z}; & R_1; 1, 1, 1; \\
 & R_2; 1, -1, 1; \\
\Upsilon; \Sigma/\Gamma\Sigma; \sigma_{da}, \mathcal{T}\sigma_{2z}; & R_1; 1, 1, 1; \\
 & R_2; 1, -1, 1; \\
\}
\( \Gamma_v; \{ C^+_{4z}, C_{2z}, \sigma_y, \mathcal{T} \}; \) Non-Centrosymmetric; without SOC

| \Gamma; (000); \( C^+_{4z}, \sigma_y, \mathcal{T} \) | \( R_1 \); | 1; 1, 1, 1; |
|---------|---------|---------|
|         | \( R_2 \); | 1; 1, -1, 1; |
|         | \( R_3 \); | 1; -1, 1, 1; |
|         | \( R_4 \); | 1; -1, -1, 1; |
|         | \( R_5 \); | 2; \( i\sigma_2, \sigma_3, -\sigma_0 \); |
| \( N; (0 \frac{1}{2} 0) \); \( \sigma_y, \mathcal{T} \) | \( R_1 \); | 1, 1, 1; |
|         | \( R_2 \); | 1, -1, 1; |
| \( X; (00 \frac{1}{2}) \); \( \sigma_{db}, C_{2z}, \mathcal{T} \) | \( R_5 \); | 2; \( i\sigma_2, \sigma_3, -\sigma_0 \); |
| \( Z; (\frac{1}{4} \frac{1}{4} \frac{1}{4}) \); \( C^+_{4z}, C_{2z}, \sigma_y, \mathcal{T} \); \{ \( R_5, R_6 \) \}; | 2; \( i\sigma_3, \sigma_0, \sigma_0, \sigma_1 \); |
|         | \{ \( R_7, R_8 \) \}; | 2; -\( i\sigma_3, \sigma_0, -\sigma_0, \sigma_1 \); |
|         | \( R_9 \); | 2; \( \sigma_1, -\sigma_0, \sigma_3, -\sigma_0 \); |
| \( P; (\frac{1}{4} \frac{1}{4} \frac{1}{4}) \); \( \sigma_{db}, C_{2z}, C^+_{4z}, \mathcal{T} \); \( R_{10} \); | 2; \( -1^{1/4} \sigma_3, \sigma_2, -\frac{\sigma_0+i\sigma_2}{2} \); |
| \( \Lambda; \Gamma A/\Gamma Z \); \( C^+_{4z}, \sigma_y \); | \( R_1 \); | 1, 1, 1; |
|         | \( R_2 \); | 1, 1, -1; |
|         | \( R_3 \); | 1, -1, 1; |
|         | \( R_4 \); | 1, -1, -1; |
|         | \( R_5 \); | 2; \( i\sigma_2, \sigma_3 \); |
| \( V; Z V \); \( C^+_{4z}, C_{2z}, \sigma_y \); | \( R_6 \); | 1; i, 1, 1; |
|         | \( R_7 \); | 1; -i, 1, 1; |
|         | \( R_8 \); | 1; -i, 1, -1; |
|         | \( R_9 \); | 1; i, 1, -1; |
|         | \( R_{10} \); | 2; \( \sigma_1, -\sigma_0, \sigma_3 \); |
| \( W; X P \); \( \sigma_{db}, C_{2z} \); | \( R_5 \); | 2; \( \sigma_2, \sigma_3 \); |
| \( \Sigma; \Gamma Z/\Gamma \Sigma \); \( \sigma_y, \mathcal{T} \sigma_z \); | \( R_1 \); | 1, 1, 1; |
|         | \( R_2 \); | 1, -1, 1; |
| \( F; Z F \); \( \sigma_y, \mathcal{T} \sigma_z \); | \( R_1 \); | 1, 1, 1; |
|         | \( R_2 \); | 1, -1, 1; |
| \( Q; N P \); \( E, \mathcal{T} \sigma_y \); | \( R_1 \); | 1, 1, 1; |
| \( \Delta; \Gamma X \); \( \sigma_{db}, \mathcal{T} \sigma_{da} \); | \( R_1 \); | 1, 1, 1; |
|         | \( R_2 \); | 1, -1, 1; |
| \( U; Z U \); \( \sigma_{db}, \mathcal{T} \sigma_{da} \); \{ \( R_1, R_2 \) \}; | 2; \( -i\sigma_3, -i\sigma_2 \); |
| \( Y; X Z / X Y \); \( \sigma_{da}, \mathcal{T} C_{2z} \); \{ \( R_2, R_4 \) \}; | 2; \( \sigma_3, \sigma_1 \); |

\( \pi \)
\[ \Gamma^v_1 \{ C^{+}_{41}, C^{+}_{42}, \sigma_y, T \}; \text{Non-Centrosymmetric; without SOC} \]

\begin{tabular}{|c|c|c|}
\hline
\( \Gamma \) & \( (000) \) & \( C^{+}_{41}, \sigma_y, T \) \\
\hline
\( R_1 \) & 1 & 1, 1, 1; \\
\( R_2 \) & 1 & 1, -1, 1; \\
\( R_3 \) & 1 & -1, 1, 1; \\
\( R_4 \) & 1 & -1, -1, 1; \\
\( R_5 \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( N \) & \( \{ 0 \frac{1}{4} 0 \} \) & \( \sigma_y, T \) \\
\hline
\( R_6 \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( X \) & \( \{ 0 \frac{1}{2} \} \) & \( \sigma_{20}, C_{20}, T \) \\
\hline
\( R_7 \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( Z \) & \( \{ 1 \frac{1}{2} \} \) & \( C^{+}_{42}, C_{21}, \sigma_y, T \) \\
\hline
\( R_8 \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( P \) & \( \{ 1 \frac{3}{4} \} \) & \( \sigma_{20}, C_{20}, C^{+}_{42}, T \) \\
\hline
\( R_9 \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( V \) & \( \{ 0 \frac{1}{4} \} \) & \( \sigma_y, T \) \\
\hline
\( R_{10} \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( W \) & \( \{ 0 \frac{1}{2} \} \) & \( \sigma_{20}, C_{20} \) \\
\hline
\( R_{11} \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( \Sigma \) & \( \{ 1 \frac{1}{4} \} \) & \( \sigma_y, T \) \\
\hline
\( R_{12} \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( F \) & \( \{ 1 \frac{3}{4} \} \) & \( \sigma_y, T \) \\
\hline
\( R_{13} \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( Q \) & \( \{ 0 \frac{1}{4} \} \) & \( E, T \sigma_y \) \\
\hline
\( R_{14} \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( \Delta \) & \( \{ 0 \frac{1}{2} \} \) & \( \sigma_{20}, T \sigma_{20} \) \\
\hline
\( R_{15} \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( U \) & \( \{ 0 \frac{1}{4} \} \) & \( \sigma_{20}, T \sigma_{20} \) \\
\hline
\( R_{16} \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\( Y \) & \( \{ 0 \frac{1}{2} \} \) & \( \sigma_{20}, T C_{20} \) \\
\hline
\( R_{17} \) & 2 & 0, \( \sigma_2, \sigma_3, -\sigma_0 \); \\
\hline
\end{tabular}
### SG 111

\( \Gamma \); \( \{ S_{4z}^+ \}_{000} \), \( \{ C_{2x} \}_{000} \), \( T \); Non-Centrosymmetric; without SOC

\[
\begin{array}{c|c|c}
\Gamma & (000); & S_{4z}^+, C_{2x}, T; \\
R_1 & 1; & 1,1,1; \\
R_2 & 1; & 1,−1,1; \\
R_3 & 1; & −1,1,1; \\
R_4 & 1; & −1,−1,1; \\
R_5 & 2; & i\sigma_2, \sigma_3, −\sigma_0; \quad \text{P-QNL}_{\Gamma Z}; \\
\end{array}
\]

\[
\begin{array}{c|c|c}
M & (\frac{1}{2} \frac{1}{2} 0); & S_{4z}^+, C_{2x}, T; \\
R_1 & 1; & 1,1,1; \\
R_2 & 1; & 1,−1,1; \\
R_3 & 1; & −1,1,1; \\
R_4 & 1; & −1,−1,1; \\
R_5 & 2; & i\sigma_2, \sigma_3, −\sigma_0; \quad \text{P-QNL}_{MA}; \\
\end{array}
\]

\[
\begin{array}{c|c|c}
Z & (00\frac{1}{2}); & S_{4z}^+, C_{2x}, T; \\
R_1 & 1; & 1,1,1; \\
R_2 & 1; & 1,−1,1; \\
R_3 & 1; & −1,1,1; \\
R_4 & 1; & −1,−1,1; \\
R_5 & 2; & i\sigma_2, \sigma_3, −\sigma_0; \quad \text{P-QNL}_{\Gamma Z}; \\
\end{array}
\]

\[
\begin{array}{c|c|c}
A & (\frac{1}{2} \frac{1}{2} \frac{1}{2}); & S_{4z}^+, C_{2x}, T; \\
R_1 & 1; & 1,1,1; \\
R_2 & 1; & 1,−1,1; \\
R_3 & 1; & −1,1,1; \\
R_4 & 1; & −1,−1,1; \\
R_5 & 2; & i\sigma_2, \sigma_3, −\sigma_0; \quad \text{P-QNL}_{MA}; \\
\end{array}
\]

\[
\begin{array}{c|c|c}
R & (0\frac{1}{2} \frac{1}{2}); & C_{2x}, C_{2y}, T; \\
R_1 & 1; & 1,1,1; \\
R_2 & 1; & 1,−1,1; \\
R_3 & 1; & −1,1,1; \\
R_4 & 1; & −1,−1,1; \\
\end{array}
\]

\[
\begin{array}{c|c|c}
X & (0\frac{1}{2} 0); & C_{2x}, C_{2y}, T; \\
R_1 & 1; & 1,1,1; \\
R_2 & 1; & 1,−1,1; \\
R_3 & 1; & −1,1,1; \\
R_4 & 1; & −1,−1,1; \\
\end{array}
\]

\[
\begin{array}{c|c|c}
\Delta & \Gamma X; & C_{2y}, TC_{2x}; \\
R_1 & 1; & 1,1; \\
R_2 & 1; & −1,1; \\
\end{array}
\]

\[
\begin{array}{c|c|c}
U & \Gamma Z; & C_{2y}, TC_{2x}; \\
R_1 & 1; & 1,1; \\
R_2 & 1; & −1,1; \\
\end{array}
\]

\[
\begin{array}{c|c|c}
\Lambda & \Gamma Z; & C_{2x}, \sigma_{db}, S_{4z}^+, T; \\
R_1 & 1; & 1,1,1; \\
R_2 & 1; & −1,1,1; \\
\{ R_3, R_4 \}; & 2; & −\sigma_0, \sigma_3, −i\sigma_2; \quad \text{QLN}; \\
\end{array}
\]

\[
\begin{array}{c|c|c}
\Sigma & \Gamma M; & \sigma_{db}, TC_{da}; \\
R_1 & 1; & 1,1; \\
R_2 & 1; & −1,1; \\
\end{array}
\]

\[
\begin{array}{c|c|c}
S & \Gamma ZA; & \sigma_{db}, TC_{da}; \\
R_1 & 1; & 1,1; \\
R_2 & 1; & −1,1; \\
\end{array}
\]
\begin{align*}
Y &; \text{ XM; } C_{2x}, TC_{2y}; \quad R_1; 1; 1,1; \\
&; \quad R_2; 1; -1,1; \\
T &; \text{ RA; } C_{2x}, TC_{2y}; \quad R_1; 1; 1,1; \\
&; \quad R_2; 1; -1,1; \\
W &; \text{ XR; } C_{2z}, TC_{2y}; \quad R_1; 1; 1,1; \\
&; \quad R_2; 1; -1,1; 
\end{align*}
Γ; (000); $S_{4d}^+, C_{2v}, T$;  
\begin{align*}
R_1: & \quad 1; 1, 1, 1; \\
R_2: & \quad 1; 1, -1, 1; \\
R_3: & \quad 1; -1, -1, 1; \\
R_4: & \quad 1; -1, -1, 1; \\
R_5: & \quad 2; i\sigma_2,\sigma_3, -\sigma_0; \quad \text{P-QNL}_{42}Z; \\
\end{align*}

M; $(\frac{1}{2}, \frac{1}{2}, 0)$; $S_{4d}^+, C_{2v}, T$;  
\begin{align*}
R_1: & \quad 1; 1, 1, 1; \\
R_2: & \quad 1; 1, -1, 1; \\
R_3: & \quad 1; -1, 1, 1; \\
R_4: & \quad 1; -1, -1, 1; \\
R_5: & \quad 2; i\sigma_2,\sigma_3, -\sigma_0; \quad \text{P-QNL}_{MA}; \\
\end{align*}

Z; $(0,0,\frac{1}{2})$; $S_{4d}^+, C_{2v}, C_{2v}, T$; \{R_5, R_6\}: 2; $i\sigma_3,\sigma_0,\sigma_0, \sigma_1$; \quad P-WNLs;  
\begin{align*}
\{R_7, R_8\}: & \quad 2; -i\sigma_3,\sigma_0, -\sigma_0, \sigma_1; \quad \text{P-WNLs}; \\
R_9: & \quad 2; \sigma_1, -\sigma_0,\sigma_3, -\sigma_0; \quad \text{P-WNLs}; \\
\end{align*}

A: $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$; $S_{4d}^+, C_{2v}, C_{2v}, T$; \{R_5, R_6\}: 2; $i\sigma_3,\sigma_0,\sigma_0, \sigma_1$; \quad P-WNLs;  
\begin{align*}
\{R_7, R_8\}: & \quad 2; -i\sigma_3,\sigma_0, -\sigma_0, \sigma_1; \quad \text{P-WNLs}; \\
R_9: & \quad 2; \sigma_1, -\sigma_0,\sigma_3, -\sigma_0; \quad \text{P-WNLs}; \\
\end{align*}

R; $(0, \frac{1}{2}, \frac{1}{2})$; $C_{2v}, C_{2v}, T$;  
\begin{align*}
R_1: & \quad 1; 1, 1, 1; \\
R_2: & \quad 1; 1, -1, 1; \\
R_3: & \quad 1; -1, 1, 1; \\
R_4: & \quad 1; -1, -1, 1; \\
\end{align*}

X; $(0, \frac{1}{2}, 0)$; $C_{2v}, C_{2v}, T$;  
\begin{align*}
R_1: & \quad 1; 1, 1, 1; \\
R_2: & \quad 1; 1, -1, 1; \\
R_3: & \quad 1; -1, 1, 1; \\
R_4: & \quad 1; -1, -1, 1; \\
\end{align*}

Δ; ΓX; $C_{2v}, T_{C_{2v}}$;  
\begin{align*}
R_1: & \quad 1; 1, 1; \\
R_2: & \quad 1; -1, 1; \\
\end{align*}

U; ZR; $C_{2v}, T_{C_{2v}}$;  
\begin{align*}
R_1: & \quad 1; 1, 1; \\
R_2: & \quad 1; -1, 1; \\
R_4: & \quad 1; -1, 1; \\
\end{align*}

Λ; ΓZ; $C_{2v}, \sigma_{db}, S_{4d}^+, T$;  
\begin{align*}
R_1: & \quad 1; 1, 1, 1; \\
R_2: & \quad 1; 1, -1, 1; \\
\{R_3, R_4\}: & \quad 2; -\sigma_0,\sigma_3, -i\sigma_2; \quad \text{QNL}; \quad 0 \\
\end{align*}

V; ΛA; $C_{2v}, \sigma_{db}, S_{4d}^+, T$;  
\begin{align*}
R_1: & \quad 1; 1, 1, 1; \\
R_2: & \quad 1; 1, -1, 1; \\
\{R_3, R_4\}: & \quad 2; -\sigma_0,\sigma_3, -i\sigma_2; \quad \text{QNL}; \quad 0 \\
\end{align*}

Σ; ΓM; $\sigma_{db}, T\sigma_{da}$;  
\begin{align*}
R_1: & \quad 1; 1, 1; \\
R_2: & \quad 1; -1, 1; \\
\end{align*}

\(Z\); ΖA; $\sigma_{db}, T\sigma_{da}$;  
\begin{align*}
\{R_1, R_2\}: & \quad 2; -i\sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \\
\end{align*}

Y; ΧM; $C_{2v}, T_{C_{2v}}$;  
\begin{align*}
R_1: & \quad 1; 1, 1; \\
R_2: & \quad 1; -1, 1; \\
\end{align*}

T; RA; $C_{2v}, T_{C_{2v}}$;  
\begin{align*}
R_1: & \quad 1; 1, 1; \\
R_4: & \quad 1; -1, 1; \\
\end{align*}

W; XR; $C_{2v}, T_{C_{2v}}$;  
\begin{align*}
R_1: & \quad 1; 1, 1; \\
R_2: & \quad 1; -1, 1; \\
\end{align*}
\[ \Gamma_q; \{S^+_4, 000\}, \{C_2, 1/2 1\}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\[ \begin{array}{c|c}
\Gamma & (000); S^+_4, C, \mathcal{T}; \\
R_1 & 1, 1, 1; \\
R_2 & 1, 1, 1; \\
R_3 & 1, 1, 1; \\
R_4 & 1, 1, 1; \\
R_5 & 2, \pm \sigma_2, \sigma_3, -\sigma_0; \ P-QNL_{\Gamma Z} \\
M; (1 1/2 0); S^+_4, C_2, \sigma_{db}, \mathcal{T}; \\
\{R_5, R_6\} & 2, \pm \sigma_3, \sigma_0, -\sigma_0; \ P-NS; \\
\{R_7, R_8\} & 2, \pm \sigma_3, \sigma_0, -\sigma_0; \ P-NS; \\
R_6 & 2, \pm \sigma_3, \sigma_0, -\sigma_0; \ P-NS; \\
Z; (00 1/2); S^+_4, C_2, \mathcal{T}; \\
R_1 & 1, 1, 1; \\
R_2 & 1, 1, 1; \\
R_3 & 1, 1, 1; \\
R_4 & 1, 1, 1; \\
R_5 & 2, \pm \sigma_2, \sigma_3, -\sigma_0; \ P-QNL_{\Gamma Z} \\
A; (1 1 1 12); S^+_4, C_2, \sigma_{db}, \mathcal{T}; \\
\{R_5, R_6\} & 2, \pm \sigma_3, \sigma_0, -\sigma_0; \ P-NS; \\
\{R_7, R_8\} & 2, \pm \sigma_3, \sigma_0, -\sigma_0; \ P-NS; \\
R_6 & 2, \pm \sigma_3, \sigma_0, -\sigma_0; \ P-NS; \\
R; (0 1/2 0); C_2y, C_2, \mathcal{T}; \\
R_5 & 2, \pm \sigma_2, \sigma_3, -\sigma_0; \ P-NS_{\text{MARX}}; \\
X; (0 1/2 0); C_2y, C_2, \mathcal{T}; \\
R_5 & 2, \pm \sigma_2, \sigma_3, -\sigma_0; \ P-NS_{\text{MARX}}; \\
\Delta; \Delta X; C_2y, \mathcal{T}C_2s; \\
R_1 & 1, 1; \\
R_2 & 1, 1; \\
R_3 & 1, 1; \\
U; ZR; C_2y, \mathcal{T}C_2s; \\
R_1 & 1, 1; \\
R_2 & 1, 1; \\
A; \Delta X; C_2s, \sigma_{db}, S^+_4, \mathcal{T}; \\
R_1 & 1, 1, 1; \\
R_2 & 1, 1, 1; \\
\{R_3, R_4\} & 2, \pm \sigma_0, \sigma_3, -\sigma_2; \ P-QNL; 0 \\
V; MA; C_2s, \sigma_{db}, S^+_4, \mathcal{T}; \\
\{R_1, R_2\} & 2, \pm \sigma_0, \sigma_3, -\sigma_2; \ P-NS_{\text{MARX}} \\
\{R_3, R_4\} & 2, \pm \sigma_0, \sigma_3, -\sigma_2; \ P-NS_{\text{MARX}} \\
\Sigma; \Gamma M; \sigma_{db}, \mathcal{T} \sigma_{da}; \\
R_1 & 1, 1; \\
R_2 & 1, 1; \\
S; ZA; \sigma_{db}, \mathcal{T} \sigma_{da}; \\
R_1 & 1, 1; \\
R_2 & 1, 1; \\
Y; XM; C_2x, \mathcal{T}C_2y; \\
\{R_2, R_4\} & 2, \pm \sigma_3, -\sigma_2; \ P-NS_{\text{MARX}} \\
T; RA; C_2x, \mathcal{T}C_2y; \\
\{R_2, R_4\} & 2, \pm \sigma_3, -\sigma_2; \ P-NS_{\text{MARX}} \\
W; XR; C_2x, \mathcal{T}C_2y; \\
\{R_1, R_2\} & 2, \pm \sigma_3, -\sigma_2; \ P-NS_{\text{MARX}} \\
\]
\( \Gamma \); \{ \Gamma_{q} \}; \{ S_{4z}^{+} \}; \{ C_{2z} \}; \{ \frac{1}{2} \}; \{ \frac{1}{2} \}; \{ T \}; Non-Centrosymmetric; without SOC

\[ S_{4z}^{+}, C_{2z}, T; \begin{array}{l}
\Gamma_{000}; S_{4z}^{+}, C_{2z}, T; \quad R_{1}; \quad 1, 1, 1; \\
R_{2}; \quad 1, -1, 1; \\
R_{3}; \quad 1, -1, 1; \\
R_{4}; \quad 1, -1, 1; \\
R_{5}; \quad 2, i\sigma_{2}, \sigma_{3}, -\sigma_{0}; \quad P-QNL_{\Gamma_{2}}; \\
\end{array} \]

\[ M; \{ \frac{1}{2} \}; S_{4z}^{+}, C_{2z}, \sigma_{db}, T; \begin{array}{l}
\{ R_{5}, R_{6} \}; \quad 2, i\sigma_{3}, \sigma_{0}, \sigma_{0}, \sigma_{1}; \quad P-NSS; \\
\{ R_{7}, R_{8} \}; \quad 2, -i\sigma_{3}, \sigma_{0}, -\sigma_{0}, \sigma_{1}; \quad P-NSS; \\
R_{9}; \quad 2, \sigma_{1}, -\sigma_{0}, \sigma_{3}, -\sigma_{0}; \quad P-NSS; \\
\end{array} \]

\[ Z; \{ 000 \}; S_{4z}^{+}, C_{2z}, T; \begin{array}{l}
\{ R_{5}, R_{6} \}; \quad 2, i\sigma_{3}, \sigma_{0}, \sigma_{0}, \sigma_{1}; \quad P-WNLs; \\
\{ R_{7}, R_{8} \}; \quad 2, -i\sigma_{3}, \sigma_{0}, -\sigma_{0}, \sigma_{1}; \quad P-WNLs; \\
R_{9}; \quad 2, \sigma_{1}, -\sigma_{0}, \sigma_{3}, -\sigma_{0}; \quad P-WNLs; \\
\end{array} \]

\[ A; \{ \frac{1}{2} \}; S_{4z}^{+}, \sigma_{db}, T; \begin{array}{l}
\{ R_{5}, R_{6} \}; \quad 2, -\sigma_{0}, i\sigma_{3}, \sigma_{1}; \quad P-NSS; \\
\{ R_{7}, R_{8} \}; \quad 2, \sigma_{0}, -i\sigma_{3}; \quad P-NSS; \\
\{ R_{10}, R_{10} \}; \quad 4, i\Gamma_{0, 3}, i\Gamma_{0, 2}, -\Gamma_{2, 2}; \quad QDP; \quad 0 \\
\end{array} \]

\[ R; \{ 0 \}; S_{2y}, C_{2z}, T; \begin{array}{l}
R_{5}; \quad 2, i\sigma_{2}, \sigma_{3}, -\sigma_{0}; \quad P-NS_{MARX}; \\
\end{array} \]

\[ X; \{ 0 \}; S_{2y}, C_{2z}, T; \begin{array}{l}
R_{5}; \quad 2, i\sigma_{2}, \sigma_{3}, -\sigma_{0}; \quad P-NS_{MARX}; \\
\end{array} \]

\[ \Delta; \{ 0 \}; S_{2y}, T; \begin{array}{l}
R_{1}; \quad 1, 1, 1; \\
R_{2}; \quad 1, -1, 1; \\
R_{4}; \quad 1, -1, 1; \\
\end{array} \]

\[ \Lambda; \{ 0 \}; S_{2y}, \sigma_{db}, S_{4z}^{+} T; \begin{array}{l}
R_{1}; \quad 1, 1, 1; \\
R_{2}; \quad 1, -1, 1; \\
\end{array} \]

\[ V; \{ 0 \}; S_{2y}, \sigma_{db}, T; \begin{array}{l}
R_{1}; \quad 2, \sigma_{0}, -\sigma_{3}, \sigma_{1}; \quad L-NS_{MARX} \\
R_{3}; \quad 2, -\sigma_{0}, -\sigma_{0}, -i\sigma_{2}; \quad L-NS_{MARX} \\
R_{4}; \quad 2, -\sigma_{0}, -\sigma_{0}, -i\sigma_{2}; \quad L-NS_{MARX} \\
\end{array} \]

\[ \Sigma; \{ 0 \}; \sigma_{db}, T; \begin{array}{l}
R_{1}; \quad 1, 1, 1; \\
R_{2}; \quad 1, -1, 1; \\
\end{array} \]

\[ S; \{ 0 \}; \sigma_{db}, T; \begin{array}{l}
R_{1}; \quad 2, -i\sigma_{3}, -i\sigma_{2}; \quad WNL; \quad \pi \\
\end{array} \]

\[ Y; \{ 0 \}; S_{2y}, T; \begin{array}{l}
R_{2}; \quad 2, \sigma_{3}, -i\sigma_{2}; \quad L-NS_{MARX} \\
\end{array} \]

\[ T; \{ 0 \}; S_{2y}, T; \begin{array}{l}
R_{1}; \quad 2, -\sigma_{3}, -i\sigma_{2}; \quad L-NS_{MARX} \\
\end{array} \]

\[ W; \{ 0 \}; S_{2y}, T; \begin{array}{l}
R_{1}; \quad 2, \sigma_{3}, -i\sigma_{2}; \quad L-NS_{MARX} \\
\end{array} \]
\[\Gamma; (000); S^+_{4z}, C_{2a}, T; \]
\[R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[R_3; 1; -1, 1, 1;\]
\[R_4; 1; -1, -1, 1;\]
\[R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{ P-QNL}_{\Gamma, 2};\]

\[M; (\frac{1}{2}\frac{1}{2}0); S^+_{4z}, C_{2a}, T; \]
\[R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[R_3; 1; -1, 1, 1;\]
\[R_4; 1; -1, -1, 1;\]
\[R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{ P-QNL}_{M, 2};\]

\[Z; (00\frac{1}{2}); S^+_{4z}, C_{2a}, T; \]
\[R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[R_3; 1; -1, 1, 1;\]
\[R_4; 1; -1, -1, 1;\]
\[R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{ P-QNL}_{M, 2};\]

\[A; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); S^+_{4z}, C_{2a}, T; \]
\[R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[R_3; 1; -1, 1, 1;\]
\[R_4; 1; -1, -1, 1;\]
\[R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{ P-QNL}_{M, 2};\]

\[R; (0\frac{1}{2}\frac{1}{2}); C_{2a}, \sigma_y, T; \]
\[R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[R_3; 1; -1, 1, 1;\]
\[R_4; 1; -1, -1, 1;\]
\[\{R_3, R_4\}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \text{ QNL}; 0\]

\[\Delta; \Gamma X; \sigma_x, T\sigma_y; \]
\[R_1; 1; 1, 1;\]
\[R_2; 1; -1, 1;\]

\[U; \Gamma Z; \sigma_x, T\sigma_y; \]
\[R_1; 1; 1, 1;\]
\[R_2; 1; -1, 1;\]

\[V; \Gamma M; C_{2a}, C_{2b}, T; \]
\[R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[\{R_3, R_4\}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \text{ QNL}; 0\]

\[\Sigma; \Gamma M; C_{2a}, C_{2b}, T; \]
\[R_1; 1; 1, 1;\]
\[R_2; 1; -1, 1;\]

\[S; \sigma_y, T C_{2a}; \]
\[R_1; 1; 1, 1;\]
\[R_2; 1; -1, 1;\]

\[Y; \sigma_y, T C_{2a}; \]
\[R_1; 1; 1, 1;\]
\[R_2; 1; -1, 1;\]
$T; RA; \sigma_y, TC_{2z}; R_1; 1, 1;
R_2; 1; -1, 1;
W; XR; C_{2z}, \sigma_y; R_1; 1, 1;
R_2; 1; 1, -1;
R_3; 1; -1, 1;
R_4; 1; -1, -1;$
\[ \Gamma; (000); S_{4z}^+, C_{2a}, T; R_1; 1; 1, 1, 1; \]
\[ R_2; 1; 1, -1, 1; \]
\[ R_3; 1; -1, 1, 1; \]
\[ R_4; 1; -1, -1, 1; \]
\[ R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{xz}; \]
\[ M; (\frac{1}{2} \frac{1}{2} 0); S_{4z}^+, C_{2a}, T; R_1; 1; 1, 1, 1; \]
\[ R_2; 1; 1, -1, 1; \]
\[ R_3; 1; -1, 1, 1; \]
\[ R_4; 1; -1, -1, 1; \]
\[ R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{MA}; \]
\[ Z; (00 \frac{1}{2}); S_{4z}^+, C_{2z}, C_{2a}, T; \{ R_0, R_6 \}; 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \text{P-WNLs}; \]
\[ \{ R_7, R_8 \}; 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \text{P-WNLs}; \]
\[ R_9; 2; \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \text{P-WNLs}; \]
\[ A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); S_{4z}^+, C_{2z}, C_{2a}, T; \{ R_0, R_6 \}; 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \text{P-WNLs}; \]
\[ \{ R_7, R_8 \}; 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \text{P-WNLs}; \]
\[ R_9; 2; \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \text{P-WNLs}; \]
\[ R; (0 \frac{1}{2} 0); \sigma_x, C_{2z}, T; \{ R_2, R_8 \}; 2; i\sigma_3, \sigma_0, \sigma_1; \text{P-WNLs}; \]
\[ \{ R_0, R_8 \}; 2; i\sigma_3, -\sigma_0, \sigma_1; \text{P-WNLs}; \]
\[ X; (0 \frac{1}{2} 0); C_{2z}, \sigma_y, T; \{ R_1 \}; 1; 1, 1, 1; \]
\[ \{ R_2 \}; 1; 1, -1, 1; \]
\[ \{ R_3 \}; 1; -1, 1, 1; \]
\[ \{ R_4 \}; 1; -1, -1, 1; \]
\[ \Delta; \Gamma X; \sigma_z, T \sigma_y; \{ R_1 \}; 1, 1, 1; \]
\[ \{ R_2 \}; 1, -1, 1; \]
\[ U; \Gamma Z; \sigma_z, T \sigma_y; \{ R_1, R_3 \}; 2; -i\sigma_3, -i\sigma_2; \text{WNL}; \pi \]
\[ \Lambda; \Gamma Z; C_{2z}, \sigma_y, S_{4z}^+ T; \{ R_1 \}; 1, 1, 1, 1; \]
\[ \{ R_3, R_4 \}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \text{QNL}; 0 \]
\[ V; \Gamma A; C_{2z}, \sigma_y, S_{4z}^+ T; \{ R_1 \}; 1, 1, 1, 1; \]
\[ \{ R_3, R_4 \}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \text{QNL}; 0 \]
\[ \Sigma; \Gamma M; C_{2a}, C_{2b} T; \{ R_1 \}; 1, 1, 1; \]
\[ \{ R_2 \}; 1, -1, 1; \]
\[ S; \Gamma A; C_{2a}, C_{2b} T; \{ R_2 \}; 1, 1, 1; \]
\[ \{ R_4 \}; 1, -1, 1; \]
\[ Y; \Gamma X; \sigma_y, T C_{2z}; \{ R_1 \}; 1, 1, 1; \]
\[ \{ R_2 \}; 1, -1, 1; \]
\[ T; \Gamma A; \sigma_y, T C_{2z}; \{ R_1, R_2 \}; 2; -i\sigma_3, \sigma_1; \text{WNL}; \pi \]
\[ W; \Gamma R; C_{2z}, \sigma_y; \{ R_1 \}; 1, 1, 1; \]
\[ \{ R_2 \}; 1, 1, -1; \]
\[ \{ R_3 \}; 1, -1, 1; \]
\[ \{ R_4 \}; 1, -1, -1; \]
\( \Gamma_q; \{S_{\frac{1}{4}}^+|000\}, \{C_{2a}| \frac{1}{4}\}, T; \) Non-Centrosymmetric; without SOC

\( \Gamma; (000); \quad S_{\frac{1}{4}}^+, C_{2a}, T; \)
- \( R_1; \quad 1, 1, 1; \)
- \( R_2; \quad 1, 1, -1, 1; \)
- \( R_3; \quad 1, -1, 1, 1; \)
- \( R_4; \quad 1, -1, -1, 1; \)
- \( R_5; \quad 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{T';Z}; \)

\( M; (\frac{1}{2}, \frac{1}{2}, 0); \quad S_{\frac{1}{4}}^+, C_{2z}, C_{2a}, T; \)
- \( \{R_5, R_6\}; \quad 2, i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNLs}; \)
- \( \{R_7, R_8\}; \quad 2, -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-WNLs}; \)
- \( R_9; \quad 2, \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \)

\( Z; (00\frac{1}{2}); \quad S_{\frac{1}{4}}^+, C_{2a}, T; \)
- \( R_1; \quad 1, 1, 1; \)
- \( R_2; \quad 1, 1, -1, 1; \)
- \( R_3; \quad 1, -1, 1, 1; \)
- \( R_4; \quad 1, -1, -1, 1; \)
- \( R_5; \quad 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{T';Z}; \)

\( A; (\frac{1}{2}, \frac{1}{2}, \frac{1}{2}); \quad S_{\frac{1}{4}}^+, C_{2z}, C_{2a}, T; \)
- \( \{R_5, R_6\}; \quad 2, i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNLs}; \)
- \( \{R_7, R_8\}; \quad 2, -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-WNLs}; \)
- \( R_9; \quad 2, \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \)

\( R; (0\frac{1}{2}, 0); \quad \sigma_2, C_{2z}, T; \)
- \( R_5; \quad 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \)

\( X; (0\frac{1}{2}, 0); \quad \sigma_2, C_{2z}, T; \)
- \( R_5; \quad 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \)

\( \Delta; \quad \Gamma X; \quad \sigma_2, T \sigma_y; \)
- \( R_1; \quad 1, 1, 1; \)
- \( R_2; \quad 1, -1, 1; \)

\( U; \quad Z R; \quad \sigma_2, T \sigma_y; \)
- \( R_1; \quad 1, 1, 1; \)
- \( R_2; \quad 1, -1, 1; \)

\( \Lambda; \quad \Gamma Z; \quad C_{2z} \sigma_y S_{\frac{1}{4}}^+, T; \)
- \( R_1; \quad 1, 1, 1; \)
- \( R_2; \quad 1, -1, 1; \)
- \( \{R_3, R_4\}; \quad 2, -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{QNL}; \quad 0 \)

\( V; \quad M A; \quad \sigma_2, C_{2z}, S_{\frac{1}{4}}^+, T; \)
- \( R_2; \quad 1, -i, 1, 1; \)
- \( R_4; \quad 1, i, 1, 1; \)
- \( \{R_6, R_8\}; \quad 2, -i\sigma_3, -\sigma_0, -i\sigma_2; \quad \text{QNL}; \quad 0 \)

\( \Sigma; \quad \Gamma M; \quad C_{2a} C_{2b} T; \)
- \( R_1; \quad 1, 1, 1; \)
- \( R_2; \quad 1, -1, 1; \)

\( S; \quad Z A; \quad C_{2a} C_{2b} T; \)
- \( R_1; \quad 1, 1, 1; \)
- \( R_2; \quad 1, -1, 1; \)

\( Y; \quad X M; \quad \sigma_y T C_{2z}; \)
- \( \{R_2, R_4\}; \quad 2, \sigma_3, \sigma_1; \quad \text{WNL}; \quad \pi \)

\( T; \quad R A; \quad \sigma_y T C_{2z}; \)
- \( \{R_2, R_4\}; \quad 2, \sigma_3, \sigma_1; \quad \text{WNL}; \quad \pi \)

\( W; \quad X R; \quad \sigma_y C_{2z}; \)
- \( R_5; \quad 2, \sigma_2, \sigma_3; \quad \text{WNL}; \quad \pi \)
Γ;\(\{S^+_4,000\}\), \(\{C_{2v},1\frac{1}{2}\frac{1}{2}\frac{1}{2}\}\), \(T\); Non-Centrosymmetric; without SOC

\[\begin{align*}
\Gamma_{(000)}: \quad & S^+_4, C_{2v}, T; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1; \\
R_3: & \quad 1, 1, 1; \\
R_4: & \quad 1, -1, 1; \\
R_5: & \quad 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\pi}; \\
M_{(\frac{1}{2}\frac{1}{2}\frac{1}{2})}: \quad & S^+_4, C_{2v}, C_{2v}, T; \\
\{R_5,R_6\}: & \quad 2, i\sigma_3, \sigma_0, \sigma_1; \quad \text{P-WNL}; \\
\{R_7,R_8\}: & \quad -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-WNL}; \\
R_9: & \quad 2, \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{P-WNL}; \\
Z_{(00\frac{1}{2})}: \quad & S^+_4, C_{2v}, C_{2v}, T; \\
\{R_5,R_6\}: & \quad 2, i\sigma_3, \sigma_0, \sigma_1; \quad \text{P-WNL}; \\
\{R_7,R_8\}: & \quad -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-WNL}; \\
R_9: & \quad 2, \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{P-WNL}; \\
A_{(\frac{1}{2}\frac{1}{2}\frac{1}{2})}: \quad & S^+_4, C_{2v}, T; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, 1, -1, 1; \\
R_3: & \quad 1, -1, 1, 1; \\
R_4: & \quad 1, -1, 1, 1; \\
R_5: & \quad 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\pi}; \\
R: \quad & (0\frac{1}{2}\frac{1}{2}) \quad \sigma_y, C_{2v}, T; \\
R_5: & \quad 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-WNL}; \\
X: \quad & (0\frac{1}{2}\frac{1}{2}) \quad \sigma_x, C_{2v}, T; \\
R_5: & \quad 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-WNL}; \\
\Delta: \quad & \Gamma' \quad \sigma_y, T \sigma_y; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1; \\
R_3: & \quad 2, -i\sigma_1, -i\sigma_2; \quad \text{WNL}; \\
U: \quad & \Gamma' \quad \sigma_2, T \sigma_y; \\
\{R_1,R_2\}: & \quad 2, -i\sigma_1, -i\sigma_2; \quad \text{WNL}; \\
\Lambda: \quad & \Gamma' \quad C_{2v}, \sigma_y, S^+_4; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1; \\
\{R_3,R_4\}: & \quad -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{QNL}; \\
V: \quad & \Gamma' \quad \sigma_2, C_{2v}, S^+_4; \\
R_2: & \quad -i, 1, 1; \\
R_4: & \quad i, 1, 1; \\
\{R_6,R_8\}: & \quad 2, -i\sigma_3, -\sigma_0, -i\sigma_2; \quad \text{QNL}; \\
\Sigma: \quad & \Gamma' \quad C_{2v}, C_{2v}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1; \\
Y: \quad & \Gamma' \quad \sigma_y, T C_{2v}; \\
\{R_2,R_4\}: & \quad 2, \sigma_0, \sigma_1; \quad \text{WNL}; \\
T: \quad & \Gamma' \quad \sigma_y, T C_{2v}; \\
R_2: & \quad 1, i, 1; \\
R_4: & \quad 1, i, 1; \\
W: \quad & \Gamma' \quad \sigma_y, C_{2v}; \\
R_5: & \quad 2, \sigma_2, \sigma_3; \quad \text{WNL}; \\
\end{align*}\]
\[ \Gamma; (000); S_{1,0}^+; C_{2h}; \mathcal{T}; R_1; \quad 1; \, 1, \, 1; \]
\[ \quad R_2; \quad 1; \, 1, \, -1; \]
\[ \quad R_3; \quad 1; \, -1, \, 1; \]
\[ \quad R_4; \quad 1; \, -1, \, -1; \]
\[ \quad R_5; \quad 2; \, i\sigma_2, \sigma_3, \, -\sigma_0; \quad \text{P-QNL}_{\Gamma_2}; \]
\[ N; (0\frac{1}{2},0); \, \sigma_y; \mathcal{T}; \]
\[ \quad R_1; \quad 1; \, 1; \]
\[ \quad R_2; \quad 1; \, -1, \, 1; \]
\[ X; (00\frac{3}{2}); \, C_{2v}; C_{2h}; \mathcal{T}; \]
\[ \quad R_1; \quad 1; \, 1, \, 1; \]
\[ \quad R_2; \quad 1; \, 1, \, -1; \]
\[ \quad R_3; \quad 1; \, -1, \, 1; \]
\[ \quad R_4; \quad 1; \, -1, \, -1; \]
\[ Z; (\frac{1}{2},\frac{1}{2},\frac{1}{2}); \, S_{1,0}^+; C_{2v}; \mathcal{T}; \]
\[ \quad R_1; \quad 1; \, 1, \, 1; \]
\[ \quad R_2; \quad 1; \, 1, \, -1; \]
\[ \quad R_3; \quad 1; \, -1, \, 1; \]
\[ \quad R_4; \quad 1; \, -1, \, -1; \]
\[ P; (\frac{1}{2},\frac{1}{2},\frac{1}{2}); \, S_{1,0}^+; \mathcal{T}; \sigma_y; \]
\[ \quad R_1; \quad 1; \, 1; \]
\[ \quad R_2; \quad 1; \, i; \, 1; \]
\[ \quad R_3; \quad 1; \, -1; \]
\[ \quad R_4; \quad 1; \, -i, \, 1; \]
\[ \Lambda; \, \Gamma\Lambda/T\Sigma; \, C_{2v}; \sigma_y; S_{1,0}^+; \mathcal{T}; \]
\[ \quad R_1; \quad 1; \, 1, \, 1; \]
\[ \quad R_2; \quad 1; \, 1, \, -1; \]
\[ \quad \{R_3, R_4\}; \quad 2; \, -\sigma_0, \sigma_3, \, -i\sigma_2; \quad \text{QNL}; \quad 0 \]
\[ V; \, ZV; \, C_{2v}; \sigma_y; S_{1,0}^+; \mathcal{T}; \]
\[ \quad R_1; \quad 1; \, 1, \, 1; \]
\[ \quad R_2; \quad 1; \, 1, \, -1; \]
\[ \quad \{R_3, R_4\}; \quad 2; \, -\sigma_0, \sigma_3, \, -i\sigma_2; \quad \text{QNL}; \quad 0 \]
\[ W; \, XP; \, C_{2v}; \mathcal{T}; \]
\[ \quad R_1; \quad 1; \, 1; \]
\[ \quad R_2; \quad 1; \, -1, \, 1; \]
\[ \Sigma; \, \Gamma\Sigma/T\Sigma; \, \sigma_y; \mathcal{T}; C_{2s}; \]
\[ \quad R_1; \quad 1; \, 1, \, 1; \]
\[ \quad R_2; \quad 1; \, -1, \, 1; \]
\[ F; \, ZF; \, \sigma_y; \mathcal{T}; C_{2s}; \]
\[ \quad R_1; \quad 1; \, 1, \, 1; \]
\[ \quad R_2; \quad 1; \, -1, \, 1; \]
\[ Q; \, NP; \, E; \mathcal{T}; \sigma_y; \]
\[ \quad R_1; \quad 1; \, 1, \, 1; \]
\[ \Delta; \, \Gamma\Delta; \, C_{2a}; C_{2b}; \mathcal{T}; \]
\[ \quad R_1; \quad 1; \, 1, \, 1; \]
\[ \quad R_2; \quad 1; \, -1, \, 1; \]
\[ U; \, ZU; \, C_{2a}; C_{2b}; \mathcal{T}; \]
\[ \quad R_1; \quad 1; \, 1, \, 1; \]
\[ \quad R_2; \quad 1; \, -1, \, 1; \]
\[ Y; \, XZ/XY; \, C_{2b}; \mathcal{T}; C_{2s}; \]
\[ \quad R_1; \quad 1; \, 1, \, 1; \]
\[ \quad R_2; \quad 1; \, -1, \, 1; \]
\[ \Gamma^0; \{S^\pm_4, C_{4v}, T\}; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma; (000); \quad & S^+_4, C_{2v}, T; \\
& R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
& R_3; 1, -1, 1; \\
& R_4; 1, -1, 1; \\
& R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{\Gamma^0}; \\
N; (0\frac{1}{2}0); \quad & \sigma_y, T; \\
& \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \text{P-WNLs}; \\
X; (00\frac{1}{2}); \quad & C_{2v}, C_{2v}, T; \\
& R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
& R_3; 1, -1, 1; \\
& R_4; 1, -1, 1; \\
& R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{\Gamma^0}; \\
Z; (\frac{1}{2}1\frac{1}{2}); \quad & S^+_4, C_{2v}, T; \\
& R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
& R_3; 1, -1, 1; \\
& R_4; 1, -1, 1; \\
& R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-QNL}_{\Gamma^0}; \\
P; (\frac{1}{2}1\frac{1}{2}); \quad & S^+_4, T\sigma_y; \\
& \{R_1, R_3\}; 2; \sigma_3, -i\sigma_2; \text{P-WNLs}; \\
& \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNLs}; \\
\Lambda; \quad & \Gamma\Lambda/\Gamma Z; \\
& C_{2v}, \sigma_y, S^+_4, T; \\
& R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
& \{R_3, R_4\}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \text{QNLS}; 0 \\
V; \quad & ZV; \\
& C_{2v}, \sigma_y, S^+_4, T; \\
& R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
& \{R_3, R_4\}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \text{QNLS}; 0 \\
W; \quad & \chi P; \\
& C_{2v}, C_{2v}, T; \\
& R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
\Sigma; \quad & \Gamma Z/\Sigma; \\
& \sigma_y, T C_{2v}; \\
& R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
F; \quad & ZF; \\
& \sigma_y, T C_{2v}; \\
& R_1; 1, -1, 1; \\
& R_2; 1, 1, 1; \\
Q; \quad & NP; \\
& E, T \sigma_y; \\
& \{R_1, R_1\}; 2; \sigma_0, -i\sigma_2; \text{WNL}; \pi \\
\Delta; \quad & \Gamma X; \\
& C_{2v}, C_{2v}, T; \\
& R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
U; \quad & ZU; \\
& C_{2v}, C_{2v}, T; \\
& R_1; 1, -1, 1; \\
& R_2; 1, 1, 1; \\
Y; \quad & XZ/XY; \\
& C_{2v}, T C_{2v}; \\
& R_1; 1, 1, 1; \\
& R_2; 1, -1, 1; \\
\]
| Symbol | Description | Branches | Trans. |\( \Gamma \) |\( \Lambda \) |\( \Sigma \) |\( \Delta \) |\( \Psi \) |\( \Omega \) |\( \Upsilon \) |
|--------|-------------|----------|--------|---------|---------|---------|---------|---------|---------|---------|
| \( \Gamma \) | \( (000) \) | \( S_{4}^{+} \), \( C_{2z} \); | \( T \); |\( \Gamma_{3} \): |\( \Gamma_{5} \): |\( \Gamma_{4} \): |\( \Gamma_{3} \): |\( \Gamma_{2} \): |\( \Gamma_{1} \): |\( \Gamma_{1} \): |
| \( \Lambda \) | \( \Gamma_{A}/T_{Z} \) | \( C_{2z}, \sigma_{db}, S_{4}^{+} \); | \( T \); |\( \Gamma_{3}, \Gamma_{4} \): \( \pm \sigma_{o} \); |\( \Gamma_{3} \): \( \pm \sigma_{o} \); |\( \Gamma_{4} \): \( \pm \sigma_{o} \); |\( \Gamma_{3} \): \( \pm \sigma_{o} \); |\( \Gamma_{4} \): \( \pm \sigma_{o} \); |\( \Gamma_{3} \): \( \pm \sigma_{o} \); |\( \Gamma_{4} \): \( \pm \sigma_{o} \); |
| \( \Sigma \) | \( \Gamma_{Z}/T_{Z} \) | \( C_{2z}, T \); | | | | | | | | |
| \( \Delta \) | \( \Gamma_{X} \) | \( \sigma_{db}, T \sigma_{da} \); | | | | | | | | |
\( \Gamma_v^0: \{ S_{4v}^+ | 000 \}, \{ C_{2z}, | \frac{1}{4} \frac{3}{4} \frac{1}{4} \} \), \( T \); Non-Centrosymmetric; without SOC

\[ \Gamma: (000): \quad S_{4v}^+, C_{2z}, T; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ R_3; \quad 1, -1, 1; \]
\[ R_4; \quad 1, -1, 1; \]
\[ R_5; \quad 2; \quad i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-QNL}_Z; \]
\[ N: (0 \frac{1}{4} 0); \quad C_{2y}, T; \quad R_1; \quad 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ X: (00 \frac{1}{4}); \quad \sigma_{db}, C_{2z}, T; \quad R_5; \quad 2; \quad i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \]
\[ Z: (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad S_{4v}^+, C_{2z}, C_{2z}, T; \quad \{ R_5, R_6 \}; \quad 2; \quad \sigma_3, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNLs}; \]
\[ \{ R_7, R_8 \}; \quad 2; \quad -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-WNLs}; \]
\[ R_0; \quad 2; \quad \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{13}; \quad 2; \quad e^{i\pi/4} \sigma_0 - i\sigma_2, -i\sigma_0, \sigma_1; \quad \text{P-WNLs} \]
\[ R_{14}; \quad 2; \quad -e^{i\pi/4} \sigma_0 + i\sigma_2, -i\sigma_0, \sigma_1; \quad \text{P-WNLs} \]
\[ \Lambda: \quad \Gamma \Lambda/\Gamma Z; \quad C_{2z}, \sigma_{db}, S_{4v}^+, T; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ \{ R_3, R_4 \}; \quad 2; \quad -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{QNL}; \quad 0 \]
\[ V: \quad Z V; \quad \sigma_{da}, C_{2z}, S_{4v}^+, T; \quad R_2; \quad 1; \quad -i, 1, 1; \]
\[ R_4; \quad 1; \quad i, 1, 1; \]
\[ \{ R_6, R_8 \}; \quad 2; \quad -i\sigma_3, -\sigma_0, -i\sigma_2; \quad \text{QNL}; \quad 0 \]
\[ W: \quad X P; \quad \sigma_{da}, C_{2z}; \quad R_5; \quad 2; \quad \sigma_2, \sigma_3; \quad \text{WNL}; \quad \pi \]
\[ \Sigma: \quad \Gamma Z/\Gamma Z; \quad C_{2z}, T C_{2y}; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ F: \quad Z F; \quad C_{2z}, T C_{2y}; \quad R_2; \quad 1, 1, 1; \]
\[ R_4; \quad 1, -1, 1; \]
\[ Q: \quad N P; \quad C_{2y}; \quad R_4; \quad 1; \]
\[ R_8; \quad 1; \quad -1; \]
\[ \Delta: \quad \Gamma X; \quad \sigma_{db}, T \sigma_{da}; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ U: \quad Z U; \quad \sigma_{db}, T \sigma_{da}; \quad \{ R_1, R_2 \}; \quad 2; \quad -i\sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \]
\[ Y: \quad X Z/X Y; \quad \sigma_{da}, T C_{2z}; \quad \{ R_2, R_4 \}; \quad 2; \quad \sigma_3, \sigma_1; \quad \text{WNL}; \quad \pi \]
\( \Gamma \); (000): \( C_4^+ \), \( C_2 \), \( I \), \( T \): 
\[ \begin{align*}
R_1 &: 1, 1, 1, 1; \\
R_2 &: 1, -1, 1, 1; \\
R_3 &: -1, 1, 1, 1; \\
R_4 &: -1, -1, 1, 1; \\
R_5 &: 2; i \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{ P-QNL}_\Gamma; \\
R_6 &: 1, 1, -1, 1; \\
R_7 &: 1, -1, -1, 1; \\
R_8 &: 1, -1, 1, 1; \\
R_9 &: 1, -1, -1, 1; \\
R_{10} &: 2; i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-QNL}_\Gamma; \\
\end{align*} \]

\( M \); (1 1 1 0): \( C_4^+ \), \( C_2 \), \( I \), \( T \):
\[ \begin{align*}
R_1 &: 1, 1, 1, 1; \\
R_2 &: 1, -1, 1, 1; \\
R_3 &: -1, 1, 1, 1; \\
R_4 &: -1, -1, 1, 1; \\
R_5 &: 2; i \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{ P-QNL}_M; \\
R_6 &: 1, 1, -1, 1; \\
R_7 &: 1, -1, -1, 1; \\
R_8 &: 1, -1, 1, 1; \\
R_9 &: 1, -1, -1, 1; \\
R_{10} &: 2; i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-QNL}_M; \\
\end{align*} \]

\( Z \); (0 0 1 2): \( C_4^+ \), \( C_2 \), \( I \), \( T \):
\[ \begin{align*}
R_1 &: 1, 1, 1, 1; \\
R_2 &: 1, -1, 1, 1; \\
R_3 &: -1, 1, 1, 1; \\
R_4 &: -1, -1, 1, 1; \\
R_5 &: 2; i \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{ P-QNL}_Z; \\
R_6 &: 1, 1, -1, 1; \\
R_7 &: 1, -1, -1, 1; \\
R_8 &: 1, -1, 1, 1; \\
R_9 &: 1, -1, -1, 1; \\
R_{10} &: 2; i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-QNL}_Z; \\
\end{align*} \]

\( A \); (1 1 1 2): \( C_4^+ \), \( C_2 \), \( I \), \( T \):
\[ \begin{align*}
R_1 &: 1, 1, 1, 1; \\
R_2 &: 1, -1, 1, 1; \\
R_3 &: -1, 1, 1, 1; \\
R_4 &: -1, -1, 1, 1; \\
R_5 &: 2; i \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{ P-QNL}_A; \\
R_6 &: 1, 1, -1, 1; \\
R_7 &: 1, -1, -1, 1; \\
R_8 &: 1, -1, 1, 1; \\
R_9 &: 1, -1, -1, 1; \\
R_{10} &: 2; i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-QNL}_A; \\
\end{align*} \]
$R$: \( 0 \frac{1}{2} \frac{1}{2} \frac{1}{2} \); \( C_{2z}, C_{2y}, I, T \); 
- \( R_1 \); 1, 1, 1, 1;
- \( R_2 \); 1, −1, 1, 1;
- \( R_3 \); 1, −1, 1, 1;
- \( R_4 \); 1, −1, −1, 1;
- \( R_5 \); 1, 1, −1, 1;
- \( R_6 \); 1, −1, −1, 1;
- \( R_7 \); 1, −1, −1, 1;
- \( R_8 \); 1, −1, −1, 1;

$X$: \( 0 \frac{1}{2} 0 \); \( C_{2z}, C_{2y}, I, T \); 
- \( R_1 \); 1, 1, 1, 1;
- \( R_2 \); 1, −1, 1, 1;
- \( R_3 \); 1, −1, 1, 1;
- \( R_4 \); 1, −1, −1, 1;
- \( R_5 \); 1, 1, −1, 1;
- \( R_6 \); 1, −1, −1, 1;
- \( R_7 \); 1, −1, −1, 1;
- \( R_8 \); 1, −1, −1, 1;

$\Delta$: \( \Gamma X \); \( C_{2y}, \sigma_x, I, T \); 
- \( R_1 \); 1, 1, 1, 1;
- \( R_2 \); 1, −1, 1, 1;
- \( R_3 \); 1, −1, 1, 1;
- \( R_4 \); 1, −1, −1, 1;

$U$: \( Z R \); \( C_{2y}, \sigma_x, I, T \); 
- \( R_1 \); 1, 1, 1, 1;
- \( R_2 \); 1, −1, 1, 1;
- \( R_3 \); 1, −1, 1, 1;
- \( R_4 \); 1, −1, −1, 1;

$\Lambda$: \( \Gamma Z \); \( C_{4z}, \sigma_y, I, T \); 
- \( R_1 \); 1, 1, 1, 1;
- \( R_2 \); 1, −1, 1, 1;
- \( R_3 \); 1, −1, 1, 1;
- \( R_4 \); 1, −1, −1, 1;
- \( R_5 \); 2, \( i\sigma_x, \sigma_y, -\sigma_z \); QNL; 0

$V$: \( M A \); \( C_{4z}, \sigma_y, I, T \); 
- \( R_1 \); 1, 1, 1, 1;
- \( R_2 \); 1, −1, 1, 1;
- \( R_3 \); 1, −1, 1, 1;
- \( R_4 \); 1, −1, −1, 1;
- \( R_5 \); 2, \( i\sigma_x, \sigma_y, -\sigma_z \); QNL; 0

$\Sigma$: \( \Gamma M \); \( C_{2a}, \sigma_z, I, T \); 
- \( R_1 \); 1, 1, 1, 1;
- \( R_2 \); 1, −1, 1, 1;
- \( R_3 \); 1, −1, 1, 1;
- \( R_4 \); 1, −1, −1, 1;

$S$: \( Z A \); \( C_{2a}, \sigma_z, I, T \); 
- \( R_1 \); 1, 1, 1, 1;
- \( R_2 \); 1, −1, 1, 1;
- \( R_3 \); 1, −1, 1, 1;
- \( R_4 \); 1, −1, −1, 1;

$Y$: \( X M \); \( C_{2x}, \sigma_z, I, T \); 
- \( R_1 \); 1, 1, 1, 1;
- \( R_2 \); 1, −1, 1, 1;
- \( R_3 \); 1, −1, 1, 1;
- \( R_4 \); 1, −1, −1, 1;
$T; \ RA; C_{2z,\sigma_z,IT}; R_1; 1; 1,1,1;$
$R_2; 1; 1,−1,1;$
$R_3; 1; −1,1,1;$
$R_4; 1; −1,−1,1;$

$W; XR; C_{2z,\sigma_y,IT}; R_1; 1; 1,1,1;$
$R_2; 1; 1,−1,1;$
$R_3; 1; −1,1,1;$
$R_4; 1; −1,−1,1;$
\( \Gamma \); \((000)\): \(C_{4v}^+, C_{2h}, I, T\):

- \(R_1\): 1, 1, 1, 1;
- \(R_2\): 1, -1, 1, 1;
- \(R_3\): 1, -1, 1, 1;
- \(R_4\): 1, -1, 1, 1;
- \(R_5\): 2; \(i\sigma_2, \sigma_3, \sigma_0, \sigma_0\); \(P\)-\(QNL_{\sigma Z}\);
- \(R_6\): 1, 1, -1, 1;
- \(R_7\): 1, -1, -1, 1;
- \(R_8\): 1, -1, -1, 1;
- \(R_9\): 1, -1, -1, 1;
- \(R_{10}\): 2; \(i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0\); \(P\)-\(QNL_{\sigma Z}\);

\(M\); \((\frac{1}{2}, 0, 1)\): \(C_{4v}^+, C_{2h}, I, T\):

- \(R_1\): 1, 1, 1, 1;
- \(R_2\): 1, -1, 1, 1;
- \(R_3\): 1, -1, 1, 1;
- \(R_4\): 1, -1, 1, 1;
- \(R_5\): 2; \(i\sigma_2, \sigma_3, \sigma_0, -\sigma_0\); \(P\)-\(QNL_{\sigma MA}\);
- \(R_6\): 1, 1, -1, 1;
- \(R_7\): 1, -1, -1, 1;
- \(R_8\): 1, -1, -1, 1;
- \(R_9\): 1, -1, -1, 1;
- \(R_{10}\): 2; \(i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0\); \(P\)-\(QNL_{\sigma MA}\);

\(Z\); \((00\frac{1}{2})\): \(I, \sigma_{db}, C_{4v}^+, T\):

- \(R_{10}\): 2; \(-\sigma_3, i\sigma_2, \sigma_0, -\sigma_0\); \(P\)-\(WNLs\);
- \(R_{11}\): 2; \(-\sigma_3, i\sigma_2, -\sigma_0, -\sigma_0\); \(P\)-\(WNLs\);

\(A\); \((\frac{1}{2}, 1, 1)\): \(I, \sigma_{db}, C_{4v}^+, T\):

- \(R_{10}\): 2; \(-\sigma_3, i\sigma_2, \sigma_0, -\sigma_0\); \(P\)-\(WNLs\);
- \(R_{11}\): 2; \(-\sigma_3, i\sigma_2, -\sigma_0, -\sigma_0\); \(P\)-\(WNLs\);

\(R\); \((0, 1, \frac{1}{2})\): \(\sigma_z, C_{2h}, C_{2z}, T\):

- \(R_{10}\): 2; \(i\sigma_2, \sigma_3, \sigma_0, -\sigma_0\); \(P\)-\(WNLs\);

\(X\); \((0, \frac{1}{2}, 0)\): \(C_{2h}, C_{2h}, I, T\):

- \(R_1\): 1, 1, 1, 1;
- \(R_2\): 1, -1, 1, 1;
- \(R_3\): 1, -1, 1, 1;
- \(R_4\): 1, -1, 1, 1;
- \(R_6\): 1, -1, -1, 1;
- \(R_7\): 1, -1, -1, 1;
- \(R_8\): 1, -1, -1, 1;
- \(R_{10}\): 2; \(i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0\); \(P\)-\(WNLs\);

\(\Delta\); \(\Gamma X\): \(C_{2h}, \sigma_z, IT\):

- \(R_1\): 1, 1, 1;
- \(R_2\): 1, -1, 1;
- \(R_3\): 1, -1, 1;
- \(R_4\): 1, -1, 1;

\(U\); \(ZR\): \(\sigma_z, C_{2h}, IT\):

- \(R_5\): 2; \(\sigma_2, \sigma_3, -i\sigma_1\); \(WNL\); \(\pi\)
Λ: ΓZ; $C^+_{4z}, \sigma y, IT; \ R_1; 1; 1,1,1$;  
  $R_2; 1; 1,−1,1$;  
  $R_3; 1; −1,1,1$;  
  $R_4; 1; −1,−1,1$;  
  $R_5; 2; i\sigma_2, \sigma_3, −\sigma_0; QNL; 0$

V: MA; $C^+_{4z}, \sigma y, IT; \ R_1; 1; 1,1,1$;  
  $R_2; 1; 1,−1,1$;  
  $R_3; 1; −1,1,1$;  
  $R_4; 1; −1,−1,1$;  
  $R_5; 2; i\sigma_2, \sigma_3, −\sigma_0; QNL; 0$

Σ: ΓM; $C_2a, \sigma z, IT; \ R_1; 1; 1,1,1$;  
  $R_2; 1; 1,−1,1$;  
  $R_3; 1; −1,1,1$;  
  $R_4; 1; −1,−1,1$;

S: ZA; $\sigma_z, C_2a, IT; \ R_5; 2; \sigma_2, \sigma_3, −i\sigma_1; \ WNL; \pi$

Y: XM; $C_2a, \sigma z, IT; \ R_1; 1; 1,1,1$;  
  $R_2; 1; 1,−1,1$;  
  $R_3; 1; −1,1,1$;  
  $R_4; 1; −1,−1,1$;

T: RA; $\sigma_z, C_2a, IT; \ R_5; 2; \sigma_2, \sigma_3, −i\sigma_1; \ WNL; \pi$

W: XR; $C_{2z}, \sigma y, IT; \ R_1; 1; 1,1,1$;  
  $R_2; 1; 1,−1,1$;  
  $R_3; 1; −1,1,1$;  
  $R_4; 1; −1,−1,1$;
\[ \Gamma; \{ C_{4v}^+ \} \{ \frac{1}{2} \frac{1}{2} \frac{1}{2} \} ; \{ C_{2x} \} \{ 000 \} ; \{ I \} \{ \frac{1}{2} \frac{1}{2} \frac{1}{2} \} ; T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; (000); C_{4v}^+ , C_{2x}, I, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, -1, 1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2; i \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_{\Gamma Z}; \]
\[ R_6; 1, 1, 1, -1; \]
\[ R_7; 1, -1, -1, 1; \]
\[ R_8; 1, -1, 1, 1; \]
\[ R_9; 1, -1, -1, 1; \]
\[ R_{10}; 2; i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_{\Gamma Z}; \]

\[ M; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{4v}^+ , \sigma_x , C_{2x}; T; \]
\[ R_0; 2; \sigma_1 , i \sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{11}; 2; -i \sigma_2 , i \sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{12}; 2; -\sigma_1 , i \sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{14}; 2; -i \sigma_2 , -i \sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]

\[ Z; (00 \frac{1}{2}); C_{4v}^+ , C_{2x}, I, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, -1, 1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2; i \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_{\Gamma Z}; \]
\[ R_6; 1, 1, 1, -1; \]
\[ R_7; 1, -1, -1, 1; \]
\[ R_8; 1, -1, 1, 1; \]
\[ R_9; 1, -1, -1, 1; \]
\[ R_{10}; 2; i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_{\Gamma Z}; \]

\[ A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{4v}^+ , \sigma_x , C_{2x}, T; \]
\[ R_0; 2; \sigma_1 , i \sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{11}; 2; -i \sigma_2 , i \sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{12}; 2; -\sigma_1 , i \sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{14}; 2; -i \sigma_2 , -i \sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]

\[ R_{0} (0 \frac{1}{2}); \sigma_x, \sigma_y, C_{2y}, T; \]
\[ R_5; 2; i \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{10}; 2; i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs}; \]

\[ X; (0 \frac{1}{2}); \sigma_x, \sigma_y, C_{2y}, T; \]
\[ R_5; 2; i \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{10}; 2; i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs}; \]

\[ \Delta ; \Gamma X; \quad C_{2y}, \sigma_x, I, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, -1, 1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ U ; \Gamma R; \quad C_{2y}, \sigma_x, I, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, -1, 1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]

\[ \Lambda ; \Gamma Z; \quad C_{4v}^+ , \sigma_y , I, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, -1, 1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2; i \sigma_2, \sigma_3, -\sigma_0; \quad \text{QLN}; \quad 0 \]
| V; MA; $C_{4v}, C_{2v}, \sigma_{da}, IT$ | $R_5$; 1; $-i, 1, 1, 1$ |
| R$_6$; 1; $i, 1, 1, 1$ |
| R$_7$; 1; $i, 1, -1, 1$ |
| R$_8$; 1; $-i, 1, -1, 1$ |
| R$_9$; 2; $-\sigma_1, -\sigma_0, \sigma_3, -i\sigma_3$; QNL; 0 |

| $\Sigma$; GM; $C_{2h}, \sigma_z, IT$ | $R_1$; 1; 1, 1, 1 |
| $R_2$; 1; 1, -1, 1 |
| $R_3$; 1; -1, 1, 1 |
| $R_4$; 1; -1, -1, 1 |

| $S$; ZA; $C_{2h}, \sigma_z, IT$ | $R_1$; 1; 1, 1, 1 |
| $R_2$; 1; 1, -1, 1 |
| $R_3$; 1; -1, 1, 1 |
| $R_4$; 1; -1, -1, 1 |

| Y; XM; $\sigma_y, C_{2v}, IT$ | $R_5$; 2; $\sigma_2, \sigma_3, -i\sigma_1$; WNL; $\pi$ |

| T; RA; $\sigma_y, C_{2v}, IT$ | $R_5$; 2; $\sigma_2, \sigma_3, -i\sigma_1$; WNL; $\pi$ |

| W; XR; $\sigma_y, C_{2v}, IT$ | $R_5$; 2; $\sigma_2, \sigma_3, -i\sigma_1$; WNL; $\pi$ |
$$\Gamma_q; \{C_{4z}^+|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}, \{C_{2z}|000\}, \{I|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}; T; \text{Centrosymmetric; without SOC}$$

| $\Gamma$ | (000) | $C_{4z}^+, C_{2z}, I, T$ | $R_1$ | 1; 1, 1, 1; |
|---------|-------|-----------------|--------|----------------|
|         |       | $R_2$ | 1; 1, −1, 1, 1; |
|         |       | $R_3$ | 1; −1, 1, 1, 1; |
|         |       | $R_4$ | 1; −1, −1, 1, 1; |
|         |       | $R_5$ | 2; $i\sigma_2, \sigma_3, \sigma_0, −\sigma_0$; P-QNL; $\Gamma Z$; |
|         |       | $R_6$ | 1; 1, 1, −1, 1; |
|         |       | $R_7$ | 1; 1, −1, −1, 1; |
|         |       | $R_8$ | 1; −1, −1, −1, 1; |
|         |       | $R_9$ | 1; −1, −1, −1, 1; |
|         |       | $R_{10}$ | 2; $i\sigma_2, \sigma_3, −\sigma_0, −\sigma_0$; P-QNL; $\Gamma Z$; |
|         |       | $M_{\frac{1}{2}\frac{1}{2}\frac{1}{2}}$; $C_{4z}^+, \sigma_x, C_{2z}, T$ | $R_0$ | 2; $\sigma_1, i\sigma_2, \sigma_1, −\sigma_0$; P-WNLs; |
|         |       | $R_{11}$ | 2; $−i\sigma_2, i\sigma_2, \sigma_1, −\sigma_0$; P-WNLs; |
|         |       | $R_{12}$ | 2; $−\sigma_1, i\sigma_2, \sigma_1, −\sigma_0$; P-WNLs; |
|         |       | $R_{13}$ | 2; $−i\sigma_2, −i\sigma_2, \sigma_1, −\sigma_0$; P-WNLs; |
|         |       | $Z_{\frac{1}{2}\frac{1}{2}}$; $I, \sigma_{db}, C_{4z}^+, T$ | $R_{10}$ | 2; $−\sigma_3, i\sigma_2, \sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $R_{11}$ | 2; $−\sigma_3, i\sigma_2, −\sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $A_{\frac{1}{2}\frac{1}{2}\frac{1}{2}}$; $C_{4z}^+, \sigma_{db}, C_{2b}, T$ | $R_0$ | 2; $\sigma_1, i\sigma_2, \sigma_1, −\sigma_0$; P-WNLs; |
|         |       | $R_{11}$ | 2; $−i\sigma_2, i\sigma_2, \sigma_1, −\sigma_0$; P-WNLs; |
|         |       | $R_{12}$ | 2; $−\sigma_1, i\sigma_2, \sigma_1, −\sigma_0$; P-WNLs; |
|         |       | $R_{13}$ | 2; $−i\sigma_2, −i\sigma_2, \sigma_1, −\sigma_0$; P-WNLs; |
|         |       | $R_{14}$ | 2; $−\sigma_1, i\sigma_2, \sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $R_{15}$ | 2; $−i\sigma_2, −i\sigma_2, \sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $R_{16}$ | 2; $−\sigma_1, i\sigma_2, \sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $R_{17}$ | 2; $−i\sigma_2, i\sigma_2, \sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $X_{\frac{1}{2}\frac{1}{2}0}$; $\sigma_x, \sigma_y, C_{2y}, T$ | $R_{10}$ | 2; $\sigma_2, \sigma_3, \sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $R_{11}$ | 2; $\sigma_2, \sigma_3, −\sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $R_{12}$ | 2; $\sigma_2, \sigma_3, −\sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $R_{13}$ | 2; $\sigma_2, \sigma_3, −\sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $R_{14}$ | 2; $\sigma_2, \sigma_3, −\sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $R_{15}$ | 2; $\sigma_2, \sigma_3, −\sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $R_{16}$ | 2; $\sigma_2, \sigma_3, −\sigma_0, −\sigma_0$; P-WNLs; |
|         |       | $U_{\frac{1}{2}\frac{1}{2}0}$; $\sigma_x, I, T$ | $R_{10}$ | 2; $\sigma_2, \sigma_3, −i\sigma_1$; WNL; $\pi$ |
|         |       | $R_{11}$ | 1; 1, 1, 1; |
|         |       | $R_{12}$ | 1; 1, −1, 1; |
|         |       | $R_{13}$ | 1; −1, 1, 1; |
|         |       | $R_{14}$ | 1; −1, −1, 1; |
|         |       | $R_{15}$ | 2; $i\sigma_2, \sigma_3, −\sigma_0$; QNL; 0 |
|         |       | $V_{\frac{1}{2}\frac{1}{2}0}$; $C_{4z}^+, C_{2z}, \sigma_{db}, I, T$ | $R_{10}$ | 2; $\sigma_2, \sigma_3, −i\sigma_1$; WNL; $\pi$ |
|         |       | $R_{11}$ | 1; 1, 1, 1; |
|         |       | $R_{12}$ | 1; 1, −1, 1; |
|         |       | $R_{13}$ | 1; −1, −1, 1; |
|         |       | $R_{14}$ | 1; −1, −1, 1; |
|         |       | $R_{15}$ | 2; $−\sigma_1, −\sigma_0, \sigma_3, −i\sigma_3$; QNL; 0 |
|         |       | $\Sigma_{\frac{1}{2}\frac{1}{2}0}$; $C_{2z}, \sigma_z, I, T$ | $R_{10}$ | 2; $\sigma_2, \sigma_3, −i\sigma_1$; WNL; $\pi$ |
|         |       | $R_{11}$ | 1; 1, 1, 1; |
|         |       | $R_{12}$ | 1; 1, −1, 1; |
|         |       | $R_{13}$ | 1; −1, −1, 1; |
|         |       | $R_{14}$ | 1; −1, −1, 1; |
|         |       | $S_{\frac{1}{2}\frac{1}{2}0}$; $\sigma_x, C_{2z}, I, T$ | $R_{10}$ | 2; $\sigma_2, \sigma_3, −i\sigma_1$; WNL; $\pi$ |
|         |       | $R_{11}$ | 1; 1, 1, 1; |
|         |       | $R_{12}$ | 1; 1, −1, 1; |
|         |       | $R_{13}$ | 1; −1, −1, 1; |
|         |       | $R_{14}$ | 1; −1, −1, 1; |
\( T; \ RA; \sigma_y, C_{2x}, IT; \ R_2; 1; -i, 1, 1; \)
\( R_4; 1; i, 1, 1; \)
\( R_6; 1; -i, -1, 1; \)
\( R_8; 1; i, -1, 1; \)
\( W; \ XR; \sigma_y, C_{2z}, IT; \ R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \ WNL; \pi \)
Γ: (000): \( C_{4v}^{+}, C_{2v}, I, T \);
\[
\begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, -1, 1, 1; \\
R_3 & : 1, -1, 1, 1; \\
R_4 & : 1, -1, 1, 1; \\
R_5 & : 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{ P-QNL}_{TZ}; \\
R_6 & : 1, 1, -1, 1; \\
R_7 & : 1, 1, -1, 1; \\
R_8 & : 1, -1, -1, 1; \\
R_9 & : 1, -1, -1, 1; \\
R_{10} & : 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-QNL}_{TZ}; \\
\end{align*}
\]

M: (\(\frac{1}{2}10\)): \( C_{2v}, C_{2v}, \sigma_{dv}, I, T \);
\[
\begin{align*}
\{R_5, R_6\} & : 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \text{ P-NSs}; \\
\{R_7, R_8\} & : 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_0, \sigma_1; \text{ P-NSs}; \\
R_{10} & : 2; i\sigma_2, -\sigma_0, \sigma_3, \sigma_0, -\sigma_0; \text{ P-NSs}; \\
\{R_{15}, R_{16}\} & : 2; i\sigma_3, \sigma_0, -\sigma_0, -\sigma_0, \sigma_1; \text{ P-NSs}; \\
\{R_{17}, R_{18}\} & : 2; -i\sigma_3, \sigma_0, -\sigma_0, -\sigma_0, \sigma_1; \text{ P-NSs}; \\
R_{20} & : 2; i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-NSs}; \\
\end{align*}
\]

Z: (00\(\frac{1}{2}\)): \( C_{4v}^{+}, C_{2v}, I, T \);
\[
\begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, -1, 1, 1; \\
R_3 & : 1, -1, 1, 1; \\
R_4 & : 1, -1, 1, 1; \\
R_5 & : 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{ P-QNL}_{TZ}; \\
R_6 & : 1, 1, -1, 1; \\
R_7 & : 1, -1, -1, 1; \\
R_8 & : 1, -1, -1, 1; \\
R_9 & : 1, -1, -1, 1; \\
R_{10} & : 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-QNL}_{TZ}; \\
\end{align*}
\]

A: (\(\frac{1}{2}1\frac{1}{2}\)): \( C_{2v}, C_{2v}, \sigma_{dv}, I, T \);
\[
\begin{align*}
\{R_5, R_6\} & : 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \text{ P-NSs}; \\
\{R_7, R_8\} & : 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_0, \sigma_1; \text{ P-NSs}; \\
R_{10} & : 2; i\sigma_2, -\sigma_0, \sigma_3, \sigma_0, -\sigma_0; \text{ P-NSs}; \\
\{R_{15}, R_{16}\} & : 2; i\sigma_3, \sigma_0, -\sigma_0, -\sigma_0, \sigma_1; \text{ P-NSs}; \\
\{R_{17}, R_{18}\} & : 2; -i\sigma_3, \sigma_0, -\sigma_0, -\sigma_0, \sigma_1; \text{ P-NSs}; \\
R_{20} & : 2; i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-NSs}; \\
\end{align*}
\]

R: (0\(\frac{1}{2}\)\(\frac{1}{2}\)): \( \sigma_x, \sigma_y, \sigma_z, T \);
\[
\begin{align*}
R_5 & : 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{ P-NS}_{MARX}; \\
R_{10} & : 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-NS}_{MARX}; \\
\end{align*}
\]

X: (0\(\frac{1}{2}\)0): \( \sigma_x, \sigma_y, \sigma_z, T \);
\[
\begin{align*}
R_5 & : 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{ P-NS}_{MARX}; \\
R_{10} & : 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-NS}_{MARX}; \\
\end{align*}
\]

Δ: ΓX; \( C_{2v}, \sigma_x, IT \);
\[
\begin{align*}
R_1 & : 1, 1, 1; \\
R_2 & : 1, -1, 1; \\
R_3 & : 1, -1, 1; \\
R_4 & : 1, -1, 1; \\
\end{align*}
\]

U: ZR; \( C_{2v}, \sigma_x, IT \);
\[
\begin{align*}
R_1 & : 1, 1, 1; \\
R_2 & : 1, -1, 1; \\
R_3 & : 1, -1, 1; \\
R_4 & : 1, -1, 1; \\
\end{align*}
\]
| Group | Symbol | Description | R1, R2, R3, R4, R5, R6, R7, R8, R9, R10 | Notes |
|-------|--------|-------------|---------------------------------|-------|
| A; ΓZ | $C_{4z}, \sigma_y, IT$ | $R_1$: 1, 1, 1; $R_2$: 1, 1, -1, 1; $R_3$: 1, -1, 1, 1; $R_4$: 1, -1, -1, 1; $R_5$: 2, $i\sigma_2, \sigma_3, -\sigma_0$; QNL; 0 |
| V; MA | $\sigma_x, C_{2x}, \sigma_{da}, IT$ | $\{R_5, R_6\}$: 2, $-i\sigma_3, \sigma_0, \sigma_1$; L-NS; $\{R_7, R_8\}$: 2, $i\sigma_3, \sigma_0, -\sigma_0, \sigma_1$; L-NS; $R_{10}$: 2, $-i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0$; L-NS |
| Σ; ΓM | $C_{2a}, \sigma_z, IT$ | $R_1$: 1, 1, 1; $R_2$: 1, 1, -1, 1; $R_3$: 1, -1, 1, 1; $R_4$: 1, -1, -1, 1; |
| S; ZA | $C_{2a}, \sigma_z, IT$ | $R_1$: 1, 1, 1; $R_2$: 1, 1, -1, 1; $R_3$: 1, -1, 1, 1; $R_4$: 1, -1, -1, 1; |
| Y; XM | $\sigma_y, \sigma_z, IT$ | $\{R_2, R_4\}$: 2, $\sigma_3, \sigma_0, \sigma_1$; L-NS_{MARX}; $\{R_6, R_8\}$: 2, $\sigma_3, -\sigma_0, \sigma_1$; L-NS_{MARX}; |
| T; RA | $\sigma_y, \sigma_z, IT$ | $\{R_2, R_4\}$: 2, $\sigma_3, \sigma_0, \sigma_1$; L-NS_{MARX}; $\{R_6, R_8\}$: 2, $\sigma_3, -\sigma_0, \sigma_1$; L-NS_{MARX}; |
| W; XR | $\sigma_y, C_{2x}, IT$ | $R_5$: 2, $\sigma_2, \sigma_3, -\sigma_0$; L-NS_{MARX}; |
\[ \Gamma_q; \{ C_{4\zeta}^\dagger \{ \frac{1}{2} \frac{1}{2} 0 \}, \{ C_{2x} \{ \frac{1}{2} \frac{1}{2} 0 \}, \{ I \{ 00 \frac{1}{2} \} \}, \mathcal{T}; \text{Centrosymmetric; without SOC} \]

\[
\Gamma; (000); \quad C_{4\zeta}^+, C_{2x}, I, \mathcal{T};
\]

\[
R_1; \quad 1, 1, 1, 1;
R_2; \quad 1, -1, 1, 1;
R_3; \quad 1, -1, 1, 1;
R_4; \quad 1, -1, -1, 1;
R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_{\Gamma Z};
R_6; \quad 1, 1, 1, -1;
R_7; \quad 1, -1, -1, 1;
R_8; \quad 1, -1, 1, -1;
R_9; \quad 1, -1, -1, 1;
R_{10}; \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_{\Gamma Z};
\]

\[
M; \{ \frac{1}{2} \frac{1}{2} 0 \}; \quad C_{2x}, C_{2x}, \sigma_{db}, I, \mathcal{T}; \quad \{ R_5, R_6 \}; \quad 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-NSs};
\]

\[
\{ R_7, R_8 \}; \quad 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_0, \sigma_1; \quad \text{P-NSs};
R_9; \quad 2; i\sigma_2, -\sigma_0, \sigma_3, \sigma_0, \sigma_0; \quad \text{P-NSs};
\]

\[
\{ R_{10}, R_{16} \}; \quad 2; i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-NSs};
\]

\[
\{ R_{15}, R_{18} \}; \quad 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_0, \sigma_1; \quad \text{P-NSs};
R_{10}; \quad 2; i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-NSs};
R_{11}; \quad 2; -\sigma_3, i\sigma_2, -\sigma_0, -\sigma_0; \quad \text{P-WNLs};
\]

\[
\{ R_{12}, R_{13} \}; \quad 4; -\Gamma_{0,3}, \Gamma_{0,3}, -i\Gamma_{3,3}, \Gamma_{1,0}; \quad \text{QDP}; \quad 0
\]

\[
Z; (00\frac{1}{2}); \quad I, \sigma_{db}, C_{4\zeta}^+, \mathcal{T};
\]

\[
R_1; \quad 2; -\sigma_3, i\sigma_2, \sigma_0, -\sigma_0; \quad \text{P-WNLs};
R_{11}; \quad 2; -\sigma_3, i\sigma_2, -\sigma_0, -\sigma_0; \quad \text{P-WNLs};
\]

\[
A; \{ \frac{1}{2} \frac{1}{2} \frac{1}{2} \}; \quad I, \sigma_{db}, S_{4\zeta}^+, \mathcal{T}; \quad \{ R_{10}, R_{13} \}; \quad 4; -\Gamma_{0,3}, \Gamma_{0,3}, -i\Gamma_{3,3}, \Gamma_{1,0}; \quad \text{QDP}; \quad 0
\]

\[
R; (0\frac{1}{2}); \quad C_{2y}, C_{2x}, I, \mathcal{T};
\]

\[
R_1; \quad 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNL/NS};
R_{10}; \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNL/NS};
\]

\[
X; (0\frac{1}{2}); \quad \sigma_x, \sigma_y, \sigma_z, \mathcal{T};
\]

\[
R_1; \quad 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-N_{\text{MARX}}};
R_{10}; \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-N_{\text{MARX}}};
\]

\[
\Lambda; \quad \Gamma X; \quad C_{2y}, \sigma_x, I, \mathcal{T};
\]

\[
R_1; \quad 1, 1, 1, 1;
R_2; \quad 1, -1, -1, 1;
R_3; \quad 1, -1, 1, 1;
R_4; \quad 1, -1, -1, 1;
\]

\[
U; \quad \text{ZR}; \quad \sigma_x, C_{2y}, I, \mathcal{T};
\]

\[
R_2; \quad 2; \sigma_2, \sigma_3, -i\sigma_1; \quad \text{WNL}; \quad \pi
\]

\[
\Lambda; \quad \Gamma Z; \quad C_{4\zeta}^+, \sigma_y, I, \mathcal{T};
\]

\[
R_1; \quad 1, 1, 1, 1;
R_2; \quad 1, -1, -1, 1;
R_3; \quad 1, -1, 1, 1;
R_4; \quad 1, -1, -1, 1;
R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{QNL}; \quad 0
\]

\[
V; \quad \text{MA}; \quad \sigma_x, C_{2x}, \sigma_{db}, I, \mathcal{T};
\]

\[
\{ R_5, R_6 \}; \quad 2; -i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \quad \text{L-NSs};
\]

\[
\{ R_7, R_8 \}; \quad 2; i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{L-NSs};
R_{10}; \quad 2; -i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{L-NSs};
\]

\[
\Sigma; \quad \Gamma M; \quad C_{20}, \sigma_z, I, \mathcal{T};
\]

\[
R_1; \quad 1, 1, 1, 1;
R_2; \quad 1, -1, -1, 1;
R_3; \quad 1, -1, 1, 1;
R_4; \quad 1, -1, -1, 1;
R_5; \quad 2; i\sigma_2, \sigma_3, -i\sigma_1; \quad \text{WNL}; \quad \pi
\]

\[
Y; \quad \text{XM}; \quad \sigma_y, \sigma_z, I, \mathcal{T};
\]

\[
\{ R_2, R_4 \}; \quad 2; \sigma_3, \sigma_0, \sigma_1; \quad \text{L-N_{\text{MARX}}};
\]

\[
\{ R_6, R_8 \}; \quad 2; \sigma_3, -\sigma_0, \sigma_1; \quad \text{L-N_{\text{MARX}}};
\]

\[
\{ R_3, R_5 \}; \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-NSs};
\]

\[
\{ R_7, R_9 \}; \quad 2; i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-NSs};
\]

\[
\{ R_{10}, R_{11} \}; \quad 2; i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{P-NSs};
\]

\[
\{ R_{12}, R_{13} \}; \quad 4; -\Gamma_{0,3}, \Gamma_{0,3}, -i\Gamma_{3,3}, \Gamma_{1,0}; \quad \text{QDP}; \quad 0
\]
$T; \ RA; C_{2x}, \sigma_y, i\sigma_T; \ R_5; 2; \sigma_2, -i\sigma_1, -i\sigma_3; \text{L-NS}_{\text{MARX}}$;

$W; \ XR; \sigma_y, C_{2x}, i\sigma_T; \ R_5; 2; \sigma_2, \sigma_3, -\sigma_0; \ \text{L-NS}_{\text{MARX}}$;
Γ: (000): \(\Gamma^+_{4z}, C_{4z}, I, T\);
\(R_1\): 1, 1, 1, 1;
\(R_2\): 1, 1, 1, 1;
\(R_3\): 1, 1, 1, 1;
\(R_4\): 1, 1, 1, 1;
\(R_5\): 2, \(i\sigma_2, \sigma_3, \sigma_0, -\sigma_0\); P-QNL\(\Gamma_Z\);
\(R_6\): 1, 1, 1, 1;
\(R_7\): 1, 1, 1, 1;
\(R_8\): 1, 1, 1, 1;
\(R_9\): 1, 1, 1, 1;
\(R_{10}\): 2, \(i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0\); P-QNL\(\Gamma_Z\);

\(M\): (\(\frac{1}{2} 1 0\)): \(\Gamma^+_{4z}, C_{4z}, \sigma_x, I, T\);
\(R_0\): \(\sigma_1, i\sigma_2, \sigma_1, -\sigma_0\); P-NSs;
\(R_{11}\): \(-i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0\); P-NSs;
\(R_{12}\): \(-\sigma_1, i\sigma_2, \sigma_1, -\sigma_0\); P-NSs;
\(R_{13}\): \(-i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0\); P-NSs;

\(Z\): (00\(\frac{1}{2}\)): \(\Gamma^+_{4z}, C_{4z}, I, T\);
\(R_1\): 1, 1, 1, 1;
\(R_2\): 1, 1, 1, 1;
\(R_3\): 1, 1, 1, 1;
\(R_4\): 1, 1, 1, 1;
\(R_5\): 2, \(i\sigma_2, \sigma_3, \sigma_0, -\sigma_0\); P-QNL\(\Gamma_Z\);
\(R_6\): 1, 1, 1, 1;
\(R_7\): 1, 1, 1, 1;
\(R_8\): 1, 1, 1, 1;
\(R_9\): 1, 1, 1, 1;
\(R_{10}\): 2, \(i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0\); P-QNL\(\Gamma_Z\);

\(A\): (\(\frac{1}{2} 1 \frac{1}{2}\)): \(\Gamma^+_{4z}, C_{4z}, \sigma_x, I, T\);
\(R_0\): \(\sigma_1, i\sigma_2, \sigma_1, -\sigma_0\); P-NSs;
\(R_{11}\): \(-i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0\); P-NSs;
\(R_{12}\): \(-\sigma_1, i\sigma_2, \sigma_1, -\sigma_0\); P-NSs;
\(R_{13}\): \(-i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0\); P-NSs;

\(R\): (\(\frac{1}{2} \frac{1}{2} 0\)): \(C_{2y}, C_{2x}, \sigma_x, I, T\);
\(R_5\): \(\sigma_2, \sigma_3, \sigma_0, -\sigma_0\); P-NS\(\text{MARX}\);
\(R_{10}\): \(\sigma_2, \sigma_3, -\sigma_0, -\sigma_0\); P-NS\(\text{MARX}\);

\(X\): (0\(\frac{1}{2} 0\)): \(C_{2y}, C_{2x}, \sigma_x, I, T\);
\(R_5\): \(\sigma_2, \sigma_3, \sigma_0, -\sigma_0\); P-NS\(\text{MARX}\);
\(R_{10}\): \(\sigma_2, \sigma_3, -\sigma_0, -\sigma_0\); P-NS\(\text{MARX}\);

\(\Delta\): \(\Gamma X\); \(C_{2y}, \sigma_x, I T\);
\(R_1\): 1, 1, 1, 1;
\(R_2\): 1, 1, 1, 1;
\(R_3\): 1, 1, 1, 1;
\(R_4\): 1, 1, 1, 1;

\(U\): \(\Gamma Z\); \(C_{2y}, \sigma_x, I T\);
\(R_1\): 1, 1, 1, 1;
\(R_2\): 1, 1, 1, 1;
\(R_3\): 1, 1, 1, 1;
\(R_4\): 1, 1, 1, 1;

\(\Lambda\): \(\Gamma Z\); \(C_{4z}, \sigma_y, I T\);
\(R_1\): 1, 1, 1, 1;
\(R_2\): 1, 1, 1, 1;
\(R_3\): 1, 1, 1, 1;
\(R_4\): 1, 1, 1, 1;
\(R_5\): 2, \(i\sigma_2, \sigma_3, -\sigma_0\); QNL; 0
V; MA; $C_{4v}^{+}, \sigma_y, IT$; \{R_1, R_4\}; 2; $\sigma_3, \sigma_3, \sigma_1$; \text{L-NS}_{\text{MARX}};
\{R_2, R_3\}; 2; $\sigma_3, -\sigma_3, \sigma_1$; \text{L-NS}_{\text{MARX}};
R_5; 2; $i\sigma_2, \sigma_3, -i\sigma_1$; \text{L-NS}_{\text{MARX}};

$\Sigma$; GM; $C_{2h}, \sigma_z, IT$; $R_1$; 1; 1, 1, 1;
R_2; 1; 1, −1, 1;
R_3; 1; −1, 1, 1;
R_4; 1; −1, −1, 1;

$S$; ZA; $C_{2h}, \sigma_z, IT$; $R_1$; 1; 1, 1, 1;
R_2; 1; 1, −1, 1;
R_3; 1; −1, 1, 1;
R_4; 1; −1, −1, 1;

$Y$; XM; $C_{2v}, \sigma_y, IT$; $R_5$; 2; $\sigma_2, \sigma_3, -i\sigma_1$; \text{L-NS}_{\text{MARX}};

$T$; RA; $C_{2v}, \sigma_y, IT$; $R_5$; 2; $\sigma_2, \sigma_3, -i\sigma_1$; \text{L-NS}_{\text{MARX}};

$W$; XR; $C_{2v}, \sigma_y, IT$; \{R_1, R_4\}; 2; $\sigma_3, \sigma_3, \sigma_1$; \text{L-NS}_{\text{MARX}};
\{R_2, R_3\}; 2; $\sigma_3, -\sigma_3, \sigma_1$; \text{L-NS}_{\text{MARX}};
\[ \Gamma_q; \{ (C^+_4 \Gamma_{[000]}), (C_{2x} \sigma_z \Gamma_{[\frac{1}{2} \frac{1}{2} 0]}), (I\Gamma_{[\frac{1}{2} \frac{1}{2} \frac{1}{2}]}) \}, \Gamma; \text{Centrosymmetric; without SOC} \]

\( \Gamma; (000): \) \( C^+_4, C_{2x}, I, \mathcal{T} \):

- \( R_1; \) 1, 1, 1, 1;
- \( R_2; \) 1, 1, 1, 1;
- \( R_3; \) 1, 1, 1, 1;
- \( R_4; \) 1, 1, 1, 1;
- \( R_5; \) 2, \( i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-QNL\( \Gamma \); 2, \(-i\sigma_2, \sigma_3, \sigma_0, \sigma_0; \)
- \( R_6; \) 1, 1, 1, 1;
- \( R_7; \) 1, 1, 1, 1;
- \( R_8; \) 1, 1, 1, 1;
- \( R_9; \) 1, 1, 1, 1;
- \( R_{10}; \) 2, \( i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-QNL\( \Gamma \);

\( M; (\frac{1}{2} \frac{1}{2} 0); \) \( C^+_4, C_{2x}, \sigma_x, \mathcal{T} \):

- \( R_0; \) 2, \( \sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \) P-NSs;
- \( R_{11}; \) 2, \( -i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0; \) P-NSs;
- \( R_{12}; \) 2, \( -\sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \) P-NSs;
- \( R_{14}; \) 2, \( -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \) P-NSs;

\( Z; (00 \frac{1}{2}); \) \( I, \sigma_{dB}, C^+_4, \mathcal{T} \):

- \( R_{10}; \) 1, 2, \( -\sigma_3, i\sigma_2, \sigma_0, -\sigma_0; \) WNLs;
- \( R_{11}; \) 2, \( -\sigma_3, i\sigma_2, \sigma_0, -\sigma_0; \) WNLs;
- \( \{ R_{12}, R_{13} \}; \) 4, \( -\Gamma_{0,3}, i\Gamma_{0,2}, -i\Gamma_{3,3}, \Gamma_{1,0}; \) QDP; 0

\( A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \) \( C_{2x}, C^+_4, I, \mathcal{T} \):

- \( \{ R_9, R_{10} \}; \) 4, \( i\Gamma_{3,3}, \Gamma_{0,1}, \Gamma_{0,3}, \Gamma_{1,0}; \) QDP; 0
- \( \{ R_{13}, R_{14} \}; \) 4, \( i\Gamma_{3,0}, \Gamma_{0,2}, \Gamma_{0,3}, \Gamma_{1,0}; \) QDP; 0

\( R; (0 \frac{1}{2} \frac{1}{2}); \) \( \sigma_y, C_{2x}, I, \mathcal{T}; \)

- \( \{ R_0, R_{10} \}; \) 4, \( i\Gamma_{3,0}, \Gamma_{0,1}, \Gamma_{0,3}, \Gamma_{1,0}; \) DP; 0

\( X; (0 \frac{1}{2} 0); \) \( C_{2y}, C_{2x}, \sigma_x, \mathcal{T} \):

- \( R_5; \) 2, \( i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-NS\( \text{MARX} \);
- \( R_{10}; \) 2, \( i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \) P-NS\( \text{MARX} \);

\( \Delta; \) \( \Gamma_X; \) \( C_{2y}, \sigma_x, \mathcal{I}; \)

- \( R_1; \) 1, 1, 1, 1;
- \( R_2; \) 1, 1, 1, 1;
- \( R_3; \) 1, 1, 1, 1;
- \( R_4; \) 1, 1, 1, 1;

\( U; \) \( \Gamma_R; \) \( \sigma_z, C_{2y}, \mathcal{I}; \)

- \( R_5; \) 2, \( \sigma_2, \sigma_3, -i\sigma_1; \) WNL; \( \pi \)

\( \Lambda; \) \( \Gamma_Z; \) \( C^+_4, \sigma_y, \mathcal{I}; \)

- \( R_1; \) 1, 1, 1, 1;
- \( R_2; \) 1, 1, 1, 1;
- \( R_3; \) 1, 1, 1, 1;
- \( R_4; \) 1, 1, 1, 1;

\( V; \) \( \text{MA}; \) \( C^+_4, \sigma_y, \mathcal{I}; \)

- \( \{ R_1, R_4 \}; \) 2, \( \sigma_3, \sigma_3, \sigma_1; \) L-NS\( \text{MARX} \);
- \( \{ R_2, R_3 \}; \) 2, \( \sigma_3, -\sigma_3, \sigma_1; \) L-NS\( \text{MARX} \);
- \( \{ R_5 \}; \) 2, \( i\sigma_2, \sigma_3, -i\sigma_1; \) QNL; 0

\( \Sigma; \) \( \Gamma_M; \) \( C_{2x}, \sigma_z, \mathcal{I}; \)

- \( R_1; \) 1, 1, 1, 1;
- \( R_2; \) 1, 1, 1, 1;
- \( R_3; \) 1, 1, 1, 1;
- \( R_4; \) 1, 1, 1, 1;

\( S; \) \( \text{ZA}; \) \( \sigma_z, C_{2x}, \mathcal{I}; \)

- \( R_5; \) 2, \( \sigma_2, \sigma_3, -i\sigma_1; \) WNL; \( \pi \)

\( Y; \) \( \text{XM}; \) \( C_{2x}, \sigma_y, \mathcal{I}; \)

- \( R_5; \) 2, \( \sigma_2, \sigma_3, -i\sigma_1; \) L-NS\( \text{MARX} \);

\( T; \) \( \text{RA}; \) \( C_{2x}, \sigma_y, \mathcal{I}; \)

\( \{ R_2, R_8 \}; \) 2, \( \sigma_3, -i\sigma_3, \sigma_1; \) L-NS\( \text{MARX} \);
\( \{ R_4, R_6 \}; \) 2, \( -\sigma_3, -i\sigma_3, \sigma_1; \) L-NS\( \text{MARX} \);
\( \{ R_2, R_3 \}; \) 2, \( \sigma_3, -\sigma_3, \sigma_1; \) L-NS\( \text{MARX} \);

\( W; \) \( \text{XR}; \) \( C_{2x}, \sigma_y, \mathcal{I}; \)

\( \{ R_1, R_4 \}; \) 2, \( \sigma_3, \sigma_3, \sigma_1; \) L-NS\( \text{MARX} \);
\( \{ R_2, R_3 \}; \) 2, \( \sigma_3, -\sigma_3, \sigma_1; \) L-NS\( \text{MARX} \);
SG 131

$\Gamma_q; \{C_{4z}^+ \{001\}\}, \{C_{2z}\{000\}\}, \{I\{000\}\}. T; \text{Centrosymmetric; without SOC}$

$\Gamma; \ (000); \ C_{4z}^+, C_{2z}, I, T; \ \begin{align*}
R_1: & \ 1, 1, 1, 1; \\
R_2: & \ 1, -1, 1, 1; \\
R_3: & \ 1, -1, 1, 1; \\
R_4: & \ 1, -1, -1, 1; \\
R_5: & \ 2; \ i \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \ \text{P-QNL}_2; \\
R_6: & \ 1, 1, -1, 1; \\
R_7: & \ 1, -1, -1, 1; \\
R_8: & \ 1, -1, 1, 1; \\
R_9: & \ 1, -1, 1, 1; \\
R_{10}: & \ 2; \ i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \ \text{P-QNL}_2; \\
\end{align*}$

$M; \ (1\frac{1}{2} 0); \ C_{4z}^+, C_{2z}, I, T; \ \begin{align*}
R_1: & \ 1, 1, 1, 1; \\
R_2: & \ 1, -1, 1, 1; \\
R_3: & \ 1, -1, 1, 1; \\
R_4: & \ 1, -1, 1, 1; \\
R_5: & \ 2; \ i \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \ \text{P-QNL}_{MA}; \\
R_6: & \ 1, 1, -1, 1; \\
R_7: & \ 1, -1, -1, 1; \\
R_8: & \ 1, -1, 1, 1; \\
R_9: & \ 1, -1, -1, 1; \\
R_{10}: & \ 2; \ i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \ \text{P-QNL}_{MA}; \\
\end{align*}$

$Z; \ (00\frac{1}{2}); \ C_{4z}^+, \sigma_{db}, C_{2b}, T; \ \begin{align*}
R_9: & \ 2; \ \sigma_1, i \sigma_2, \sigma_1, -\sigma_0; \ \text{P-WNLs}; \\
R_{11}: & \ 2; \ -i \sigma_2, i \sigma_2, \sigma_1, -\sigma_0; \ \text{P-WNLs}; \\
R_{12}: & \ 2; \ -\sigma_1, i \sigma_2, \sigma_1, -\sigma_0; \ \text{P-WNLs}; \\
R_{14}: & \ 2; \ -i \sigma_2, -i \sigma_2, \sigma_1, -\sigma_0; \ \text{P-WNLs}; \\
R_{15}: & \ 2; \ -\sigma_1, -i \sigma_2, \sigma_1, -\sigma_0; \ \text{P-WNLs}; \\
\end{align*}$

$A; \ (1\frac{1}{2} 1\frac{1}{2}); \ C_{4z}^+, \sigma_{db}, C_{2b}, T; \ \begin{align*}
R_9: & \ 2; \ \sigma_1, i \sigma_2, \sigma_1, -\sigma_0; \ \text{P-WNLs}; \\
R_{11}: & \ 2; \ -i \sigma_2, i \sigma_2, \sigma_1, -\sigma_0; \ \text{P-WNLs}; \\
R_{12}: & \ 2; \ -\sigma_1, i \sigma_2, \sigma_1, -\sigma_0; \ \text{P-WNLs}; \\
R_{14}: & \ 2; \ -i \sigma_2, -i \sigma_2, \sigma_1, -\sigma_0; \ \text{P-WNLs}; \\
R_{15}: & \ 2; \ -\sigma_1, -i \sigma_2, \sigma_1, -\sigma_0; \ \text{P-WNLs}; \\
\end{align*}$

$R; \ (01\frac{1}{2}); \ C_{2z}, C_{2y}, I, T; \ \begin{align*}
R_1: & \ 1, 1, 1, 1; \\
R_2: & \ 1, -1, 1, 1; \\
R_3: & \ 1, -1, 1, 1; \\
R_4: & \ 1, -1, -1, 1; \\
R_5: & \ 1, 1, -1, 1; \\
R_6: & \ 1, -1, -1, 1; \\
R_7: & \ 1, -1, -1, 1; \\
R_8: & \ 1, -1, -1, 1; \\
\end{align*}$
\( X; (0,\frac{1}{2},0) \); \( C_{2\bar{z}}, C_{2y}, I, T \);
\( R_1; 1, 1, 1, 1; \)
\( R_2; 1, -1, 1, 1; \)
\( R_3; 1, -1, 1, 1; \)
\( R_4; 1, -1, -1, 1; \)
\( R_5; 1, 1, -1, 1; \)
\( R_6; 1, -1, 1, 1; \)
\( R_7; 1, -1, -1, 1; \)
\( R_8; 1, -1, -1, 1; \)

\( \Delta; \Gamma_X; C_{2y}, \sigma_z, IT \);
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, -1, 1; \)

\( U; ZR; C_{2y}, \sigma_z, IT \);
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, -1, 1; \)

\( \Lambda; \Gamma_Z; C_{4z}, \sigma_y, IT \);
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, -1, 1; \)
\( R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; \) QNL; 0

\( V; \Gamma_A; C_{4z}^+, \sigma_y, IT \);
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, -1, 1; \)
\( R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; \) QNL; 0

\( \Sigma; \Gamma_M; C_{2a}, \sigma_z, IT \);
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, -1, 1; \)

\( S; ZA; C_{2a}, \sigma_z, IT \);
\( R_5; 2, \sigma_2, \sigma_3, -\sigma_0; \) WNL; \( \pi \)

\( Y; \Gamma_M; C_{2z}, \sigma_z, IT \);
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, -1, 1; \)

\( T; \Gamma_A; C_{2z}, \sigma_z, IT \);
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, -1, 1; \)

\( W; \Gamma_R; C_{2z}, \sigma_y, IT \);
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)
\( R_3; 1, -1, 1; \)
\( R_4; 1, -1, -1, 1; \)
\( \Gamma ; \{ C_{4x}^+ | 000 \}, \{ C_{2x} | 000 \}, \{ I | 000 \}, \mathcal{T} \); Centrosymmetric; without SOC

\[ \Gamma \; (000) \; C_{4x}^+, C_{2x}, I, \mathcal{T}; \]
\[ R_1; \; 1, 1, 1, 1; \]
\[ R_2; \; 1, -1, 1, 1; \]
\[ R_3; \; 1, -1, 1, 1; \]
\[ R_4; \; 1, -1, -1, 1; \]
\[ R_5; \; 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_Z; \]
\[ R_6; \; 1, 1, 1, -1; \]
\[ R_7; \; 1, -1, -1, 1; \]
\[ R_8; \; 1, -1, 1, 1; \]
\[ R_9; \; 1, -1, -1, 1; \]
\[ R_{10}; \; 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_Z; \]

\[ M; \; (\frac{1}{2} \frac{1}{2} 0) \; C_{4x}^+, C_{2x}, I, \mathcal{T}; \]
\[ R_1; \; 1, 1, 1, 1; \]
\[ R_2; \; 1, -1, 1, 1; \]
\[ R_3; \; 1, -1, 1, 1; \]
\[ R_4; \; 1, -1, -1, 1; \]
\[ R_5; \; 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_M; \]
\[ R_6; \; 1, 1, 1, -1; \]
\[ R_7; \; 1, 1, -1, 1; \]
\[ R_8; \; 1, -1, 1, 1; \]
\[ R_9; \; 1, -1, -1, 1; \]
\[ R_{10}; \; 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_M; \]

\[ Z; \; (00 \frac{1}{2}) \; C_{4x}, \sigma_x, C_{2x}, \mathcal{T}; \]
\[ R_0; \; 2, \sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{11}; \; 2, -i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{12}; \; 2, -\sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{14}; \; 2, -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]

\[ A; \; (\frac{1}{2} \frac{1}{2} \frac{1}{2}) \; C_{4x}, \sigma_x, C_{2x}, \mathcal{T}; \]
\[ R_0; \; 2, \sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{11}; \; 2, -i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{12}; \; 2, -\sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{14}; \; 2, -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \]

\[ R; \; (0 \frac{1}{2} \frac{1}{2}) \; \sigma_x, C_{2y}, C_{2z}, \mathcal{T}; \]
\[ R_5; \; 2, i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_{10}; \; 2, i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs}; \]

\[ X; \; (0 \frac{1}{2} 0) \; C_{2x}, C_{2y}, I, \mathcal{T}; \]
\[ R_1; \; 1, 1, 1, 1; \]
\[ R_2; \; 1, -1, 1, 1; \]
\[ R_3; \; 1, -1, 1, 1; \]
\[ R_4; \; 1, -1, -1, 1; \]
\[ R_5; \; 1, 1, 1, -1; \]
\[ R_6; \; 1, -1, 1, -1; \]
\[ R_7; \; 1, -1, -1, 1; \]
\[ R_8; \; 1, -1, -1, 1; \]

\[ \Delta; \; \Gamma X; \quad C_{2y}, \sigma_x, I, \mathcal{T}; \]
\[ R_1; \; 1, 1, 1; \]
\[ R_2; \; 1, -1, 1; \]
\[ R_3; \; 1, -1, 1; \]
\[ R_4; \; 1, -1, -1; \]

\[ U; \; ZR; \quad \sigma_z, C_{2y}, I, \mathcal{T}; \]
\[ R_5; \; 2, \sigma_2, \sigma_3, -i\sigma_1; \quad \text{WNL}; \quad \pi \]
| \( \Lambda; \Gamma Z \): \( C_{4v}^{+}, \sigma_y, IT \) | \( R_1 \): 1, 1, 1; |
| \( R_2 \): 1, 1, \(-1, 1\); |
| \( R_3 \): 1, \(-1, 1, 1\); |
| \( R_4 \): 1, \(-1, -1, 1\); |
| \( R_5 \): 2; \( i\sigma_2, \sigma_3, -\sigma_0 \); QNL; 0 |

| \( V; MA \): \( C_{4v}^{+}, \sigma_y, IT \) | \( R_1 \): 1, 1, 1, 1; |
| \( R_2 \): 1, 1, \(-1, 1\); |
| \( R_3 \): 1, \(-1, 1, 1\); |
| \( R_4 \): 1, \(-1, -1, 1\); |
| \( R_5 \): 2; \( i\sigma_2, \sigma_3, -\sigma_0 \); QNL; 0 |

| \( \Sigma; \Gamma M \): \( C_{2a}, \sigma_x, IT \) | \( R_1 \): 1, 1, 1, 1; |
| \( R_2 \): 1, 1, \(-1, 1\); |
| \( R_3 \): 1, \(-1, 1, 1\); |
| \( R_4 \): 1, \(-1, -1, 1\); |

| \( S; \Gamma A \): \( C_{2a}, \sigma_d, IT \) | \( R_2 \): 1, 1, 1, 1; |
| \( R_4 \): 1, \(-1, 1, 1\); |
| \( R_6 \): 1, \(-1, 1, 1\); |
| \( R_8 \): 1, \(-1, -1, 1\); |

| \( Y; \Gamma M \): \( C_{2v}, \sigma_z, IT \) | \( R_1 \): 1, 1, 1, 1; |
| \( R_2 \): 1, 1, \(-1, 1\); |
| \( R_3 \): 1, \(-1, 1, 1\); |
| \( R_4 \): 1, \(-1, -1, 1\); |

| \( T; RA \): \( \sigma_z, C_{2v}, IT \) | \( R_5 \): 2; \( \sigma_2, \sigma_3, -i\sigma_1 \); WNL; \( \pi \) |

| \( W; XR \): \( C_{2v}, \sigma_y, IT \) | \( R_1 \): 1, 1, 1, 1; |
| \( R_2 \): 1, 1, \(-1, 1\); |
| \( R_3 \): 1, \(-1, 1, 1\); |
| \( R_4 \): 1, \(-1, -1, 1\); |
\[ \Gamma; \{ C_{\frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}}, \{ C_{2z}\{000\}, \{ I\frac{1}{2} \frac{1}{2} \frac{1}{2} \}\}; \ Centrosymmetric; \ without \ SOC \]

\[ \Gamma; \ (000); \ C_{4z}^+, \ C_{2z}, I, T; \]

\[ \begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, 1, -1, 1; \\
R_3 & : 1, -1, 1, 1; \\
R_4 & : 1, -1, -1, 1; \\
R_5 & : 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_{\Gamma Z}; \\
R_6 & : 1, 1, 1, 1; \\
R_7 & : 1, 1, -1, 1; \\
R_8 & : 1, -1, 1, 1; \\
R_9 & : 1, -1, -1, 1; \\
R_{10} & : 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_{\Gamma Z}; \\
R_{11} & : 2; \sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \\
R_{12} & : 2; -i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \\
R_{13} & : 2; -\sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \\
R_{14} & : 2; -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \\
R_{15} & : 2; -\sigma_3, i\sigma_2, \sigma_0, -\sigma_0; \quad \text{P-WNLs}; \\
R_{16} & : 2; -\sigma_3, i\sigma_2, -\sigma_0, -\sigma_0; \quad \text{P-WNLs}; \\
\end{align*} \]

\[ \begin{align*}
\{ R_{12}, R_{13} \} & : 4; -\Gamma_{0,3,4}\Gamma_{0,2,3,}\Gamma_{3,3,1,0}; \quad \text{QDP}; \quad 0 \\
\end{align*} \]

\[ \begin{align*}
X; \ (0\frac{1}{2} \frac{1}{2}); \ C_{4z}^+, \ C_{2z}, I, T; \\
R_5 & : 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNLs}; \\
R_{10} & : 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs}; \\
R_{11} & : 2; \sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \\
R_{12} & : 2; -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \\
R_{13} & : 2; -\sigma_3, i\sigma_2, \sigma_0, -\sigma_0; \quad \text{P-WNLs}; \\
R_{14} & : 2; -\sigma_3, i\sigma_2, -\sigma_0, -\sigma_0; \quad \text{P-WNLs}; \\
\end{align*} \]
\[ \Sigma: \Gamma M; C_{2a, \sigma_z, IT}; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ S; ZA; C_{2a, \sigma_z, IT}; R_5; 2; \sigma_2, \sigma_3, -\sigma_0; \text{WNL}; \pi \]
\[ Y; XM; \sigma_y, C_{2x}, IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL}; \pi \]
\[ T; RA; \sigma_y, C_{2z}, IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL}; \pi \]
\[ W; XR; \sigma_y, C_{2z}, IT; R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \text{WNL}; \pi \]
\[ \Gamma_q; \{ C^{+}_{4z} \mid \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ C_{2z} \mid 000 \}, \{ I \mid \frac{1}{2} \frac{1}{2} \frac{1}{2} \}; \text{Centrosymmetric; without SOC} \]

\[
\begin{array}{ll}
\Gamma; (000); & C^{+}_{4z}, C_{2z}, I, T; \\
R_1; & 1, 1, 1, 1;
R_2; & 1, -1, 1, 1;
R_3; & 1, -1, 1, 1;
R_4; & 1, -1, 1, 1;
R_5; & \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_Z; \\
R_6; & 1, 1, -1, 1;
R_7; & 1, -1, -1, 1;
R_8; & 1, -1, -1, 1;
R_9; & 1, -1, -1, 1;
R_{10}; & \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_Z; \\
\end{array}
\]

\[
\begin{array}{ll}
M; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); & C^{+}_{4z}, \sigma_x, C_{2z}, T; \\
R_1; & 1, 1, 1, 1;
R_2; & -1, -1, 1, 1;
R_3; & 1, -1, -1, 1;
R_4; & 1, 1, -1, 1;
R_5; & \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_A; \\
R_6; & 1, 1, -1, 1;
R_7; & 1, -1, -1, 1;
R_8; & 1, -1, -1, 1;
R_9; & 1, -1, -1, 1;
R_{10}; & \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_A; \\
\end{array}
\]

\[
\begin{array}{ll}
R; (0 \frac{1}{2} \frac{1}{2}); & \sigma_y, C_{2y}, C_{2z}, T; \\
R_1; & 1, 1, 1, 1;
R_2; & \sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNLs;}
R_{10}; & \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs;}
\end{array}
\]

\[
\begin{array}{ll}
X; (0 \frac{1}{2} \frac{1}{2}); & \sigma_x, \sigma_y, C_{2y}, T; \\
R_1; & 1, 1, 1, 1;
R_{10}; & \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs;}
\end{array}
\]

\[
\begin{array}{ll}
\Delta; \Gamma X; & C_{2y}, \sigma_x, I T; \\
R_1; & 1, 1, 1, 1;
R_2; & 1, -1, 1, 1;
R_3; & 1, -1, 1, 1;
R_4; & 1, -1, 1, 1;
\end{array}
\]

\[
\begin{array}{ll}
U; \Gamma R; & \sigma_z, C_{2y}, I T; \\
R_1; & 1, 1, 1, 1;
R_2; & 1, -1, 1, 1;
R_3; & 1, -1, 1, 1;
R_4; & 1, -1, 1, 1;
R_5; & \sigma_2, \sigma_3, -\sigma_1; \quad \text{WNL; } \pi
\end{array}
\]

\[
\begin{array}{ll}
\Lambda; \Gamma Z; & C^{+}_{4z}, \sigma_y, I T; \\
R_1; & 1, 1, 1, 1;
R_2; & 1, -1, 1, 1;
R_3; & 1, -1, 1, 1;
R_4; & 1, -1, 1, 1;
R_5; & \sigma_2, \sigma_3, -\sigma_0; \quad \text{QNL; } 0
\end{array}
\]
V: MA; \(C_{4v}, C_{2v}, \sigma_d, IT\); 
\[ \begin{align*}
R_5 & : -i, 1, 1, 1; \\
R_6 & : i, 1, 1, 1; \\
R_7 & : i, 1, -1, 1; \\
R_8 & : -i, 1, -1, 1; \\
R_9 & : 2; -\sigma_1, -\sigma_6, \sigma_3, -i\sigma_3; \text{QNL} ; 0
\end{align*} \]

\[ \sum; \Gamma M; C_{2a}, \sigma_z, IT; \]
\[ \begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, -1, 1, 1; \\
R_3 & : 1, -1, 1, 1; \\
R_4 & : 1, -1, -1, 1; \\
R_5 & : 2; -\sigma_1, -\sigma_6, \sigma_3, -i\sigma_3; \text{QNL} ; 0
\end{align*} \]

\[ \Sigma; \Gamma M; C_{2a}, \sigma_z, IT; \]

\[ \begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, 1, 1, 1; \\
R_3 & : 1, -1, 1, 1; \\
R_4 & : 1, -1, -1, 1; \\
R_5 & : 2; -\sigma_1, -\sigma_6, \sigma_3, -i\sigma_3; \text{QNL} ; 0
\end{align*} \]

\[ \Sigma; \sum; C_{2a}, \sigma_z, IT; \]

\[ \begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, 1, 1, 1; \\
R_3 & : 1, -1, 1, 1; \\
R_4 & : 1, -1, -1, 1; \\
R_5 & : 2; -\sigma_1, -\sigma_6, \sigma_3, -i\sigma_3; \text{QNL} ; 0
\end{align*} \]

\[ \Sigma; \sum; C_{2a}, \sigma_z, IT; \]

\[ \begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, 1, 1, 1; \\
R_3 & : 1, -1, 1, 1; \\
R_4 & : 1, -1, -1, 1; \\
R_5 & : 2; -\sigma_1, -\sigma_6, \sigma_3, -i\sigma_3; \text{QNL} ; 0
\end{align*} \]

\[ \Sigma; \sum; C_{2a}, \sigma_z, IT; \]

\[ \begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, 1, 1, 1; \\
R_3 & : 1, -1, 1, 1; \\
R_4 & : 1, -1, -1, 1; \\
R_5 & : 2; -\sigma_1, -\sigma_6, \sigma_3, -i\sigma_3; \text{QNL} ; 0
\end{align*} \]

\[ \Sigma; \sum; C_{2a}, \sigma_z, IT; \]

\[ \begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, 1, 1, 1; \\
R_3 & : 1, -1, 1, 1; \\
R_4 & : 1, -1, -1, 1; \\
R_5 & : 2; -\sigma_1, -\sigma_6, \sigma_3, -i\sigma_3; \text{QNL} ; 0
\end{align*} \]

\[ \Sigma; \sum; C_{2a}, \sigma_z, IT; \]

\[ \begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, 1, 1, 1; \\
R_3 & : 1, -1, 1, 1; \\
R_4 & : 1, -1, -1, 1; \\
R_5 & : 2; -\sigma_1, -\sigma_6, \sigma_3, -i\sigma_3; \text{QNL} ; 0
\end{align*} \]
\( \Gamma_q; \{ C_{4z}^{+}, C_{2z}, J, T \}; \quad R_3; \quad 1, 1, 1, 1; \)

\( R_4; \quad 1, 1, -1, 1; \)

\( R_5; \quad 2; i\sigma_2, \sigma_0, \sigma_0; \quad \text{P-QNL}_{\Gamma Z}; \)

\( R_6; \quad 1, 1, 1, 1; \)

\( R_7; \quad 1, 1, -1, 1; \)

\( R_8; \quad 1, 1, -1, 1; \)

\( R_9; \quad 1, 1, 1, 1; \)

\( M; \{ \frac{1}{3}, \frac{1}{3}, \frac{1}{3} \}; C_{2z}, C_{2z}, J, T; \quad \{ R_5, R_6 \}; \quad 2; i\sigma_2, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-NSs}; \)

\( \{ R_7, R_8 \}; \quad 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_0, \sigma_1; \quad \text{P-NSs}; \)

\( R_9; \quad 2; i\sigma_2, -\sigma_0, \sigma_0, -\sigma_0; \quad \text{P-NSs}; \)

\( \{ R_{13}, R_{14} \}; \quad 4; i\Gamma_{3,0}, i\Gamma_{0,2}, i\Gamma_{0,3}, i\Gamma_{1,0}; \quad \text{QDP}; \quad 0 \)

\( \Delta; \Gamma X; \quad C_{2y}, \sigma_z, J, T; \quad R_1; \quad 1, 1, 1, 1; \)

\( R_2; \quad 1, 1, -1, 1; \)

\( R_3; \quad 1, 1, 1, 1; \)

\( R_4; \quad 1, -1, 1, 1; \)

\( U; \Gamma R; \quad C_{2y}, \sigma_z, J, T; \quad R_1; \quad 1, 1, 1, 1; \)

\( R_2; \quad 1, 1, -1, 1; \)

\( R_3; \quad 1, 1, 1, 1; \)

\( R_4; \quad 1, -1, 1, 1; \)

\( V; \Gamma Z; \quad C_{2z}, \sigma_x, J, T; \quad \{ R_5, R_6 \}; \quad 2; -i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \quad \text{L-NSs}; \)

\( \{ R_7, R_8 \}; \quad 2; i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{L-NSs}; \)

\( R_{10}; \quad 2; -i\sigma_2, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{L-NSs}; \)
\[ \sum; \Gamma M; C_{2a, \sigma z, IT}; R_1; \quad 1; 1, 1, 1; \]
\[ R_2; \quad 1; 1, -1, 1; \]
\[ R_3; \quad 1; -1, 1, 1; \]
\[ R_4; \quad 1; -1, -1, 1; \]
\[ S; \, ZA; C_{2a, \sigma z, IT}; R_5; \quad 2; \sigma_2, \sigma_3, -\sigma_0; \text{WNL}; \pi \]
\[ Y; \, XM; C_{2z, \sigma_1, IT}; \{ R_2, R_4 \}; \quad 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}\_\text{MARX}; \]
\[ \{ R_6, R_8 \}; \quad 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NS}\_\text{MARX}; \]
\[ T; \, RA; C_{2z, \sigma_2, IT}; \{ R_2, R_4 \}; \quad 2; \sigma_3, \sigma_0, \sigma_1; \text{L-NS}\_\text{MARX}; \]
\[ \{ R_6, R_8 \}; \quad 2; \sigma_3, -\sigma_0, \sigma_1; \text{L-NS}\_\text{MARX}; \]
\[ W; \, XR; \sigma_y, C_{2z, IT}; R_5; \quad 2; \sigma_2, \sigma_3, -\sigma_0; \text{L-NS}\_\text{MARX}; \]
\[ \Gamma; \{C_{4y}^{+}[\frac{1}{2}\frac{1}{2}\frac{1}{2}], \{C_{2x}[\frac{1}{2}\frac{1}{2}0], \{I[00\frac{1}{2}]\}\}; \text{Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma; \quad (000): & \quad C_{4y}^{+},C_{2x},I,T; \quad R_3; \quad 1; 1,1,1,1; \\
R_2; & \quad 1; 1,-1,1,1; \\
R_3; & \quad 1; -1,1,1,1; \\
R_4; & \quad 1; -1,-1,1,1; \\
R_5; & \quad 2; i\sigma_2,\sigma_3,\sigma_0,-\sigma_0; \quad \text{P-QNL}_\Gamma; \\
R_6; & \quad 1; 1,1,-1,1; \\
R_7; & \quad 1; 1,-1,-1,1; \\
R_8; & \quad 1; -1,1,-1,1; \\
R_9; & \quad 1; -1,-1,-1,1; \\
R_{10}; & \quad 2; i\sigma_2,\sigma_3,-\sigma_0,-\sigma_0; \quad \text{P-QNL}_\Gamma; \\
M; \quad (\frac{1}{2}\frac{1}{2}0): & \quad C_{2x},C_{2z},\sigma_{xy},I,T; \quad \{R_5, R_6\}; \quad 2; i\sigma_3,\sigma_0,\sigma_0,\sigma_1; \quad \text{P-NSs}; \\
\{R_7, R_8\}; \quad 2; -i\sigma_3,\sigma_0,-\sigma_0,\sigma_0,\sigma_1; \quad \text{P-NSs}; \\
R_{10}; & \quad 2; i\sigma_2,-\sigma_0,\sigma_3,\sigma_0,-\sigma_0; \quad \text{P-NSs}; \\
\{R_{15}, R_{16}\}; \quad 2; i\sigma_3,\sigma_0,-\sigma_0,\sigma_1; \quad \text{P-NSs}; \\
\{R_{17}, R_{18}\}; \quad 2; -i\sigma_3,\sigma_0,-\sigma_0,-\sigma_0,\sigma_1; \quad \text{P-NSs}; \\
R_{20}; & \quad 2; i\sigma_2,-\sigma_0,\sigma_3,-\sigma_0,-\sigma_0; \quad \text{P-NSs}; \\
Z; \quad (00\frac{1}{2}): & \quad C_{4y}^{+},\sigma_x,C_{2x},T; \quad R_9; \quad 2; \sigma_1,i\sigma_2,\sigma_1,-\sigma_0; \quad \text{P-WNLs}; \\
R_{11}; & \quad 2; -i\sigma_2,\sigma_2,\sigma_1,-\sigma_0; \quad \text{P-WNLs}; \\
R_{12}; & \quad 2; -\sigma_1,i\sigma_2,\sigma_1,-\sigma_0; \quad \text{P-WNLs}; \\
R_{14}; & \quad 2; -i\sigma_2,-i\sigma_2,\sigma_1,-\sigma_0; \quad \text{P-WNLs}; \\
A; \quad (\frac{1}{2}\frac{1}{2}\frac{1}{2}): & \quad C_{4y}^{+},C_{2z},\sigma_x,T; \quad R_9; \quad 2; \sigma_1,i\sigma_2,\sigma_1,-\sigma_0; \quad \text{P-NSs}; \\
R_{11}; & \quad 2; -i\sigma_2,i\sigma_2,\sigma_1,-\sigma_0; \quad \text{P-NSs}; \\
R_{12}; & \quad 2; -\sigma_1,i\sigma_2,\sigma_1,-\sigma_0; \quad \text{P-NSs}; \\
R_{14}; & \quad 2; -i\sigma_2,-i\sigma_2,\sigma_1,-\sigma_0; \quad \text{P-NSs}; \\
R; \quad (0\frac{1}{2}\frac{1}{2}): & \quad C_{2y},C_{2z},I,T; \quad R_9; \quad 2; i\sigma_2,\sigma_3,\sigma_0,-\sigma_0; \quad \text{P-NSs}; \\
R_{10}; & \quad 2; i\sigma_2,\sigma_3,-\sigma_0,-\sigma_0; \quad \text{P-NSs}; \\
X; \quad (0\frac{1}{2}0): & \quad \sigma_x,\sigma_y,\sigma_z,T; \quad R_9; \quad 2; i\sigma_2,\sigma_3,\sigma_0,-\sigma_0; \quad \text{P-NS}_{\text{MARX}}; \\
R_{10}; & \quad 2; i\sigma_2,\sigma_3,-\sigma_0,-\sigma_0; \quad \text{P-NS}_{\text{MARX}}; \\
\Delta; \Gamma; \quad C_{2y},\sigma_x,IT; \quad R_1; \quad 1; 1,1,1; \\
R_2; & \quad 1; 1,-1,1; \\
R_3; & \quad 1; -1,1,1; \\
R_4; & \quad 1; -1,-1,1; \\
U; \quad ZR; \quad \sigma_x,C_{2y},IT; \quad R_9; \quad 2; \sigma_2,\sigma_3,-i\sigma_1; \quad \text{WNL}; \quad \pi \\
\Lambda; \quad \Gamma; \quad C_{4y}^{+},\sigma_y,IT; \quad R_1; \quad 1; 1,1,1; \\
R_2; & \quad 1; 1,-1,1; \\
R_3; & \quad 1; -1,1,1; \\
R_4; & \quad 1; -1,-1,1; \\
R_5; & \quad 2; i\sigma_2,\sigma_3,-\sigma_0; \quad \text{QNL}; \quad 0 \\
V; \quad \text{MA}; \quad \sigma_x,C_{2z},\sigma_{xy},IT; \quad \{R_5, R_6\}; \quad 2; -i\sigma_3,\sigma_0,\sigma_0,\sigma_1; \quad \text{L-NSs}; \\
\{R_7, R_8\}; \quad 2; i\sigma_3,\sigma_0,-\sigma_0,\sigma_1; \quad \text{L-NSs}; \\
R_{10}; & \quad 2; -i\sigma_2,-\sigma_0,\sigma_3,-\sigma_0; \quad \text{L-NSs};
Σ: ΓM; $C_{2a,\sigma_z,IT}$; $R_1$: 1; 1,1,1;
$R_2$: 1; 1,−1,1;
$R_3$: 1; −1,1,1;
$R_4$: 1; −1,−1,1;

S: ZA; $C_{2a,\sigma_{db},IT}$; $R_2$: 1; 1,1,1;
$R_4$: 1; −1,1,1;
$R_6$: 1; 1,−1,1;
$R_8$: 1; −1,−1,1;

Y: XM; $C_{2x,\sigma_z,IT}$; $\{R_2, R_4\}$: 2; $\sigma_3, \sigma_0, \sigma_1$; L-NS$_{MARX}$;
$\{R_6, R_8\}$: 2; $\sigma_3, -\sigma_0, \sigma_1$; L-NS$_{MARX}$;

T: RA; $C_{2x,\sigma_z,IT}$; $R_5$: 2; $\sigma_2, \sigma_1, -i\sigma_1$; L-NS$_{MARX}$;

W: XR; $\sigma_y, C_{2x, IT}$; $R_5$: 2; $\sigma_2, \sigma_3, -\sigma_0$; L-NS$_{MARX}$;
\( \Gamma_q; \{ C_{4z}^+|000\}, \{ C_{2z}x|\frac{1}{2}\frac{1}{2}0\}, \{ I|\frac{1}{2}\frac{1}{2}\frac{1}{2}0\}, T; \text{Centrosymmetric; without SOC} \)

\[
\begin{array}{|c|c|c|c|}
\hline
& \Gamma; (000); \quad C_{4z}^+, C_{2z}, I, T; & R_1; & 1, 1, 1, 1; \\
& & R_2; & 1, -1, 1, 1; \\
& & R_3; & -1, 1, 1, 1; \\
& & R_4; & -1, -1, 1, 1; \\
& & R_5; & \quad 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_\Gamma^Z; \\
& & R_6; & 1, 1, -1, 1; \\
& & R_7; & 1, -1, -1, 1; \\
& & R_8; & -1, 1, -1, 1; \\
& & R_9; & -1, -1, -1, 1; \\
& & R_{10}; & \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_\Gamma^Z; \\
\hline
& M; (\frac{1}{2}\frac{1}{2}0); \quad C_{4z}^+, C_{2z}, \sigma_x, T; & R_{10}; & 2; \sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-NSs}; \\
& & R_{11}; & -i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-NSs}; \\
& & R_{12}; & -\sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-NSs}; \\
& & R_{13}; & -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-NSs}; \\
\hline
& Z; (00\frac{1}{2}); \quad C_{4z}^+, \sigma_{db}, C_{2b}, T; & R_{10}; & 2; \sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \\
& & R_{11}; & -i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \\
& & R_{12}; & -\sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \\
& & R_{13}; & -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs}; \\
\hline
& A; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad I, \sigma_{db}, S_{4z}^+, T; & R_{10}; & 2; -\sigma_3, i\sigma_2, \sigma_0, -\sigma_0; \quad \text{P-NSs}; \\
& & R_{11}; & -\sigma_3, i\sigma_2, -\sigma_0, -\sigma_0; \quad \text{P-NSs}; \\
& & \{ R_{12}, R_{13} \}; & \quad 4; -\Gamma_{0,3}, i\Gamma_{0,2}, -i\Gamma_{3,3}, \Gamma_{1,0}; \quad \text{QDP}; \quad 0 \\
\hline
& R; (0\frac{1}{2}\frac{1}{2}); \quad C_{2y}, C_{2z}, \sigma_x, T; & R_5; & 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-NS}_{\text{MARX}}; \\
& & R_{10}; & 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-NS}_{\text{MARX}}; \\
\hline
& X; (0\frac{1}{2}0); \quad C_{2y}, C_{2z}, \sigma_x, T; & R_5; & 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-NS}_{\text{MARX}}; \\
& & R_{10}; & 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-NS}_{\text{MARX}}; \\
\hline
& \Delta; \quad \Gamma_X; \quad C_{2y}, \sigma_x, I, T; & R_1; & 1, 1, 1, 1; \\
& & R_2; & 1, -1, 1, 1; \\
& & R_3; & 1, 1, 1, 1; \\
& & R_4; & 1, -1, 1; \\
\hline
& U; \quad \text{ZR}; \quad C_{2y}, \sigma_x, I, T; & R_1; & 1, 1, 1, 1; \\
& & R_2; & 1, 1, -1, 1; \\
& & R_3; & 1, -1, 1, 1; \\
& & R_4; & 1, -1, 1; \\
\hline
& \Lambda; \quad \Gamma_Z; \quad C_{4z}^+, \sigma_y, I, T; & R_1; & 1, 1, 1, 1; \\
& & R_2; & 1, -1, 1, 1; \\
& & R_3; & 1, -1, 1, 1; \\
& & R_4; & 1, -1, 1; \\
& & R_5; & 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{QNL}; \quad 0 \\
\hline
& V; \quad \text{MA}; \quad C_{4z}^+, \sigma_y, I, T; & \{ R_1, R_4 \}; & 2; \sigma_3, \sigma_3, \sigma_1; \quad \text{L-NS}_{\text{MARX}}; \\
& & \{ R_2, R_3 \}; & 2; \sigma_3, -\sigma_3, \sigma_1; \quad \text{L-NS}_{\text{MARX}}; \\
& & R_5; & 2; i\sigma_2, \sigma_3, -i\sigma_1; \quad \text{L-NS}_{\text{MARX}}; \\
\hline
& \Sigma; \quad \Gamma_M; \quad C_{2y}, \sigma_z, I, T; & R_1; & 1, 1, 1, 1; \\
& & R_2; & 1, -1, 1, 1; \\
& & R_3; & 1, -1, 1, 1; \\
& & R_4; & 1, -1, 1; \\
\end{array}
\]
S; ZA; $C_{2a,\sigma_z,IT}; R_5$; 2; $\sigma_2,\sigma_3,\sigma_0$; WNL; $\pi$

Y; XM; $C_{2x,\sigma_z,IT}; R_5$; 2; $\sigma_2, -i\sigma_3, -i\sigma_3$; L-NS$_{MARX}$;

T; RA; $C_{2x,\sigma_z,IT}; R_5$; 2; $\sigma_2, -i\sigma_3, -i\sigma_3$; L-NS$_{MARX}$;

W; XR; $C_{2x,\sigma_y,IT}; \{R_1, R_4\}$; 2; $\sigma_3, \sigma_3, \sigma_1$; L-NS$_{MARX}$;

$\{R_2, R_3\}$; 2; $\sigma_3, -\sigma_3, \sigma_1$; L-NS$_{MARX}$;
$\Gamma_q$: \{C_4^\pm|00\frac{1}{2}\}, \{C_{2x}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}, \{I|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}; Centrosymmetric; without SOC

| $\Gamma$; (000) | $C_4^x,C_2x,I,T$; | $R_5$;  | 1,1,1,1; |
|--------------|------------------|--------|--------|
| $R_6$;       | 1,1,−1,1;        |
| $R_7$;       | −1,1,1,1;        |
| $R_8$;       | −1,−1,1,1;       |
| $R_9$;       | 2, iσ_2, σ_3, σ_0, −σ_0; | P-QNL_{E2}; |
| $R_{10}$;    | 1,1,−1,1;        |
| $R_{11}$;    | 1,−1,1,1;        |
| $R_{12}$;    | 2, iσ_2, σ_3, σ_0, −σ_0; | P-QNL_{E2}; |
| $R_{13}$;    | 1,1,−1,1;        |
| $R_{14}$;    | 1,−1,−1,1;       |

$M; (\frac{1}{2}\frac{1}{2}\frac{1}{2})$: $C_4^x,C_{2x},σ_x,T$; $R_5$; 2, σ_1, iσ_2, σ_1, −σ_0; P-NSs; $R_{11}$; 2, iσ_2, iσ_2, σ_1, −σ_0; P-NSs; $R_{12}$; 2, −σ_1, iσ_2, σ_1, −σ_0; P-NSs; $R_{13}$; 2, −iσ_2, −iσ_2, σ_1, −σ_0; P-NSs; $R_{14}$; 2, −iσ_2, −iσ_2, σ_1, −σ_0; P-NSs; $R_{15}$; 2, iσ_3, σ_0, σ_0, σ_1; P-NSs; $R_{16}$; 2, iσ_2, −σ_0, σ_3, σ_0, −σ_0; P-NSs; $R_{17}$; 2, −iσ_3, σ_0, −σ_0, −σ_0, σ_1; P-NSs; $R_{18}$; 2, −iσ_2, −σ_0, σ_3, σ_0, −σ_0; P-NSs; $R_{19}$; 2, iσ_2, −σ_0, σ_3, −σ_0, −σ_0; P-NSs;

$Z; (00\frac{1}{2})$: $C_4^x,σ_x,C_{2x},T$; $R_9$; 2, σ_1, iσ_2, σ_1, −σ_0; P-WNLS; $R_{11}$; 2, iσ_2, iσ_2, σ_1, −σ_0; P-WNLS; $R_{12}$; 2, −σ_1, iσ_2, σ_1, −σ_0; P-WNLS; $R_{13}$; 2, −iσ_2, −iσ_2, σ_1, −σ_0; P-WNLS; $R_{14}$; 2, −iσ_2, −iσ_2, σ_1, −σ_0; P-WNLS; $R_{15}$; 2, iσ_3, σ_0, σ_0, σ_1; P-NSs; $R_{16}$; 2, iσ_2, −σ_0, σ_3, σ_0, −σ_0; P-NSs; $R_{17}$; 2, −iσ_3, σ_0, −σ_0, −σ_0, σ_1; P-NSs; $R_{18}$; 2, −iσ_2, −σ_0, σ_3, σ_0, −σ_0; P-NSs; $R_{19}$; 2, iσ_2, −σ_0, σ_3, −σ_0, −σ_0; P-NSs; $R_{20}$; 2, iσ_2, −σ_0, σ_3, −σ_0, −σ_0; P-NSs;

$A; (\frac{1}{2}\frac{1}{2}\frac{1}{2})$: $C_{2x},C_{2x},σ_{ab},I,T$; $\{R_5, R_6\}$; 2, iσ_3, σ_0, σ_0, σ_0, σ_1; P-NSs; $\{R_7, R_8\}$; 2, iσ_3, σ_0, σ_0, σ_0, σ_1; P-NSs; $\{R_9, R_{10}\}$; 2, iσ_2, σ_3, σ_0, −σ_0; P-NSs; $\{R_{11}, R_{12}\}$; 2, iσ_3, σ_0, σ_0, −σ_0, σ_1; P-NSs; $\{R_{13}, R_{14}\}$; 2, −iσ_3, σ_0, −σ_0, −σ_0, σ_1; P-NSs; $\{R_{15}, R_{16}\}$; 2, −iσ_2, −σ_0, σ_3, σ_0, −σ_0; P-NSs; $\{R_{17}, R_{18}\}$; 2, iσ_2, −σ_0, σ_3, σ_0, −σ_0; P-NSs; $\{R_{19}, R_{20}\}$; 2, iσ_2, −σ_0, σ_3, −σ_0, −σ_0; P-NSs; $\{R_{21}, R_{22}\}$; 2, iσ_2, −σ_0, σ_3, −σ_0, −σ_0; P-NSs;

$X; (01\frac{1}{2})$: $C_{2y},C_{2x},σ_z,T$; $R_5$; 2, iσ_2, σ_3, σ_0, −σ_0; P-NS_{MARX}; $R_{10}$; 2, iσ_2, σ_3, −σ_0, −σ_0; P-NS_{MARX};

$\Delta; \Gamma_X$: $C_{2y},σ_x,I,T$; $R_5$; 1,1,1,1; $R_6$; 1,1,−1,1; $R_7$; 1,−1,1,1; $R_8$; 1,−1,−1,1; $R_9$; 2, σ_2, σ_3, −iσ_1; WNL; $\pi$

$U; Z_R$: $σ_z,C_{2y},I,T$; $R_5$; 2, σ_2, σ_3, −iσ_1; WNL; $\pi$

$\Lambda; \Gamma_Z$: $C_4^x,σ_y,I,T$; $R_5$; 1,1,1,1; $R_6$; 1,1,−1,1; $R_7$; 1,−1,1,1; $R_8$; 1,−1,−1,1; $R_9$; 2, iσ_2, σ_3, −σ_0; QNL; $0$

$V; M_A$: $C_4^x,σ_y,I,T$; $\{R_1, R_4\}$; 2, σ_3, σ_3, σ_1; L-NS_{MARX}; $\{R_2, R_3\}$; 2, σ_3, −σ_3, σ_1; L-NS_{MARX}; $R_5$; 2, iσ_2, σ_3, −iσ_1; L-NS_{MARX};

$\Sigma; \Gamma_M$: $C_{2s},σ_z,I,T$; $R_5$; 1,1,1,1; $R_6$; 1,1,−1,1; $R_7$; 1,−1,1,1; $R_8$; 1,−1,−1,1; $R_9$; 2, iσ_2, σ_3, −σ_0; QNL; $0$
\[ S; \ ZA; \ C_{2a, \sigma, IT}; \ R_2; \ 1; 1, 1, 1; \]
\[ R_4; \ 1; -1, 1, 1; \]
\[ R_6; \ 1; 1, -1, 1; \]
\[ R_8; \ 1; -1, -1, 1; \]
\[ Y; \ XM; \ C_{2x, \sigma}; IT; \ R_3; \ 2; \sigma_2, -i\sigma_3, -i\sigma_3; \ L-NS_{MARX}; \]
\[ T; \ RA; \ C_{2x, \sigma_y}; IT; \ \{R_2, R_8\}; \ 2; \sigma_3, -i\sigma_3, \sigma_1; \ L-NS_{MARX}; \]
\[ \{R_4, R_6\}; \ 2; -\sigma_3, -i\sigma_3, \sigma_1; \ L-NS_{MARX}; \]
\[ W; \ XR; \ C_{2z, \sigma_y}; IT; \ \{R_1, R_4\}; \ 2; \sigma_3, \sigma_3, \sigma_1; \ L-NS_{MARX}; \]
\[ \{R_2, R_3\}; \ 2; \sigma_3, -\sigma_3, \sigma_1; \ L-NS_{MARX}; \]
\( \Gamma_{iv} \): \( \{C_{4v}^+|000\}, \{C_{2v}|000\}, \{I|000\}, \mathcal{T}; \) Centrosymmetric; without SOC

\( \Gamma; (000); \) \( C_{4v}^+C_{2v},I,\mathcal{T}; \) \( R_1; \) 1, 1, 1, 1;
\( R_2; \) 1, -1, 1, 1;
\( R_3; \) 1, -1, 1, 1;
\( R_4; \) 1, -1, -1, 1;
\( R_5; \) 2, \( i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-NQL\( \Gamma\mathcal{Z}; \)
\( R_6; \) 1, 1, 1, 1;
\( R_7; \) 1, -1, -1, 1;
\( R_8; \) 1, -1, -1, 1;
\( R_9; \) 1, -1, -1, 1;
\( R_{10}; \) 2, \( i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \) P-NQL\( \Gamma\mathcal{Z}; \)

\( N; (0^1\frac{1}{2}0); \) \( C_{2v},I,\mathcal{T}; \) \( R_1; \) 1, 1, 1, 1;
\( R_2; \) 1, -1, 1, 1;
\( R_3; \) 1, -1, 1, 1;
\( R_4; \) 1, -1, -1, 1;

\( X; (00\frac{1}{2}); \) \( C_{2v},C_{2v},I,\mathcal{T}; \) \( R_1; \) 1, 1, 1, 1;
\( R_2; \) 1, -1, 1, 1;
\( R_3; \) 1, -1, 1, 1;
\( R_4; \) 1, -1, -1, 1;
\( R_5; \) 1, 1, -1, 1;
\( R_6; \) 1, -1, -1, 1;
\( R_7; \) 1, -1, -1, 1;
\( R_8; \) 1, -1, -1, 1;

\( Z; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \) \( C_{4v}^+C_{2v},I,\mathcal{T}; \) \( R_1; \) 1, 1, 1, 1;
\( R_2; \) 1, -1, 1, 1;
\( R_3; \) 1, -1, 1, 1;
\( R_4; \) 1, -1, -1, 1;
\( R_5; \) 2, \( i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \) P-NQL\( \Gamma\mathcal{Z}; \)
\( R_6; \) 1, 1, 1, 1;
\( R_7; \) 1, -1, -1, 1;
\( R_8; \) 1, -1, -1, 1;
\( R_9; \) 1, -1, -1, 1;
\( R_{10}; \) 2, \( i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \) P-NQL\( \Gamma\mathcal{Z}; \)

\( P; (\frac{1}{4}\frac{1}{4}\frac{1}{4}); \) \( S_{4v}^+C_{2v},\mathcal{I}\mathcal{T}; \) \( R_1; \) 1, 1, 1, 1;
\( R_2; \) 1, -1, 1, 1;
\( R_3; \) 1, -1, 1, 1;
\( R_4; \) 1, -1, -1, 1;
\( R_5; \) 2, \( i\sigma_2, \sigma_3, -\sigma_0; \) P-WNLs;

\( \Lambda; \Gamma\mathcal{A}/\Gamma\mathcal{Z}; \) \( C_{4v}^+,\sigma_0,\mathcal{I}\mathcal{T}; \) \( R_1; \) 1, 1, 1, 1;
\( R_2; \) 1, -1, 1, 1;
\( R_3; \) 1, -1, 1, 1;
\( R_4; \) 1, -1, -1, 1;
\( R_5; \) 2, \( i\sigma_2, \sigma_3, -\sigma_0; \) QNL; 0
| Symbol | Spinor | $C_{\Delta}^\perp \sigma_y, IT$ | $R_1$ | $1$, $1$, $1$; |
|--------|--------|----------------------------------|-------|----------------|
|        |        | $R_2$ | $1$, $1$, $-1$, $1$; |
|        |        | $R_3$ | $1$, $-1$, $1$, $1$; |
|        |        | $R_4$ | $1$, $-1$, $-1$, $1$; |
|        |        | $R_5$ | $2$, $i \sigma_2, \sigma_3, -\sigma_0$; QNL; $0$ |
|        |        | $W$; XP | $C_{2z, \sigma_{ab}, IT}$ | $R_1$ | $1$, $1$, $1$; |
|        |        | $R_2$ | $1$, $1$, $-1$, $1$; |
|        |        | $R_3$ | $1$, $-1$, $1$, $1$; |
|        |        | $R_4$ | $1$, $-1$, $-1$, $1$; |
|        |        | $\Sigma$; $\Gamma Z/\Gamma \Sigma$; $C_{2z, \sigma_z, IT}$ | $R_1$ | $1$, $1$, $1$; |
|        |        | $R_2$ | $1$, $1$, $-1$, $1$; |
|        |        | $R_3$ | $1$, $-1$, $1$, $1$; |
|        |        | $R_4$ | $1$, $-1$, $-1$, $1$; |
|        |        | $F$; ZF; $C_{2z, \sigma_z, IT}$ | $R_1$ | $1$, $1$, $1$; |
|        |        | $R_2$ | $1$, $1$, $-1$, $1$; |
|        |        | $R_3$ | $1$, $-1$, $1$, $1$; |
|        |        | $R_4$ | $1$, $-1$, $-1$, $1$; |
|        |        | $Q$; NP; $C_{2y, IT}$ | $R_1$ | $1$, $1$, $1$; |
|        |        | $R_2$ | $1$, $-1$, $1$; |
|        |        | $\Delta$; $\Gamma X$; $C_{2z, \sigma_z, IT}$ | $R_1$ | $1$, $1$, $1$; |
|        |        | $R_2$ | $1$, $1$, $-1$, $1$; |
|        |        | $R_3$ | $1$, $-1$, $1$, $1$; |
|        |        | $R_4$ | $1$, $-1$, $-1$, $1$; |
|        |        | $U$; ZU; $C_{2z, \sigma_z, IT}$ | $R_1$ | $1$, $1$, $1$; |
|        |        | $R_2$ | $1$, $1$, $-1$, $1$; |
|        |        | $R_3$ | $1$, $-1$, $1$, $1$; |
|        |        | $R_4$ | $1$, $-1$, $-1$, $1$; |
|        |        | $Y$; XZ/XY; $C_{2z, \sigma_{ab}, IT}$ | $R_1$ | $1$, $1$, $1$; |
|        |        | $R_2$ | $1$, $1$, $-1$, $1$; |
|        |        | $R_3$ | $1$, $-1$, $1$, $1$; |
|        |        | $R_4$ | $1$, $-1$, $-1$, $1$; |
Γ\(\nu\): \(C_{14z}^+|\frac{1}{2}|0\), \(C_{2z}|000\), \(I|\frac{1}{2}|1\); Centrosymmetric; without SOC

Γ; (000): \(C_{4z}^+C_{2z}, I, T; R_1\): 1; 1, 1, 1, 1;
R\(_2\): 1; 1, 1, 1, 1;
R\(_3\): 1; 1, 1, 1, 1;
R\(_4\): 1; 1, 1, 1, 1;
R\(_5\): 2; \(i\sigma_2, \sigma_3, \sigma_0, -\sigma_0\); P-QNL\(_{\Gamma Z}\);
R\(_6\); 1; 1, 1, 1, 1;
R\(_7\); 1; 1, 1, 1, 1;
R\(_8\); 1; 1, 1, 1, 1;
R\(_9\); 1; 1, 1, 1, 1;
R\(_10\); 2; \(i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0\); P-QNL\(_{\Gamma Z}\);

N; (0\(\frac{1}{2}\)0): \(\sigma_yC_{2y}, T; R_5\): 2; \(\sigma_2, \sigma_2, -\sigma_0\); P-WNLs;

X; (00\(\frac{1}{2}\)): \(C_{2z}C_{2a}, I, T; R_1\): 1; 1, 1, 1, 1;
R\(_2\): 1; 1, 1, 1, 1;
R\(_3\): 1; 1, 1, 1, 1;
R\(_4\): 1; 1, 1, 1, 1;
R\(_5\); 1; 1, 1, 1, 1;
R\(_6\); 1; 1, 1, 1, 1;
R\(_7\); 1; 1, 1, 1, 1;
R\(_8\); 1; 1, 1, 1, 1;
R\(_9\); 1; 1, 1, 1, 1;
R\(_10\); 2; \(i\sigma_2, \sigma_2, -\sigma_0, -\sigma_0\); P-QNL\(_{\Gamma Z}\);

Z; (\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)): \(C_{4z}^+C_{2z}, I, T; R_1\): 1; 1, 1, 1, 1;
R\(_2\): 1; 1, 1, 1, 1;
R\(_3\): 1; 1, 1, 1, 1;
R\(_4\): 1; 1, 1, 1, 1;
R\(_5\); 2; \(i\sigma_2, \sigma_3, \sigma_0, -\sigma_0\); P-QNL\(_{\Gamma Z}\);
R\(_6\); 1; 1, 1, 1, 1;
R\(_7\); 1; 1, 1, 1, 1;
R\(_8\); 1; 1, 1, 1, 1;
R\(_9\); 1; 1, 1, 1, 1;
R\(_10\); 2; \(i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0\); P-QNL\(_{\Gamma Z}\);

P; (\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)): \(S_{4z}^+C_{2z}, I, T; \{R_1, R_4\}\): 2; \(\sigma_3, \sigma_3, \sigma_1\); P-WNLs;
\{R\(_2, R_3\)\}: 2; \(\sigma_3, -\sigma_3, \sigma_1\); P-WNLs;
R\(_5\); 2; \(i\sigma_2, \sigma_3, -i\sigma_1\); P-WNLs;

Λ; ΓΛ/TZ; \(C_{4z}^+\sigma_y, I, T; R_1\): 1; 1, 1, 1;
R\(_2\): 1; 1, 1, 1;
R\(_3\): 1; 1, 1, 1;
R\(_4\); 1; 1, 1, 1;
R\(_5\); 2; \(i\sigma_2, \sigma_3, -\sigma_0\); QNL; 0

V; ZV; \(C_{4z}^+\sigma_y, I, T; R_1\): 1; 1, 1, 1;
R\(_2\): 1; 1, 1, 1;
R\(_3\): 1; 1, 1, 1;
R\(_4\): 1; 1, 1, 1;
R\(_5\); 2; \(i\sigma_2, \sigma_3, -\sigma_0\); QNL; 0
\[
\begin{array}{l}
W; XP: \quad C_{2z, \sigma d, IT}: \\
R_1: 1; 1; 1; \\
R_2: 1; 1, -1; 1; \\
R_3: 1; -1; 1; \\
R_4: 1; -1; -1; 1; \\
\Sigma; \Gamma Z/\Gamma \Sigma: C_{2x, \sigma z, IT}: \\
R_1: 1; 1; 1; \\
R_2: 1; 1; -1; 1; \\
R_3: 1; -1; 1; \\
R_4: 1; -1; -1; 1; \\
F; ZF: C_{2x, \sigma z, IT}: \\
R_1: 1; 1; -1; 1; \\
R_2: 1; 1; 1; \\
R_3: 1; -1; -1; 1; \\
R_4: 1; -1; 1; 1; \\
Q; NP: \quad C_{2y, IT}: \{R_1, R_2\}: \{2; \sigma_3, \sigma_1\}; \text{ WN Li; } \pi \\
\Delta; \Gamma X: \quad C_{2a, \sigma z, IT}: \\
R_1: 1; 1; 1; \\
R_2: 1; 1; -1; 1; \\
R_3: 1; -1; 1; \\
R_4: 1; -1; -1; 1; \\
U; ZU: \quad C_{2a, \sigma z, IT}: \\
R_1: 1; -1; -1; 1; \\
R_2: 1; -1; 1; 1; \\
R_3: 1; 1; -1; 1; \\
R_4: 1; 1; 1; \\
Y; XZ/XY: \quad C_{2b, \sigma d, IT}: \\
R_1: 1; 1; 1; \\
R_2: 1; 1; -1; 1; \\
R_3: 1; -1; 1; 1; \\
R_4: 1; -1; -1; 1; \\
\end{array}
\]
| Γ: (000); $C_{4z}^{+}, C_{2x}, I,T;$ | $R_1$: 1; 1,1,1,1; |
| | $R_2$: 1; 1,−1,1,1; |
| | $R_3$: 1; −1,1,1,1; |
| | $R_4$: 1; −1,−1,1,1; |
| | $R_5$: 2; $i\sigma_2, \sigma_3, \sigma_0, -\sigma_0;$ |
| | $R_6$: 1; 1,1,−1,1; |
| | $R_7$: 1; 1,−1,−1,1; |
| | $R_8$: 1; −1,1,−1,1; |
| | $R_9$: 1; −1,−1,−1,1; |
| | $R_{10}$: 2; $i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0;$ |

$\Gamma_{\Gamma}^0$: \{\(C_{4z}^{+}[0\frac{1}{2}0]\), \(C_{2x}[\frac{1}{2} \frac{1}{2} 0]\), \(I[\frac{1}{2} \frac{1}{2} 0]\); Centrosymmetric; without SOC

### N: (0\(\frac{1}{2}\)0); $C_{2y}, I,T;$

| $R_1$: 1; 1,1,1; |
| $R_2$: 1; 1,−1,1; |
| $R_3$: 1; −1,1,1; |
| $R_4$: 1; −1,−1,1; |

### X: (00\(\frac{1}{2}\)); $\sigma_z, \sigma_{dd}, C_{2x}, I,T;$

| $R_5$: 2; $i\sigma_2, \sigma_3, \sigma_0, -\sigma_0;$ |
| $R_{10}$: 2; $i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0;$ |

### Z: (\(\frac{1}{2} \frac{1}{2} \frac{1}{2}\)); $C_{4z}^{+}, \sigma_{dd}, C_{2x}, I,T;$

| $R_5$: 2; $\sigma_1, i\sigma_2, \sigma_1, -\sigma_0;$ |
| $R_{11}$: 2; $-i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0;$ |
| $R_{12}$: 2; $-\sigma_1, i\sigma_2, \sigma_1, -\sigma_0;$ |
| $R_{14}$: 2; $-i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0;$ |

### P: (\(\frac{1}{2} \frac{1}{2} \frac{1}{2}\)); $S_{xx}, E, C_{2y}, I,T;$

| $R_{13}$: 2; \((\frac{1}{2} + \frac{1}{2})(\sigma_0 - i\sigma_3), -i\sigma_0, \sigma_1, -i\sigma_1;$ |
| $R_{14}$: 2; \((-\frac{1}{2} - \frac{1}{2})(\sigma_0 + i\sigma_3), -i\sigma_0, \sigma_1, -i\sigma_1;$ |

### A: ΓΛ/ΓΣ; $C_{4z}^{+}, \sigma_y, I,T;$

| $R_1$: 1; 1,1,1; |
| $R_2$: 1; 1,−1,1; |
| $R_3$: 1; −1,1,1; |
| $R_4$: 1; −1,−1,1; |
| $R_5$: 2; $i\sigma_2, \sigma_3, -\sigma_0;$ |

### V: ZV; $C_{4z}^{+}, \sigma_x, E, I,T;$

| $R_6$: 1; $-i, 1,1,1;$ |
| $R_7$: 1; $-i, -1,1,1;$ |
| $R_8$: 1; $i, 1,1,1;$ |
| $R_9$: 1; $i, -1,1,1;$ |
| $R_{10}$: 2; $\sigma_2, \sigma_3, \sigma_0, -\sigma_0;$ |

### W: XP; $C_{2x}, \sigma_{dd}, I,T;$

| $R_5$: 2; $\sigma_2, -i\sigma_3, -\sigma_0;$ |

### Σ: ΓZ/ΓΣ; $C_{2x}, \sigma_x, I,T;$

| $R_1$: 1; 1,1,1; |
| $R_2$: 1; 1,−1,1; |
| $R_3$: 1; −1,1,1; |
| $R_4$: 1; −1,−1,1; |

### F: ZF; $C_{2x}, \sigma_z, I,T;$

| $R_1$: 1; $-1,1,1;$ |
| $R_2$: 1; $-1, -1,1;$ |
| $R_3$: 1; 1,1,1; |
| $R_4$: 1; 1,−1,1; |
| $Q; NP: C_{2h}, IT$  | $R_2; 1, 1, 1$ |
|----------------------|----------------|
|                      | $R_4; 1, -1, 1$ |
| $\Delta; \Gamma_X$:  | $C_{2v}, \sigma_d, IT$  | $R_3; 1, 1, 1, 1$ |
|                      | $R_2; 1, 1, -1, 1$ |
|                      | $R_3; 1, -1, 1, 1$ |
|                      | $R_4; 1, -1, -1, 1$ |
| $U; Z_{d_v}$         | $C_{2h}, \sigma_d, IT$  | $R_5; 2, \sigma_2, \sigma_3, -\sigma_0$; WNL; $\pi$ |
| $Y; XZ/XY$           | $C_{2h}, \sigma_d, IT$  | $R_5; 2, \sigma_2, \sigma_3, -\sigma_0$; WNL; $\pi$ |
Γ'₄; \{C_{4v}^{+}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}; \{C_{2h}^{+}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}; \{I|000\}, T; Centrosymmetric; without SOC

Γ; (000); \quad C_{4v}^{+}, C_{2h}, I, T; 
  R₁; 1; 1,1,1,1;
  R₂; 1; 1,−1,1,1;
  R₃; 1; −1,1,1,1;
  R₄; 1; −1,−1,1,1;
  R₅; 2; iσ₂,σ₃,σ₀,−σ₀; P-QNL₄∩Z;
  R₆; 1; 1,1,−1,1;
  R₇; 1; 1,−1,−1,1;
  R₈; 1; −1,1,−1,1;
  R₀; 1; −1,−1,−1,1;
  R₁₀; 2; iσ₂,σ₃,−σ₀,−σ₀; P-QNL₄∩Z;

N; (0\frac{1}{2}0); \quad σ_y, I, T; 
  R₅; 2; iσ₂,σ₃,−σ₀; P-WNLs;

X; (00\frac{1}{2}); \quad σ_z, C_{2z}, C_{2h}, T; 
  R₂; 2; iσ₂,σ₃,σ₀,−σ₀; P-WNLs;
  R₆; 2; iσ₂,σ₃,σ₀,−σ₀; P-WNLs;
  R₁₀; 2; iσ₂,σ₃,−σ₀,−σ₀; P-WNLs;

Z; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad C_{4v}^{+}, σ_{db}, C_{2h}, T; 
  R₀; 2; σ₁, iσ₂,σ₁,−σ₀; P-WNLs;
  R₁₁; 2; −iσ₂, iσ₂,σ₁,−σ₀; P-WNLs;
  R₁₂; 2; −σ₁, iσ₂,σ₁,−σ₀; P-WNLs;
  R₁₄; 2; −iσ₂,−iσ₂,σ₁,−σ₀; P-WNLs;

P; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad S_{4h}, E, C_{2g}, I, T; \{R₁₃, R₁₄\}; 4; (\overline{\frac{1}{2}}−\overline{\frac{1}{4}})(Γ_{0,3}+iΓ_{3,0})\), DP; 0
  −iΓ_{0,0}, Γ_{3,1}, Γ_{1,0};

Λ; ΓΛ/TZ; \quad C_{4v}^{+}, σ_y, I, T; 
  R₁; 1; 1,1,1;
  R₂; 1; 1,−1,1;
  R₃; 1; −1,1,1;
  R₄; 1; −1,−1,1;
  R₅; 2; iσ₂,σ₃,−σ₀; QNL; 0

V; ZV; \quad C_{4v}^{+}, σ_z, E, I, T; 
  R₆; 1; i,1,1,1;
  R₇; 1; i,−1,1,1;
  R₈; 1; −i,1,1,1;
  R₀; 1; −i,−1,1,1;
  R₁₀; 2; −σ₂,σ₃,σ₀,−σ₀; QNL; 0

W; XP; \quad C_{2h}, σ_{da}, I, T; 
  R₅; 2; σ₂,σ₃,−σ₀; WNL; π

Σ; ΓZ/ΓΣ; \quad C_{2h}, σ_z, I, T; 
  R₁; 1; 1,1,1;
  R₂; 1; 1,−1,1;
  R₃; 1; −1,1,1;
  R₄; 1; −1,−1,1;

F; ZF; \quad C_{2h}, σ_z, I, T; 
  R₁; 1; −1,1,1;
  R₂; 1; −1,−1,1;
  R₃; 1; 1,1,1;
  R₄; 1; 1,−1,1;

Q; NP; \quad C_{2h}, I, T; \{R₁, R₂\}; 2; σ₃,σ₁; WNL; π

Δ; ΓX; \quad C_{2h}, σ_z, I, T; 
  R₁; 1; 1,1,1;
  R₂; 1; 1,−1,1;
  R₃; 1; −1,1,1;
  R₄; 1; −1,−1,1;

U; ZU; \quad C_{2h}, σ_z, I, T; 
  R₅; 2; σ₂,σ₃,−σ₀; WNL; π

Y; XZ/XY; \quad C_{2h}, σ_{da}, I, T; 
  R₅; 2; σ₂,σ₃,−σ₀; WNL; π
Γ, (000); \( C_3^+ \), \( \Gamma \); \( R_1 \); 1, 1, 1;
{\( R_2, R_3 \)}; 2; \( \frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2} \), \( \sigma_1 \); C-2 WP; 2

M, (0\( \frac{1}{2} \)0); \( E, \mathcal{T} \); \( R_1 \); 1, 1, 1;
A, (00\( \frac{1}{2} \)); \( C_3^+, \mathcal{T} \); \( R_1 \); 1, 1, 1;
{\( R_2, R_3 \)}; 2; \( \frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2} \), \( \sigma_1 \); C-2 WP; 2

L, (0\( \frac{1}{2} \)\( \frac{1}{2} \)); \( E, \mathcal{T} \); \( R_1 \); 1, 1, 1;
K, (\( \frac{1}{2} \)\( \frac{1}{2} \)0); \( C_3^+ \); \( R_1 \); 1, 1;
\( R_2 \); 1; \((-1)^{2/3} \);
\( R_3 \); 1; \(-\sqrt{3}i \);

H, (\( \frac{1}{2} \)\( \frac{1}{2} \)\( \frac{1}{2} \)); \( C_3^+ \); \( R_1 \); 1, 1;
\( R_2 \); 1; \((-1)^{2/3} \);
\( R_3 \); 1; \(-\sqrt{3}i \);

Δ, ΓA, \( C_3^+ \); \( R_1 \); 1, 1;
\( R_2 \); 1; \((-1)^{2/3} \);
\( R_3 \); 1; \(-\sqrt{3}i \);

U, ML; \( E \); \( R_1 \); 1, 1;

P, KH; \( C_3^+ \); \( R_1 \); 1, 1;
\( R_2 \); 1; \((-1)^{2/3} \);
\( R_3 \); 1; \(-\sqrt{3}i \);

T, ΓK; \( E \); \( R_1 \); 1, 1;

S, AH; \( E \); \( R_1 \); 1, 1;

T', MK; \( E \); \( R_1 \); 1, 1;

S'; LH; \( E \); \( R_1 \); 1, 1;

Σ, ΓM; \( E \); \( R_1 \); 1, 1;

R, AL; \( E \); \( R_1 \); 1, 1;
\[ \Gamma_h; \{ C^+_3[00\frac{1}{2}] \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (000); C^+_3, T; R_1; 1; 1, 1; \]
\[ \{ R_2, R_3 \}; 2; \frac{-\sigma_0+\iota \sqrt{3} \sigma_3}{2}, \sigma_1; \text{C-2 WP; 2} \]

\[ M; (0\frac{1}{2}0); E, T; R_1; 1; 1, 1; \]

\[ A; (00\frac{1}{2}); C^+_3, T; R_1; 1; 1, 1; \]
\[ \{ R_2, R_3 \}; 2; \frac{-\sigma_0+\iota \sqrt{3} \sigma_3}{2}, \sigma_1; \text{C-2 WP; 2} \]

\[ L; (0\frac{1}{2}\frac{1}{2}); E, T; R_1; 1; 1, 1; \]

\[ K; (\frac{1}{2}\frac{3}{2}0); C^+_3; R_1; 1; 1; \]
\[ R_2; 1; (-1)^{2/3}; \]
\[ R_3; 1; -\sqrt{-1}; \]

\[ H; (\frac{1}{2}\frac{3}{2}\frac{3}{2}); C^-_3; R_1; 1; 1; \]
\[ R_2; 1; (-1)^{2/3}; \]
\[ R_3; 1; -\sqrt{-1}; \]

\[ \Delta; \Gamma A; \quad C^+_3; \quad R_1; 1; 1; \]
\[ R_2; 1; (-1)^{2/3}; \]
\[ R_3; 1; -\sqrt{-1}; \]

\[ U; \quad \text{ML}; \quad E; \quad R_1; 1; 1; \]

\[ P; \quad \text{KH}; \quad C^+_3; \quad R_1; 1; 1; \]
\[ R_2; 1; (-1)^{2/3}; \]
\[ R_3; 1; -\sqrt{-1}; \]

\[ T; \quad \Gamma K; \quad E; \quad R_1; 1; 1; \]

\[ S; \quad \text{AH}; \quad E; \quad R_1; 1; 1; \]

\[ T'; \quad \text{MK}; \quad E; \quad R_1; 1; 1; \]

\[ S'; \quad \text{LH}; \quad E; \quad R_1; 1; 1; \]

\[ \Sigma; \quad \Gamma M; \quad E; \quad R_1; 1; 1; \]

\[ R; \quad \text{AL}; \quad E; \quad R_1; 1; 1; \]
\( \Gamma_h: \{C_3^+ |00\frac{2}{3}\}, T; \) Non-Centrosymmetric; without SOC

\( \Gamma; (000); C_3^+, T; R_1; 1, 1, 1; \) 
\( \{R_2, R_3\}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_1; \) C-2 WP; 2

\( M; (0\frac{1}{2}0); E, T; R_1; 1, 1, 1; \)

\( A; (00\frac{1}{2}); C_3^+, T; R_1; 1, 1, 1; \) 
\( \{R_2, R_3\}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_1; \) C-2 WP; 2

\( L; (0\frac{1}{2}\frac{1}{2}); E, T; R_1; 1, 1, 1; \)

\( K; (\frac{1}{3} \frac{2}{3} 0); C_3^++; R_1; 1, 1; \) 
\( R_2; 1; (-1)^{2/3}; \) 
\( R_3; 1; -\sqrt{-1}; \)

\( H; (\frac{1}{3} \frac{2}{3} \frac{1}{2}); C_3^++; R_1; 1; 1; \) 
\( R_2; 1; (-1)^{2/3}; \) 
\( R_3; 1; -\sqrt{-1}; \)

\( \Delta; \Gamma_A; C_3^++; R_1; 1; 1; \) 
\( R_2; 1; (-1)^{2/3}; \) 
\( R_3; 1; -\sqrt{-1}; \)

\( U; ML; E; R_1; 1; 1; \)

\( P; KH; C_3^++; R_1; 1; 1; \) 
\( R_2; 1; (-1)^{2/3}; \) 
\( R_3; 1; -\sqrt{-1}; \)

\( T; \Gamma_K; E; R_1; 1; 1; \)

\( S; \Gamma_\Lambda; E; R_1; 1; 1; \)

\( T'; MK; E; R_1; 1; 1; \)

\( S'; LH; E; R_1; 1; 1; \)

\( \Sigma; \Gamma_M; E; R_1; 1; 1; \)

\( R; AL; E; R_1; 1; 1; \)
\( \Gamma_{rh}; \{ C^+_3 | 000 \}, T; \) Non-Centrosymmetric; without SOC

\[
\begin{align*}
\Gamma; \quad (000): & \quad C^+_3, T; R_1; \quad 1; 1; 1; \quad \{ R_2, R_3 \}; 2; \frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_1; \text{C-2 WP}; 2 \\
Z; \quad \left( \frac{1}{3} \frac{1}{3} \frac{1}{3} \right): & \quad C^+_3, T; R_1; \quad 1; 1; 1; \quad \{ R_2, R_3 \}; 2; \frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_1; \text{C-2 WP}; 2 \\
L; \quad (0 \frac{1}{2} 0); & \quad E, T; \quad R_1; \quad 1; 1; 1; \\
(a) F; \quad (0 \frac{1}{2} \frac{1}{2}); & \quad E, T; \quad R_1; \quad 1; 1; 1; \\
(b) F; \quad \left( \frac{1}{2} \frac{1}{2} 0 \right); & \quad E, T; \quad R_1; \quad 1; 1; 1; \\
\Lambda; \quad \Gamma\Lambda/\Gamma Z; \quad C^+_3; & \quad R_1; \quad 1; 1; \\
& \quad R_2; \quad 1; (-1)^{2/3}; \\
& \quad R_3; \quad 1; -\sqrt[3]{1}; \\
P; \quad ZP; \quad C^+_3; & \quad R_1; \quad 1; 1; \\
& \quad R_2; \quad 1; (-1)^{2/3}; \\
& \quad R_3; \quad 1; -\sqrt[3]{1}; \\
B; \quad ZB; \quad E; & \quad R_1; \quad 1; 1; \\
\Sigma; \quad \Gamma F/\Gamma \Sigma; \quad E; & \quad R_1; \quad 1; 1; \\
Q; \quad FQ; \quad E; & \quad R_1; \quad 1; 1; \\
Y; \quad LZ/LY; \quad \Sigma; & \quad R_1; \quad 1; 1; \\
\end{align*}
\]
$\Gamma_h: \{S_0^+|000\}, T; \text{Centrosymmetric; without SOC}$

$$\Gamma; (000): \quad S_0^+, T: \quad R_1: 1; 1, 1;$$

$$\{R_2, R_6\}: 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_1; \text{P-WNLs};$$

$$\{R_3, R_5\}: 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_1; \text{P-WNLs};$$

$$R_4: 1; -1, 1;$$

$$M; (0\frac{1}{2}0): \quad I, T: \quad R_1: 1; 1, 1;$$

$$R_2: 1; -1, 1;$$

$$A; (00\frac{1}{2}): \quad S_0^+, T: \quad R_1: 1; 1, 1;$$

$$\{R_2, R_6\}: 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_1; \text{P-WNLs};$$

$$\{R_3, R_5\}: 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_1; \text{P-WNLs};$$

$$R_4: 1; -1, 1;$$

$$L; (0\frac{1}{2}\frac{1}{2}): \quad I, T: \quad R_1: 1; 1, 1;$$

$$R_2: 1; -1, 1;$$

$$K; (\frac{1}{3}\frac{2}{3}0): \quad C_3^+, I, T: \quad R_1: 1; 1, 1;$$

$$\{R_2, R_3\}: 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_1; \text{P-WNL}_{KH};$$

$$H; (\frac{1}{3}\frac{2}{3}\frac{1}{3}): \quad C_3^+, I, T: \quad R_1: 1; 1, 1;$$

$$\{R_2, R_3\}: 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_1; \text{P-WNL}_{KH};$$

$$\Delta; \quad \Gamma A: \quad C_3^+, I, T: \quad R_1: 1; 1, 1;$$

$$\{R_2, R_3\}: 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_1; \text{WNL; \pi}$$

$$U; \quad ML: \quad E, I, T: \quad R_1: 1; 1, 1;$$

$$P; \quad KH: \quad C_3^+, I, T: \quad R_1: 1; 1, 1;$$

$$\{R_2, R_3\}: 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_1; \text{WNL; \pi}$$

$$T; \quad \Gamma K: \quad E, I, T: \quad R_1: 1; 1, 1;$$

$$S; \quad AH: \quad E, I, T: \quad R_1: 1; 1, 1;$$

$$T'; \quad MK: \quad E, I, T: \quad R_1: 1; 1, 1;$$

$$S'; \quad LH: \quad E, I, T: \quad R_1: 1; 1, 1;$$

$$\Sigma; \quad \Gamma M: \quad E, I, T: \quad R_1: 1; 1, 1;$$

$$R; \quad AL: \quad E, I, T: \quad R_1: 1; 1, 1;$$
\[ \Gamma; (000): \quad S^+_6; T; \quad R_3; \quad 1; 1, 1; \\
\{R_2, R_6\}; 2; \ \frac{a_0 + i\sqrt{3}a_3}{2}, \sigma_1; \quad \text{P-WNLs;} \\
\{R_3, R_6\}; 2; \ \frac{-a_0 + i\sqrt{3}a_3}{2}, \sigma_1; \quad \text{P-WNLs;} \\
R_4; \quad 1; -1, 1; \]

\[ Z; \quad (\frac{1}{2} \ 1 \ 1); \quad S^+_6; T; \quad R_3; \quad 1; 1, 1; \\
\{R_2, R_6\}; 2; \ \frac{a_0 + i\sqrt{3}a_3}{2}, \sigma_1; \quad \text{P-WNLs;} \\
\{R_3, R_6\}; 2; \ \frac{-a_0 + i\sqrt{3}a_3}{2}, \sigma_1; \quad \text{P-WNLs;} \\
R_4; \quad 1; -1, 1; \]

\[ L; \quad (0 \frac{1}{2} 0); \quad I, T; \quad R_3; \quad 1; 1, 1; \\
R_2; \quad 1; -1, 1; \]

(a) \[ F; \quad (0 \frac{1}{2} \frac{1}{2}); \quad I, T; \quad R_3; \quad 1; 1, 1; \\
R_2; \quad 1; -1, 1; \]

(b) \[ F; \quad (\frac{1}{2} \frac{1}{2} 0); \quad I, T; \quad R_3; \quad 1; 1, 1; \\
R_2; \quad 1; -1, 1; \]

\[ \Lambda; \quad \Gamma \Lambda/TZ; \quad C^+_3; I, T; \quad R_3; \quad 1; 1, 1; \\
\{R_2, R_3\}; 2; \ \frac{a_0 + i\sqrt{3}a_3}{2}, \sigma_1; \quad \text{WNL;} \quad \pi \]

\[ P; \quad ZP; \quad C^+_3; I, T; \quad R_3; \quad 1; 1, 1; \\
\{R_2, R_3\}; 2; \ \frac{a_0 + i\sqrt{3}a_3}{2}, \sigma_1; \quad \text{WNL;} \quad \pi \]

\[ B; \quad ZB; \quad E, I, T; \quad R_3; \quad 1; 1, 1; \]

\[ \Sigma; \quad \Gamma F/\Gamma \Sigma; \quad E, I, T; \quad R_3; \quad 1; 1, 1; \]

\[ Q; \quad FQ; \quad E, I, T; \quad R_3; \quad 1; 1, 1; \]

\[ Y; \quad LZ/LY; \quad E, I, T; \quad R_3; \quad 1; 1, 1; \]
Γ: (000); \( C^+_3, C^{'}_{21}, T \); \( R_1; 1, 1, 1; \)
\( R_2; 1, 1, -1, 1; \)
\( R_3; 2; \frac{\sigma_0 - \sqrt{3} \sigma_3}{2}, \sigma_3, -\sigma_0; \) C-2 WP; 2

\( M; (0 \frac{1}{2} 0); \ C^{'}_{21}, T; \)
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)

\( A; (00 \frac{1}{2}); \ C^+_3, C^{'}_{21}, T; \)
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1, 1; \)
\( R_3; 2; \frac{\sigma_0 + \sqrt{3} \sigma_3}{2}, \sigma_3, -\sigma_0; \) C-2 WP; 2

\( L; (0 \frac{1}{2} \frac{1}{2}); \ C^{'}_{21}, T; \)
\( R_1; 1, 1, 1; \)
\( R_2; 1, -1, 1; \)

\( K; (\frac{1}{2} \frac{1}{2} 0); \ C^+_3, C^{'}_{22}, T; \)
\( R_1; 1, 1, 1; \)
\( R_2; 1; (-1)^{2/3}, 1; \)
\( R_3; 1; -\sqrt{-1}, 1; \)

\( H; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ C^+_3, C^{'}_{22}, T; \)
\( R_1; 1, 1, 1; \)
\( R_2; 1; (-1)^{2/3}, 1; \)
\( R_3; 1; -\sqrt{-1}, 1; \)

\( \Delta; \Gamma A; \ C^+_3, C^{'}_{22}, T; \)
\( R_1; 1, 1, 1; \)
\( R_2; 1; (-1)^{2/3}, 1; \)
\( R_3; 1; -\sqrt{-1}, 1; \)

\( U; ML; \ E, C^{'}_{21}, T; \)
\( R_1; 1, 1, 1; \)

\( P; KH; \ C^+_3, C^{'}_{22}, T; \)
\( R_1; 1, 1, 1; \)
\( R_2; 1; (-1)^{2/3}, 1; \)
\( R_3; 1; -\sqrt{-1}, 1; \)

\( T; \Gamma K; \ E, C^{'}_{22}, T; \)
\( R_1; 1, 1, 1; \)

\( S; AH; \ E, C^{'}_{22}, T; \)
\( R_1; 1, 1, 1; \)

\( T'; MK; \ E, C^{'}_{21}, T; \)
\( R_1; 1, 1, 1; \)

\( S'; LH; \ E, C^{'}_{21}, T; \)
\( R_1; 1, 1, 1; \)

\( \Sigma; \Gamma M; \ C^{'}_{21}; \)
\( R_1; 1, 1; \)
\( R_2; 1; -1; \)

\( R; AL; \ C^{'}_{21}; \)
\( R_1; 1, 1; \)
\( R_2; 1; -1; \)
\[ \Gamma_\text{h}; \{ C_3^+ |000 \}, \{ C_{21}'' |000 \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \ (000); \quad C_3^+, C_{21}'' T; \quad R_1; \ 1, 1, 1; \]
\[ R_2; \ 1, -1, 1; \]
\[ R_3; \ 2; \ \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{C-2 WP; 2} \]

\[ M; \ (0\frac{1}{2}0); \quad C_{21}'' T; \quad R_1; \ 1, 1, 1; \]
\[ R_2; \ 1, -1, 1; \]

\[ A; \ (00\frac{1}{2}); \quad C_3^+, C_{21}'' T; \quad R_1; \ 1, 1, 1; \]
\[ R_2; \ 1, -1, 1; \]
\[ R_3; \ 2; \ \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{C-2 WP; 2} \]

\[ L; \ (0\frac{1}{2}\frac{1}{2}); \quad C_{21}'' T; \quad R_1; \ 1, 1, 1; \]

\[ K; \ (\frac{1}{2}\frac{1}{2}0); \quad C_3^+, C_{21}''; \quad R_1; \ 1, 1, 1; \]
\[ R_2; \ 1, -1, 1; \]
\[ R_3; \ 2; \ \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{C-1 WP; 1} \]

\[ H; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad C_3^+, C_{21}''; \quad R_1; \ 1, 1, 1; \]
\[ R_2; \ 1, -1, 1; \]
\[ R_3; \ 2; \ \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{C-1 WP; 1} \]

\[ \Delta; \Gamma A; \quad C_3^+, C_{21}'' T; \quad R_1; \ 1, 1, 1; \]
\[ R_2; \ 1; (-1)^{2/3}, 1; \]
\[ R_3; \ 1; -\sqrt{-1}, 1; \]

\[ U; \ ML; \quad E, C_{21}'' T; \quad R_1; \ 1, 1, 1; \]

\[ P; \ KH; \quad C_3^+, \quad R_1; \ 1, 1; \]
\[ R_2; \ 1; (-1)^{2/3}, 1; \]
\[ R_3; \ 1; -\sqrt{-1}; \]

\[ T; \Gamma K; \quad C_{22}'' T; \quad R_1; \ 1, 1; \]
\[ R_2; \ 1; -1; \]

\[ S; \ AH; \quad C_{22}'' T; \quad R_1; \ 1, 1; \]
\[ R_2; \ 1; -1; \]

\[ T'; \ MK; \quad C_{21}'' T; \quad R_1; \ 1, 1; \]
\[ R_2; \ 1; -1; \]

\[ S'; \ LH; \quad C_{21}'' T; \quad R_1; \ 1, 1; \]
\[ R_2; \ 1; -1; \]

\[ \Sigma; \Gamma M; \quad E, C_{21}'' T; \quad R_1; \ 1, 1, 1; \]

\[ R; \ AL; \quad E, C_{21}'' T; \quad R_1; \ 1, 1, 1; \]
SG 151

\[ \Gamma_h; \{ C^+_3 [00\frac{1}{3}], C^\prime_{21} [00\frac{2}{3}] \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (000); C^+_3, C^\prime_{21}, T; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 2; \frac{x_0 - \sqrt{3} x_3}{2}, \sigma_3, -\sigma_0; \text{C-2 WP}; 2 \]

\[ M; (0\frac{1}{2}0); C^\prime_{21}, T; R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]

\[ A; (00\frac{1}{2}); C^+_3, C^\prime_{22}, T; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 2; \frac{x_0 - \sqrt{3} x_3}{2}, \sigma_3, -\sigma_0; \text{C-2 WP}; 2 \]

\[ L; (0\frac{1}{2}\frac{1}{2}); C^\prime_{21}, T; R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]

\[ K; (\frac{1}{3}\frac{2}{3}0); C^+_3, C^\prime_{22}, T; R_1; 1, 1, 1; \]
\[ R_2; 1, \frac{1}{2}, \frac{1}{2}, 1; \]
\[ R_3; 1, -1, 1; \]

\[ H; (\frac{1}{3}\frac{2}{3}\frac{1}{2}); C^+_3, C^\prime_{22}, T; R_1; 1, 1, 1; \]
\[ R_2; 1, \frac{1}{2}, \frac{1}{2}, 1; \]
\[ R_3; 1, -1, 1; \]

\[ \Delta; \Gamma A; C^+_3, C^\prime_{22}, T; R_1; 1, 1, 1; \]
\[ R_2; 1, \frac{1}{2}, \frac{1}{2}, 1; \]
\[ R_3; 1, -1, 1; \]

\[ U; \text{ML}; E, C^\prime_{21}, T; R_1; 1, 1, 1; \]

\[ P; \text{KH}; C^+_3, C^\prime_{22}, T; R_1; 1, 1, 1; \]
\[ R_2; 1, \frac{1}{2}, \frac{1}{2}, 1; \]
\[ R_3; 1, -1, 1; \]

\[ T; \Gamma K; E, C^\prime_{22}, T; R_1; 1, 1, 1; \]

\[ S; \text{AH}; E, C^\prime_{22}, T; R_1; 1, 1, 1; \]

\[ T^\prime; \text{MK}; E, C^\prime_{21}, T; R_1; 1, 1, 1; \]

\[ S^\prime; \text{LH}; E, C^\prime_{21}, T; R_1; 1, 1, 1; \]

\[ \Sigma; \Gamma M; C^\prime_{21}; R_1; 1, 1; \]
\[ R_2; 1, -1; \]

\[ R; \text{AL}; C^\prime_{21}; R_3; 1, 1; \]
\[ R_6; 1, -1; \]
Γ: (000); \( C_3^+ \cdot C_{21}^T \); \( R_1 \): 1, 1, 1;
    \( R_2 \): 1, 1, -1, 1;
    \( R_3 \): 2; \( \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0 \); C-2 WP; 2

M: (0\( \frac{1}{2} \)0); \( C_{21}^T \);
    \( R_1 \): 1, 1, 1;
    \( R_2 \): 1, -1, 1;

A: (00\( \frac{1}{2} \)); \( C_3^+ \cdot C_{21}^T \);
    \( R_1 \): 1, 1, 1, 1;
    \( R_2 \): 1, 1, -1, 1;
    \( R_3 \): 2; \( \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0 \); C-2 WP; 2

L: (0\( \frac{1}{2} \)\( \frac{1}{2} \)); \( C_{21}^T \);
    \( R_1 \): 1, 1, 1;
    \( R_2 \): 1, -1, 1;

K: (\( \frac{1}{2} \)\( \frac{1}{2} \)0); \( C_3^+ \cdot C_{21}^T \);
    \( R_1 \): 1, 1, 1;
    \( R_2 \): 1, -1, 1;
    \( R_3 \): 2; \( \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3 \); C-1 WP; 1

H: (\( \frac{1}{2} \)\( \frac{3}{4} \)\( \frac{1}{4} \)); \( C_3^+ \cdot C_{21}^T \);
    \( R_1 \): 1, 1, 1;
    \( R_2 \): 1, -1, 1;
    \( R_3 \): 2; \( \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3 \); C-1 WP; 1

Δ: ΓA;
    \( C_3^+ \cdot C_{22}^T \);
    \( R_1 \): 1, 1, 1;
    \( R_2 \): 1; \((-1)^{2/3}, 1\);
    \( R_3 \): 1; \(-\sqrt[3]{-1}, 1\);

U: ML; \( E \cdot C_{21}^T \);
    \( R_1 \): 1, 1, 1;

P: KH; \( C_3^+ \);
    \( R_1 \): 1, 1;
    \( R_2 \): 1; \((-1)^{2/3}, 1\);
    \( R_3 \): 1; \(-\sqrt[3]{-1}\);

T: ΓK; \( C_{22}^T \);
    \( R_1 \): 1, 1;
    \( R_2 \): 1, 1;

S: AH; \( C_{22}^T \);
    \( R_2 \): 1, 1;
    \( R_5 \): 1, 1;

T': MK; \( C_{21}^T \);
    \( R_1 \): 1, 1;
    \( R_2 \): 1, -1;

S': LH; \( C_{21}^T \);
    \( R_3 \): 1, 1;
    \( R_6 \): 1, -1;

Σ: ΓM; \( E \cdot C_{21}^T \);
    \( R_1 \): 1, 1, 1;

R: AL; \( E \cdot C_{21}^T \);
    \( R_1 \): 1, 1, 1;
$\Gamma_h; \{C^+_3|00\frac{2}{3}\}, \{C'_2|00\frac{1}{3}\}, T; \text{Non-Centrosymmetric; without SOC}$

$\Gamma; (000); C^+_3 , C'_2 , T;
R_1 ; 1; 1,1,1;
R_2 ; 1; 1,-1,1;
R_3 ; 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3 , -\sigma_0 ; C-2 \text{ WP}; 2$

$M; (0\frac{1}{2}0); C'_2 , T;
R_1 ; 1; 1,1;
R_2 ; 1; -1,1;$

$A; (00\frac{1}{2}); C^+_3 , C'_2 , T;
R_1 ; 1; 1,1,1;
R_2 ; 1; 1,-1,1;
R_3 ; 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3 , -\sigma_0 ; C-2 \text{ WP}; 2$

$L; (0\frac{1}{2}\frac{1}{2}); C'_2 , T;
R_1 ; 1; 1,1;
R_2 ; 1; -1,1;$

$K; (\frac{1}{3}\frac{2}{3}0); C^+_3 , C'_2 , T;
R_1 ; 1; 1,1;
R_2 ; 1; (-1)^{2/3}, 1;
R_3 ; 1; -\sqrt[3]{-1}, 1;$

$H; (\frac{1}{3}\frac{2}{3}\frac{1}{2}); C^+_3 , C'_2 , T;
R_1 ; 1; 1,1;
R_2 ; 1; (-1)^{2/3}, 1;
R_3 ; 1; -\sqrt[3]{-1}, 1;$

$\Delta; \Gamma A; C^+_3 , C'_2 , T;
R_1 ; 1; 1,1;
R_2 ; 1; (-1)^{2/3}, 1;
R_3 ; 1; -\sqrt[3]{-1}, 1;$

$U; ML; E , C'_2 , T;
R_1 ; 1; 1,1;$

$P; KH; C^+_3 , C'_2 , T;
R_1 ; 1; 1,1;
R_2 ; 1; (-1)^{2/3}, 1;
R_3 ; 1; -\sqrt[3]{-1}, 1;$

$T; \Gamma K; E , C'_2 , T;
R_1 ; 1; 1,1;$

$S; AH; E , C'_2 , T;
R_1 ; 1; 1,1;$

$T'; MK; E , C'_2 , T;
R_1 ; 1; 1,1;$

$S'; LH; E , C'_2 , T;
R_1 ; 1; 1,1;$

$\Sigma; \Gamma M; C'_2 ;
R_1 ; 1; 1;
R_2 ; 1; -1;$

$R; AL; C'_2 ;
R_2 ; 1; 1;
R_5 ; 1; -1;
\[
\begin{align*}
\Gamma: \ (000) &; \ C^+_{3}, C''_{21}, T; \ R_1; 1; 1,1,1; \\
& \quad R_2; 1; 1,-1,1; \\
& \quad R_3; 2; \frac{-\sigma_0-i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{ C-2 WP; 2} \\
M: \ (0\frac{1}{2}0) &; \ C''_{21}, T; \ R_1; 1; 1,1; \\
& \quad R_2; 1; -1,1; \\
A: \ (00\frac{1}{2}) &; \ C^+_{3}, C''_{21}, T; \ R_1; 1; 1,1,1; \\
& \quad R_2; 1; 1,-1,1; \\
& \quad R_3; 2; \frac{-\sigma_0-i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{ C-2 WP; 2} \\
L: \ (0\frac{1}{2}\frac{1}{2}) &; \ C''_{21}, T; \ R_1; 1; 1,1; \\
& \quad R_2; 1; -1,1; \\
K: \ (\frac{1}{2}\frac{3}{4}0) &; \ C^+_{3}, C''_{21}; \ R_1; 1; 1,1; \\
& \quad R_2; 1; 1,-1; \\
& \quad R_3; 2; \frac{-\sigma_0+i\sqrt{3}\sigma_2}{2}, \sigma_3; \text{ C-1 WP; 1} \\
H: \ (\frac{3}{4}\frac{3}{4}\frac{1}{2}) &; \ C^+_{3}, C''_{21}; \ R_1; 1; 1,1; \\
& \quad R_2; 1; 1,-1; \\
& \quad R_3; 2; \frac{-\sigma_0+i\sqrt{3}\sigma_2}{2}, \sigma_3; \text{ C-1 WP; 1} \\
\Delta: \ \Gamma A; \ & \ C^+_{3}, C''_{22}, T; \ R_1; 1; 1,1; \\
& \quad R_2; 1; (-1)^{2/3}, 1; \\
& \quad R_3; 1; -\sqrt{-1}, 1; \\
U: \ ML; \ & \ E, C''_{21}, T; \ R_1; 1; 1,1; \\
P: \ KH; \ & \ C^+_{3}; \ R_1; 1; 1; \\
& \quad R_2; 1; (-1)^{2/3}; \\
& \quad R_3; 1; -\sqrt{-1}; \\
T: \ \Gamma K; \ & \ C''_{22}; \ R_1; 1; 1; \\
& \quad R_2; 1; -1; \\
S: \ AH; \ & \ C''_{22}; \ R_3; 1; 1; \\
& \quad R_6; 1; -1; \\
T': \ MK; \ & \ C''_{21}; \ R_1; 1; 1; \\
& \quad R_2; 1; -1; \\
S': \ LH; \ & \ C''_{21}; \ R_2; 1; 1; \\
& \quad R_5; 1; -1; \\
\Sigma: \ \Gamma M; \ & \ E, C''_{21}, T; \ R_1; 1; 1,1; \\
R: \ AL; \ & \ E, C''_{21}, T; \ R_1; 1; 1,1; 
\end{align*}
\]
\[ \Gamma; \quad (000); \quad \{C_3^+|000\}, \{C_{21}'|000\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma &; \quad (000); \quad C_3^+, C_{21}', T; \quad R_1; 1, 1, 1; \\
&; \quad R_2; 1, 1, -1, 1; \\
&; \quad R_3; 2, \frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, -\sigma_0; \text{C-2 WP}; 2 \\
\end{align*}
\]

\[
\begin{align*}
Z &; \quad (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad C_3^+, C_{21}', T; \quad R_1; 1, 1, 1; \\
&; \quad R_2; 1, 1, -1, 1; \\
&; \quad R_3; 2, \frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, -\sigma_0; \text{C-2 WP}; 2 \\
\end{align*}
\]

\[
\begin{align*}
L &; \quad (0 \frac{1}{2} 0); \quad C_{22}', T; \quad R_1; 1, 1, 1; \\
&; \quad R_2; 1, -1, 1; \\
(a)F; \quad (0 \frac{1}{2} \frac{1}{2}); \quad C_{21}', T; \quad R_1; 1, 1, 1; \\
&; \quad R_2; 1, -1, 1; \\
(b)F; \quad (\frac{1}{2} \frac{1}{2} 0); \quad C_{23}', T; \quad R_1; 1, 1, 1; \\
&; \quad R_2; 1, -1, 1; \\
\end{align*}
\]

\[
\begin{align*}
\Lambda &; \quad \Gamma\Lambda/\Gamma Z; \quad C_3^+, C_{22}'T; \quad R_1; 1, 1, 1; \\
&; \quad R_2; 1, (-1)^{2/3}, 1; \\
&; \quad R_3; 1, -\sqrt{-1}, 1; \\
\end{align*}
\]

\[
\begin{align*}
P &; \quad ZP; \quad C_3^+, C_{22}'T; \quad R_1; 1, 1, 1; \\
&; \quad R_2; 1, (-1)^{2/3}, 1; \\
&; \quad R_3; 1, -\sqrt{-1}, 1; \\
\end{align*}
\]

\[
\begin{align*}
B &; \quad ZB; \quad C_{21}'; \quad R_1; 1, 1; \\
&; \quad R_2; 1, -1; \\
\end{align*}
\]

\[
\begin{align*}
\Sigma &; \quad \Gamma F/\Gamma \Sigma; \quad C_{21}'; \quad R_1; 1, 1; \\
&; \quad R_2; 1, -1; \\
\end{align*}
\]

\[
\begin{align*}
Q &; \quad FQ; \quad C_{23}'; \quad R_1; 1, 1; \\
&; \quad R_2; 1, -1; \\
\end{align*}
\]

\[
\begin{align*}
Y &; \quad LZ/\Lambda Y; \quad C_{22}'; \quad R_1; 1, 1; \\
&; \quad R_2; 1, -1; \\
\end{align*}
\]
\[ \Gamma_h; \{ C_3^+ |000 \}, \{ \sigma_{v1} |000 \}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \quad \text{(000):} \quad C_3^+ \sigma_{v1}, \mathcal{T}; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, 1, -1, 1; \]
\[ R_3; \quad 2; \quad \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-WNLs;} \]

\[ M; \quad (0 \frac{1}{2} 0); \quad \sigma_{v1}, \mathcal{T}; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]

\[ A; \quad (00 \frac{1}{2}); \quad C_3^+ \sigma_{v1}, \mathcal{T}; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1, 1; \]
\[ R_3; \quad 2; \quad \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-WNLs;} \]

\[ L; \quad (0 \frac{1}{2} \frac{1}{2}); \quad \sigma_{v1}, \mathcal{T}; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]

\[ K; \quad (\frac{1}{2} \frac{1}{2} 0); \quad C_3^+ \sigma_{v2}; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1 \quad (-1)^{2/3}, 1; \]
\[ R_3; \quad 1; \quad -\sqrt[3]{-1}, 1; \]

\[ H; \quad (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad C_3^+ \sigma_{v2}; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1 \quad (-1)^{2/3}, 1; \]
\[ R_3; \quad 1; \quad -\sqrt[3]{-1}, 1; \]

\[ \Delta; \quad \Gamma A; \quad C_3^+ \sigma_{v1}; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, 1, -1; \]
\[ R_3; \quad 2; \quad \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \quad \text{WNL;} \quad \pi \]

\[ U; \quad \text{ML}; \quad \sigma_{v1}; \quad R_1; \quad 1, 1; \]
\[ R_2; \quad 1, -1; \]

\[ P; \quad \text{KH}; \quad C_3^+; \quad R_1; \quad 1, 1; \]
\[ R_2; \quad 1 \quad (-1)^{2/3}; \]
\[ R_3; \quad 1; \quad -\sqrt[3]{-1}; \]

\[ T; \quad \Gamma K; \quad E, \mathcal{T}\sigma_{v2}; \quad R_1; \quad 1, 1, 1; \]

\[ S; \quad \text{AH}; \quad E, \mathcal{T}\sigma_{v2}; \quad R_1; \quad 1, 1, 1; \]

\[ T; \quad \text{MK}; \quad E, \mathcal{T}\sigma_{v1}; \quad R_1; \quad 1, 1, 1; \]

\[ S; \quad \text{LH}; \quad E, \mathcal{T}\sigma_{v1}; \quad R_1; \quad 1, 1, 1; \]

\[ \Sigma; \quad \Gamma M; \quad \sigma_{v1}; \quad R_1; \quad 1, 1; \]
\[ R_2; \quad 1, -1; \]

\[ R; \quad \text{AL}; \quad \sigma_{v1}; \quad R_1; \quad 1, 1; \]
\[ R_2; \quad 1, -1; \]
\(\Gamma_h; \{C^+_3 |000\}, \{\sigma_{d1} |000\}, T\); Non-Centrosymmetric; without SOC

\[\Gamma; (000); C^+_3, \sigma_{d1}, T; R_3; 1, 1, 1;\]
\[R_2; 1, 1, -1, 1;\]
\[R_5; 2; \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{P-WNLs};\]

\[M; (0\frac{1}{2}0); \sigma_{d1}, T; R_3; 1, 1, 1;\]
\[R_2; 1, -1, 1;\]

\[A; (00\frac{1}{2}); C^+_3, \sigma_{d1}, T; R_3; 1, 1, 1, 1;\]
\[R_2; 1, 1, -1, 1;\]
\[R_3; 2; \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{P-WNLs};\]

\[L; (0\frac{1}{2}\frac{1}{2}); \sigma_{d1}, T; R_3; 1, 1, 1;\]
\[R_2; 1, -1, 1;\]

\[K; (0\frac{3}{2}0); C^+_3, \sigma_{d1}; R_3; 1, 1, 1;\]
\[R_2; 1, 1, -1;\]
\[R_3; 2; \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \text{P-WNL}_{KH};\]

\[H; (0\frac{3}{2}\frac{1}{2}); C^+_3, \sigma_{d1}; R_3; 1, 1, 1;\]
\[R_2; 1, 1, -1;\]
\[R_3; 2; \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \text{P-WNL}_{KH};\]

\[\Delta; \Gamma_A; C^+_3, \sigma_{d1}; R_3; 1, 1, 1;\]
\[R_2; 1, 1, -1;\]
\[R_3; 2; \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \text{WNL}; \pi\]

\[U; \text{ML}; \sigma_{d1}; R_3; 1, 1;\]
\[R_2; 1, -1;\]

\[P; \text{KH}; C^+_3, \sigma_{d1}; R_3; 1, 1, 1;\]
\[R_2; 1, 1, -1;\]
\[R_3; 2; \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \text{WNL}; \pi\]

\[T; \Gamma_K; \sigma_{d2}; R_3; 1, 1;\]
\[R_2; 1, -1;\]

\[S; \text{AH}; \sigma_{d2}; R_3; 1, 1;\]
\[R_2; 1, -1;\]

\[T'; \text{MK}; \sigma_{d1}; R_3; 1, 1;\]
\[R_2; 1, -1;\]

\[S'; \text{LH}; \sigma_{d1}; R_3; 1, 1;\]
\[R_2; 1, -1;\]

\[\Sigma; \Gamma_M; E,T\sigma_{d1}; R_3; 1, 1, 1;\]

\[R; \text{AL}; E,T\sigma_{d1}; R_3; 1, 1, 1;\]
\[ \Gamma; (000); C_3^+; \sigma_{\epsilon_1}; T; R_1; 1; 1, 1, 1; \]
\[ R_2; 1; 1, -1, 1; \]
\[ R_3; 2; -\frac{\alpha_0 - \sqrt{3}\alpha_2}{2}, \sigma_3, -\sigma_0; \]
\[ \text{P-WNLs;} \]
\[ M; (0\frac{1}{2}0); \sigma_{\epsilon_1}, T; R_1; 1; 1, 1; \]
\[ R_2; 1; -1, 1; \]
\[ \text{P-WNLs;} \]
\[ A; (00\frac{1}{2}); C_3^+; \sigma_{\epsilon_1}, T; \{ R_1, R_4 \}; 2; -\sigma_0, i\sigma_3, \sigma_1; \]
\[ \{ R_0, R_6 \}; 4; \frac{\Gamma_0, 0 - \sqrt{3}\Gamma_{0, 2}}{2}, i\Gamma_{0, 3}, -\Gamma_{2, 2}; \]
\[ \text{DP; 0} \]
\[ L; (0\frac{1}{2}\frac{1}{2}); \sigma_{\epsilon_1}, T; \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_1; \]
\[ \text{P-WNL;} \]
\[ K; (\frac{1}{2}\frac{1}{2}0); C_3^+; \sigma_{\epsilon_2}; R_1; 1; 1, 1; \]
\[ R_2; 1; (-1)^{2/3}, 1; \]
\[ R_3; 1; (-1)^{4/3}, 1; \]
\[ \text{P-WNLs;} \]
\[ H; (\frac{1}{2}\overline{3}\frac{1}{2}); C_3^+; \sigma_{\epsilon_2}; \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \]
\[ \{ R_2, R_2 \}; 2; (-1)^{2/3}\sigma_0, -i\sigma_2; \]
\[ \{ R_3, R_3 \}; 2; (-1)^{4/3}\sigma_0, -i\sigma_2; \]
\[ \text{P-WNLs;} \]
\[ \Delta; \Gamma A; C_3^+; \sigma_{\epsilon_1}; R_1; 1; 1, 1; \]
\[ R_2; 1; 1, -1; \]
\[ R_3; 2; -\frac{\alpha_0 - \sqrt{3}\alpha_2}{2}, \sigma_3; \]
\[ \text{WNL; } \pi \]
\[ U; \overline{1}; \sigma_{\epsilon_1}; R_1; 1; 1; \]
\[ R_2; 1; -1; \]
\[ P; \overline{1}; C_3^+; \sigma_{\epsilon_1}; R_1; 1; 1; \]
\[ R_2; 1; (-1)^{2/3}; \]
\[ R_3; 1; -\sqrt{3}; \]
\[ \text{T; } \Gamma K; E, \overline{T} \sigma_{\epsilon_2}; R_1; 1; 1, 1; \]
\[ S; \overline{1}; C_3^+; \sigma_{\epsilon_2}; \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \]
\[ \text{WNL; } \pi \]
\[ T'; \overline{1}; E, \overline{T} \sigma_{\epsilon_1}; R_1; 1; 1, 1; \]
\[ S'; \overline{1}; L H; E, \overline{T} \sigma_{\epsilon_1}; \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \]
\[ \text{WNL; } \pi \]
\[ \text{R; } \overline{1}; \sigma_{\epsilon_1}; R_1; 1; 1; \]
\[ R_2; 1; i; \]
Γ: (000); \( C_3^+ \).\( \sigma_{d1}, \mathcal{T} \); \( R_3 \); 1, 1, 1;
\( R_2 \); 1, 1, -1, 1;
\( R_3 \); 2, \(-\frac{a_0 - i\sqrt{3a_2}}{2}, \sigma_3, -\sigma_0\); P-WNL\(_{\Gamma A}\);

\( M \): \( (0\frac{1}{2}0) \); \( \sigma_{d1}, \mathcal{T} \); \( R_3 \); 1, 1, 1;
\( R_2 \); 1, -1, 1;

\( A \): \( (00\frac{1}{2}) \); \( C_3^+ \).\( \sigma_{d1}, \mathcal{T} \); \{\( R_3, R_4 \)\}; 2, \(-\sigma_0, i\sigma_3, \sigma_1\); P-WNLs;
\{\( R_6, R_6 \)\}; 4, \( \frac{\Gamma_{0,0} - i\sqrt{3\Gamma_{0,2}}}{2} \), \( \Gamma_{0,3}, -\Gamma_{2,2} \); DP; 0

\( L \): \( (0\frac{1}{2}\frac{1}{2}) \); \( \sigma_{d1}, \mathcal{T} \); \{\( R_2, R_4 \)\}; 2, \( i\sigma_3, \sigma_1\); P-WNLs;

\( K \): \( (\frac{1}{3}20) \); \( C_3^+ \).\( \sigma_{d1} \); \( R_3 \); 1, 1, 1;
\( R_2 \); 1, 1, -1;
\( R_3 \); 2, \(-\frac{a_0 - i\sqrt{3a_2}}{2}, \sigma_3\); P-WNL\(_{KH}\);

\( H \): \( (\frac{1}{3}\frac{1}{2}\frac{1}{2}) \); \( C_3^+ \).\( \sigma_{d1} \); \( R_3 \); 1, -1, 1;
\( R_4 \); 1, -1, -1;
\( R_6 \); 2, \( \frac{1}{2} (\sigma_0 - i\sqrt{3\sigma_2}), i\sigma_3\); P-WNL\(_{KH}\);

\( \Delta \): \( \Gamma A \); \( C_3^+ \).\( \sigma_{d1} \); \( R_3 \); 1, 1, 1;
\( R_2 \); 1, 1, -1;
\( R_3 \); 2, \(-\frac{a_0 - i\sqrt{3a_2}}{2}, \sigma_3\); WNL; \( \pi \)

\( U \): \( ML \); \( \sigma_{d1} \); \( R_3 \); 1, 1;
\( R_2 \); 1, -1;

\( P \): \( KH \); \( C_3^+ \).\( \sigma_{d1} \); \( R_3 \); 1, 1, 1;
\( R_2 \); 1, 1, -1;
\( R_3 \); 2, \(-\frac{a_0 - i\sqrt{3a_2}}{2}, \sigma_3\); WNL; \( \pi \)

\( T \): \( \Gamma K \); \( \sigma_{d2} \); \( R_3 \); 1, 1;
\( R_2 \); 1, -1;

\( S \): \( AH \); \( \sigma_{d2} \); \( R_3 \); 1, -1;
\( R_2 \); 1, i;

\( T' \): \( MK \); \( \sigma_{d1} \); \( R_3 \); 1, 1;
\( R_2 \); 1, -1;

\( S' \): \( LH \); \( \sigma_{d1} \); \( R_3 \); 1, -1;
\( R_2 \); 1, i;

\( \Sigma \): \( \Gamma M \); \( E, T \).\( \sigma_{d1} \); \( R_3 \); 1, 1, 1;

\( R \): \( AL \); \( E, T \).\( \sigma_{d1} \); \{\( R_i, R_i \)\}; 2, \( \sigma_0, -i\sigma_2\); WNL; \( \pi \)
\[ \Gamma; \quad (000); \quad C^+_3, \sigma_{d1}, T; \quad R_1; 1, 1, 1; \]
\[ \quad R_2; 1, 1, -1, 1; \]
\[ \quad R_3; 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-WNL} \]

\[ Z; \quad (\frac{1}{2} \frac{1}{2} 0); \quad C^+_3, \sigma_{d1}, T; \quad R_1; 1, 1, 1; \]
\[ \quad R_2; 1, 1, -1, 1; \]
\[ \quad R_3; 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-WNL} \]

\[ L; \quad (0 \frac{1}{2} 0); \quad \sigma_{d2}, T; \]
\[ \quad R_1; 1, 1, 1; \]
\[ \quad R_2; 1, -1, 1; \]

\[ (a) F; \quad (0 \frac{1}{2} \frac{1}{2}); \quad \sigma_{d1}, T; \]
\[ \quad R_1; 1, 1, 1; \]
\[ \quad R_2; 1, -1, 1; \]

\[ (b) F; \quad (\frac{1}{2} \frac{1}{2} 0); \quad \sigma_{d3}, T; \]
\[ \quad R_1; 1, 1, 1; \]
\[ \quad R_2; 1, -1, 1; \]

\[ \Lambda; \quad \Gamma\Lambda/\Gamma Z; \quad C^+_3, \sigma_{d1}; \]
\[ \quad R_1; 1, 1, 1; \]
\[ \quad R_2; 1, 1, -1; \]
\[ \quad R_3; 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \quad \text{WNL}; \quad \pi \]

\[ P; \quad ZP; \quad C^+_3, \sigma_{d1}; \]
\[ \quad R_1; 1, 1, 1; \]
\[ \quad R_2; 1, 1, -1; \]
\[ \quad R_3; 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \quad \text{WNL}; \quad \pi \]

\[ B; \quad ZB; \quad E, T \sigma_{d1}; \]
\[ \quad R_1; 1, 1, 1; \]

\[ \Sigma; \quad \Gamma F/\Gamma \Sigma; \quad E, T \sigma_{d1}; \]
\[ \quad R_1; 1, 1, 1; \]

\[ Q; \quad FQ; \quad E, T \sigma_{d3}; \]
\[ \quad R_1; 1, 1, 1; \]

\[ Y; \quad LZ/\ LY; \quad E, T \sigma_{d2}; \]
\[ \quad R_1; 1, 1, 1; \]

\[ \text{Non-Centrosymmetric; without SOC} \]
SG 161

$\Gamma; \{C^+_3|000\}, \{\sigma_{d1}|_{\frac{1}{2}0\frac{1}{2}}\}, T; \text{Non-Centrosymmetric; without SOC}

\begin{align*}
\Gamma & : (000); \quad C^+_3, \sigma_{d1}, T; \quad R_1; 1, 1, 1; \\
& \quad R_2; 1, -1, 1; \\
& \quad R_3; 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-WNL; } \pi
\end{align*}

\begin{align*}
Z & : \left(\frac{1}{2}0\frac{1}{2}\frac{1}{2}\right); \quad C^+_3, \sigma_{d1}, T; \quad \{R_3, R_4\}; 2; -\sigma_0, i\sigma_3, \sigma_1; \quad \text{P-WNLs;}
& \quad \{R_6, R_0\}; 4; \frac{\Gamma_{0.0}}{i\Gamma_{0.0}}, i\Gamma_{0.3}, -\Gamma_{2.2}; \quad \text{DP; } 0
\end{align*}

\begin{align*}
L & : \left(0\frac{1}{2}0\right); \quad \sigma_{d2}, T; \quad \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \quad \text{P-WNLs;}
(a)F & : \left(0\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); \quad \sigma_{d1}, T; \quad R_1; 1, 1, 1; \\
& \quad R_2; 1, -1, 1;
(b)F & : \left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); \quad \sigma_{d1}, T; \quad R_1; 1, 1, 1; \\
& \quad R_2; 1, -1, 1;
\Lambda & : \Gamma A/TZ; \quad C^+_3, \sigma_{d1}; \quad R_1; 1, 1, 1; \\
& \quad R_2; 1, 1, -1; \\
& \quad R_3; 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \quad \text{WNL; } \pi
\end{align*}

\begin{align*}
P & : \text{ZP; } C^+_3, \sigma_{d1}; \quad R_1; 1, 1, 1; \\
& \quad R_2; 1, 1, -1; \\
& \quad R_3; 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \quad \text{WNL; } \pi
\end{align*}

\begin{align*}
B & : \text{ZB; } E, T \sigma_{d1}; \quad \{R_1, R_3\}; 2; \sigma_0, -i\sigma_2; \quad \text{WNL; } \pi
\end{align*}

\begin{align*}
\Sigma & : \Gamma F/\Gamma \Sigma; \quad E, T \sigma_{d1}; \quad R_1; 1, 1, 1;
Q & : \text{FQ; } E, T \sigma_{d3}; \quad R_1; 1, 1, 1;
Y & : \text{LZ/LY; } E, T \sigma_{d2}; \quad \{R_1, R_3\}; 2; \sigma_0, -i\sigma_2; \quad \text{WNL; } \pi
\end{align*}
\[ \Gamma_h; \{ S_{0}^{\pm}[000], \{ C'_{21}[000]\} \}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; (000); S_{0}^{+}, C'_{21}, T; \]
\[ R_1: 1, 1, 1, 1; \]
\[ R_2: 1, 1, -1, 1; \]
\[ R_3: 1, -1, 1, 1; \]
\[ R_4: 1, -1, -1, 1; \]
\[ R_5: 2, \frac{-a_0 - i \sqrt{2} \delta_2}{2}, \sigma_3, -\sigma_0; \text{P-WNL}_{\Gamma,A}; \]
\[ R_6: 2, \frac{-a_0 + i \sqrt{2} \delta_2}{2}, \sigma_3, -\sigma_0; \text{P-WNL}_{\Gamma,A}; \]

\[ M; (0\frac{1}{2}0); C'_{21}, I, T; \]
\[ R_1: 1, 1, 1, 1; \]
\[ R_2: 1, 1, -1, 1; \]
\[ R_3: 1, -1, 1, 1; \]
\[ R_4: 1, -1, -1, 1; \]

\[ A; (00\frac{1}{2}); S_{0}^{+}, C'_{21}, T; \]
\[ R_1: 1, 1, 1, 1; \]
\[ R_2: 1, 1, -1, 1; \]
\[ R_3: 1, -1, 1, 1; \]
\[ R_4: 1, -1, -1, 1; \]

\[ L; (0\frac{1}{2}\frac{1}{2}); C'_{21}, I, T; \]
\[ R_1: 1, 1, 1, 1; \]
\[ R_2: 1, 1, -1, 1; \]
\[ R_3: 1, -1, 1, 1; \]
\[ R_4: 1, -1, -1, 1; \]

\[ K; (\frac{1}{2}\frac{1}{2}0); C_{3}^{+}, \sigma_{d1}, I, T; \]
\[ R_1: 1, 1, 1, 1; \]
\[ R_2: 1, 1, -1, 1; \]
\[ R_3: 2, \frac{-a_0 - i \sqrt{2} \delta_2}{2}, \sigma_3, -\sigma_0; \text{P-WNL}_{K,H}; \]

\[ H; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{3}^{+}, \sigma_{d1}, I, T; \]
\[ R_1: 1, 1, 1, 1; \]
\[ R_2: 1, 1, -1, 1; \]
\[ R_3: 2, \frac{-a_0 - i \sqrt{2} \delta_2}{2}, \sigma_3, -\sigma_0; \text{P-WNL}_{K,H}; \]

\[ \Delta; \Gamma A; C_{3}^{+}, \sigma_{d1}, I, T; \]
\[ R_1: 1, 1, 1, 1; \]
\[ R_2: 1, 1, -1, 1; \]
\[ R_3: 2, \frac{-a_0 - i \sqrt{2} \delta_2}{2}, \sigma_3, -\sigma_0; \text{WNL}; \quad \pi \]

\[ U; \text{ML}; \sigma_{d1}, I, T; \]
\[ R_1: 1, 1, 1; \]
\[ R_2: 1, -1, 1; \]

\[ P; \text{KH}; C_{3}^{+}, \sigma_{d1}, I, T; \]
\[ R_1: 1, 1, 1, 1; \]
\[ R_2: 1, 1, -1, 1; \]
\[ R_3: 2, \frac{-a_0 - i \sqrt{2} \delta_2}{2}, \sigma_3, -\sigma_0; \text{WNL}; \quad \pi \]

\[ T; \Gamma K; \sigma_{d2}, I, T; \]
\[ R_1: 1, 1, 1; \]
\[ R_2: 1, -1, 1; \]

\[ S; \text{AH}; \sigma_{d2}, I, T; \]
\[ R_1: 1, 1, 1; \]
\[ R_2: 1, -1, 1; \]

\[ T'; \text{MK}; \sigma_{d1}, I, T; \]
\[ R_1: 1, 1, 1; \]
\[ R_2: 1, -1, 1; \]

\[ S'; \text{LH}; \sigma_{d1}, I, T; \]
\[ R_1: 1, 1, 1; \]
\[ R_2: 1, -1, 1; \]

\[ \Sigma; \Gamma M; C'_{21}, I, T; \]
\[ R_1: 1, 1, 1; \]
\[ R_2: 1, -1, 1; \]

\[ R; \text{AL}; C'_{21}, I, T; \]
\[ R_1: 1, 1, 1; \]
\[ R_2: 1, -1, 1; \]
\[\Gamma_h; \{S^+_0(000), \{C^+_0(00\frac{1}{2})\}, T\}; \text{Centrosymmetric; without SOC}\]

\[\Gamma; (000); S^+_0, C^+_0, T; R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[R_3; 1; -1, 1, 1;\]
\[R_4; 1; -1, -1, 1;\]
\[R_5; 2; \frac{-\sigma_0 - i\sqrt{\sigma_2}}{2}, \sigma_3, -\sigma_0; \text{P-WNL}_{\Gamma A};\]
\[R_6; 2; \frac{\sigma_0 - i\sqrt{\sigma_2}}{2}, \sigma_3, -\sigma_0; \text{P-WNL}_{\Gamma A};\]

\[M; (0\frac{1}{2}0); C^+_0, I, T; R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[R_3; 1; -1, 1, 1;\]
\[R_4; 1; -1, -1, 1;\]

\[A; (00\frac{1}{2}); \sigma_{d1}, C^+_3, I, T; \{R_7, R_8\}; 4; -i\Gamma_{3,1}, \frac{-\Gamma_{0,0} - i\sqrt{3} \Gamma_{3,3}}{2}, \Gamma_{0,3}, \Gamma_{1,0}; \text{DP}; 0\]
\[R_9; 2; i\sigma_1, \sigma_0, \sigma_3, -i\sigma_3; \text{P-WNLs};\]

\[L; (0\frac{1}{2}0); \sigma_{d1}, I, T; R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \text{P-WNL}s;\]

\[K; (\frac{1}{2}0); C^+_3, \sigma_{d1}, I, T; R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[R_3; 2; \frac{-\sigma_0 - i\sqrt{\sigma_2}}{2}, \sigma_3, -\sigma_0; \text{P-WNL}_{KH};\]

\[H; (\frac{1}{2}\frac{1}{2}0); C^+_3, \sigma_{d1}, I, T; R_3; 1; -1, i, 1;\]
\[R_4; 1; -1, -i, 1;\]
\[R_6; 2; \frac{\sigma_0 - i\sqrt{\sigma_2}}{2}, i\sigma_3, -\sigma_0; \text{P-WNL}_{KH};\]

\[\Delta; \Gamma A; C^+_3, \sigma_{d1}, I, T; R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[R_3; 2; \frac{-\sigma_0 - i\sqrt{\sigma_2}}{2}, \sigma_3, -\sigma_0; \text{WNL}; \pi;\]

\[U; ML; \sigma_{d1}, I, T; R_1; 1; 1, 1;\]
\[R_2; 1; -1, 1;\]

\[P; KH; C^+_3, \sigma_{d1}, I, T; R_1; 1; 1, 1, 1;\]
\[R_2; 1; 1, -1, 1;\]
\[R_3; 2; \frac{\sigma_0 - i\sqrt{\sigma_2}}{2}, \sigma_3, -\sigma_0; \text{WNL}; \pi;\]

\[T; \Gamma K; \sigma_{d2}, I, T; R_1; 1; 1, 1;\]
\[R_2; 1; -1, 1;\]

\[S; AH; \sigma_{d2}, I, T; R_1; 1; -i, 1;\]
\[R_2; 1; i, 1;\]

\[T'; MK; \sigma_{d1}, I, T; R_1; 1; 1, 1;\]
\[R_2; 1; -1, 1;\]

\[S'; LH; \sigma_{d1}, I, T; R_1; 1; -i, 1;\]
\[R_2; 1; i, 1;\]

\[\Sigma; \Gamma M; C^+_0, I, T; R_1; 1; 1, 1;\]
\[R_2; 1; -1, 1;\]

\[R; AL; C^+_0, I, T; \{R_2, R_4\}; 2; \sigma_3, \sigma_1; \text{WNL}; \pi;\]
\[ \Gamma_h; \{ S_6^+ |000\}, \{ C_{21}^{\text{inv}} |000\}, T; \text{Centrosymmetric; without SOC} \]

\[ \begin{align*}
\Gamma: \ (000); \ & S_6^+, C_{21}^{\text{inv}}, T; \\
& R_1; \ 1; 1,1,1; \\
& R_2; \ 1; 1, -1,1; \\
& R_3; \ 1; -1,1,1; \\
& R_4; \ 1; 1, -1,1; \\
& R_5; \ 2; -\frac{\sigma_0 + i\sqrt{2}\sigma_3}{2}, \sigma_3, -\sigma_0; \ P-\text{WNL}_{\Gamma A}; \\
& R_6; \ 2; -\frac{\sigma_0 - i\sqrt{2}\sigma_2}{2}, \sigma_3, -\sigma_0; \ P-\text{WNL}_{\Gamma A}; \\
M: \ (0^1\frac{1}{2}0); \ & C_{21}^{\text{inv}}, T; \\
& R_1; \ 1; 1,1,1; \\
& R_2; \ 1; 1, -1,1; \\
& R_3; \ 1; -1,1,1; \\
& R_4; \ 1; 1, -1,1; \\
A: \ (00\frac{1}{2}); \ & S_6^+, C_{21}^{\text{inv}}, T; \\
& R_1; \ 1; 1,1,1; \\
& R_2; \ 1; 1, -1,1; \\
& R_3; \ 1; -1,1,1; \\
& R_4; \ 1; 1, -1,1; \\
K: \ (\frac{1}{3}\frac{2}{3}0); \ & C_3^+, C_{21}^{\text{inv}}, T; \\
& R_1; \ 1; 1,1,1; \\
& R_2; \ 1; 1, -1,1; \\
& R_3; \ 2; -\frac{\sigma_0 + i\sqrt{2}\sigma_3}{2}, \sigma_3, -\sigma_0; \ P-\text{WNL}_{KH}; \\
H: \ (\frac{1}{3}\frac{2}{3}\frac{1}{2}); \ & C_3^+, C_{21}^{\text{inv}}, T; \\
& R_1; \ 1; 1,1,1; \\
& R_2; \ 1; 1, -1,1; \\
& R_3; \ 2; -\frac{\sigma_0 - i\sqrt{2}\sigma_2}{2}, \sigma_3, -\sigma_0; \ P-\text{WNL}_{KH}; \\
\Delta: \ \Gamma A; \ & C_3^+, \sigma_{01}, T; \\
& R_1; \ 1; 1,1,1; \\
& R_2; \ 1; 1, -1,1; \\
& R_3; \ 2; -\frac{\sigma_0 - i\sqrt{2}\sigma_2}{2}, \sigma_3, -\sigma_0; \ \text{WNL}; \quad \pi \\
U: \ ML; \ & \sigma_{01}, T; \\
& R_1; \ 1; 1,1; \\
& R_2; \ 1; -1,1; \\
P: \ \text{KH}; \ & C_3^+, T; \\
& R_1; \ 1; 1,1; \\
& \{ R_2, R_3 \}; \ 2; -\frac{\sigma_0 + i\sqrt{2}\sigma_3}{2}, \sigma_4; \ \text{WNL}; \quad \pi \\
T: \ \Gamma K; \ & C_{22}^{\text{inv}}, T; \\
& R_1; \ 1; 1,1; \\
& R_2; \ 1; -1,1; \\
S: \ \text{AH}; \ & C_{22}^{\text{inv}}, T; \\
& R_1; \ 1; 1,1; \\
& R_2; \ 1; -1,1; \\
T': \ \text{MK}; \ & C_{21}^{\text{inv}}, T; \\
& R_1; \ 1; 1,1; \\
& R_2; \ 1; -1,1; \\
S': \ \text{LH}; \ & C_{21}^{\text{inv}}, T; \\
& R_1; \ 1; 1,1; \\
& R_2; \ 1; -1,1; \\
\Sigma: \ \Gamma M; \ & \sigma_{01}, T; \\
& R_1; \ 1; 1,1; \\
& R_2; \ 1; -1,1; \\
R: \ \text{AL}; \ & \sigma_{01}, T; \\
& R_1; \ 1; 1,1; \\
& R_2; \ 1; -1,1; \\
\]
\( \Gamma_h; \{ \mathcal{S}^+_0[000], \mathcal{C}^{m''}_{21}[00\frac{1}{2}] \}; \mathcal{T}; \text{Centrosymmetric; without SOC} \)

\( \Gamma; (000); \mathcal{S}^+_0, \mathcal{C}^{m''}_{21}, \mathcal{T}; \)

| \( R_1 \) | 1; 1, 1, 1; |
| \( R_2 \) | 1; 1, -1, 1; |
| \( R_3 \) | 1; -1, 1, 1; |
| \( R_4 \) | 1; -1, -1, 1; |
| \( R_5 \) | \(-\frac{\sigma_0 - \sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0\); P-WNL_{CA}; |
| \( R_6 \) | \(\frac{\sigma_0 - \sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0\); P-WNL_{CA}; |

\( M; (0\frac{1}{2}0); \mathcal{C}^{m''}_{21}, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 1; 1, 1, 1; |
| \( R_2 \) | 1; 1, -1, 1; |
| \( R_3 \) | 1; -1, 1, 1; |
| \( R_4 \) | 1; -1, -1, 1; |

\( A; (00\frac{1}{2}); \sigma_{e1}, \mathcal{C}^{m''}_{3}, \mathcal{I}, \mathcal{T}; \{ R_7, R_8 \}; 4; -\Gamma_{3,1}, \frac{\Gamma_{0,0} - i\sqrt{3}\Gamma_{2,2}}{2}, \Gamma_{0,3}, \Gamma_{1,0}; \text{DP}; 0 \)

| \( R_9 \) | 2; \(i\sigma_1, \sigma_0, \sigma_3, -i\sigma_3\); P-WNLs; |
| \( R_{10} \) | P-WNLs; |

\( L; (0\frac{1}{2}0); \sigma_{e1}, \mathcal{I}, \mathcal{T}; \)

| \( R_5 \) | 2; \(i\sigma_2, \sigma_3, -\sigma_0\); P-WNLs; |

\( K; (\frac{1}{2}0\frac{1}{2}); \mathcal{C}^+_3, \mathcal{C}^{m''}_{21}, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 1; 1, 1, 1; |
| \( R_2 \) | 1; 1, -1, 1; |
| \( R_3 \) | 2; \(-\frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0\); P-WNL_{KH}; |

\( H; (\frac{1}{2}\frac{1}{2}0); \mathcal{C}^+_3, \mathcal{C}^{m''}_{21}, \mathcal{I}, \mathcal{T}; \{ R_3, R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_1; \text{P-WNLs}; \)

| \( R_6, R_7 \) | 4; \(\frac{\Gamma_{0,0} - i\sqrt{3}\Gamma_{2,2}}{2}, \Gamma_{0,3}, -\Gamma_{2,2}; \text{DP}; 0 \)

\( \Delta; \Gamma_A; \mathcal{C}^+_3, \sigma_{e1}, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 1; 1, 1, 1; |
| \( R_2 \) | 1; 1, -1, 1; |
| \( R_3 \) | 2; \(-\frac{\sigma_0 - \sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0\); WNL; \(\pi\) |

\( U; \Gamma_L; \sigma_{e1}, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 1; 1, 1; |
| \( R_2 \) | 1; -1, 1; |

\( P; \Gamma_K; \mathcal{C}^+_3, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 1; 1, 1; |

\( T; \Gamma_K; \mathcal{C}^{m''}_{22}, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 1; 1, 1; |
| \( R_2 \) | 1; -1, 1; |

\( S; \Gamma_K; \mathcal{C}^{m''}_{22}, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 2; \(\sigma_3, \sigma_1\); WNL; \(\pi\) |

\( T'; \Gamma_K; \mathcal{C}^{m''}_{22}, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 1; 1, 1; |
| \( R_2 \) | 1; -1, 1; |

\( S'; \Gamma_K; \mathcal{C}^{m''}_{22}, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 2; \(\sigma_3, \sigma_1\); WNL; \(\pi\) |

\( \Sigma; \Gamma_M; \sigma_{e1}, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 1; 1, 1; |
| \( R_2 \) | 1; -1, 1; |

\( R; \Gamma_L; \sigma_{e1}, \mathcal{I}, \mathcal{T}; \)

| \( R_1 \) | 1; -i, 1; |
| \( R_2 \) | 1; i, 1; |
\(\Gamma_{\text{rh}}; \{S_6^+|000\}, \{C_2|000\}, \mathcal{T}; \text{Centrosymmetric; without SOC}\)

\[
\begin{align*}
\Gamma; & \quad (000); \quad S_6^+, C_{21}, \mathcal{T}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1; \\
R_3: & \quad 1, 1, 1; \\
R_4: & \quad 1, -1, 1; \\
R_5: & \quad 2, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{P-WNL}\Gamma Z; \\
R_6: & \quad 2, \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{P-WNL}\Gamma Z;
\end{align*}
\]

\[
\begin{align*}
Z; & \quad (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad S_6^+, C_{21}, \mathcal{T}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, 1, 1; \\
R_3: & \quad 1, 1, 1; \\
R_4: & \quad 1, -1, 1;
\end{align*}
\]

\[
\begin{align*}
L; & \quad (0 \frac{1}{2} 0); \quad C_{22}, I, \mathcal{T}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1; \\
R_3: & \quad 1, 1, 1; \\
R_4: & \quad 1, -1, 1;
\end{align*}
\]

\[
\begin{align*}
(a) F; & \quad (0 \frac{1}{2} 0); \quad C_{21}, I, \mathcal{T}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, 1, 1; \\
R_3: & \quad 1, 1, 1; \\
R_4: & \quad 1, -1, 1;
\end{align*}
\]

\[
\begin{align*}
(b) F; & \quad (\frac{1}{2} \frac{1}{2} 0); \quad C_{23}, I, \mathcal{T}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, 1, 1; \\
R_3: & \quad 1, 1, 1; \\
R_4: & \quad 1, -1, 1;
\end{align*}
\]

\[
\begin{align*}
\Lambda; & \quad \Gamma\Lambda/TZ; \quad C_{3}^+, \sigma_{d3}, \mathcal{IT}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1; \\
R_3: & \quad 2, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{WNL}; \pi
\end{align*}
\]

\[
\begin{align*}
P; & \quad \text{ZP}; \quad C_{3}^+, \sigma_{d3}, \mathcal{IT}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, 1, 1; \\
R_3: & \quad 2, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \text{WNL}; \pi
\end{align*}
\]

\[
\begin{align*}
B; & \quad \text{ZB}; \quad C_{21}, \mathcal{IT}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1;
\end{align*}
\]

\[
\begin{align*}
\Sigma; & \quad \Gamma\Sigma/T\Sigma; \quad C_{21}, \mathcal{IT}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1;
\end{align*}
\]

\[
\begin{align*}
Q; & \quad \text{FQ}; \quad C_{23}, \mathcal{IT}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1;
\end{align*}
\]

\[
\begin{align*}
Y; & \quad \text{LZ/LY}; \quad C_{22}, \mathcal{IT}; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1;
\end{align*}
\]
$\Gamma$, (000); $S_0^+, C'_21, T$; Centrosymmetric; without SOC

$\Gamma$:  
(000); $S_0^+, C'_21, T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;  
$R_3$: 1, -1, 1;  
$R_4$: 1, -1, 1;

$R_5$: \( -\frac{a_0 - i\sqrt{\bar{\sigma}2}}{2}, \sigma_3, -\sigma_0 \); P-WNL of $\Gamma$;  

$Z$:  
(1 1 1); $\sigma_{d1}, C_3^+, T$;  
$R_7, R_8$; $\Gamma_{3,1}, \frac{-\Gamma_{0,0} - i\sqrt{\bar{\sigma}3}, \sigma_3, -\sigma_0}{2}; \Gamma_{0,0}, \Gamma_{1,0}$; DP; 0  
$R_9$: $i\sigma_1, \sigma_0, \sigma_3, -i\sigma_3$; P-WNLs;  

$L$: (0 1 0); $\sigma_{d2}, T$;  
$R_5$: $i\sigma_2, \sigma_3, -\sigma_0$; P-WNLs;  

(a)$F$: (0 1 1 2); $C_21, T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;  
$R_3$: 1, -1, 1;  
$R_4$: 1, -1, 1;  

(b)$F$: (1 1 0); $C'_23, T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;  
$R_3$: 1, -1, 1;  
$R_4$: 1, -1, 1;  

$\Lambda$: $\Gamma\Lambda/TZ$; $C_{3}^+, \sigma_{d1}, T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;  
$R_3$: \( -\frac{a_0 - i\sqrt{\bar{\sigma}2}}{2}, \sigma_3, -\sigma_0 \); WNL;  

$P$: $ZP$; $C_{3}^+, \sigma_{d1}, T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;  
$R_3$: \( -\frac{a_0 - i\sqrt{\bar{\sigma}2}}{2}, \sigma_3, -\sigma_0 \); WNL;  

$B$: $ZB$; $C'_{21}, T$;  
$R_2, R_4$: $-\sigma_3, \sigma_1$; WNL;  

$\Sigma$: $\Gamma\Sigma/T\Sigma$; $C_{3}^+, T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;  

$Q$: $FQ$; $C'_{23}, T$;  
$R_1$: 1, -1, 1;  
$R_2$: 1, 1, 1;  

$Y$: $LZ/LY$; $C'_{22}, T$;  
$R_2, R_4$: \( \sigma_3, \sigma_1 \); WNL;  

$\pi$
$\Gamma_h\{C^+_6[000]\}$; Non-Centrosymmetric; without SOC

| Point | Symmetry | $C_6^+$ | Transformation | Characters |
|-------|----------|---------|---------------|------------|
| $\Gamma$; (000) | $C_6^+$, $T_1$ | 1, 1, 1; | | |
| | | | $\{R_2, R_3\}$; 2; $\frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_1$; | C-2 WP; 2 |
| | | | $\{R_3, R_5\}$; 2; $\frac{-\sigma_0 - i\sqrt{3}\sigma_3}{2}, \sigma_1$; | C-2 WP; 2 |
| | | | $R_4$; 1; $-1, 1$; | |
| $M$; (0$\frac{1}{2}$0) | $C_2T_1$ | 1, 1, 1; | | |
| | | | $R_1$; 1; 1, 1; | |
| | | | $R_2$; 1; $-1, 1$; | |
| $A$; (00$\frac{1}{2}$) | $C_6^+$, $T_1$ | 1, 1, 1; | | |
| | | | $\{R_2, R_3\}$; 2; $\frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_1$; | C-2 WP; 2 |
| | | | $\{R_3, R_5\}$; 2; $\frac{-\sigma_0 - i\sqrt{3}\sigma_3}{2}, \sigma_1$; | C-2 WP; 2 |
| | | | $R_4$; 1; $-1, 1$; | |
| $L$; (0$\frac{1}{2}$$\frac{1}{2}$) | $C_2T_1$ | 1, 1, 1; | | |
| | | | $R_1$; 1; 1, 1; | |
| | | | $R_2$; 1; $-1, 1$; | |
| $K$; (1$\frac{2}{3}$0) | $C_3^+C_6^+$, $T_1$ | 1, 1, 1; | | |
| | | | $\{R_2, R_3\}$; 2; $\frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_1$; | C-2 WP; 2 |
| | | | $\{R_2, R_3\}$; 2; $\frac{-\sigma_0 - i\sqrt{3}\sigma_3}{2}, \sigma_1$; | C-2 WP; 2 |
| | | | $R_4$; 1; $-1, 1$; | |
| $H$; (1$\frac{1}{3}$$\frac{1}{2}$) | $C_6^+$, $T_1$ | 1, 1, 1; | | |
| | | | $\{R_2, R_3\}$; 2; $\frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_1$; | C-2 WP; 2 |
| | | | $\{R_2, R_3\}$; 2; $\frac{-\sigma_0 - i\sqrt{3}\sigma_3}{2}, \sigma_1$; | C-2 WP; 2 |
| | | | $R_4$; 1; $-1, 1$; | |
| $\Delta$; $\Gamma A$ | $C_6^+$ | 1, 1; | | |
| | | | $R_1$; 1; 1; | |
| | | | $R_2$; 1; $\sqrt{-1}$; | |
| | | | $R_3$; 1; $(-1)^{2/3}$; | |
| | | | $R_4$; 1; $-1$; | |
| | | | $R_5$; 1; $-\sqrt{-1}$; | |
| | | | $R_6$; 1; $(-1)^{2/3}$; | |
| $U$; ML | $C_2$ | 1, 1; | | |
| | | | $R_1$; 1; 1; | |
| | | | $R_2$; 1; $-1$; | |
| $P$; KH | $C_3^+$ | 1, 1; | | |
| | | | $R_1$; 1; 1; | |
| | | | $R_2$; 1; $(-1)^{2/3}$; | |
| | | | $R_3$; 1; $-\sqrt{-1}$; | |
| $T$; $\Gamma K$ | $E, C_2T_1$ | 1, 1, 1; | | |
| | | | $R_1$; 1; 1, 1; | |
| $S$; AH | $E, C_2T_1$ | 1, 1, 1; | | |
| | | | $R_1$; 1; 1, 1; | |
| $T'$; MK | $E, C_2T_1$ | 1, 1, 1; | | |
| | | | $R_1$; 1; 1, 1; | |
| $S'$; LH | $E, C_2T_1$ | 1, 1, 1; | | |
| | | | $R_1$; 1; 1, 1; | |
| $\Sigma$; $\Gamma M$ | $E, C_2T_1$ | 1, 1, 1; | | |
| | | | $R_1$; 1; 1, 1; | |
| $R$; AL | $E, C_2T_1$ | 1, 1, 1; | | |
\[ \Gamma; (000); C_6^+; T; \]
\[ \{R_1\}; \ 1; 1; 1; \]
\[ \{R_2, R_3\}; \ 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_1; \ C-2 \text{ WP}; \ 2 \]
\[ \{R_5, R_6\}; \ 2; \frac{-\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_1; \ C-2 \text{ WP}; \ 2 \]
\[ \{R_4\}; \ 1; -1, 1; \]

\[ M; (0\frac{1}{2}0); C_2T; \]
\[ \{R_1\}; \ 1; 1, 1; \]
\[ \{R_2\}; \ 1; -1, 1; \]

\[ A; (00\frac{1}{2}); C_6^+, T; \]
\[ \{R_2, R_{12}\}; \ 2; \frac{\sqrt{3}\sigma_0 + i\sigma_3}{2}, \sigma_1; \ P-\text{NS}_{ALH}; \]
\[ \{R_4, R_{10}\}; \ 2; i\sigma_3, \sigma_1; \ P-\text{NS}_{ALH}; \]
\[ \{R_6, R_8\}; \ 2; \frac{-\sqrt{3}\sigma_0 + i\sigma_3}{2}, \sigma_1; \ P-\text{NS}_{ALH}; \]

\[ L; (0\frac{1}{2}\frac{1}{2}); C_2T; \]
\[ \{R_2, R_4\}; \ 2; i\sigma_3, \sigma_1; \ P-\text{NS}_{ALH}; \]

\[ K; (\frac{1}{2}\frac{1}{2}0); C_3^+, C_6^+; T; \]
\[ \{R_1\}; \ 1; 1, 1; \]
\[ \{R_2, R_3\}; \ 2; \frac{-\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_+ + \frac{1+i\sqrt{3}}{2}, \sigma_1; \ C-1 \text{ WP}; \ 1 \]

\[ H; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_3^-, T; \]
\[ \{R_1, R_1\}; \ 2; \sigma_0, -i\sigma_2; \ P-\text{NS}_{ALH}; \]
\[ \{R_2, R_3\}; \ 2; \frac{-\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_+ + \frac{1+i\sqrt{3}}{2}, \sigma_1; \ P-\text{NS}_{ALH}; \]

\[ \Delta; \Gamma A; C_6^+; \]
\[ \{R_1\}; \ 1; 1; \]
\[ \{R_2\}; \ 1; \sqrt{-1}; \]
\[ \{R_3\}; \ 1; (-1)^{2/3}; \]
\[ \{R_4\}; \ 1; -1; \]
\[ \{R_5\}; \ 1; \sqrt{-1}; \]
\[ \{R_6\}; \ 1; (-1)^{2/3}; \]

\[ U; \text{ ML}; C_2; \]
\[ \{R_1\}; \ 1; 1; \]
\[ \{R_2\}; \ 1; -1; \]

\[ P; \text{ KH}; C_3^+; \]
\[ \{R_1\}; \ 1; 1; \]
\[ \{R_2\}; \ 1; (-1)^{2/3}; \]
\[ \{R_3\}; \ 1; \sqrt{-1}; \]

\[ T; \Gamma K; E, C_2T; \]
\[ \{R_1\}; \ 1; 1, 1; \]

\[ S; \text{ AH}; E, C_2T; \]
\[ \{R_1, R_1\}; \ 2; \sigma_0, -i\sigma_2; \ L-\text{NS}_{ALH}; \]

\[ T'; \text{ MK}; E, C_2T; \]
\[ \{R_1\}; \ 1; 1, 1; \]

\[ S'; \text{ LH}; E, C_2T; \]
\[ \{R_1, R_1\}; \ 2; \sigma_0, -i\sigma_2; \ L-\text{NS}_{ALH}; \]

\[ \Sigma; \Gamma M; E, C_2T; \]
\[ \{R_1\}; \ 1; 1, 1; \]

\[ R; \text{ AL}; E, C_2T; \]
\[ \{R_1, R_1\}; \ 2; \sigma_0, -i\sigma_2; \ L-\text{NS}_{ALH}; \]
\[ \Gamma; \ (000); \ C_{6}^{+}; \ T; \ \{ R_{1}; 1; 1; \} \]
\[ \{ R_{2}, R_{3}; 2; \frac{\sigma_{0} + i\sqrt{3}\sigma_{3}}{2}, \sigma_{1} \}; \ \text{C-2 WP}; \ 2 \]
\[ \{ R_{3}, R_{4}; 2; \frac{\sigma_{0} - i\sqrt{3}\sigma_{3}}{2}, \sigma_{1} \}; \ \text{C-2 WP}; \ 2 \]
\[ M; \ (0\frac{1}{2}0); \ C_{2}, T; \ \{ R_{1}; 1; 1; \} \]
\[ R_{2}; 1; -1, 1; \]
\[ A; \ (00\frac{1}{2}); \ C_{6}^{+}, T; \ \{ R_{2}, R_{12}; 2; \sqrt[3]{\sigma_{0} + i\sigma_{3}}, \sigma_{1} \}; \ \text{P-NS}_{ALH}; \]
\[ \{ R_{4}, R_{10}; 2; i\sigma_{3}, \sigma_{1} \}; \ \text{P-NS}_{ALH}; \]
\[ \{ R_{6}, R_{8}; 2; \frac{-\sqrt[3]{\sigma_{0} - i\sigma_{3}}}{2}, \sigma_{1} \}; \ \text{P-NS}_{ALH}; \]
\[ L; \ (0\frac{1}{2}\frac{1}{2}); \ C_{2}, T; \ \{ R_{2}, R_{4}; 2; i\sigma_{3}, \sigma_{1} \}; \ \text{P-NS}_{ALH}; \]
\[ K; \ (0\frac{1}{2}0); \ C_{3}^{+}, C_{6}^{+}; T; \ \{ R_{1}; 1; 1; \} \]
\[ \{ R_{2}, R_{3}; 2; \frac{-\sigma_{0} + i\sqrt{3}\sigma_{3}}{2}, \sigma_{1} \}; \ \text{C-1 WP}; \ 1 \]
\[ H; \ (\frac{1}{2}1\frac{1}{2}); \ C_{3}^{-}, C_{6}^{+}, T; \ \{ R_{1}, R_{1}; 2; \sigma_{0}, -i\sigma_{2} \}; \ \text{P-NS}_{ALH}; \]
\[ \{ R_{2}, R_{3}; 2; \frac{-\sigma_{0} + i\sqrt{3}\sigma_{3}}{2}, \sigma_{1} \}; \ \text{P-NS}_{ALH}; \]
\[ \Delta; \ \Gamma; \ \text{C}_{6}^{+}; \]
\[ \{ R_{1}; 1; 1; \} \]
\[ R_{2}; 1; \sqrt[3]{-1}; \]
\[ R_{3}; 1; (-1)^{2/3}; \]
\[ R_{4}; 1; -1; \]
\[ R_{5}; 1; \sqrt[3]{-1}; \]
\[ R_{6}; 1; (-1)^{2/3}; \]
\[ U; \ \text{ML}; \ C_{2}; \]
\[ \{ R_{1}; 1; 1; \} \]
\[ R_{2}; 1; -1; \]
\[ P; \ \text{KH}; \ C_{3}^{+}; \]
\[ \{ R_{1}; 1; 1; \} \]
\[ R_{2}; 1; (-1)^{2/3}; \]
\[ R_{3}; 1; -\sqrt[3]{-1}; \]
\[ T; \ \Gamma; \ \text{E}, C_{2}, T; \]
\[ \{ R_{1}; 1; 1, 1; \} \]
\[ S; \ \text{AH}; \ \{ R_{1}, R_{1}; 2; \sigma_{0}, -i\sigma_{2} \}; \ \text{L-NS}_{ALH}; \]
\[ T'; \ \text{MK}; \ C_{2}, T; \]
\[ \{ R_{1}; 1; 1, 1; \} \]
\[ S'; \ \text{LH}; \ \{ R_{1}, R_{1}; 2; \sigma_{0}, -i\sigma_{2} \}; \ \text{L-NS}_{ALH}; \]
\[ \Sigma; \ \Gamma; \ \text{E}, C_{2}, T; \]
\[ \{ R_{1}; 1; 1, 1; \} \]
\[ R; \ \text{AL}; \ \{ R_{1}, R_{1}; 2; \sigma_{0}, -i\sigma_{2} \}; \ \text{L-NS}_{ALH}; \]
SG 171

Γh; \{C_6^+|001_3\}; T; Non-Centrosymmetric; without SOC

\[ \Gamma; (000); \quad C_6^+; \quad T; \quad R_1; \quad 1; 1; 1; \]
\[ \{R_2, R_3\}; 2; \frac{a_0 + \sqrt{3}a_2}{2}, \sigma_1; \quad C-2 \text{ WP}; \quad 2 \]
\[ \{R_3, R_5\}; 2; \frac{-a_0 + \sqrt{3}a_2}{2}, \sigma_1; \quad C-2 \text{ WP}; \quad 2 \]
\[ R_4; \quad 1; -1, 1; \]

M; \(0\frac{1}{2}0\); \quad C_2; \quad T; \quad R_1; \quad 1; 1, 1; \]
\[ R_2; \quad 1; -1, 1; \]

A; \(00\frac{1}{2}\); \quad C_6^+; \quad T; \quad R_1; \quad 1; 1, 1; \]
\[ \{R_2, R_6\}; 2; \frac{a_0 + \sqrt{3}a_2}{2}, \sigma_1; \quad C-2 \text{ WP}; \quad 2 \]
\[ \{R_3, R_5\}; 2; \frac{-a_0 + \sqrt{3}a_2}{2}, \sigma_1; \quad C-2 \text{ WP}; \quad 2 \]
\[ R_4; \quad 1; -1, 1; \]

L; \(0\frac{1}{2}1\); \quad C_2; \quad T; \quad R_1; \quad 1; 1, 1; \]
\[ R_2; \quad 1; -1, 1; \]

K; \(\frac{1}{3}\frac{1}{3}0\); \quad C_3^+; \quad C_6^+; \quad T; \quad R_1; \quad 1; 1, 1; \]
\[ \{R_2, R_3\}; 2; \frac{-a_0 + \sqrt{3}a_2}{2}, \sigma_1 + (i\sqrt{3}-1)\sigma_2; \quad C-1 \text{ WP}; \quad 1 \]

H; \(\frac{1}{3}\frac{1}{3}\frac{1}{3}\); \quad C_3^+; \quad C_6^+; \quad T; \quad R_1; \quad 1; 1, 1; \]
\[ \{R_2, R_3\}; 2; \frac{-a_0 + \sqrt{3}a_2}{2}, \sigma_1 + (i\sqrt{3}-1)\sigma_2; \quad C-1 \text{ WP}; \quad 1 \]

Δ; \quad ΓA; \quad C_6^+; \quad R_1; \quad 1; 1; \]
\[ R_2; \quad 1; 3\sqrt{-1}; \]
\[ R_3; \quad 1; (-1)^{2/3}; \]
\[ R_4; \quad 1; -1; \]
\[ R_5; \quad 1; -3\sqrt{-1}; \]
\[ R_6; \quad 1; -(-1)^{2/3}; \]

U; \quad ML; \quad C_2; \quad R_1; \quad 1; 1; \]
\[ R_2; \quad 1; -1; \]

P; \quad KH; \quad C_3^+; \quad R_1; \quad 1; 1; \]
\[ R_2; \quad 1; (-1)^{2/3}; \]
\[ R_3; \quad 1; -3\sqrt{-1}; \]

T; \quad ΓK; \quad E.C_2T; \quad R_1; \quad 1; 1, 1; \]

S; \quad AH; \quad E.C_2T; \quad R_1; \quad 1; 1, 1; \]

T'; \quad MK; \quad E.C_2T; \quad R_1; \quad 1; 1, 1; \]

S'; \quad LH; \quad E.C_2T; \quad R_1; \quad 1; 1, 1; \]

Σ; \quad ΓM; \quad E.C_2T; \quad R_1; \quad 1; 1, 1; \]

R; \quad AL; \quad E.C_2T; \quad R_1; \quad 1; 1, 1;
\(\Gamma_h; C_{6g}^+ [002], T; \) Non-Centrosymmetric; without SOC

\(\Gamma; \) (000): \( C_{6g}^+ , T; \) 
- \( R_1; \) \( 1, 1, 1; \)
- \( \{ R_2, R_3 \}; \) \( 2; \frac{\sigma_{0+ i\sqrt{3}a_0}}{2}, \sigma; \) C-2 WP; 2
- \( \{ R_3, R_5 \}; \) \( 2; \frac{\sigma_{0+ i\sqrt{3}a_0}}{2}, \sigma; \) C-2 WP; 2
- \( R_4; \) \( 1; -1, 1; \)

\( M; \) (0\(1\frac{1}{2}0\)): \( C_2T; \)
- \( R_1; \) \( 1, 1, 1; \)
- \( R_2; \) \( 1, -1, 1; \)

\( A; \) (00\(\frac{1}{2}\)): \( C_{6g}^+ , T; \)
- \( R_1; \) \( 1, 1, 1; \)
- \( R_2; \) \( 1, -1, 1; \)

\( L; \) (0\(\frac{1}{2}\\frac{1}{2}\)): \( C_2T; \)
- \( R_1; \) \( 1, 1, 1; \)
- \( R_2; \) \( 1, -1, 1; \)

\( K; \) (\(\frac{1}{3}\frac{1}{3}0\)): \( C_{3g}^+ , C_{6g}^+ ; T; \)
- \( R_1; \) \( 1, 1, 1; \)
- \( \{ R_2, R_5 \}; \) \( 2; \frac{\sigma_{0+ i\sqrt{3}a_0}}{2}, \sigma; \) \( C-1 \) WP; 1

\( H; \) (\(\frac{1}{3}\frac{1}{3}\frac{1}{2}\)): \( C_{3g}^+ , C_{6g}^+ ; T; \)
- \( R_1; \) \( 1, 1, 1; \)
- \( \{ R_2, R_5 \}; \) \( 2; \frac{\sigma_{0+ i\sqrt{3}a_0}}{2}, \sigma; \) \( C-1 \) WP; 1

\( \Delta; \) \( \Gamma_A; \) \( C_{6g}^+ ; \)
- \( R_1; \) \( 1, 1; \)
- \( R_2; \) \( 1; \sqrt{-1}; \)
- \( R_5; \) \( 1; (1)^{2/3}; \)
- \( R_6; \) \( 1; -\sqrt{-1}; \)

\( U; \) \( \Gamma_L; \) \( C_{2g}; \)
- \( R_1; \) \( 1, 1; \)
- \( R_2; \) \( 1, -1; \)

\( P; \) \( \Gamma_H; \) \( C_{3g}^+ ; \)
- \( R_1; \) \( 1, 1; \)
- \( R_2; \) \( 1; (1)^{2/3}; \)
- \( R_5; \) \( 1; -\sqrt{-1}; \)

\( T; \) \( \Gamma_K; \) \( E, C_{2g}T; \)
- \( R_1; \) \( 1, 1, 1; \)

\( S; \) \( \Gamma_H; \) \( E, C_{2g}T; \)
- \( R_1; \) \( 1, 1, 1; \)

\( \Sigma; \) \( \Gamma_M; \) \( E, C_{2g}T; \)
- \( R_1; \) \( 1, 1, 1; \)

\( R; \) \( \Gamma_L; \) \( E, C_{2g}T; \)
- \( R_1; \) \( 1, 1, 1; \)
\( \Gamma_h; \{ C^+_6[001] \}, T; \) Non-Centrosymmetric; without SOC

\[
\begin{array}{llll}
\Gamma; & (000); & C^+_6, T; & R_1; \\
& & & 1; 1, 1; \\
& & & \{ R_2, R_0 \}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_1; \\
& & & \text{C-2 WP}; 2 \\
& & & \{ R_3, R_5 \}; 2; -\frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_1; \\
& & & \text{C-2 WP}; 2 \\
& & & R_4; 1; -1, 1; \\
M; & (0\frac{1}{2}0); & C_2, T; & R_1; \\
& & & 1; 1, 1; \\
& & & R_2; 1; -1, 1; \\
A; & (00\frac{1}{2}); & C^+_6, T; & \{ R_2, R_{12} \}; 2; \frac{\sqrt{3}\sigma_0 + i\sigma_3}{2}, \sigma_1; \\
& & & \text{P-NSALH}; \\
& & & \{ R_4, R_{10} \}; 2; i\sigma_3, \sigma_1; \\
& & & \text{P-NSALH}; \\
& & & \{ R_6, R_8 \}; 2; -\frac{\sqrt{3}\sigma_0 + i\sigma_3}{2}, \sigma_1; \\
& & & \text{P-NSALH}; \\
L; & (0\frac{1}{2}\frac{1}{2}); & C_2, T; & \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_1; \\
& & & \text{P-NSALH}; \\
K; & (\frac{1}{2}\frac{1}{2}0); & C^+_3, C^+_6, T; & R_1; \\
& & & 1; 1, 1; \\
& & & \{ R_2, R_3 \}; 2; \frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_- + i\frac{\sqrt{3}-1}{2}\sigma_+; \\
& & & \text{C-1 WP}; 1 \\
H; & (\frac{1}{3}\frac{2}{3}\frac{1}{2}); & C^+_3, C^+_6, T; & \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \\
& & & \text{P-NSALH}; \\
& & & \{ R_2, R_3 \}; 2; \frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_- + i\frac{\sqrt{3}-1}{2}\sigma_+; \\
& & & \text{P-NSALH}; \\
\Delta; & \Gamma A; & C^+_6; & R_1; \\
& & & 1; 1; \\
& & & R_2; 1; \sqrt{3}; \\
& & & R_3; 1; (-1)^{2/3}; \\
& & & R_4; 1; -1; \\
& & & R_5; 1; -\sqrt{3}; \\
& & & R_6; 1; -(-1)^{2/3}; \\
U; & ML; & C_2; & R_1; \\
& & & 1; 1; \\
& & & R_2; 1; -1; \\
P; & KH; & C^+_3; & R_1; \\
& & & 1; 1; \\
& & & R_2; 1; (-1)^{2/3}; \\
& & & R_3; 1; -\sqrt{3}; \\
T; & \Gamma K; & E, C_2; T; & R_1; \\
& & & 1; 1, 1; \\
S; & AH; & E, C_2; T; & \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \\
& & & \text{L-NSALH}; \\
T'; & MK; & E, C_2; T; & R_1; \\
& & & 1; 1, 1; \\
S'; & LH; & E, C_2; T; & \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \\
& & & \text{L-NSALH}; \\
\Sigma; & \Gamma M; & E, C_2; T; & R_1; \\
& & & 1; 1, 1; \\
R; & AL; & E, C_2; T; & \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \\
& & & \text{L-NSALH};
\end{array}
\]
Γ: (000); \( S_{3}^{+}, \mathcal{T} \);
\[ \Gamma_{h}; \{ S_{3}^{+} | 000 \}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma; & \quad (000); \quad S_{3}^{+}, \mathcal{T}; \quad R_{1}; \quad 1; 1, 1; \\
& \{ R_{2}, R_{6} \}; \quad 2; \frac{s_{0} + i\sqrt{3}s_{3}}{2}, \sigma_{1}; \quad \text{P-QNL}_{\Gamma A}; \\
& \{ R_{3}, R_{5} \}; \quad 2; \frac{s_{0} + i\sqrt{3}s_{3}}{2}, \sigma_{1}; \quad \text{P-QNL}_{\Gamma A}; \\
& R_{4}; \quad 1; -1, 1; \\
M; & \quad (0\frac{1}{2}0); \quad \sigma_{h}, \mathcal{T}; \quad R_{1}; \quad 1, 1, 1; \\
& \quad R_{2}; \quad 1, -1, 1; \\
A; & \quad (00\frac{1}{2}); \quad S_{3}^{+}, \mathcal{T}; \quad R_{1}; \quad 1, 1, 1; \\
& \quad \{ R_{2}, R_{6} \}; \quad 2; \frac{s_{0} + i\sqrt{3}s_{3}}{2}, \sigma_{1}; \quad \text{P-QNL}_{\Gamma A}; \\
& \quad \{ R_{3}, R_{5} \}; \quad 2; \frac{s_{0} + i\sqrt{3}s_{3}}{2}, \sigma_{1}; \quad \text{P-QNL}_{\Gamma A}; \\
& R_{4}; \quad 1; -1, 1; \\
L; & \quad (0\frac{1}{2}\frac{1}{2}); \quad \sigma_{h}, \mathcal{T}; \quad R_{1}; \quad 1, 1, 1; \\
& \quad R_{2}; \quad 1, -1, 1; \\
K; & \quad (\frac{1}{2}\frac{1}{2}0); \quad S_{3}^{+}; \quad R_{1}; \quad 1; 1; \\
& \quad R_{2}; \quad 1; \sqrt{-1}; \\
& \quad R_{3}; \quad 1; (-1)^{2/3}; \\
& \quad R_{4}; \quad 1; -1; \\
& \quad R_{5}; \quad 1; -\sqrt{-1}; \\
& \quad R_{6}; \quad 1; -(-1)^{2/3}; \\
H; & \quad (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad S_{3}^{+}; \quad R_{1}; \quad 1; 1; \\
& \quad R_{2}; \quad 1; \sqrt{-1}; \\
& \quad R_{3}; \quad 1; (-1)^{2/3}; \\
& \quad R_{4}; \quad 1; -1; \\
& \quad R_{5}; \quad 1; -\sqrt{-1}; \\
& \quad R_{6}; \quad 1; -(-1)^{2/3}; \\
\Delta; & \quad \Gamma A; \quad C_{3}^{+}, S_{3}^{+}, \mathcal{T}; \quad R_{1}; \quad 1; 1, 1; \\
& \quad \{ R_{2}, R_{3} \}; \quad 2; \frac{s_{0} + i\sqrt{3}s_{3}}{2}, \sigma_{+} - \frac{i\sqrt{3}+1}{2}\sigma_{+}; \quad \text{QLN}; \quad 0 \\
U; & \quad \text{ML}; \quad E, \mathcal{T} \sigma_{h}; \quad R_{1}; \quad 1, 1, 1; \\
P; & \quad \text{KH}; \quad C_{3}^{+}; \quad R_{1}; \quad 1; 1; \\
& \quad R_{2}; \quad 1; (-1)^{2/3}; \\
& \quad R_{3}; \quad 1; -\sqrt{-1}; \\
T; & \quad \Gamma K; \quad \sigma_{h}; \quad R_{1}; \quad 1; 1; \\
& \quad R_{2}; \quad 1; -1; \\
S; & \quad \text{AH}; \quad \sigma_{h}; \quad R_{1}; \quad 1; 1; \\
& \quad R_{2}; \quad 1; -1; \\
T'; & \quad \text{MK}; \quad \sigma_{h}; \quad R_{1}; \quad 1; 1; \\
& \quad R_{2}; \quad 1; -1; \\
S'; & \quad \text{LH}; \quad \sigma_{h}; \quad R_{1}; \quad 1; 1; \\
& \quad R_{2}; \quad 1; -1; \\
\Sigma; & \quad \Gamma M; \quad \sigma_{h}; \quad R_{1}; \quad 1; 1; \\
& \quad R_{2}; \quad 1; -1; \\
R; & \quad \text{AL}; \quad \sigma_{h}; \quad R_{1}; \quad 1; 1; \\
& \quad R_{2}; \quad 1; -1;
\[ \Gamma_h; \{C_3^+|000\}, \{C_2|000\}, \{I|000\}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; \,(000); \,C_3^+, C_2I,T; \]

\[ R_{1}; \quad 1; 1,1,1; \]
\[ \{R_2, R_3\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \text{ P-QNL}_{\Gamma,A}; \]
\[ R_{4}; \quad 1; 1, -1,1,1; \]
\[ \{R_5, R_6\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, -\sigma_0, \sigma_0, \sigma_1; \text{ P-QNL}_{\Gamma,A}; \]
\[ R_{7}; \quad 1; 1,1, -1,1; \]
\[ \{R_8, R_9\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_0, -\sigma_0, \sigma_1; \text{ P-QNL}_{\Gamma,A}; \]
\[ R_{10}; \quad 1; 1, -1, -1,1; \]
\[ \{R_{11}, R_{12}\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, -\sigma_0, -\sigma_0, \sigma_1; \text{ P-QNL}_{\Gamma,A}; \]

\[ M; \,(0\frac{1}{2}0); \,C_2I,T; \]

\[ R_{1}; \quad 1; 1,1,1; \]
\[ R_{2}; \quad 1; 1, -1,1; \]
\[ R_{3}; \quad 1; -1,1,1; \]
\[ R_{4}; \quad 1; -1, -1,1; \]

\[ A; \,(00\frac{1}{2}); \,C_3^+, C_2I,T; \]

\[ R_{1}; \quad 1; 1,1,1; \]
\[ \{R_2, R_3\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \text{ P-QNL}_{\Gamma,A}; \]
\[ R_{4}; \quad 1; 1, -1,1,1; \]
\[ \{R_5, R_6\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, -\sigma_0, \sigma_0, \sigma_1; \text{ P-QNL}_{\Gamma,A}; \]
\[ R_{7}; \quad 1; 1,1, -1,1; \]
\[ \{R_8, R_9\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_0, -\sigma_0, \sigma_1; \text{ P-QNL}_{\Gamma,A}; \]
\[ R_{10}; \quad 1; 1, -1, -1,1; \]
\[ \{R_{11}, R_{12}\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, -\sigma_0, -\sigma_0, \sigma_1; \text{ P-QNL}_{\Gamma,A}; \]

\[ L; \,(0\frac{1}{2}\frac{1}{2}); \,C_2I,T; \]

\[ R_{1}; \quad 1; 1,1,1; \]
\[ R_{2}; \quad 1; 1, -1,1; \]
\[ R_{3}; \quad 1; -1,1,1; \]
\[ R_{4}; \quad 1; -1, -1,1; \]

\[ K; \,(\frac{5}{3}0); \,S_\text{\scriptsize{3}}^+, IT; \]

\[ R_{1}; \quad 1; 1,1; \]
\[ \{R_2, R_6\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_1; \quad \text{P-WNL}_{KH}; \]
\[ \{R_3, R_5\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_1; \quad \text{P-WNL}_{KH}; \]
\[ R_{4}; \quad 1; -1,1; \]

\[ H; \,(\frac{5}{3}1); \,S_\text{\scriptsize{3}}^+, IT; \]

\[ R_{1}; \quad 1; 1,1; \]
\[ \{R_2, R_6\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_1; \quad \text{P-WNL}_{KH}; \]
\[ \{R_3, R_5\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_1; \quad \text{P-WNL}_{KH}; \]
\[ R_{4}; \quad 1; -1,1; \]

\[ \Delta; \,\Gamma\alpha; \,C_6^+, IT; \]

\[ R_{1}; \quad 1; 1,1; \]
\[ \{R_2, R_6\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_1; \text{ QNL}; \quad 0 \]
\[ \{R_3, R_5\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_1; \text{ QNL}; \quad 0 \]
\[ R_{4}; \quad 1; -1,1; \]

\[ U; \,ML; \,C_2I,T; \]

\[ R_{1}; \quad 1; 1,1; \]
\[ R_{2}; \quad 1; -1,1; \]

\[ P; \,KH; \,C_3^+, IT; \]

\[ R_{1}; \quad 1; 1,1; \]
\[ \{R_2, R_3\}; \quad 2; \frac{\sigma_0 + iv\sigma_3}{2}, \sigma_1; \text{ WNL}; \quad \pi \]

\[ T; \,\Gamma\kappa; \,\sigma_h, IT; \]

\[ R_{1}; \quad 1; 1,1; \]
\[ R_{2}; \quad 1; -1,1; \]

\[ S; \,AH; \,\sigma_h, IT; \]

\[ R_{1}; \quad 1; 1,1; \]
\[ R_{2}; \quad 1; -1,1; \]
$T'$; MK; $\sigma_h, IT$; $R_1$; 1; 1, 1;
$R_2$; 1; −1, 1;

$S'$; LH; $\sigma_h, IT$; $R_1$; 1; 1, 1;
$R_2$; 1; −1, 1;

$\Sigma$; $\Gamma_M$; $\sigma_h, IT$; $R_1$; 1; 1, 1;
$R_2$; 1; −1, 1;

$R$; AL; $\sigma_h, IT$; $R_1$; 1; 1, 1;
$R_2$; 1; −1, 1;
\[ \Gamma_h; \{ C^+_3[000], \{ C_2[00\frac{1}{2}], \{ J[00\frac{1}{2}], T; \text{Centrosymmetric; without SOC} \} \}
\]

\begin{align*}
\Gamma; \ (000); & \quad C^+_3, C_2, I, T; R_1; \quad 1; 1,1,1,1; \\
& \quad \{ R_2, R_3 \}; \quad 2; -\frac{\sigma_0+i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-QNL}_{\Gamma,A}; \\
& \quad R_4; \quad 1; 1, -1,1,1; \\
& \quad \{ R_5, R_6 \}; \quad 2; -\frac{\sigma_0+i\sqrt{3}\sigma_3}{2}, -\sigma_0, \sigma_0, \sigma_1; \quad \text{P-QNL}_{\Gamma,A}; \\
& \quad R_7; \quad 1; 1, 1, -1,1; \\
& \quad \{ R_8, R_9 \}; \quad 2; -\frac{\sigma_0+i\sqrt{3}\sigma_3}{2}, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-QNL}_{\Gamma,A}; \\
& \quad R_{10}; \quad 1; 1, -1, -1,1; \\
& \quad \{ R_{11}, R_{12} \}; \quad 2; -\frac{\sigma_0+i\sqrt{3}\sigma_3}{2}, -\sigma_0, -\sigma_0, \sigma_1; \quad \text{P-QNL}_{\Gamma,A}; \\
M; \ (0\frac{1}{2}0); & \quad C_2, I, T; \\
& \quad R_1; \quad 1; 1,1,1; \\
& \quad R_2; \quad 1; 1, -1,1; \\
& \quad R_3; \quad 1; -1,1,1; \\
& \quad R_4; \quad 1; -1, -1,1; \\
A; \ (00\frac{1}{2}); & \quad C^+_3, I, T; \\
& \quad \{ R_{13}, R_{15} \}; \quad 4; \frac{\sqrt{3}\sigma_0+3\sigma_3}{2}, \Gamma_{0,1,1,0}; \quad \text{QDP}; \quad 0 \\
& \quad R_{14}; \quad 2; i\sigma_3, \sigma_1, -i\sigma_1; \quad \text{P-NS}_{\text{ALH}}; \\
L; \ (0\frac{1}{2}\frac{1}{2}); & \quad C_2, I, T; \\
& \quad R_5; \quad 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-NS}_{\text{ALH}}; \\
K; \ (\frac{1}{2}\frac{3}{2}0); & \quad S^+_3, I, T; \\
& \quad R_1; \quad 1; 1,1; \\
& \quad \{ R_2, R_6 \}; \quad 2; \frac{\sigma_0+3\sqrt{3}\sigma_3}{2}, \sigma_1; \quad \text{P-WNL}_{\Gamma,K}; \\
& \quad \{ R_3, R_5 \}; \quad 2; -\frac{\sigma_0+3\sqrt{3}\sigma_3}{2}, \sigma_1; \quad \text{P-WNL}_{\Gamma,K}; \\
& \quad R_4; \quad 1; -1,1; \\
H; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & \quad S^+_3, I, T; \\
& \quad \{ R_1, R_4 \}; \quad 2; \sigma_3, \sigma_1; \quad \text{P-NS}_{\text{ALH}}; \\
& \quad \{ R_2, R_3 \}; \quad 2; \frac{\sigma_0+\sqrt{3}\sigma_3}{2}, \sigma_1; \quad \text{P-WNL/NS}; \\
& \quad \{ R_5, R_6 \}; \quad 2; -\frac{\sigma_0+\sqrt{3}\sigma_3}{2}, -\frac{1}{2}\sigma_3, \sigma_1; \quad \text{P-WNL/NS}; \\
\Delta; \ \Gamma A; & \quad C^+_6, I, T; \\
& \quad R_1; \quad 1; 1,1; \\
& \quad \{ R_2, R_6 \}; \quad 2; \frac{\sigma_0+\sqrt{3}\sigma_3}{2}, \sigma_1; \quad \text{QNL}; \quad 0 \\
& \quad \{ R_3, R_5 \}; \quad 2; -\frac{\sigma_0+\sqrt{3}\sigma_3}{2}, \sigma_1; \quad \text{QNL}; \quad 0 \\
& \quad R_4; \quad 1; -1,1; \\
U; \ \text{ML}; & \quad C_2, I, T; \\
& \quad R_1; \quad 1; 1,1; \\
& \quad R_2; \quad 1; -1,1; \\
P; \ \Gamma K; & \quad C^+_3, I, T; \\
& \quad R_1; \quad 1; 1,1; \\
& \quad \{ R_2, R_3 \}; \quad 2; -\frac{\sigma_0+\sqrt{3}\sigma_3}{2}, \sigma_1; \quad \text{WNL}; \quad \pi \\
T; \ \Gamma K; & \quad \sigma_h, I, T; \\
& \quad R_1; \quad 1; 1,1; \\
& \quad R_2; \quad 1; -1,1; \\
S; \ \text{AH}; & \quad \sigma_h, I, T; \\
& \quad \{ R_1, R_2 \}; \quad 2; \sigma_3, \sigma_1; \quad \text{L-NS}_{\text{ALH}}; \\
T'; \ \Gamma K; & \quad \sigma_h, I, T; \\
& \quad R_1; \quad 1; 1,1; \\
& \quad R_2; \quad 1; -1,1; \\
S'; \ \Gamma H; & \quad \sigma_h, I, T; \\
& \quad \{ R_1, R_2 \}; \quad 2; \sigma_3, \sigma_1; \quad \text{L-NS}_{\text{ALH}}; \\
\Sigma; \ \Gamma M; & \quad \sigma_h, I, T; \\
& \quad R_1; \quad 1; 1,1; \\
& \quad R_2; \quad 1; -1,1; \\
R; \ \Gamma A; & \quad \sigma_h, I, T; \\
& \quad \{ R_1, R_2 \}; \quad 2; \sigma_3, \sigma_1; \quad \text{L-NS}_{\text{ALH}}; \\
\end{align*}
Γ: (000); $C_6^+ , C_{21}^* , T$;  
$R_1$: 1, 1, 1, 1;  
$R_2$: 1, 1, -1, 1;  
$R_3$: 1, -1, 1, 1;  
$R_4$: 1, -1, -1, 1;  
$R_5$: $\frac{a_0}{2} + \frac{1}{\sqrt{3} a_2}, \sigma_3, -\sigma_0$; C-2 WP; 2  
$R_6$: $\frac{a_0}{2} - \frac{1}{\sqrt{3} a_2}, \sigma_3, -\sigma_0$; C-2 WP; 2  

M: (0)$^1/2$; $C_2 , C_{21}^* , T$;  
$R_1$: 1, 1, 1, 1;  
$R_2$: 1, 1, -1, 1;  
$R_3$: 1, -1, 1, 1;  
$R_4$: 1, -1, -1, 1;  

A: (00)$^1/2$; $C_6^+ , C_{21}^* , T$;  
$R_1$: 1, 1, 1, 1;  
$R_2$: 1, 1, -1, 1;  
$R_3$: 1, -1, 1, 1;  
$R_4$: 1, -1, -1, 1;  

K: (1$^2$)$^1/3$; $C_6^+ , C_{21}^* , C_6^* , T$;  
$R_1$: 1, 1, 1, 1;  
$R_2$: 1, 1, -1, 1;  
$R_3$: $\frac{a_0}{2} + \frac{1}{\sqrt{3} a_2}, \sigma_3, -\sigma_0$; C-1 WP; 1  

H: (1$^2$)$^1/3$; $C_6^+ , C_{21}^* , C_{6}^* , T$;  
$R_1$: 1, 1, 1, 1;  
$R_2$: 1, 1, -1, 1;  
$R_3$: $\frac{a_0}{2} - \frac{1}{\sqrt{3} a_2}, \sigma_3, -\sigma_0$; C-1 WP; 1  

Δ: ΓA; $C_6^+ , C_{23}^* T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, $\sqrt{-1}, 1$;  
$R_3$: 1, $(1)^{2/3}, 1$;  
$R_4$: 1, -1, 1;  
$R_5$: 1, $-\sqrt{-1}, 1$;  
$R_6$: 1, $-(1)^{2/3}, 1$;  

U: ML; $C_2 , C_{21}^* , T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;  

P: KH; $C_3^+ , C_{22}^* T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, $(-1)^{2/3}, 1$;  
$R_3$: 1, $-\sqrt{-1}, 1$;  

T: ΓK; $C_{22}^* , C_{22}^* T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;  

S: AH; $C_{22}^* , C_{22}^* T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;  

T': MK; $C_{21}^* , C_2 T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;  

S': LH; $C_{21}^* , C_2 T$;  
$R_1$: 1, 1, 1;  
$R_2$: 1, -1, 1;
$\Sigma$: $\Gamma M; C_{21}, C_{21}^{*} T; R_{1}; 1, 1,$
$R_{2}; 1, -1, 1$;

$R$: $\text{AL}; C_{21}, C_{21}^{*} T; R_{1}; 1, 1,$
$R_{2}; 1, -1, 1$;
\(\Gamma_h; \{C_6^+ \{00\frac{1}{2}\}\}, \{C_{21}^0\{000\}\}, T; \) Non-Centrosymmetric; without SOC

\[
\begin{align*}
\Gamma; &(000); \quad C_6^+ C_{21}^0, T; \quad R_1; \quad 1, 1, 1; \\
&\quad R_2; \quad 1, 1, -1, 1; \\
&\quad R_3; \quad 1, -1, 1, 1; \\
&\quad R_4; \quad 1, -1, -1, 1; \\
&\quad R_5; \quad 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad C-2 \text{ WP; } 2 \\
&\quad R_6; \quad 2, \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad C-2 \text{ WP; } 2 \\
M; &\left(0\frac{1}{2}0\right); \quad C_2^0 C_{21}^0, T; \quad R_1; \quad 1, 1, 1, 1; \\
&\quad R_2; \quad 1, -1, 1, 1; \\
&\quad R_3; \quad 1, -1, 1, 1; \\
&\quad R_4; \quad 1, -1, -1, 1; \\
A; &\left(00\frac{1}{2}\right); \quad C_6^+ C_{21}^0, T; \quad R_2; \quad 2, \frac{\sqrt{3}\sigma_0 + i\sigma_2}{2}, \sigma_3, -i\sigma_1; \quad \text{P-NS}_{\text{ALH}}; \\
&\quad R_5; \quad 2, -\frac{\sqrt{3}\sigma_0 + i\sigma_2}{2}, \sigma_3, -i\sigma_1; \quad \text{P-NS}_{\text{ALH}}; \\
&\quad R_6; \quad 2, i\sigma_3, \sigma_1, -i\sigma_1; \quad \text{P-NS}_{\text{ALH}}; \\
L; &\left(0\frac{1}{2}\frac{1}{2}\right); \quad C_2^0 C_{21}^0, T; \quad R_5; \quad 2, i\sigma_3, \sigma_3, -\sigma_0; \quad \text{P-NS}_{\text{ALH}}; \\
K; &\left(\frac{1}{2}0\frac{1}{2}\right); \quad C_3^+ C_{21}^0 C_6^+, T; \quad R_1; \quad 1, 1, 1, 1; \\
&\quad R_2; \quad 1, -1, 1, 1; \\
&\quad R_3; \quad 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}; \quad \text{C-1 WP; } 1 \\
H; &\left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); \quad C_3^0, C_{21}^0 C_6^+, T; \{R_1, R_2\}; \quad 2, \sigma_0, \sigma_3, -i\sigma_2; \quad \text{P-NS}_{\text{ALH}}; \\
&\quad R_3; \quad 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}; \quad \text{P-NS}_{\text{ALH}}; \\
\Delta; \text{ GA; } \quad C_6^+, C_{21}^0, T; \quad R_1; \quad 1, 1, 1; \\
&\quad R_2; \quad 1, \sqrt{-1}, 1; \\
&\quad R_3; \quad 1, (-1)^{2/3}, 1; \\
&\quad R_4; \quad 1, -1, 1; \\
&\quad R_5; \quad 1, -\sqrt{-1}, 1; \\
&\quad R_6; \quad 1, -(-1)^{2/3}, 1; \\
U; \text{ ML; } \quad C_2^+ C_{21}^0, T; \quad R_1; \quad 1, 1, 1; \\
&\quad R_2; \quad 1, -1, 1; \\
P; \text{ KH; } \quad C_3^+, C_{22}^0, T; \quad R_1; \quad 1, 1, 1; \\
&\quad R_2; \quad 1, (-1)^{2/3}, 1; \\
&\quad R_3; \quad 1, -\sqrt{-1}, 1; \\
T; \text{ GK; } \quad C_{22}^0, C_{22}^0, T; \quad R_1; \quad 1, 1, 1; \\
&\quad R_2; \quad 1, -1, 1; \\
S; \text{ AH; } \quad C_{22}^0, C_{22}^0, T; \{R_2, R_3\}; \quad 2, \sigma_3, \sigma_3; \quad \text{L-NS}_{\text{ALH}}; \\
T'; \text{ MK; } \quad C_{21}^0 C_{22}^0, T; \quad R_1; \quad 1, 1, 1; \\
&\quad R_2; \quad 1, -1, 1; \\
S'; \text{ LH; } \quad C_{21}^0, C_{21}^0, T; \{R_2, R_4\}; \quad 2, \sigma_3, -i\sigma_2; \quad \text{L-NS}_{\text{ALH}}; \\
\Sigma; \text{ GM; } \quad C_{21}^0, C_{21}^0, T; \quad R_1; \quad 1, 1, 1; \\
&\quad R_2; \quad 1, -1, 1; \\
R; \text{ AL; } \quad C_{21}^0, C_{21}^0, T; \{R_1, R_2\}; \quad 2, \sigma_3, \sigma_1; \quad \text{L-NS}_{\text{ALH}}; \\
\]
\[ \Gamma_h; \{ C_6^\dagger[00\overline{2}] \}, \{ C_2^\dagger[000] \}; \text{ Non-Centrosymmetric; without SOC} \]

\[
\begin{array}{l}
\Gamma; (000); \; C_6^\dagger, C_2^\dagger, T; \quad R_1; \quad 1, 1, 1;
R_2; \quad 1, -1, 1;
R_3; \quad 1, -1, 1;
R_4; \quad 1, -1, 1;
R_5; \quad 2, \frac{-\alpha_0 - i\sqrt{3}\phi_2}{2}, \sigma_3, -\sigma_0; \quad \text{C-2 WP; 2}
R_6; \quad 2, \frac{\alpha_0 + i\sqrt{3}\phi_2}{2}, \sigma_3, -\sigma_0; \quad \text{C-2 WP; 2}
\end{array}
\]

\[
\begin{array}{l}
M; (0\overline{1}0); \; C_2, C_{21}, T; \quad R_1; \quad 1, 1, 1;
R_2; \quad 1, -1, 1;
R_3; \quad 1, -1, 1;
R_4; \quad 1, -1, 1;
\end{array}
\]

\[
\begin{array}{l}
\Lambda; (00\overline{2}); \; C_6^\dagger, C_2^\dagger, T; \quad R_3; \quad 2, \sqrt{3}\alpha_0 + i\phi_2, \sigma_1, -i\sigma_1; \quad \text{P-NSALH;}
R_5; \quad 2, -\sqrt{3}\alpha_0 + i\phi_2, \sigma_1, -i\sigma_1; \quad \text{P-NSALH;}
R_6; \quad 2, i\sigma_3, \sigma_1, -i\sigma_1; \quad \text{P-NSALH;}
\end{array}
\]

\[
\begin{array}{l}
L; (0\overline{2}0); \; C_2, C_{21}, T; \quad R_3; \quad 2, i\sigma_3, \sigma_3, -\sigma_0; \quad \text{P-NSALH;}
\end{array}
\]

\[
\begin{array}{l}
K; (\frac{1}{3}0); \; C_6^\dagger, C_{21}^\dagger, C_6^\dagger, T; \quad R_1; \quad 1, 1, 1;
R_2; \quad 1, -1, 1;
R_3; \quad 2, \frac{-\alpha_0 - i\sqrt{3}\phi_2}{2}, \sigma_3, \frac{-\alpha_0 + i\sqrt{3}\phi_2}{2}; \quad \text{C-1 WP; 1}
\end{array}
\]

\[
\begin{array}{l}
H; (\frac{1}{3}0); \; C_3, C_{21}^\dagger, C_6^\dagger, T; \quad \{ R_1, R_2 \}; \quad 2, \sigma_0, \sigma_3, -i\sigma_2; \quad \text{P-NSALH;}
R_3; \quad 2, \frac{-\alpha_0 - i\sqrt{3}\phi_2}{2}, \sigma_3, \frac{-\alpha_0 + i\sqrt{3}\phi_2}{2}; \quad \text{P-NSALH;}
\end{array}
\]

\[
\begin{array}{l}
\Delta; \; \Gamma A; \; C_6^\dagger, C_{20}^\dagger T; \quad R_1; \quad 1, 1, 1;
R_2; \quad 1, \sqrt[3]{-1}, 1;
R_3; \quad 1, (-1)^{2/3}, 1;
R_4; \quad 1, -1, 1;
R_5; \quad 1, -\sqrt[3]{-1}, 1;
R_6; \quad 1, -(1)^{2/3}, 1;
\end{array}
\]

\[
\begin{array}{l}
U; \; \text{ML; \;} C_2, C_{21}^\dagger T; \quad R_1; \quad 1, 1, 1;
R_2; \quad 1, -1, 1;
\end{array}
\]

\[
\begin{array}{l}
P; \; \text{KH; \;} C_3^\dagger, C_{22}^\dagger T; \quad R_1; \quad 1, 1, 1;
R_2; \quad 1, (-1)^{2/3}, 1;
R_3; \quad 1, -\sqrt[3]{-1}, 1;
\end{array}
\]

\[
\begin{array}{l}
T; \; \Gamma K; \; C_{22}^\dagger, C_{22}^\dagger T; \quad R_1; \quad 1, 1, 1;
R_2; \quad 1, -1, 1;
\end{array}
\]

\[
\begin{array}{l}
S; \; \text{AH; \;} C_{22}^\dagger, C_{22}^\dagger T; \quad \{ R_2, R_8 \}; \quad 2, \sigma_3, \sigma_1; \quad \text{L-NSALH;}
\end{array}
\]

\[
\begin{array}{l}
T'; \; \text{MK; \;} C_{21}^\dagger, C_2 T; \quad R_1; \quad 1, 1, 1;
R_2; \quad 1, -1, 1;
\end{array}
\]

\[
\begin{array}{l}
S'; \; \text{LH; \;} C_{21}^\dagger, C_2 T; \quad \{ R_2, R_4 \}; \quad 2, \sigma_3, -i\sigma_2; \quad \text{L-NSALH;}
\end{array}
\]

\[
\begin{array}{l}
\Sigma; \; \Gamma M; \; C_{21}^\dagger, C_{21}^\dagger T; \quad R_1; \quad 1, 1, 1;
R_2; \quad 1, -1, 1;
\end{array}
\]

\[
\begin{array}{l}
R; \; \text{AL; \;} C_{21}^\dagger, C_{21}^\dagger T; \quad \{ R_1, R_2 \}; \quad 2, \sigma_3, \sigma_1; \quad \text{L-NSALH;}
\end{array}
\]
\( \Gamma_h; \{ C_6^+ \{00\} \}, \{ C_2^+ \{00\} \}, \mathcal{T}; \) Non-Centrosymmetric; without SOC

\( \Gamma; (000); \ C_6^+, C_{21}^+, \mathcal{T}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, -1, 1, 1; \\
R_3 & : -1, 1, 1, 1; \\
R_4 & : -1, 1, -1, 1; \\
R_5 & : -\frac{1}{2} \sqrt{3\sigma_2}, \sigma_3, -\sigma_0; \\
R_6 & : \frac{1}{2} \sqrt{3\sigma_2}, \sigma_3, -\sigma_0; \\
\end{align*}
\]
C-2 WP; 2

\( M; (0 \frac{1}{2} 0); \ C_2, C_{21}^{''}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, -1, 1, 1; \\
R_3 & : -1, 1, 1, 1; \\
R_4 & : -1, 1, -1, 1; \\
R_5 & : -\frac{1}{2} \sqrt{3\sigma_2}, \sigma_3, -\sigma_0; \\
R_6 & : \frac{1}{2} \sqrt{3\sigma_2}, \sigma_3, -\sigma_0; \\
\end{align*}
\]
C-2 WP; 2

\( A; (00 \frac{1}{2}); \ C_6^+, C_{21}^{'}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, -1, 1, 1; \\
R_3 & : -1, 1, 1, 1; \\
R_4 & : -1, -1, 1, 1; \\
R_5 & : -\frac{1}{2} \sqrt{3\sigma_2}, \sigma_3, -\sigma_0; \\
R_6 & : \frac{1}{2} \sqrt{3\sigma_2}, \sigma_3, -\sigma_0; \\
\end{align*}
\]
C-2 WP; 2

\( L; (0 \frac{1}{2} \frac{1}{2}); \ C_2, C_{21}^{''}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, -1, 1, 1; \\
R_3 & : -1, 1, 1, 1; \\
R_4 & : -1, -1, 1, 1; \\
R_5 & : -\frac{1}{2} \sqrt{3\sigma_2}, \sigma_3, -\sigma_0; \\
R_6 & : \frac{1}{2} \sqrt{3\sigma_2}, \sigma_3, -\sigma_0; \\
\end{align*}
\]
C-2 WP; 2

\( K; ( \frac{1}{3} \frac{2}{3} 0); \ C_3^+, C_{21}^{''}, C_6^+; \)
\[
\begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, -1, 1, 1; \\
R_3 & : -\frac{1}{2} \sqrt{3\sigma_2}, \sigma_3, -\frac{1}{2} \sqrt{3\sigma_2}; \\
\end{align*}
\]
C-1 WP; 1

\( H; ( \frac{1}{3} \frac{1}{3} \frac{1}{3}); \ C_3^+, C_{21}^{''}, C_6^+; \)
\[
\begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, -1, 1, 1; \\
R_3 & : -\frac{1}{2} \sqrt{3\sigma_2}, \sigma_3, -\frac{1}{2} \sqrt{3\sigma_2}; \\
\end{align*}
\]
C-1 WP; 1

\( \Delta; \Gamma A; \ C_6^+, C_{25}^{''}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1; \\
R_2 & : \sqrt{-1}, 1; \\
R_3 & : (1)^{3/2}, 1; \\
R_4 & : -1, 1; \\
R_5 & : -\sqrt{-1}, 1; \\
R_6 & : -(1)^{2/3}, 1; \\
\end{align*}
\]

\( U; ML; \ C_2, C_{21}^{''}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1; \\
R_2 & : -1, 1, 1; \\
\end{align*}
\]

\( P; KH; \ C_3^+, C_{22}^{''}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1; \\
R_2 & : (1)^{3/2}, 1; \\
R_3 & : -\sqrt{-1}, 1; \\
\end{align*}
\]

\( T; \Gamma K; \ C_{22}^{''}, C_{22}^{''}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1; \\
R_2 & : -1, 1, 1; \\
\end{align*}
\]

\( S; AH; \ C_{22}^{''}, C_{22}^{''}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1; \\
R_2 & : -1, 1, 1; \\
\end{align*}
\]

\( T'; MK; \ C_{21}^{''}, C_{21}^{''}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1; \\
R_2 & : -1, 1, 1; \\
\end{align*}
\]

\( S'; LH; \ C_{21}^{''}, C_{21}^{''}; \)
\[
\begin{align*}
R_1 & : 1, 1, 1; \\
R_2 & : -1, 1, 1; \\
\end{align*}
\]
\[ \Sigma; \Gamma M; C_{21}; C'_{21}; T; R_1; 1; 1; 1; \\
R_2; 1; -1, 1; \]

\[ R; AL; C_{21}; C''_{21}; T; R_1; 1; 1, 1; \\
R_2; 1; -1, 1; \]
SG 181

\[ \Gamma_h; \{ C_6^0[00\frac{2}{3}] \}, \{ C_2^0[000] \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma; \ (000); & \ C_6^+, C_{21}^T; & R_1; & 1, 1, 1, 1; \\
& & R_2; & 1, 1, -1, 1; \\
& & R_3; & -1, 1, 1, 1; \\
& & R_4; & -1, -1, 1, 1; \\
& & R_5; & -\frac{\sigma_0+i\sqrt{3}a_2}{2}, \sigma_3, -\sigma_0; & \text{C-2 WP; 2} \\
& & R_6; & \frac{\sigma_0-i\sqrt{3}a_2}{2}, \sigma_3, -\sigma_0; & \text{C-2 WP; 2} \\
M; \ (0\frac{1}{2}0); & \ C_2, C_{21}^{\text{mut}}; & R_1; & 1, 1, 1; \\
& & R_2; & 1, 1, -1, 1; \\
& & R_3; & -1, 1, 1, 1; \\
& & R_4; & -1, -1, 1, 1; \\
A; \ &(00\frac{1}{2}); & \ C_6^+, C_{21}^T; & R_1; & 1, 1, 1; \\
& & R_2; & 1, 1, -1, 1; \\
& & R_3; & -1, 1, 1, 1; \\
& & R_4; & -1, -1, 1, 1; \\
L; \ (0\frac{1}{2}\frac{1}{2}); & \ C_2, C_{21}^{\text{mut}}; & R_1; & 1, 1, 1; \\
& & R_2; & 1, 1, -1, 1; \\
& & R_3; & -1, 1, 1, 1; \\
& & R_4; & -1, -1, 1, 1; \\
K; \ (\frac{1}{2}\frac{2}{3}0); & \ C_3^-, C_{22}^+, C_{6}^+; & R_1; & 1, 1, 1; \\
& & R_2; & 1, -1, 1; \\
& & R_3; & -\frac{\sigma_0+i\sqrt{3}a_2}{2}, \sigma_3, \frac{\sigma_0-i\sqrt{3}a_2}{2}; & \text{C-1 WP; 1} \\
H; \ (\frac{1}{2}\frac{1}{3}\frac{1}{2}); & \ C_3^-, C_{22}^+, C_{6}^+; & R_1; & 1, 1, 1; \\
& & R_2; & 1, -1, 1; \\
& & R_3; & -\frac{\sigma_0+i\sqrt{3}a_2}{2}, \sigma_3, -\frac{\sigma_0-i\sqrt{3}a_2}{2}; & \text{C-1 WP; 1} \\
\Delta; \ \Gamma A; & \ C_6^+, C_{21}^T; & R_1; & 1, 1, 1; \\
& & R_2; & 1, \sqrt{-1}, 1; \\
& & R_3; & (-1)^{2/3}, 1; \\
& & R_4; & -1, 1; \\
& & R_5; & -\sqrt{-1}, 1; \\
& & R_6; & -(-1)^{2/3}, 1; \\
U; \ ML; & \ C_2, C_{21}^{\text{mut}}; & R_1; & 1, 1, 1; \\
& & R_2; & 1, -1, 1; \\
P; \ KH; & \ C_3^+, C_{22}^T; & R_1; & 1, 1, 1; \\
& & R_2; & 1, (-1)^{2/3}, 1; \\
& & R_3; & -\sqrt{-1}, 1; \\
T; \ \Gamma K; & \ C_{22}^{\text{mut}}, C_{22}^T; & R_1; & 1, 1, 1; \\
& & R_2; & 1, -1, 1; \\
S; \ AH; & \ C_{22}^{\text{mut}}, C_{22}^T; & R_1; & 1, 1, 1; \\
& & R_6; & -1, 1; \\
\]
\[ T'; \ MK; \ C_{21},C_2T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ S'; \ LH; \ C_{21}',C_2T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ \Sigma; \ GM; \ C_{21}',C_{21}'T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ R; \ AL; \ C_{21}',C_{21}'T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
$\Gamma$: (000); $C_6^+, C_{21}^+, T$; $R_1$: 1, 1, 1; $R_2$: 1, 1, -1, 1; $R_3$: 1, -1, 1, 1; $R_4$: 1, -1, -1, 1; $R_5$: 2; $-\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0$; C-2 WP; 2 $R_6$: 2; $\frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0$; C-2 WP; 2

$M$: (0$^1\frac{1}{2}$0); $C_2, C_{21}^+$; $R_1$: 1, 1, 1, 1; $R_2$: 1, 1, -1, 1; $R_3$: 1, -1, 1, 1; $R_4$: 1, -1, -1, 1; $R_5$: $i\sigma_3, \sigma_1, -i\sigma_1$; P-NSALH; $R_6$: $-i\sigma_3, \sigma_1, -i\sigma_1$; P-NSALH; $R_7$: $i\sigma_2, \sigma_3, -\sigma_0$; P-NSALH;

$A$: (0$^0\frac{1}{2}$); $C_6^+, C_{21}^+$; $R_1$: 2; $\sqrt{3}\sigma_0 + i\sigma_3, \sigma_1, -i\sigma_1$; P-NSALH; $R_2$: 2; $-\sqrt{3}\sigma_0 + i\sigma_3, \sigma_1, -i\sigma_1$; P-NSALH; $R_3$: $i\sigma_3, \sigma_1, -i\sigma_1$; P-NSALH; $R_4$: $i\sigma_2, \sigma_3, -\sigma_0$; P-NSALH;

$L$: (0$^0\frac{1}{2}$); $C_2, C_{21}^+$; $R_1$: 1, 1, 1, 1; $R_2$: 1, 1, -1, 1; $R_3$: 2; $-\frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3, \frac{-\sigma_0 + i\sqrt{3}\sigma_2}{2}$; C-1 WP; 1

$H$: (0$^0\frac{1}{2}$); $C_3, C_{21}^+, C_{6}^+$; $\{R_1, R_2\}$; 2; $\sigma_0, \sigma_3, -i\sigma_2$; P-NSALH; $R_3$: 2; $-\frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}$; P-NSALH;

$\Delta$: $\Gamma\Lambda$; $C_6^+, C_{21}^+$; $R_1$: 1, 1, 1; $R_2$: 1; $\sqrt{-1}, 1$; $R_3$: 1; $(-1)^{2/3}, 1$; $R_4$: 1, -1, 1; $R_5$: 1; $\sqrt{-1}, 1$; $R_6$: 1; $(-1)^{2/3}, 1$;

$U$: $\Gamma\Lambda$; $C_2, C_{21}^+$; $R_1$: 1, 1, 1; $R_2$: 1, -1, 1;

$P$: $\Gamma\Lambda$; $C_3^+, C_{21}^+$; $R_1$: 1, 1, 1; $R_2$: 1; $(-1)^{2/3}, 1$; $R_3$: 1; $\sqrt{-1}, 1$;

$T$: $\Gamma\Lambda$; $C_{21}^+, C_{22}^+$; $R_1$: 1, 1, 1; $R_2$: 1, -1, 1;

$S$: $\Gamma\Lambda$; $C_{21}^+, C_{22}^+$; $\{R_2, R_3\}$; 2; $\sigma_3, \sigma_1$; L-NSALH;

$T'$; $\Gamma\Lambda$; $C_{21}^+, C_{22}^+$; $R_1$: 1, 1, 1; $R_2$: 1, -1, 1;

$S'$; $\Gamma\Lambda$; $C_{21}^+, C_{22}^+$; $\{R_2, R_3\}$; 2; $\sigma_3, -i\sigma_2$; L-NSALH;

$\Sigma$: $\Gamma\Lambda$; $C_{21}^+, C_{22}^+$; $R_1$: 1, 1, 1; $R_2$: 1, -1, 1;

$R$: $\Gamma\Lambda$; $C_{21}^+, C_{22}^+$; $\{R_1, R_2\}$; 2; $\sigma_3, \sigma_1$; L-NSALH;
\[ \Gamma; (000); C^+_{6h}, \sigma_v, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, 1; \]
\[ R_5; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\Gamma}; \]
\[ R_6; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\Gamma}; \]

\[ M; (0 \frac{1}{2} 0); C_2, \sigma_v, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, 1; \]

\[ A; (00 \frac{1}{2}); C^+_{6h}, \sigma_v, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, 1; \]

\[ K; (\frac{1}{3} \frac{1}{3} 0); C^+_{3h}, \sigma_d, C^+_{6h}, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, \frac{-\sigma_0 + i\sqrt{3}\sigma_2}{2}; \quad \text{P-WNL}_{KH}; \]

\[ H; (\frac{1}{3} \frac{1}{3} \frac{1}{2}); C^+_{3h}, \sigma_d, C^+_{6h}, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, \frac{-\sigma_0 + i\sqrt{3}\sigma_2}{2}; \quad \text{P-WNL}_{KH}; \]

\[ \Delta; \Gamma A; \quad C^+_{6h}, \sigma_v; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, 1; \]
\[ R_5; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \quad \text{QNL}; \quad 0 \]
\[ R_6; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3; \quad \text{QNL}; \quad 0 \]

\[ U; ML; \quad C_2, \sigma_v; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, 1; \]

\[ P; KH; \quad C^+_{3h}, \sigma_d; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \quad \text{WNL}; \quad \pi \]

\[ T; \Gamma K; \quad \sigma_d, T\sigma_v; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]

\[ S; AH; \quad \sigma_d, T\sigma_v; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ T'; \text{MK}; \sigma_{d1} C_2 T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ S'; \text{LH}; \quad \sigma_{d1} C_2 T; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ \Sigma; \quad \text{GM}; \quad \sigma_{e1} T \sigma_{d1}; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\[ R; \quad \text{AL}; \quad \sigma_{e1} T \sigma_{d1}; \quad R_1; 1; 1,1; \]
\[ R_2; 1; -1,1; \]
\( \Gamma; (000); C_6^+, \sigma_v, T; \) P-QNL\(_{h,a}\); Non-Centrosymmetric; without SOC

\( \Gamma; (000); C_6^+, \sigma_v, T; \) P-QNL\(_{h,a}\);

\( M; (0\frac{1}{2}0); C_2, \sigma_v, T; \) WNL\(_{h,M}\);

\( A; (00\frac{1}{2}); C_3^+, \sigma_d, C_6^+, T; \) WNL\(_{h,M}\);

\( K; (0\frac{1}{3}0); C_3^+, \sigma_d, C_6^+, T; \) QNL\(_{h,K} \);

\( H; (0\frac{1}{3}\frac{1}{2}); C_3^+, \sigma_d, C_6^+, T; \) DNL\(_{h,K} \);

\( \Delta; \Gamma A; C_6^+, \sigma_v; \) QNL\(_{h,DA} \);

\( U; \) NL; \( C_2, \sigma_v; \) QNL\(_{h,DA} \);

\( P; KH; C_3, \sigma_d; \) WNL\(_{h,DA} \);

\( T; \) G\(_h\); \( \sigma_d, T; \) WNL\(_{h,DA} \);

\( S; \) AH; \( \sigma_d, T; \) WNL\(_{h,DA} \);

\( T'; \) MK; \( \sigma_d, C_2 T; \) WNL\(_{h,DA} \);

\( S'; \) LH; \( \sigma_d, C_2 T; \) WNL\(_{h,DA} \);

\( \Sigma; \) GM; \( \sigma_v, T; \) WNL\(_{h,DA} \);

\( R; \) AL; \( \sigma_v, T; \) WNL\(_{h,DA} \);
\[ \Gamma_h; \{ C_6^+; 00 \frac{1}{2} \}, \{ \sigma_v; 00 \frac{1}{2} \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[ R_3; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, 1, 1; \]
\[ R_5; 2, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \]
\[ R_6; 2, \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \]
\[ M; (0 \frac{1}{2} 0); C_2, \sigma_v, T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, 1, 1; \]
\[ A; (0 \frac{1}{2} \frac{1}{2}); C_3^+, \sigma_d, C_2, T; \]
\[ \{ R_4, R_{10} \}; 2, \sigma_0, \sigma_0, i\sigma_3, \sigma_1; \]
\[ \{ R_5, R_{11} \}; 2, \sigma_0, -\sigma_0, i\sigma_3, \sigma_1; \]
\[ \{ R_6, R_{12} \}; 4, \frac{-\Gamma_0, 0, 0 - i\sqrt{3}\sigma_2}{2}, \Gamma_0, 3, i\Gamma_0, 3, 0, \Gamma_1, 0; \]
\[ QDP; 0 \]
\[ L; (0 \frac{1}{2} \frac{1}{2}); \sigma_v, \sigma_d, T; \]
\[ \{ R_2, R_4 \}; 2, i\sigma_3, \sigma_0, \sigma_1; \]
\[ \{ R_6, R_8 \}; 2, i\sigma_3, -\sigma_0, \sigma_1; \]
\[ K; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_3^+, \sigma_d, C_6^+ T; \]
\[ R_3; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, -1; \]
\[ R_5; 2, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, \sigma_0 + i\sqrt{3}\sigma_2; \]
\[ R_6; 2, \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3, \sigma_0 + i\sqrt{3}\sigma_2; \]
\[ H; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_3^+, \sigma_d, C_6^+ T; \]
\[ \{ R_1, R_3 \}; 2, \sigma_0, \sigma_0, -i\sigma_2; \]
\[ \{ R_2, R_3 \}; 2, \sigma_0, -\sigma_0, -i\sigma_2; \]
\[ \{ R_3, R_3 \}; 4, \frac{-\Gamma_0, 0, 0 + i\sqrt{3}\sigma_2}{2}, \Gamma_0, 3, \sqrt{3}\sigma_2, + i\sigma_2, 0; \]
\[ DP; 0 \]
\[ \Delta; \Gamma \Delta; C_6^+, \sigma_v; \]
\[ R_3; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, -1; \]
\[ R_5; 2, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \]
\[ R_6; 2, \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3; \]
\[ U; M L; C_2, \sigma_v; \]
\[ R_3; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1; \]
\[ R_3; 2, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \]
\[ P; K H; C_3^+, \sigma_d; \]
\[ R_3; 1, 1, 1; \]
\[ R_2; 1, 1, -1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, -1; \]
\[ R_3; 2, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3; \]
\[ T; \Gamma K; \sigma_{d_2}, T \sigma_v; \]
\[ R_3; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ S; A H; \sigma_{d_2}, T \sigma_v; \]
\[ \{ R_3, R_1 \}; 2, \sigma_0, -i\sigma_2; \]
\[ \{ R_2, R_2 \}; 2, -\sigma_0, -i\sigma_2; \]
\[ T'; M K; \sigma_d, C_2 T; \]
\[ R_3; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ T'; \Gamma K; \sigma_{d_1}, C_2 T; \]
\[ \{ R_3, R_1 \}; 2, \sigma_0, -i\sigma_2; \]
\[ \{ R_2, R_2 \}; 2, -\sigma_0, -i\sigma_2; \]
\[ S'; L H; \sigma_{d_1}, C_2 T; \]
\[ \{ R_3, R_1 \}; 2, \sigma_0, -i\sigma_2; \]
\[ \{ R_2, R_2 \}; 2, -\sigma_0, -i\sigma_2; \]
\[ \Sigma; \Gamma M; \sigma_v, \sigma_d; \]
\[ R_3; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R; A L; \sigma_v, \sigma_d; \]
\[ \{ R_3, R_1 \}; 2, \sigma_0, -i\sigma_2; \]
\[ \{ R_2, R_2 \}; 2, -\sigma_0, -i\sigma_2; \]
| Symbol | (000) | $C^+_6, \sigma_{v1, T}$ | $R_1$ | 1, 1, 1; |
|--------|-------|-------------------|--------|----------|
|        | $R_2$ | 1, 1, −1, 1;      |        |          |
|        | $R_3$ | 1, −1, 1, 1;      |        |          |
|        | $R_4$ | 1, −1, −1, 1;     |        |          |
|        | $R_5$ | $\begin{pmatrix} \sigma_0 - i\sqrt{3}\sigma_2 \\ \sigma_3 \\ \sigma_0 \end{pmatrix}$; P-QNL\(\Gamma\)A; |        |          |
|        | $R_6$ | $\begin{pmatrix} \sigma_0 + i\sqrt{3}\sigma_2 \\ \sigma_3 \\ \sigma_0 \end{pmatrix}$; P-QNL\(\Gamma\)A; |        |          |
| $M$    | (0\(\frac{1}{2}\)0) | $C_2, \sigma_{v1, T}$ | $R_1$ | 1, 1, 1; |
|        | $R_2$ | 1, 1, −1, 1;      |        |          |
|        | $R_3$ | 1, −1, 1, 1;      |        |          |
|        | $R_4$ | 1, −1, −1, 1;     |        |          |
|        | $A$   | (00\(\frac{1}{2}\)) | $C^+_3, \sigma_{v1, C_2, T}$ | $\{R_4, R_{10}\}$; 2 | $\sigma_0, \sigma_0, i\sigma_3, \sigma_1$; P-NS\(\text{ALH}\); |
|        |          | $\{R_5, R_{11}\}$; 2 | $\sigma_0, -\sigma_0, i\sigma_3, \sigma_1$; P-NS\(\text{ALH}\); |        |          |
|        |          | $\{R_6, R_{12}\}$; 4 | $-\Gamma_{0,0} - i\sqrt{3}\Gamma_{0,2}, \Gamma_{0,3}, i\Gamma_{3,0}, \Gamma_{1,0}$; QDP; 0 |
| $L$    | (0\(\frac{1}{2}\)\(\frac{1}{2}\)) | $\sigma_{d1, \sigma_{v1, T}}$ | $\{R_2, R_4\}$; 2 | $\sigma_3, \sigma_0, \sigma_1$; P-NS\(\text{ALH}\); |
|        |          | $\{R_6, R_8\}$; 2 | $\sigma_3, -\sigma_0, \sigma_1$; P-NS\(\text{ALH}\); |        |          |
| $K$    | (\(\frac{3}{2}\)\(\frac{3}{2}\)) | $C^+_3, \sigma_{d1, C_6^+ T}$ | $R_1$ | 1, 1, 1; |
|        | $R_2$ | 1, 1, −1, 1;      |        |          |
|        | $R_3$ | 2, $\sigma_0 - i\sqrt{3}\sigma_2, \sigma_3, \sigma_0 + i\sqrt{3}\sigma_2$; P-WNL\(\text{KH}\); |        |          |
| $H$    | (\(\frac{3}{2}\)\(\frac{3}{2}\)) | $C^+_3, \sigma_{d1, C_6^+ T}$ | $\{R_3, R_4\}$; 2 | $-\sigma_0, \sigma_3, -i\sigma_2$; P-NS\(\text{ALH}\); |
|        |          | $R_6$; 2 | $\sigma_0 - i\sqrt{3}\sigma_2, i\sigma_3, -\sqrt{3}\sigma_0 + i\sigma_2$; P-WNL/NS; |        |          |
| $\Delta$ | $\Gamma A$ | $C^+_6, \sigma_{v1}$ | $R_1$ | 1, 1, 1; |
|        | $R_2$ | 1, 1, 1;          |        |          |
|        | $R_3$ | 1, 1, 1;          |        |          |
|        | $R_4$ | 1, 1, 1;          |        |          |
| $U$    | $\text{ML}$ | $C_2, \sigma_{v1}$ | $R_1$ | 1, 1, 1; |
|        | $R_2$ | 1, 1, 1;          |        |          |
|        | $R_3$ | 1, 1, 1;          |        |          |
|        | $P$    | $C^+_3, \sigma_{d1}$ | $R_1$ | 1, 1, 1; |
|        | $R_2$ | 1, 1, 1;          |        |          |
|        | $R_3$ | 2, $\sigma_0 - i\sqrt{3}\sigma_2, \sigma_3$; WNL; \(\pi\) |        |          |
| $T$    | $\Gamma K$ | $\sigma_{d2, \tau\sigma_{v2}}$ | $R_1$ | 1, 1, 1; |
|        | $R_2$ | 1, 1, 1;          |        |          |
|        | $S$    | $\text{AH}$ | $\sigma_{d2, \tau\sigma_{v2}}$ | $\{R_1, R_2\}$; 2 | $-i\sigma_3, \sigma_1$; L-NS\(\text{ALH}\); |
| $T'$   | $\text{MK}$ | $\sigma_{d1, C_2 T}$ | $R_1$ | 1, 1, 1; |
|        | $R_2$ | 1, 1, 1;          |        |          |
| $S'$   | $\text{LH}$ | $\sigma_{d1, C_2 T}$ | $\{R_1, R_2\}$; 2 | $-i\sigma_3, -i\sigma_2$; L-NS\(\text{ALH}\); |
| $\Sigma$ | $\Gamma M$ | $\sigma_{v1, \tau\sigma_{d1}}$ | $R_1$ | 1, 1, 1; |
|        | $R_2$ | 1, 1, 1;          |        |          |
| $R$    | $\text{AL}$ | $\sigma_{v1, \tau\sigma_{d1}}$ | $\{R_1, R_1\}$; 2 | $\sigma_0, -i\sigma_2$; L-NS\(\text{ALH}\); |
|        |          | $\{R_2, R_2\}$; 2 | $-\sigma_0, -i\sigma_2$; L-NS\(\text{ALH}\); |        |
\[ \Gamma_h; \{ S_3^+, C_{21}' \}; \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (000); S_3^+, C_{21}', \mathcal{T}; \]

- \( R_1; 1, 1, 1; \)
- \( R_2; 1, -1, 1; \)
- \( R_3; 1, -1, 1; \)
- \( R_4; 1, -1, 1; \)
- \( R_5; 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \) \( \text{P-QNL}_{\Gamma A} \)
- \( R_6; 2, \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \) \( \text{P-QNL}_{\Gamma A} \)

\[ M; (0\frac{1}{2}0); C_{21}', \mathcal{S}_{v1}, \mathcal{T}; \]

- \( R_1; 1, 1, 1; \)
- \( R_2; 1, -1, 1; \)
- \( R_3; 1, -1, 1; \)
- \( R_4; 1, -1, 1; \)

\[ A; (00\frac{1}{2}); S_3^+, C_{21}', \mathcal{T}; \]

- \( R_1; 1, 1, 1; \)
- \( R_2; 1, -1, 1; \)
- \( R_3; 1, -1, 1; \)
- \( R_4; 1, -1, 1; \)
- \( R_5; 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \) \( \text{P-QNL}_{\Gamma A} \)
- \( R_6; 2, \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \) \( \text{P-QNL}_{\Gamma A} \)

\[ L; (0\frac{1}{2}\frac{1}{2}); C_{21}', \mathcal{S}_{v1}, \mathcal{T}; \]

- \( R_1; 1, 1, 1; \)
- \( R_2; 1, -1, 1; \)
- \( R_3; 1, -1, 1; \)
- \( R_4; 1, -1, 1; \)

\[ K; (\frac{1}{3}\frac{2}{3}0); S_3^+, \mathcal{T}_{v2}; \]

- \( R_1; 1, 1; \)
- \( R_2; 1, \sqrt{-1}, 1; \)
- \( R_3; 1, (-1)^{2/3}, 1; \)
- \( R_4; 1, -1, 1; \)
- \( R_5; 1, -\sqrt{-1}, 1; \)
- \( R_6; 1, -(1)^{2/3}, 1; \)

\[ H; (\frac{1}{3}\frac{2}{3}\frac{1}{2}); S_3^+, \mathcal{T}_{v2}; \]

- \( R_1; 1, 1; \)
- \( R_2; 1, \sqrt{-1}, 1; \)
- \( R_3; 1, (-1)^{2/3}, 1; \)
- \( R_4; 1, -1, 1; \)
- \( R_5; 1, -\sqrt{-1}, 1; \)
- \( R_6; 1, -(1)^{2/3}, 1; \)

\[ \Delta; \Gamma A; C_3^+, \mathcal{S}_{v1}, S_3^+ \mathcal{T}; \]

- \( R_1; 1, 1, 1; \)
- \( R_2; 1, -1, 1; \)
- \( R_3; 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}; \text{QLN}; \) \( 0 \)

\[ U; \text{ML}; \mathcal{S}_{v1}, \mathcal{T}_{\sigma_h}; \]

- \( R_1; 1, 1, 1; \)
- \( R_2; 1, -1, 1; \)

\[ P; \text{KH}; C_3^+, C_{21}' \mathcal{T}; \]

- \( R_1; 1, 1, 1; \)
- \( R_2; 1, (-1)^{2/3}, 1; \)
- \( R_3; 1, \sqrt{-1}, 1; \)

\[ T; \Gamma K; \mathcal{S}_{v1}, \mathcal{T}_{v2}; \]

- \( R_1; 1, 1, 1; \)
- \( R_2; 1, -1, 1; \)

\[ S; \text{AH}; \mathcal{S}_{v1}, \mathcal{T}_{v2}; \]

- \( R_1; 1, 1, 1; \)
- \( R_2; 1, -1, 1; \)
$T'$; MK; $\sigma_h T \sigma_v$; $R_1; 1; 1,1$;  
$R_2; 1; -1,1$;  
$f'; LH; \sigma_h T \sigma_v$; $R_1; 1; 1,1$;  
$R_4; 1; -1,1$;  
$\Sigma; \Gamma M; C_{21}'; \sigma_v$; $R_1; 1; 1,1$;  
$R_2; 1; 1, -1$;  
$R_3; 1; -1,1$;  
$R_4; 1; -1,-1$;  
$R; AL; C_{21}'; \sigma_v$; $R_1; 1; 1,1$;  
$R_2; 1; 1, -1$;  
$R_3; 1; -1,1$;  
$R_4; 1; -1,-1$;
\[ \Gamma_h; \{ S^+_{31} | 000 \}, \{ C'_{21} | 00 \frac{1}{2} \}; \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{array}{ll}
\Gamma; (000); S^+_{31}, C'_{21}, \mathcal{T}; \\
R_1; & 1, 1, 1; \\
R_2; & 1, 1, -1, 1; \\
R_3; & 1, -1, 1; \\
R_4; & 1, -1, -1, 1; \\
R_5; & \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \\
R_6; & \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \\
\end{array}
\]

\[
\begin{array}{ll}
M; (0\frac{1}{2}0); C'_{21}, \sigma_v1, \mathcal{T}; \\
R_1; & 1, 1, 1; \\
R_2; & 1, -1, 1; \\
R_3; & 1, -1, 1; \\
R_4; & 1, -1, -1; \\
\end{array}
\]

\[ A; (00\frac{1}{2}); \sigma_v1, C^+_{31}, \sigma_h, \mathcal{T}; \{ R_7, R_8 \}; 4; -i\Gamma_{3.1}, -\frac{\Gamma_{0,0} + i\sqrt{3}\Gamma_{0,3}}{2}, \Gamma_{0,3,3}, \Gamma_{1,0}; \text{QDP}; 0 \]

\[
\begin{array}{ll}
R_9; & 2, i\sigma_1, \sigma_0, \sigma_3, -i\sigma_3; \\
R_{10}; & -i\sigma_2, \sigma_3, -\sigma_0; \\
\end{array}
\]

\[ L; (0\frac{1}{2}\frac{1}{2}); \sigma_v1, \sigma_h, \mathcal{T}; \\
R_3; & 2, i\sigma_2, \sigma_3, -\sigma_0; \\
\]

\[ K; (\frac{1}{2}\frac{1}{2}0); S^+_{31}, \mathcal{T}; \sigma_v2; \\
R_1; & 1, 1, 1; \\
R_2; & 1, \sqrt{-1}, 1; \\
R_3; & 1, (-1)^{2/3}, 1; \\
R_4; & 1, -1, 1; \\
R_5; & 1, -\sqrt{-1}, 1; \\
R_6; & 1, (-1)^{2/3}, 1; \\
\]

\[ H; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); S^+_{31}, \mathcal{T}; \sigma_v2; \\
\{ R_1, R_2 \}; 2, \sigma_3, -i\sigma_2; \\
\{ R_2, R_5 \}; 2, \sqrt{-1}\sigma_3, -i\sigma_2; \\
\{ R_3, R_6 \}; 2, (-1)^{2/3}\sigma_3, -i\sigma_2; \\
\]

\[ \Delta; \Gamma A; C^+_{31}, \sigma_v1, S^+_{31}, \mathcal{T}; \\
R_1; & 1, 1, 1; \\
R_2; & 1, -1, 1; \\
R_3; & 2, -\frac{-\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3, -\frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}; \\
\]

\[ U; \Gamma L; \sigma_v1, \mathcal{T}; \sigma_h; \\
R_1; & 1, 1, 1; \\
R_2; & 1, -1, 1; \\
\]

\[ P; \Gamma K; C^+_{31}, C'_{21}, \mathcal{T}; \\
R_1; & 1, 1, 1; \\
R_2; & 1, (-1)^{2/3}, 1; \\
R_3; & 1, -\sqrt{-1}, 1; \\
\]

\[ T; \Gamma K; \sigma_h, \mathcal{T}; \sigma_v2; \\
R_1; & 1, 1, 1; \\
R_2; & 1, -1, 1; \\
\]

\[ S; \Gamma H; \sigma_h, \mathcal{T}; \sigma_v2; \\
\{ R_1, R_2 \}; 2, \sigma_3, -i\sigma_2; \\
\]

\[ T'; \Gamma K; \sigma_h, \mathcal{T}; \sigma_v1; \\
R_1; & 1, 1, 1; \\
R_2; & 1, -1, 1; \\
\]

\[ S'; \Gamma L; \sigma_h, \mathcal{T}; \sigma_v1; \\
\{ R_1, R_2 \}; 2, \sigma_3, -i\sigma_2; \\
\]

\[ \Sigma; \Gamma M; C'_{21}, \sigma_v1; \\
R_1; & 1, 1, 1; \\
R_2; & 1, -1, 1; \\
R_3; & 1, -1, 1; \\
R_4; & 1, -1, 1; \\
\]

\[ R; \Gamma L; C'_{21}, \sigma_h; \\
R_5; & 2, \sigma_2, \sigma_3; \\
\]

\[ \text{WNL}; \pi \]

\[ \text{P-QNL}_{\mathcal{T},A} \]

\[ \text{P-WNLs}; \]

\[ \text{QNL}; 0 \]
\( \Gamma_h; \{ S_3^+ | 000 \}, \{ C_{21}'' | 000 \}, \mathcal{T} \); Non-Centrosymmetric; without SOC

\[
\begin{align*}
\Gamma; \ (000): \ & S_3^+, C_{21}'' , \mathcal{T}; \\
R_1 &: 1, 1, 1, 1; \\
R_2 &: 1, -1, 1, 1; \\
R_3 &: 1, -1, 1, 1; \\
R_4 &: 1, -1, -1, 1; \\
R_5 &: \frac{\sigma_0 - i \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\Gamma} \\
R_6 &: \frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\Gamma} \\
M; \ (0, 0, \frac{1}{2}): \ & C_{21}'' , \sigma_{d1}, \mathcal{T}; \\
R_1 &: 1, 1, 1, 1; \\
R_2 &: 1, -1, 1, 1; \\
R_3 &: 1, -1, 1, 1; \\
R_4 &: 1, -1, -1, 1; \\
R_5 &: \frac{\sigma_0 - i \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\Gamma} \\
R_6 &: \frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\Gamma} \\
A; \ (00, \frac{1}{2}): \ & S_3^+, C_{21}'' , \mathcal{T}; \\
R_1 &: 1, 1, 1, 1; \\
R_2 &: 1, -1, 1, 1; \\
R_3 &: 1, -1, 1, 1; \\
R_4 &: 1, -1, -1, 1; \\
R_5 &: \frac{\sigma_0 - i \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\Gamma} \\
R_6 &: \frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\Gamma} \\
L; \ (0, \frac{1}{2}, \frac{1}{2}): \ & C_{21}'' , \sigma_{d1}, \mathcal{T}; \\
R_1 &: 1, 1, 1, 1; \\
R_2 &: 1, -1, 1, 1; \\
R_3 &: 1, -1, 1, 1; \\
R_4 &: 1, -1, -1, 1; \\
R_5 &: \frac{\sigma_0 - i \sqrt{3} \sigma_2}{2}, \sigma_3; \quad \text{P-WNL}_{K \mathcal{H}} \\
R_6 &: \frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}, \sigma_3; \quad \text{P-WNL}_{K \mathcal{H}} \\
K; \ (\frac{1}{3}, 0): \ & S_3^+, C_{21}'' ; \\
R_1 &: 1, 1, 1; \\
R_2 &: 1, -1, 1; \\
R_3 &: 1, -1, 1; \\
R_4 &: 1, -1, -1; \\
R_5 &: \frac{\sigma_0 - i \sqrt{3} \sigma_2}{2}, \sigma_3; \quad \text{P-WNL}_{K \mathcal{H}} \\
R_6 &: \frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}, \sigma_3; \quad \text{P-WNL}_{K \mathcal{H}} \\
H; \ (\frac{1}{3}, \frac{1}{2}): \ & S_3^+, C_{21}'' ; \\
R_1 &: 1, 1, 1; \\
R_2 &: 1, -1, 1; \\
R_3 &: 1, -1, 1; \\
R_4 &: 1, -1, -1; \\
R_5 &: \frac{\sigma_0 - i \sqrt{3} \sigma_2}{2}, \sigma_3; \quad \text{P-WNL}_{K \mathcal{H}} \\
R_6 &: \frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}, \sigma_3; \quad \text{P-WNL}_{K \mathcal{H}} \\
\Delta; \ \Gamma \mathcal{A}; \ & C_3^+, \sigma_{d1}, S_3^+, \mathcal{T}; \\
R_1 &: 1, 1, 1, 1; \\
R_2 &: 1, -1, 1, 1; \\
R_3 &: \frac{\sigma_0 - i \sqrt{3} \sigma_2}{2}, \sigma_3, -\frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}; \quad \text{QNL}; \quad 0 \\
U; \ \mathcal{M}L; \ & \sigma_{d1}, \mathcal{T} \sigma_h; \\
R_1 &: 1, 1, 1; \\
R_2 &: 1, -1, 1; \\
P; \ \mathcal{K}h; \ & C_3^+, \sigma_{d1}; \\
R_1 &: 1, 1, 1; \\
R_2 &: 1, -1, 1; \\
R_3 &: \frac{\sigma_0 - i \sqrt{3} \sigma_2}{2}, \sigma_3; \quad \text{WNL}; \quad \pi \\
T; \ \Gamma \mathcal{K}; \ & C_{22}'' , \sigma_{d2}; \\
R_1 &: 1, 1, 1; \\
R_2 &: 1, -1, 1; \\
R_3 &: 1, -1, 1; \\
R_4 &: 1, -1, -1;
$S;\ \text{AH;}\ C_{22}''\sigma_{d2};\ R_1;\ 1,1,1;$
\hspace{1cm}R_2;\ 1,1,\ -1;
\hspace{1cm}R_3;\ 1,\ -1,1;
\hspace{1cm}R_4;\ 1,\ -1,\ -1;

$T';\ \text{MK;}\ C_{21}''\sigma_{d1};\ R_1;\ 1,1,1;$
\hspace{1cm}R_2;\ 1,1,\ -1;
\hspace{1cm}R_3;\ 1,\ -1,1;
\hspace{1cm}R_4;\ 1,\ -1,\ -1;

$S';\ \text{LH;}\ C_{21}''\sigma_{d1};\ R_1;\ 1,1,1;$
\hspace{1cm}R_2;\ 1,1,\ -1;
\hspace{1cm}R_3;\ 1,\ -1,1;
\hspace{1cm}R_4;\ 1,\ -1,\ -1;

$\Sigma;\ \Gamma M;\ \sigma_h,T\sigma_{d1};\ R_1;\ 1,1,1;$
\hspace{1cm}R_2;\ 1,\ -1,1;

$R;\ \text{AL;}\ \sigma_h,T\sigma_{d1};\ R_1;\ 1,1,1;$
\hspace{1cm}R_2;\ 1,\ -1,1;$
| Γ, (000): $S_3^+, C_{21}^+, T$ | $R_1$: 1, 1, 1; |
| | $R_2$: 1, 1, -1, 1; |
| | $R_3$: 1, -1, 1, 1; |
| | $R_4$: 1, -1, -1, 1; |
| | $R_5$: $\frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0$; |
| | $R_6$: $\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0$; |
| | P-QNL\(\Gamma\); |
| | M, (0\(\frac{1}{2}\)0): $C_{21}^+, \sigma_{d1}, T$ | $R_1$: 1, 1, 1, 1; |
| | $R_2$: 1, 1, -1, 1; |
| | $R_3$: 1, -1, 1, 1; |
| | $R_4$: 1, -1, -1, 1; |
| | $R_5$: $\frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3$; |
| | $R_6$: $\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3$; |
| | P-QNL\(\Gamma\); |
| | A, (0\(\frac{1}{2}\)\(\frac{1}{2}\)): $\sigma_{d1}, C_{3}^+, \sigma_{d1}, T$ | $R_7$, $R_8$: $-i\Gamma_{3,1}, \Gamma_{0,0,0}, \sqrt{3} \Gamma_{3,3,3}, \Gamma_{0,0,0}, \Gamma_{1,0}$; |
| | | QDP; 0 |
| | | $R_9$: 2, $i\sigma_1, \sigma_0, \sigma_3, -i\sigma_3$; |
| | | P-WNLs; |
| | L, (0\(\frac{1}{2}\)\(\frac{1}{2}\)): $\sigma_{d1}, \sigma_{h}, T$ | $R_3$: 2, $i\sigma_2, \sigma_3, -\sigma_0$; |
| | | P-WNLs; |
| | K, (\(\frac{1}{2}\)\(\frac{1}{2}\)0): $S_3^+, C_{21}^+$ | $R_1$: 1, 1, 1; |
| | | $R_2$: 1, 1, -1; |
| | | $R_3$: 1, -1, 1; |
| | | $R_4$: 1, -1, -1; |
| | | $R_5$: $\frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3$; |
| | | $R_6$: $\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3$; |
| | | P-WNLs; |
| | H, (\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)): $\sigma_{d1}, C_{3}^+, \sigma_{h}$ | $R_7$: 2, $-i\sigma_1, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3$; |
| | | $R_8$: 2, $i\sigma_1, \frac{-\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_3$; |
| | | P-WNLs; |
| | | $R_9$: 2, $i\sigma_1, \sigma_0, \sigma_3$; |
| | | P-WNLs; |
| | \(\Delta, \Gamma A\): $C_{3}^+, \sigma_{d1}, S_3^+, T$ | $R_1$: 1, 1, 1, 1; |
| | | $R_2$: 1, 1, -1, 1; |
| | | $R_3$: 2, $\frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}$; |
| | | QNL; 0 |
| | \(U, ML\): $\sigma_{d1}, T \sigma_{h}$ | $R_1$: 1, 1, 1; |
| | | $R_2$: 1, -1, 1; |
| | \(P, KH\): $C_{3}^+, \sigma_{d1}$ | $R_1$: 1, 1, 1; |
| | | $R_2$: 1, 1, -1; |
| | | $R_3$: 2, $\frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3$; |
| | | WNL; π |
| | \(T, \Gamma K\): $C_{22}^+, \sigma_{d1}$ | $R_1$: 1, 1, 1; |
| | | $R_2$: 1, 1, -1; |
| | | $R_3$: 1, -1, 1; |
| | | $R_4$: 1, -1, -1; |
| | \(S, AH\): $C_{22}^+, \sigma_{h}$ | $R_5$: 2, $\sigma_2, \sigma_3$; |
| | | WNL; π |
| | \(T, MK\): $C_{21}^+, \sigma_{d1}$ | $R_1$: 1, 1, 1; |
| | | $R_2$: 1, 1, -1; |
| | | $R_3$: 1, -1, 1; |
| | | $R_4$: 1, -1, -1; |
| | \(S, LH\): $C_{21}^+, \sigma_{h}$ | $R_5$: 2, $\sigma_2, \sigma_3$; |
| | | WNL; π |
| | \(\Sigma, \Gamma M\): $\sigma_{h}, T \sigma_{d1}$ | $R_1$: 1, 1, 1; |
| | | $R_2$: 1, -1, 1; |
| | | $R_3$: 1, -1, -1; |
| | \(R, AL\): $\sigma_{h}, T \sigma_{d1}$ | $\{R_1, R_2\}$: 2, $\sigma_3, -i\sigma_2$; |
| | | WNL; π |
SG 190-200

Γ; (000); \( C_3^+ \), \( C_{21}^0, C_2, I, T \); R₁: 1, 1, 1, 1, 1;
R₂: 1, −1, 1, 1, 1;
R₃: 2; \(-\frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, \sigma_0, \sigma_0, -\sigma_0\); P-QNL \( \Gamma_A \)
R₄: 1, 1, −1, 1, 1;
R₅: 1, −1, −1, 1, 1;
R₆: 2; \(-\frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, -\sigma_0, \sigma_0, -\sigma_0\); P-QNL \( \Gamma_A \)
R₇: 1, 1, 1, −1, 1;
R₈: 1, −1, 1, −1, 1;
R₉: 2; \(-\frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, \sigma_0, -\sigma_0, -\sigma_0\); P-QNL \( \Gamma_A \)
R₁₀: 1, 1, 1, −1, 1;
R₁₁: 1, −1, −1, −1, 1;
R₁₂: 2; \(-\frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, -\sigma_0, -\sigma_0, -\sigma_0\); P-QNL \( \Gamma_A \)

M; (0\( \frac{1}{2} \)0); \( C_2, C_{21}^0, I, T \);
R₁: 1, 1, 1, 1;
R₂: 1, −1, 1, 1;
R₃: 1, −1, 1, 1;
R₄: 1, −1, 1, 1;
R₅: 1, 1, −1, 1, 1;
R₆: 1, −1, −1, 1, 1;
R₇: 1, 1, 1, −1, 1;
R₈: 1, −1, −1, −1, 1;
R₉: 2; \(-\frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, \sigma_0, -\sigma_0, -\sigma_0\); P-QNL \( \Gamma_A \)
R₁₀: 1, 1, 1, −1, 1;
R₁₁: 1, −1, −1, −1, 1;
R₁₂: 2; \(-\frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, -\sigma_0, -\sigma_0, -\sigma_0\); P-QNL \( \Gamma_A \)

A; (00\( \frac{1}{2} \)); \( C_3^+ \), \( C_{21}^0, C_2, I, T \);
R₁: 1, 1, 1, 1, 1;
R₂: 1, −1, 1, 1, 1;
R₃: 2; \(-\frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, \sigma_0, \sigma_0, -\sigma_0\); P-QNL \( \Gamma_A \)
R₄: 1, 1, −1, 1, 1;
R₅: 1, 1, −1, 1, 1;
R₆: 2; \(-\frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, -\sigma_0, \sigma_0, -\sigma_0\); P-QNL \( \Gamma_A \)
R₇: 1, 1, 1, −1, 1;
R₈: 1, −1, 1, −1, 1;
R₉: 2; \(-\frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, \sigma_0, -\sigma_0, -\sigma_0\); P-QNL \( \Gamma_A \)
R₁₀: 1, 1, 1, −1, 1;
R₁₁: 1, −1, −1, −1, 1;
R₁₂: 2; \(-\frac{\alpha_0 - i\sqrt{3}\alpha_2}{2}, \sigma_3, -\sigma_0, -\sigma_0, -\sigma_0\); P-QNL \( \Gamma_A \)

L; (0\( \frac{1}{2} \)\( \frac{1}{2} \)); \( C_2, C_{21}^0, I, T \);
R₁: 1, 1, 1, 1;
R₂: 1, −1, 1, 1;
R₃: 1, −1, 1, 1;
R₄: 1, −1, −1, 1;
R₅: 1, 1, 1, −1, 1;
R₆: 1, −1, 1, −1, 1;
R₇: 1, −1, −1, −1, 1;
R₈: 1, −1, −1, −1, 1;
\[ K; \left( \frac{1}{2} \frac{2}{3} 0 \right); S_{21}^+, C_{21}^+, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2, -\frac{\sigma_0 - \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; P-WNL_{KH}; \]
\[ R_6; 2, \frac{\sigma_0 - \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; P-WNL_{KH}; \]
\[ H; \left( \frac{1}{2} \frac{1}{3} \frac{1}{3} \frac{2}{3} \right); S_{21}^+, C_{21}^+, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R_5; 2, -\frac{\sigma_0 - \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; P-WNL_{KH}; \]
\[ R_6; 2, \frac{\sigma_0 - \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; P-WNL_{KH}; \]
\[ \Delta; \Gamma A; C_{21}^+, \sigma_v, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 0; \]
\[ R_5; 2, -\frac{\sigma_0 - \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; QNL; \]
\[ R_6; 2, \sigma_0 - \sqrt{3} \sigma_2, \sigma_3, -\sigma_0; QNL; \]
\[ U; \Gamma L; C_2, \sigma_v, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ P; \Gamma H; C_{21}^+, \sigma_v, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ T; \Gamma K; C_{22}^+, \sigma_v, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ S; \Gamma H; C_{22}^+, \sigma_v, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ T'; \Gamma K; C_{21}^+, \sigma_v, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ S'; \Gamma H; C_{21}^+, \sigma_v, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ \Sigma; \Gamma M; C_{21}^+, \sigma_v, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ R; \Gamma L; C_{21}^+, \sigma_v, IT; R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, -1, 1; \]
\[ \Gamma _h; \{ C'_3 |000 \}, \{ C'_2 |000 \}, \{ C_2 |000 \}, \{ I |000 \}; T; \text{Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma; \ (000); \ C_3^+, C_{21}, C_2, I, T; & \quad R_3; \ 1; 1, 1, 1, 1; \\
R_2; & \quad 1; 1, -1, 1, 1; \\
R_1; & \quad 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_{GA} \\
R_1; & \quad 1; 1, -1, 1, 1; \\
R_0; & \quad 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_{GA} \\
R_7; & \quad 1; 1, 1, -1, 1; \\
R_6; & \quad 1; 1, -1, 1, 1; \\
R_5; & \quad 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_{GA} \\
R_4; & \quad 1; 1, 1, -1, 1; \\
R_3; & \quad 1; 1, -1, -1, 1; \\
R_2; & \quad 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_{GA} \\
R_1; & \quad 1; 1, -1, -1, 1; \\
\end{align*}
\]

\[
\begin{align*}
M; \ (0\frac{1}{2}0); \ C_2, C_{21}^\prime, I, T; & \quad R_5; \ 1; 1, 1, 1; \\
R_4; & \quad 1, -1, 1, 1; \\
R_3; & \quad 1, -1, 1, 1; \\
R_2; & \quad 1, -1, -1, 1; \\
R_1; & \quad 1, 1, -1, 1; \\
R_6; & \quad 1, -1, 1, 1; \\
R_7; & \quad 1, -1, -1, 1; \\
R_8; & \quad 1; 1, -1, -1, 1; \\
\end{align*}
\]

\[
\begin{align*}
A; \ (00\frac{1}{2}); \ \sigma_{d1}, C_3^+, \sigma_6, C_2, T; \ {\{ R_7, R_8 \}}; & \quad 4; -i\tilde{\Gamma}_{3,3}, -\frac{\gamma_{0,0} - i\sqrt{3}\gamma_{3,3}}{2}, \Gamma_{0,0}, \Gamma_{1,0}; \quad \text{QDP}; \quad 0 \\
R_9; & \quad 2; i\sigma_1, \sigma_0, -\sigma_0, \sigma_0, -i\sigma_3; \quad \text{P-WNLs} \\
\{ R_{16}, R_{17} \}; & \quad 4; -i\tilde{\Gamma}_{3,3}, -\frac{\gamma_{0,0} - i\sqrt{3}\gamma_{3,3}}{2}, \Gamma_{0,0}, -\Gamma_{0,0}, \Gamma_{1,0}; \quad \text{QDP}; \quad 0 \\
R_{18}; & \quad 2; i\sigma_1, \sigma_0, -\sigma_0, \sigma_0, -i\sigma_3; \quad \text{P-WNLs} \\
R_{19}; & \quad 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNLs} \\
R_{20}; & \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs} \\
\end{align*}
\]

\[
\begin{align*}
L; \ (0\frac{1}{2}\frac{1}{2}); \ \sigma_{v1}, I, C_2, T; & \quad R_5; \ 1; 1, 1, 1; \\
R_4; & \quad 1, -1, 1; \\
R_3; & \quad 1, -1, 1; \\
R_2; & \quad 1, 1, -1; \\
R_1; & \quad 1; 1, -1, 1; \\
\end{align*}
\]

\[
\begin{align*}
K; \ (\frac{1}{3}\frac{1}{3}0); \ S_3^+, C_{21}^\prime, I, T; & \quad R_5; \ 1; 1, 1, 1; \\
R_4; & \quad 1, -1, 1; \\
R_3; & \quad 1, -1, 1; \\
R_2; & \quad 1, 1, -1; \\
R_1; & \quad 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNL}_{KH} \\
R_0; & \quad 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-WNL}_{KH} \\
\end{align*}
\]

\[
\begin{align*}
H; \ (\frac{1}{3}\frac{1}{3}\frac{1}{3}); \ \sigma_{d1}, C_3^+, \sigma_6, I, T; \ {\{ R_7, R_8 \}}; & \quad 4; -i\Gamma_{0,1}, -\frac{\gamma_{0,0} - i\sqrt{3}\gamma_{3,3}}{2}, \Gamma_{0,0}, \Gamma_{1,0}; \quad \text{DP}; \quad 0 \\
R_9; & \quad 2; i\sigma_1, \sigma_0, \sigma_0, -\sigma_0; \quad \text{P-WNLs} \\
\end{align*}
\]

\[
\begin{align*}
\Delta; \ \Gamma A; \ C_6^+, \sigma_{v1}, I, T; & \quad R_5; \ 1; 1, 1, 1; \\
R_4; & \quad 1, -1, 1; \\
R_3; & \quad 1, -1, 1; \\
R_2; & \quad 1, 1, -1; \\
R_1; & \quad 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{QNL}; \quad 0 \\
R_0; & \quad 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{QNL}; \quad 0 \\
\end{align*}
\]

\[
\begin{align*}
U; \ ML; \ C_2, \sigma_{v1}, I, T; & \quad R_5; \ 1; 1, 1, 1; \\
R_4; & \quad 1, -1, 1; \\
R_3; & \quad 1, -1, 1; \\
R_2; & \quad 1, 1, -1; \\
R_1; & \quad 1; 1, -1, 1; \\
\end{align*}
\]
P; KH; $C_3^{+} \sigma_{d1, IT}; R_1; 1, 1, 1;
R_2; 1, 1, \sigma_1, \sigma_3, \sigma_0; WNL; \pi$

$T; \Gamma K; C_{22}^{\nu} \sigma_{d1, IT}; R_1; 1, 1, 1,
R_2; 1, 1, \sigma_3, \sigma_0; WNL; \pi$

$S; \Lambda H; C_{22}^{\nu} \sigma_{h, IT}; R_1; 1, 1, 1,
R_2; 1, 1, \sigma_3, \sigma_0; WNL; \pi$

$T'; MK; C_{21}^{\nu} \sigma_{d1, IT}; R_1; 1, 1, 1,
R_2; 1, 1, \sigma_3, \sigma_0; WNL; \pi$

$S'; LH; C_{21}^{\nu} \sigma_{h, IT}; R_1; 1, 1, 1,
R_2; 1, 1, \sigma_3, \sigma_0; WNL; \pi$

$\Sigma; \Gamma M; C_{21}^{\nu} \sigma_{\nu, IT}; R_1; 1, 1, 1,
R_2; 1, 1, \sigma_3, \sigma_0; WNL; \pi$

$R; AL; C_{21}^{\nu} \sigma_{h, IT}; R_1; 1, 1, 1,
R_2; 1, 1, \sigma_3, \sigma_0; WNL; \pi$
\[ \Gamma_h; \{C_3^+|000\}, \{C_2^+|000\}, \{C_2|00\^\perp\}, \{I|000\}; T; \text{Centrosymmetric; without SOC} \]

\[
\begin{align*}
\Gamma: & \quad (000); \quad C_3^+ , C_{21}^+ , C_{21} , I , T; \\
R_1: & \quad 1, 1, 1, 1, 1; \\
R_2: & \quad 1, 1, -1, 1, 1; \\
R_3: & \quad \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_\Gamma \\
R_4: & \quad 1, 1, 1, -1, 1; \\
R_5: & \quad 1, 1, -1, 1, 1; \\
R_6: & \quad \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_\Gamma \\
R_7: & \quad 1, 1, 1, -1, 1; \\
R_8: & \quad 1, 1, -1, -1, 1; \\
R_9: & \quad 2; \quad \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-QNL}_\Gamma \\
R_{10}: & \quad 1, 1, -1, -1, 1; \\
R_{11}: & \quad 1, 1, 1, -1, 1; \\
R_{12}: & \quad 2; \quad \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-QNL}_\Gamma \\
\end{align*}
\]

\[
M: (0\frac{\sqrt{3}}{2}0); \quad C_2 , C_{21}^\perp , I , T; \\
R_1: & \quad 1, 1, 1, 1; \\
R_2: & \quad -1, 1, 1, 1; \\
R_3: & \quad 1, -1, 1, 1; \\
R_4: & \quad 1, -1, 1, 1; \\
R_5: & \quad 1, 1, -1, 1; \\
R_6: & \quad 1, -1, -1, 1; \\
R_7: & \quad 1, -1, 1, 1; \\
R_8: & \quad 1, -1, -1, 1; \\
A: (0\frac{\sqrt{3}}{2}); \quad C_6^+ , C_{21}^+ , I , T; \\
R_{13}: & \quad 2; \quad i\sigma_3, \sigma_1, \sigma_1, -i\sigma_1; \quad \text{P-NS}_\text{ALH} \\
R_{14}: & \quad 2; \quad i\sigma_3, \sigma_1, -\sigma_1, -i\sigma_1; \quad \text{P-NS}_\text{ALH} \\
R_{15}: & \quad 4; \quad \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \Gamma_0, \Gamma_1, \Gamma_1, -\Gamma_0; \quad \text{QDP}; \quad 0 \\
L: (0\frac{\sqrt{2}}{2}); \quad C_2 , I , \sigma_{d1} , T; \\
R_5: & \quad 2; \quad i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-NS}_\text{ALH} \\
R_{18}: & \quad 2; \quad i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-NS}_\text{ALH} \\
K: (0\frac{\sqrt{2}}{2}); \quad S_3^+ , C_{21}^\perp , I , T; \\
R_1: & \quad 1, 1, 1; \\
R_2: & \quad 1, -1, 1; \\
R_3: & \quad 1, -1, 1; \\
R_4: & \quad 1, -1, -1; \\
R_5: & \quad 2; \quad \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-WNL}_\text{KH} \\
R_6: & \quad 2; \quad \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{P-WNL}_\text{KH} \\
H: (0\frac{\sqrt{3}}{2}); \quad S_3^+ , C_{21}^\perp , I , T; \\
\{R_1, R_4\}: & \quad 2; \quad \sigma_3, \sigma_3, \sigma_3; \quad \text{P-NS}_\text{ALH} \\
\{R_2, R_3\}: & \quad 2; \quad \sigma_3, -\sigma_3, \sigma_3; \quad \text{P-NS}_\text{ALH} \\
\{R_5, R_6\}: & \quad 4; \quad \frac{-\Gamma_3, 3, 0 - i\sqrt{3}\Gamma_3, 3, 2}{2}, \Gamma_3, 3, 3, \Gamma_1, 0; \quad \text{DP}; \quad 0 \\
\Delta: \quad \Gamma_A; \quad C_6^+ , \sigma_{e1} , I , T; \\
R_1: & \quad 1, 1, 1, 1; \\
R_2: & \quad 1, 1, -1, 1; \\
R_3: & \quad 1, 1, 1, 1; \\
R_4: & \quad 1, -1, 1, 1; \\
R_5: & \quad 2; \quad \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{QNL}; \quad 0 \\
R_6: & \quad 2; \quad \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{QNL}; \quad 0 \\
U: \quad \text{ML}; \quad C_2 , \sigma_{e1} , I , T; \\
R_1: & \quad 1, 1, 1, 1; \\
R_2: & \quad 1, 1, -1, 1; \\
R_3: & \quad 1, 1, 1, 1; \\
R_4: & \quad 1, 1, -1, 1;
\[ P: \text{KH; } C_{3}^{+}, \sigma_{d1}, IT; \ R_{1}; \quad 1, 1, 1; \]
\[ R_{2}; \quad 1, -1, 1; \]
\[ R_{3}; \quad 2; \left( -\sigma_{0} - i\sqrt{3}\sigma_{2} \right), \sigma_{3}, -\sigma_{0}; \text{ WNL; } \pi \]
\[ T: \text{ΓK; } C_{22}^{+}, \sigma_{d2}, IT; \ R_{1}; \quad 1, 1, 1; \]
\[ R_{2}; \quad 1, -1, 1; \]
\[ R_{3}; \quad 1, -1, 1; \]
\[ R_{4}; \quad 1, -1, 1; \]
\[ S: \text{AH; } C_{22}^{+}, \sigma_{d2}, IT; \ R_{1}; \quad 1, 1, 1; \]
\[ \{ R_{2}, R_{4} \}; \quad 2; \sigma_{3}, \sigma_{0}, \sigma_{1}; \text{ L-NS}_{\text{ALH}}; \]
\[ \{ R_{6}, R_{8} \}; \quad 2; \sigma_{3}, -\sigma_{0}, \sigma_{1}; \text{ L-NS}_{\text{ALH}}; \]
\[ T': \text{MK; } C_{21}^{+}, \sigma_{d1}, IT; \ R_{1}; \quad 1, 1, 1; \]
\[ R_{2}; \quad 1, -1, 1; \]
\[ R_{3}; \quad 1, -1, 1; \]
\[ R_{4}; \quad 1, -1, 1; \]
\[ S': \text{LH; } C_{21}^{+}, \sigma_{d1}, IT; \ R_{1}; \quad 1, 1, 1; \]
\[ \{ R_{2}, R_{4} \}; \quad 2; \sigma_{3}, \sigma_{0}, \sigma_{1}; \text{ L-NS}_{\text{ALH}}; \]
\[ \{ R_{6}, R_{8} \}; \quad 2; \sigma_{3}, -\sigma_{0}, \sigma_{1}; \text{ L-NS}_{\text{ALH}}; \]
\[ \Sigma: \text{ΓM; } C_{21}^{+}, \sigma_{e1}, IT; \ R_{1}; \quad 1, 1, 1; \]
\[ R_{2}; \quad 1, -1, 1; \]
\[ R_{3}; \quad 1, -1, 1; \]
\[ R_{4}; \quad 1, -1, 1; \]
\[ R: \text{AL; } \sigma_{h}, C_{21}^{+}, IT; \ R_{5}; \quad 2; \sigma_{2}, \sigma_{3}, -\sigma_{0}; \text{ L-NS}_{\text{ALH}}; \]
| Group | Plane | Transformations |
|-------|-------|----------------|
| \( \Gamma \) | \( (000) \) | \( C_3^+, C_{21}^+, C_2I, I, T \) |
| \( R_1 \) | 1 | 1, 1, 1, 1, 1 |
| \( R_2 \) | 1 | -1, 1, 1, 1, 1 |
| \( R_3 \) | 2 | \( -\sigma_0 - i\sqrt{3}\sigma_2 \), \( \sigma_3, \sigma_0, \sigma_0, -\sigma_0 \) |
| \( R_4 \) | 1 | 1, 1, -1, 1, 1 |
| \( R_5 \) | 1 | 1, -1, 1, 1, 1 |
| \( R_6 \) | 2 | \( -\sigma_0 - i\sqrt{3}\sigma_2 \), \( \sigma_3, \sigma_0, \sigma_0, -\sigma_0 \) |
| \( R_7 \) | 1 | 1, 1, 1, -1, 1 |
| \( R_8 \) | 1 | 1, -1, 1, -1, 1 |
| \( R_9 \) | 2 | \( -\sigma_0 - i\sqrt{3}\sigma_2 \), \( \sigma_3, \sigma_0, -\sigma_0, -\sigma_0 \) |
| \( R_{10} \) | 1 | 1, 1, -1, -1, 1 |
| \( R_{11} \) | 1 | 1, -1, 1, -1, 1 |
| \( R_{12} \) | 2 | \( -\sigma_0 - i\sqrt{3}\sigma_2 \), \( \sigma_3, \sigma_0, -\sigma_0, -\sigma_0 \) |

| Group | Plane | Transformations |
|-------|-------|----------------|
| \( \Gamma \) | \( \frac{1}{2}0 \) | \( C_2^+, C_{21}^+, C_2I, I, T \) |
| \( R_1 \) | 1 | 1, 1, 1, 1 |
| \( R_2 \) | 1 | -1, 1, 1, 1 |
| \( R_3 \) | 1 | 1, -1, 1, 1 |
| \( R_4 \) | 1 | -1, -1, 1, 1 |
| \( R_5 \) | 1 | 1, 1, -1, 1 |
| \( R_6 \) | 1 | -1, 1, -1, 1 |
| \( R_7 \) | 1 | 1, -1, -1, 1 |
| \( R_8 \) | 1 | -1, -1, -1, 1 |

| Group | Plane | Transformations |
|-------|-------|----------------|
| \( A \) | \( \frac{1}{2}0 \) | \( C_6^+, C_{21}^+, C_2I, I, T \) |
| \( R_{13} \) | 2 | \( i\sigma_3, \sigma_1, \sigma_1, -i\sigma_1 \) |
| \( R_{14} \) | 2 | \( i\sigma_3, \sigma_1, -\sigma_1, -i\sigma_1 \) |
| \( R_{15} \) | 4 | \( \sqrt{\frac{3}{2}}\Gamma_0, \tau_{0,3}, \Gamma_0, \Gamma_0, -\Gamma_0, \Gamma_0 \) |

| Group | Plane | Transformations |
|-------|-------|----------------|
| \( L \) | \( \frac{1}{2}0 \) | \( C_2I, \sigma_1, I, T \) |
| \( R_5 \) | 2 | \( -i\sigma_2, \sigma_3, \sigma_0, -\sigma_0 \) |
| \( R_{10} \) | 2 | \( i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0 \) |

| Group | Plane | Transformations |
|-------|-------|----------------|
| \( K \) | \( \frac{1}{3}0 \) | \( S_3^+, C_{21}^+, I, T \) |
| \( R_1 \) | 1 | 1, 1, 1 |
| \( R_2 \) | 1 | -1, 1, 1 |
| \( R_3 \) | 1 | -1, 1, 1 |
| \( R_4 \) | 1 | -1, -1, 1 |
| \( R_5 \) | 2 | \( -\sigma_0 - i\sqrt{3}\sigma_2 \), \( \sigma_3, -\sigma_0 \) |
| \( R_6 \) | 2 | \( -\sigma_0 - i\sqrt{3}\sigma_2 \), \( \sigma_3, -\sigma_0 \) |
| \( H \) | \( \frac{1}{3}0 \) | \( \sigma_1, C_{21}^+, \sigma_0 I, T \) |
| \( R_7 \) | 2 | \( -i\sigma_1, \sigma_3, -\sigma_0 \) |
| \( R_8 \) | 2 | \( i\sigma_1, \sigma_3, -\sigma_0 \) |
| \( R_9 \) | 2 | \( i\sigma_1, \sigma_0, \sigma_3, -\sigma_1 \) |

| Group | Plane | Transformations |
|-------|-------|----------------|
| \( \Delta \) | \( \Gamma A \) | \( C_6^+, \sigma_1, I, T \) |
| \( R_1 \) | 1 | 1, 1, 1 |
| \( R_2 \) | 1 | -1, 1, 1 |
| \( R_3 \) | 1 | -1, 1, 1 |
| \( R_4 \) | 1 | -1, -1, 1 |
| \( R_5 \) | 2 | \( -\sigma_0 - i\sqrt{3}\sigma_2 \), \( \sigma_3, -\sigma_0 \) |
| \( R_6 \) | 2 | \( -\sigma_0 - i\sqrt{3}\sigma_2 \), \( \sigma_3, -\sigma_0 \) |

| Group | Plane | Transformations |
|-------|-------|----------------|
| \( U \) | \( ML \) | \( C_2I, \sigma_1, I, T \) |
| \( R_1 \) | 1 | 1, 1, 1 |
| \( R_2 \) | 1 | -1, 1, 1 |
| \( R_3 \) | 1 | -1, 1, 1 |
| \( R_4 \) | 1 | -1, -1, 1 |
\[
\begin{align*}
&\quad P; \text{KH}; \quad C_3^+; \sigma_{d1}; IT; \quad R_1; \quad 1; 1,1,1; \\
&\quad R_2; \quad 1; 1,-1,1; \\
&\quad R_3; \quad 2; \frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -\sigma_0; \quad \text{WNL}; \quad \pi \\
&\quad T; \text{\Gamma K}; \quad C_{22}^+; \sigma_{d2}; IT; \quad R_1; \quad 1; 1,1,1; \\
&\quad R_2; \quad 1; 1,-1,1; \\
&\quad R_3; \quad 1; -1,1,1; \\
&\quad R_4; \quad 1; -1,-1,1; \\
&\quad S; \text{\Lambda H}; \quad \sigma_h; C_{22}^+; IT; \quad R_5; \quad 2; \sigma_2, \sigma_3, -\sigma_0; \quad \text{L-NS}_{\text{ALH}}; \\
&\quad T'; \text{\Phi K}; \quad C_{21}^+; \sigma_{d3}; IT; \quad R_1; \quad 1; 1,1,1; \\
&\quad R_2; \quad 1; 1,-1,1; \\
&\quad R_3; \quad 1; -1,1,1; \\
&\quad R_4; \quad 1; -1,-1,1; \\
&\quad S'; \text{\Lambda H}; \quad \sigma_h; C_{21}^+; IT; \quad R_5; \quad 2; \sigma_2, \sigma_3, -\sigma_0; \quad \text{L-NS}_{\text{ALH}}; \\
&\quad \Sigma; \text{\Gamma M}; \quad C_{21}^+; \sigma_{v1}; IT; \quad R_1; \quad 1; 1,1,1; \\
&\quad R_2; \quad 1; 1,-1,1; \\
&\quad R_3; \quad 1; -1,1,1; \\
&\quad R_4; \quad 1; -1,-1,1; \\
&\quad R; \text{\Lambda L}; \quad \sigma_h; \sigma_{v1}; IT; \quad \{R_2, R_4\}; \quad 2; \sigma_3, \sigma_0, \sigma_1; \quad \text{L-NS}_{\text{ALH}}; \\
&\quad \quad \{R_6, R_8\}; \quad 2; \sigma_3, -\sigma_0, \sigma_1; \quad \text{L-NS}_{\text{ALH}}; 
\end{align*}
\]
\[ \Gamma_c; \{ C_{31}^+ | 000 \}, \{ C_{2z} | 000 \}, \{ C_{2y} | 000 \}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\begin{align*}
\Gamma &: \ (000); \quad C_{31}^+, C_{2z}, C_{2y}, \mathcal{T}; \quad R_1; \quad 1, 1, 1, 1; \\
& \quad \{ R_2, R_3 \}; \quad 2; \quad -\frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \quad \text{C-4 WP}; \quad 4 \\
& \quad R_4; \quad 3; \quad A_9, -\frac{A_0 + 2\sqrt{3}A_8}{3}, A_{10}, -\frac{i(\sqrt{3} - i)A_0}{2}; \quad \text{C-2 TP}; \quad 2 \\
X &: \ (0 \frac{1}{2} 0); \quad C_{2z}, C_{2y}, \mathcal{T}; \quad R_1; \quad 1, 1, 1, 1; \\
& \quad R_2; \quad 1, 1, -1, 1; \\
& \quad R_3; \quad 1, -1, 1, 1; \\
& \quad R_4; \quad 1, -1, -1, 1; \\
M &: \ (\frac{1}{3} \frac{1}{2} 0); \quad C_{2z}, C_{2y}, \mathcal{T}; \quad R_1; \quad 1, 1, 1, 1; \\
& \quad R_2; \quad 1, -1, 1, 1; \\
& \quad R_3; \quad 1, -1, 1, 1; \\
& \quad R_4; \quad 1, -1, -1, 1; \\
R &: \ (\frac{1}{3} \frac{1}{2} \frac{1}{2}); \quad C_{31}^+, C_{2z}, C_{2y}, \mathcal{T}; \quad R_1; \quad 1, 1, 1, 1; \\
& \quad \{ R_2, R_3 \}; \quad 2; \quad -\frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \quad \text{C-4 WP}; \quad 4 \\
& \quad R_4; \quad 3; \quad A_9, -\frac{A_0 + 2\sqrt{3}A_8}{3}, A_{10}, -\frac{i(\sqrt{3} - i)A_0}{2}; \quad \text{C-2 TP}; \quad 2 \\
\Delta &: \ \Gamma X; \quad C_{2y}, \mathcal{T} C_{2z}; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, -1, 1; \\
\Sigma &: \ \Gamma M; \quad E, \mathcal{T} C_{2z}; \quad R_1; \quad 1, 1; \\
\Lambda &: \ \Gamma R; \quad C_{31}^+; \quad R_1; \quad 1, 1; \\
& \quad R_2; \quad 1, (-1)^{2/3}; \\
& \quad R_3; \quad 1, -\frac{1}{\sqrt{3}}; \\
S &: \ \pi X R; \quad E, \mathcal{T} C_{2y}; \quad R_1; \quad 1, 1, 1; \\
Z &: \ \pi X M; \quad C_{2z}, \mathcal{T} C_{2z}; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, -1, 1; \\
T &: \ \pi M R; \quad C_{2z}, \mathcal{T} C_{2z}; \quad R_1; \quad 1, 1, 1; \\
& \quad R_2; \quad 1, -1, 1; \\
\end{align*}
\( \Gamma \): (000); \( C_{31}^+, C_{2x}, C_{2y}, T \);

\( \Gamma \): (000); \( C_{31}^+, C_{2x}, C_{2y}, T \);

\( R_1 \): 1; 1,1,1,1;

\[ \{ R_2, R_3 \}; \frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \]

\( \Delta \): \( \Gamma \); 2; C-4 WP; 4

\( X \): (\( \frac{1}{2}0\frac{1}{2} \)); \( C_{2x}, C_{2y}, T \);

\( R_1 \): 1; 1,1,1;

\( R_2 \); 1; 1,1,1;

\( R_3 \): 1; -1,1,1;

\( R_4 \): 1; -1,1,1;

\( \Lambda \): \( \Gamma \);

\( \{ R_2, R_3 \}; \frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0; \]

\( \Sigma \): \( \Gamma \); (000);

\( S \): \( \Gamma \); 1; 1,1;

\( Z \): \( \Gamma \); (000);

\( Q \): \( \Gamma \); 1; 1;
\[
\begin{align*}
\Gamma; \quad (000): & \quad C_{31}^+, C_{2x}, C_{2y}, T; \quad R_1: 1, 1, 1, 1; \\
& \quad \{R_2, R_3\}: 2; -\frac{\sigma_0 + i\sqrt{3} \sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \quad C-4 \ WP; 4 \\
& \quad R_4: 3; A_0, -\frac{A_0 + 2\sqrt{3} A_8}{3}, A_{10}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad C-2 \ TP; 2 \\
H; \quad \left(\frac{1}{2} \frac{1}{2} \frac{1}{2}\right): & \quad C_{31}^+, C_{2x}, C_{2y}, T; \quad R_1: 1, 1, 1, 1; \\
& \quad \{R_2, R_3\}: 2; -\frac{\sigma_0 + i\sqrt{3} \sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \quad C-4 \ WP; 4 \\
& \quad R_4: 3; A_0, -\frac{A_0 + 2\sqrt{3} A_8}{3}, A_{10}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad C-2 \ TP; 2 \\
P; \quad \left(\frac{1}{4} \frac{1}{4} \frac{1}{4}\right): & \quad C_{31}^+, C_{2x}, C_{2y}; \quad R_1: 1, 1, 1; \\
& \quad R_2: 1; (-1)^{2/3}, 1, 1; \\
& \quad R_3: 1; -\frac{1}{\sqrt{3}}1, 1, 1; \\
& \quad R_4: 3; A_0, -\frac{A_0}{3} - \frac{2A_8}{\sqrt{3}}, A_{10}; \quad C-2 \ TP; 2 \\
N; \quad (00 \frac{1}{2}): & \quad C_{2x}, T; \quad R_1: 1, 1, 1; \\
& \quad R_2: 1; -1, 1; \\
\Sigma; \quad \Gamma N; & \quad E TC_{2x}; \quad R_1: 1, 1, 1; \\
\Delta; \quad \Gamma H; & \quad C_{2y}, TC_{2x}; \quad R_1: 1, 1, 1; \\
& \quad R_2: 1; -1, 1; \\
\Lambda; \quad \Gamma P; & \quad C_{31}^+; \quad R_1: 1; 1; \\
& \quad R_2: 1; (-1)^{2/3}; \\
& \quad R_3: 1; -\frac{1}{\sqrt{3}}1; \\
D; \quad NP; & \quad C_{2x}; \quad R_1: 1; 1; \\
& \quad R_2: 1; -1; \\
G; \quad \Gamma N; & \quad E TC_{2x}; \quad R_1: 1, 1, 1; \\
F; \quad \Gamma H; & \quad C_{34}^+; \quad R_1: 1; 1; \\
& \quad R_2: 1; (-1)^{2/3}; \\
& \quad R_3: 1; -\frac{1}{\sqrt{3}}1; 
\end{align*}
\]
\[ \Gamma_c; \{ C_{31}^+ |000 \}, \{ C_{2z} | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ C_{2y} |0 \frac{1}{2} \frac{1}{2} \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; (000); C_{31}^+, C_{2z}, C_{2y}, T; R_1; 1, 1, 1, 1; \{ R_2, R_3 \}; 2; -\frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}, \sigma_0, \sigma_0, \sigma_1; C-4 \text{ WP}; 4 \]

\[ R_4; 3; A_9 - \frac{A_0 + 2 \sqrt{3} A_8}{3}, A_{10}, -i \frac{(\sqrt{3}-i) A_0}{2}; C-2 \text{ TP}; 2 \]

\[ X; (0 \frac{1}{2} 0); C_{2y}, C_{2z}, T; R_5; 2; i \sigma_2, \sigma_3, -\sigma_0; \]

\[ M; (\frac{1}{2} \frac{1}{2} 0); C_{2y}, C_{2z}, T; \{ R_2, R_4 \}; 2; i \sigma_3, \sigma_0, \sigma_1; P-\text{NS} ; \]

\[ \{ R_6, R_8 \}; 2; i \sigma_3, -\sigma_0, \sigma_1; P-\text{NS} ; \]

\[ R; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{31}^-, C_{2x}, C_{2y}, T; \{ R_4, R_4 \}; 4; \Gamma_27, -i \Gamma_{0,1}, i \Gamma_{0,2}, -\Gamma_{2,2}; \]

\[ \{ R_5, R_6 \}; 4; \Gamma_{11,1}, -i \Gamma_{3,1}, i \Gamma_{0,2}, \Gamma_{1,0}; C-2 \text{ DP}; 2 \]

\[ \Delta; \Gamma X; C_{2y}, TC_{2z}; R_1; 1, 1, 1; R_2; 1; -1, 1; \]

\[ \Sigma; \Gamma M; E, TC_{2z}; R_1; 1, 1, 1; \]

\[ \Lambda; \Gamma R; C_{31}^+; R_1; 1, 1; R_2; 1; (-1)^{2/3}; R_3; 1; -\sqrt{3}; \]

\[ S; XR; E, TC_{2y}; \{ R_1, R_1 \}; 2 \sigma_0, -i \sigma_2; L-\text{NS}_{XMR}; \]

\[ Z; XM; C_{2x}, TC_{2z}; \{ R_2, R_2 \}; 2 \sigma_3, \sigma_1; L-\text{NS}_{XMR}; \]

\[ T; MR; C_{2z}, TC_{2z}; \{ R_2, R_2 \}; 2 \sigma_0, -i \sigma_2; L-\text{NS}_{XMR}; \]

\[ \{ R_4, R_4 \}; 2; -\sigma_0, -i \sigma_2; L-\text{NS}_{XMR}; \]
Γ; \{C_{31}^+, \{C_{2z}, 1/2 \}, \{C_{2y}|0 \}, \}; T; Non-Centrosymmetric; without SOC

Γ; (000); \{C_{31}^+, C_{2z}, C_{2y}, T\}; R_1; 1; 1, 1, 1;
\{R_2, R_3\}; 2; -\sigma_0 + i\sqrt{3}\sigma_3, \sigma_0, \sigma_0, \sigma_1; C-4 WP; 4
R_4; 3; A_0, -\frac{A_0 + 2\sqrt{3}A_8}{3}, A_{10}, -\frac{i(\sqrt{3}-1)A_0}{2}; C-2 TP; 2

H; \{\frac{1}{2} \}; \{C_{31}^-, C_{2z}, C_{2y}, T\}; R_4; 1; -1, -1, -1, 1;
\{R_3, R_5\}; 2; \frac{\sigma_0 - i\sqrt{3}\sigma_3}{2}, -\sigma_0, -\sigma_0, \sigma_1; C-4 WP; 4
R_8; 3; -A_0, -A_{13}, \frac{A_0 + 2\sqrt{3}A_8}{3}, -\frac{i(\sqrt{3}-1)A_0}{2}; C-2 TP; 2

P; \{\frac{1}{4} \}; \{C_{31}^+, C_{2z}, C_{2y}\}; R_7; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_21, \sigma_22; C-1 WP; 1
R_6; 2; \sigma_{16}, \sigma_{21}, \sigma_{22}; C-1 WP; 1
R_9; 2; \sigma_{19}, \sigma_{21}, \sigma_{22}; C-1 WP; 1

N; (00 \frac{1}{2}); \{C_{2z}, T\}; R_1; 1; 1, 1;
R_2; 1; -1, 1;

Σ; ΓN; \{E, TC_{2z}\}; R_1; 1; 1, 1;
R_2; 1; -1, 1;

Δ; ΓH; \{C_{2y}, TC_{2z}\}; R_1; 1; 1, 1;
R_2; 1; -1, 1;

Λ; ΓP; \{C_{31}^+, \}; R_1; 1; 1;
R_2; 1; (-1)^{2/3};
R_3; 1; -\sqrt{3};

D; NP; \{C_{2z}\}; R_2; 1; 1;
R_4; 1; -1;

G; HN; \{E, TC_{2z}\}; R_1; 1; 1, 1;

F; PH; \{C_{34}^+, \}; R_2; 1; -(-1)^{3/6};
R_4; 1; i;
R_6; 1; -\sqrt{3};
Γ; (000); $S^{+}_{y01},C_{2x},C_{2y},\mathcal{T}$; $R_{1}$; 1, 1, 1, 1; $\{R_{2},R_{3}\}$; 2; $-\frac{-\sigma_{0}+i\sqrt{3}\sigma_{0}}{2},\sigma_{0},\sigma_{0},\sigma_{1}$; P-WNL\textsubscript{PR}; $R_{4}$; 3; $A_{11}, -\frac{\Lambda_{0}+2\sqrt{3}\Lambda_{0}}{3}, A_{10}, -\frac{i(\sqrt{3}+1)\Lambda_{0}}{2}$; QCTP; 0 $R_{5}$; 1; -1, 1, 1, 1; $\{R_{6},R_{7}\}$; 2; $\frac{\sigma_{0}+i\sqrt{3}\sigma_{0}}{2},\sigma_{0},\sigma_{0},\sigma_{1}$; P-WNL\textsubscript{PR}; $R_{8}$; 3; $-A_{11}, -\frac{\Lambda_{0}+2\sqrt{3}\Lambda_{0}}{3}, A_{10}, -\frac{i(\sqrt{3}-1)\Lambda_{0}}{2}$; QCTP; 0

X; (0$\frac{1}{2}$0); $C_{2x},C_{2y},I,\mathcal{T}$; $R_{1}$; 1, 1, 1, 1; $R_{2}$; 1; -1, 1, 1, 1; $R_{3}$; 1; 1, -1, 1, 1; $R_{4}$; 1; -1, -1, 1, 1; $R_{5}$; 1; 1, 1, -1, 1; $R_{6}$; 1; -1, 1, -1, 1; $R_{7}$; 1; 1, 1, -1, 1; $R_{8}$; 1; -1, -1, -1, 1;

M; ($\frac{1}{2}$10); $C_{2x},C_{2y},I,\mathcal{T}$; $R_{1}$; 1, 1, 1, 1; $R_{2}$; 1; -1, 1, 1, 1; $R_{3}$; 1; 1, -1, 1, 1; $R_{4}$; 1; -1, -1, 1, 1; $R_{5}$; 1; 1, 1, -1, 1; $R_{6}$; 1; -1, 1, -1, 1; $R_{7}$; 1; 1, 1, -1, 1; $R_{8}$; 1; -1, -1, -1, 1;

R; ($\frac{1}{2}$1$\frac{1}{2}$1); $S^{+}_{y01},C_{2x},C_{2y},\mathcal{T}$; $R_{1}$; 1, 1, 1, 1; $\{R_{2},R_{3}\}$; 2; $\frac{-\sigma_{0}+i\sqrt{3}\sigma_{0}}{2},\sigma_{0},\sigma_{0},\sigma_{1}$; P-WNL\textsubscript{PR}; $R_{4}$; 3; $A_{11}, -\frac{\Lambda_{0}+2\sqrt{3}\Lambda_{0}}{3}, A_{10}, -\frac{i(\sqrt{3}-1)\Lambda_{0}}{2}$; QCTP; 0 $R_{5}$; 1; -1, 1, 1, 1; $\{R_{6},R_{7}\}$; 2; $\frac{\sigma_{0}+i\sqrt{3}\sigma_{0}}{2},\sigma_{0},\sigma_{0},\sigma_{1}$; P-WNL\textsubscript{PR}; $R_{8}$; 3; $-A_{11}, -\frac{\Lambda_{0}+2\sqrt{3}\Lambda_{0}}{3}, A_{10}, -\frac{i(\sqrt{3}+1)\Lambda_{0}}{2}$; QCTP; 0

Δ; ΓX; $C_{2y},\sigma_{x},I,\mathcal{T}$; $R_{1}$; 1, 1, 1, 1; $R_{2}$; 1; 1, -1, 1; $R_{3}$; 1; -1, 1, 1; $R_{4}$; 1; -1, -1, 1;

Σ; ΓM; $\sigma_{z},I,\mathcal{T}$; $R_{1}$; 1, 1, 1; $R_{2}$; 1; -1, 1;

Λ; ΓR; $C_{3y}^{+},I,\mathcal{T}$; $R_{1}$; 1, 1, 1; $\{R_{2},R_{3}\}$; 2; $\frac{1}{2}(\sigma_{0}+i\sqrt{3}\sigma_{0}),\sigma_{1}$; WNL; $\pi$

S; XR; $\sigma_{y},I,\mathcal{T}$; $R_{1}$; 1, 1, 1; $R_{2}$; 1; -1, 1;

Z; XM; $C_{2x},\sigma_{z},I,\mathcal{T}$; $R_{1}$; 1, 1, 1, 1; $R_{2}$; 1; -1, 1, 1; $R_{3}$; 1; -1, 1, 1; $R_{4}$; 1; -1, -1, 1;

T; MR; $C_{2y},\sigma_{y},I,\mathcal{T}$; $R_{1}$; 1, 1, 1, 1; $R_{2}$; 1; -1, 1, 1; $R_{3}$; 1; -1, 1, 1; $R_{4}$; 1; -1, -1, 1;
SG 201

Γc; \{S^±_{61}|\frac{1}{2} \frac{1}{2} \frac{1}{2}\}, \{C_{2z}|000\}, \{C_{2y}|000\}, T; Centrosymmetric; without SOC

Γ; (000); \ S^+_6{1},C_{2z},C_{2y},T; R_1; 1; 1,1,1,1;
\{R_2,R_3\}; 2; \frac{-\alpha_0-i\alpha_3\sqrt{3}a}{2}, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNL}_\Gamma;\Gamma_R;
R_4; 3; A_{11}, -\frac{A_0+2\sqrt{3}A_2}{3}, A_{10}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad \text{QCTP}; 0
R_5; 1; 1,1,1,1;
\{R_6,R_7\}; 2; \frac{\sigma_0+i\alpha_3\sqrt{3}a}{2}, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNL}_\Gamma;\Gamma_R;
R_8; 3; -A_{11}, -\frac{A_0+2\sqrt{3}A_2}{3}, A_{10}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad \text{QCTP}; 0

X; (0\frac{1}{2}0); \sigma_x,\sigma_y,C_{2y},T; R_5; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNLs};
R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs};
M; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \sigma_x,\sigma_z,C_{2z},T; R_5; 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-WNLs};
R_{10}; 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs};

R; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ S^+_6{1},C_{2z},C_{2y},T; R_1; 1; 1,1,1,1;
\{R_2,R_3\}; 2; \frac{-\alpha_0-i\alpha_3\sqrt{3}a}{2}, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNL}_\Gamma;\Gamma_R;
R_4; 3; A_{11}, -\frac{A_0+2\sqrt{3}A_2}{3}, A_{10}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad \text{QCTP}; 0
R_5; 1; 1,1,1,1;
\{R_6,R_7\}; 2; \frac{\sigma_0+i\alpha_3\sqrt{3}a}{2}, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNL}_\Gamma;\Gamma_R;
R_8; 3; -A_{11}, -\frac{A_0+2\sqrt{3}A_2}{3}, A_{10}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad \text{QCTP}; 0

Δ; ΓX; \; C_{2y},\sigma_z,IT;
R_1; 1; 1,1,1;
R_2; 1; 1,-1,1;
R_3; 1; 1,1,1;
R_4; 1; 1,-1,1;

Σ; ΓM; \; \sigma_z,IT;
R_1; 1; 1,1;
R_2; 1; 1,-1,1;
R_3; 1; 1,1,1;
R_4; 1; 1,-1,1;

Λ; ΓR; \; C^+_{31},IT;
R_1; 1; 1,1;
\{R_2,R_3\}; 2; \frac{1}{2}(\sigma_0+i\sqrt{3}a), \sigma_1; \quad \text{WNL}; \; \pi

S; XR; \; \sigma_y,IT;
R_2; 1; 1,1;
R_4; 1; 1,1;

Z; XM; \; \sigma_y,C_{2z},IT;
R_5; 2; \sigma_2, \sigma_3, -i\sigma_1; \quad \text{WNL}; \; \pi

T; MR; \; \sigma_y,C_{2z},IT;
R_2; 1; -i,1,1;
R_4; 1; 1,1,1;
R_6; 1; -i,-1,1;
R_8; 1; i,-1,1;
\[ \Gamma \uparrow; \{ S_{61}^{+}\} , \{ C_{2y}\} , \{ C_{2y}\} \}; \text{Centrosymmetric; without SOC} \]

\[
\begin{array}{l}
\Gamma; \ (000); \ S_{61}^{+}, C_{2y}, C_{2y}, T; \ R_{1}; \ 1, 1, 1, 1; \\
\{ R_{2}, R_{3} \}; \ 2, \ -\frac{\sigma_{0} - i\sqrt{3}\sigma_{3}}{2}, \sigma_{0}, \sigma_{0}, \sigma_{1}; \ P\text{-WNL}_{\Gamma\uparrow}; \\
R_{4}; \ 3, \ A_{11}, -\frac{A_{0} + 2\sqrt{3}A_{0}}{3}, A_{10}, -i(\sqrt{3} - i)A_{0}; \ QCTP; \ 0 \\
R_{5}; \ 1, -1, 1, 1, 1; \\
\{ R_{6}, R_{7} \}; \ 2, \ \frac{\sigma_{0} + i\sqrt{3}\sigma_{3}}{2}, \sigma_{0}, \sigma_{0}, \sigma_{1}; \ P\text{-WNL}_{\Gamma\uparrow}; \\
R_{8}; \ 3, \ -A_{11}, -\frac{A_{0} + 2\sqrt{3}A_{0}}{3}, A_{10}, -i(\sqrt{3} - i)A_{0}; \ QCTP; \ 0 \\
\end{array}
\]

\[
\begin{array}{l}
X; \ (\frac{1}{2}0\frac{1}{2}); \ C_{2y}, C_{2y}, I, T; \ R_{1}; \ 1, 1, 1, 1; \\
R_{2}; \ 1, -1, 1, 1; \\
R_{3}; \ 1, 1, -1, 1; \\
R_{4}; \ 1, -1, 1, 1; \\
R_{5}; \ 1, 1, -1, 1; \\
R_{6}; \ 1, -1, 1, 1; \\
R_{7}; \ 1, 1, 1, -1; \\
R_{8}; \ 1, -1, -1, 1; \\
\end{array}
\]

\[
\begin{array}{l}
L; \ (\frac{1}{2}\frac{1}{2} \frac{1}{2}); \ S_{61}^{+}, T; \ R_{1}; \ 1, 1, 1; \\
\{ R_{2}, R_{6} \}; \ 2, \ \frac{1}{2} (\sigma_{0} + i\sqrt{3}\sigma_{3}), \sigma_{1}; \ P\text{-WNL}_{\Gamma\uparrow}; \\
\{ R_{3}, R_{5} \}; \ 2, \ \frac{1}{2} (-\sigma_{0} + i\sqrt{3}\sigma_{3}), \sigma_{1}; \ P\text{-WNL}_{\Gamma\uparrow}; \\
R_{4}; \ 1, -1, 1; \\
\end{array}
\]

\[
\begin{array}{l}
W; \ (\frac{1}{2}\frac{1}{2} \frac{1}{2}); \ C_{2x}, \sigma_{x}, IT; \ R_{1}; \ 1, 1, 1; \\
R_{2}; \ 1, -1, 1; \\
R_{3}; \ 1, -1, 1; \\
R_{4}; \ 1, -1, 1; \\
\end{array}
\]

\[
\begin{array}{l}
\Delta; \ \Gamma X; \ C_{2y}, \sigma_{x}, IT; \ R_{1}; \ 1, 1, 1; \\
R_{2}; \ 1, 1, 1; \\
R_{3}; \ 1, -1, 1; \\
R_{4}; \ 1, -1, 1; \\
\end{array}
\]

\[
\begin{array}{l}
\Lambda; \ \Gamma L; \ C_{31}^{+}, IT; \ R_{1}; \ 1, 1, 1; \\
\{ R_{2}, R_{3} \}; \ 2, \ \frac{1}{2} (-\sigma_{0} + i\sqrt{3}\sigma_{3}), \sigma_{1}; \ \text{WNL}; \ \pi \\
\end{array}
\]

\[
\begin{array}{l}
\Sigma; \ \Gamma \Sigma; \ \sigma_{x}, IT; \ R_{1}; \ 1, 1, 1; \\
R_{2}; \ 1, -1, 1; \\
\end{array}
\]

\[
\begin{array}{l}
S; \ \Gamma S; \ \sigma_{y}, IT; \ R_{1}; \ 1, 1, 1; \\
R_{2}; \ 1, -1, 1; \\
\end{array}
\]

\[
\begin{array}{l}
Z; \ \Gamma W; \ C_{2x}, \sigma_{x}, IT; \ R_{1}; \ 1, 1, 1; \\
R_{2}; \ 1, -1, 1; \\
R_{3}; \ 1, -1, 1; \\
R_{4}; \ 1, -1, 1; \\
\end{array}
\]

\[
\begin{array}{l}
Q; \ \Gamma W; \ E, IT; \ R_{1}; \ 1, 1, 1; \\
\end{array}
\]
$\Gamma; (000); \quad S_{61}^+, C_{2x}, C_{2y}, T; \quad R_1; \quad 1, 1, 1, 1;
\begin{align*}
\{R_2, R_3\}; & 2; -\frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; & \text{P-WNL}_{\Gamma L}; \\
R_4; & 3; -A_{12} - 2\sqrt{3}A_{0}, A_{10}, -i\frac{\sqrt{3} - i}{2}A_0; & \text{QCTP}; 0 \\
R_5; & 1; -1, 1, 1; & \\
\{R_6, R_7\}; & 2; -\frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; & \text{P-WNL}_{\Gamma L}; \\
R_8; & 3; -A_{12} - 2\sqrt{3}A_{0}, A_{10}, -i\frac{\sqrt{3} - i}{2}A_0; & \text{QCTP}; 0 \\
\end{align*}

$X; (\frac{1}{2}0\frac{1}{2}); \quad \sigma_2, \sigma_y, C_{2y}, T; \quad R_5; \quad 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; & \text{P-WNLs}; \\
R_{10}; & 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; & \text{P-WNLs}; \\
L; (\frac{1}{2}1\frac{1}{2}); \quad S_{61}^+, T; \quad R_1; \quad 1, 1, 1; & \\
\{R_2, R_3\}; & 2; \frac{1}{2} \left( \sigma_0 + i\sqrt{3}\sigma_3 \right), \sigma_1; & \text{P-WNL}_{\Gamma L}; \\
{R_3, R_4}; & 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3}\sigma_3 \right), \sigma_1; & \text{P-WNL}_{\Gamma L}; \\
R_4; & 1; -1, 1; & \\
W; (\frac{1}{2}\frac{3}{2}\frac{1}{2}); \quad \sigma_2, C_{2x}, IT; \quad R_9; & \sqrt{-1}\sigma_3, \sigma_2, -\sigma_0; & \text{P-WNLS}_{\chi}; \\
\Delta; \Gamma X; \quad C_{2y}, \sigma_x, IT; \quad R_1; \quad 1, 1, 1, 1; & \\
R_2; & 1, 1, -1, 1; & \\
R_3; & 1, -1, 1, 1; & \\
R_4; & 1, -1, -1, 1; & \\
A; \Gamma L; \quad C_{31}^+, IT; \quad R_1; \quad 1, 1, 1; & \\
{R_2, R_3}; & 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3}\sigma_3 \right), \sigma_1; & \text{WNL}; \pi \\
\Sigma; \Gamma \Sigma; \quad \sigma_2, IT; \quad R_1; \quad 1, 1, 1; & \\
R_2; & 1, -1, 1; & \\
S; \Gamma \Sigma; \quad \sigma_y, IT; \quad R_2; \quad 1, 1, 1; & \\
R_4; & 1, -1, 1; & \\
Z; \Gamma \Sigma; \quad \sigma_y, C_{2x}, IT; \quad R_5; \quad 2; \sigma_2, \sigma_3, -i\sigma_1; & \text{WNL}; \pi \\
Q; \Gamma \Sigma; \quad E, IT; \quad R_1; \quad 1, 1, 1;
\[ \Gamma^0; \{S^+_0[000], \{C_2z[000], \{C_2y[000]\}, T; \text{Centrosymmetric; without SOC} \}
\]

\[ \Gamma; (000); S^+_0, C_{2z}, C_{2y}, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ \{R_2, R_3\}; 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \text{P-WNL}_{\Gamma P}; \]
\[ R_4; 3; A_{11}, -\frac{A_0 + 2\sqrt{3}A_2}{3}, A_{10}, -\frac{i(\sqrt{3} - 1)A_0}{2}; \text{QCTP}; 0 \]
\[ R_5; 1; -1, 1, 1, 1; \]
\[ \{R_6, R_7\}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \text{P-WNL}_{\Gamma P}; \]
\[ R_8; 3; -A_{11}, -\frac{A_0 + 2\sqrt{3}A_2}{3}, A_{10}, -\frac{i(\sqrt{3} - 1)A_0}{2}; \text{QCTP}; 0 \]

\[ H; \left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right); S^+_0, C_{2z}, C_{2y}, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ \{R_2, R_3\}; 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \text{P-WNL}_{PH}; \]
\[ R_4; 3; A_{11}, -\frac{A_0 + 2\sqrt{3}A_2}{3}, A_{10}, -\frac{i(\sqrt{3} - 1)A_0}{2}; \text{QCTP}; 0 \]
\[ R_5; 1; -1, 1, 1, 1; \]
\[ \{R_6, R_7\}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \text{P-WNL}_{PH}; \]
\[ R_8; 3; -A_{11}, -\frac{A_0 + 2\sqrt{3}A_2}{3}, A_{10}, -\frac{i(\sqrt{3} - 1)A_0}{2}; \text{QCTP}; 0 \]

\[ P; \left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right); C^+_3, C_{2z}, C_{2y}, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ \{R_2, R_3\}; 2; -\frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \text{P-WNL}_{\Gamma P/PH}; \]
\[ R_4; 3; A_0, -\frac{A_0 + 2\sqrt{3}A_2}{3}, A_{10}, -\frac{i(\sqrt{3} - 1)A_0}{2}; \text{TP}; 0 \]

\[ N; (00\frac{1}{2}); C_{2z}, I; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, 1, -1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, -1; \]

\[ \Sigma; \Gamma N; \sigma_z, I T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]

\[ \Delta; \Gamma H; C_{2y}, \sigma_x, I T; \]
\[ R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, -1; \]

\[ \Lambda; \Gamma P; C^+_3, I T; \]
\[ R_1; 1, 1, 1; \]
\[ \{R_2, R_3\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_1; \text{WNL}; \pi \]

\[ D; \Gamma P; C_{2z}, I T; \]
\[ R_1; 1, 1; \]
\[ R_2; 1, -1; \]

\[ G; \Gamma N; \sigma_x, I T; \]
\[ R_1; 1, 1; \]
\[ R_2; 1, -1; \]

\[ F; \Gamma H; C^+_3, I T; \]
\[ R_1; 1, 1; \]
\[ \{R_2, R_3\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_1; \text{WNL}; \pi \]
\[ \Gamma_c; \{ S_{01}^+ [000], \{ C_{2y} \{ \frac{1}{2} \alpha_0 \} \}, \{ C_{2y} \{ \frac{1}{2} \alpha_+ \} \}, \{ T \}; Centrosymmetric; without \text{SOC} \]

\[ \begin{align*}
\Gamma; & \quad (000) \quad S_{01}^+, \{ C_{2x}, C_{2y}, T \}; \\
\{ R_2, R_3 \}; & \quad 2; \frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNL}_{GR} \\
R_4; & \quad 3; A_{11} - A_{10} + 2\sqrt{3}A_0, A_{10} - \frac{i(\sqrt{3} - 1)A_0}{2}; \quad \text{QCTP}; \quad 0 \\
R_5; & \quad 1; -1, 1, 1, 1; \quad \text{P-WNL}_{GR} \\
\{ R_6, R_7 \}; & \quad 2; \frac{2\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-WNL}_{GR} \\
R_8; & \quad 3; -A_{11} - A_{10} + 2\sqrt{3}A_0, A_{10} - \frac{i(\sqrt{3} - 1)A_0}{2}; \quad \text{QCTP}; \quad 0 \\
X; & \quad (0 \frac{1}{2} 0) \quad C_{2y}, \{ C_{2x}, \sigma_z, T \}; \\
R_2; & \quad 2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \quad \text{P-NS}_{XMR}; \\
R_{10}; & \quad 2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-NS}_{XMR}; \\
M; & \quad (\frac{1}{2} \frac{1}{2} 0) \quad C_{2x}, \{ C_{2x}, \sigma_z, T \}; \\
\{ R_9, R_{10} \}; & \quad 4; i\Gamma_{3,0}, \Gamma_{0,1}, \Gamma_{0,3}, \Gamma_{1,0}; \quad \text{P-DNL}_{MR}; \\
R; & \quad (\frac{1}{2} \frac{1}{2} \frac{1}{2}) \quad C_{2x}, \{ C_{2x}, \sigma_z, T \}; \\
\{ R_4, R_4 \}; & \quad 4; \frac{\Gamma_{0,0} - i\sqrt{3}\Gamma_{0,3}}{2}, \Gamma_{28}, \Gamma_{29}, \Gamma_{0,0}, -\Gamma_{2,2}; \quad \text{P-DNL}_{MR}; \\
\{ R_5, R_6 \}; & \quad 4; \Gamma_{8}, \Gamma_{9}, \Gamma_{10}, \Gamma_{0,0}, \Gamma_{1,0}; \quad \text{P-DNL}_{MR}; \\
\{ R_{11}, R_{11} \}; & \quad 4; \frac{\Gamma_{0,0} - i\sqrt{3}\Gamma_{0,3}}{2}, \Gamma_{28}, \Gamma_{29}, -\Gamma_{0,0}, -\Gamma_{2,2}; \quad \text{P-DNL}_{MR}; \\
\{ R_{12}, R_{13} \}; & \quad 4; \Gamma_{8}, \Gamma_{9}, \Gamma_{10}, -\Gamma_{0,0}, \Gamma_{1,0}; \quad \text{P-DNL}_{MR}; \\
\Delta; & \quad \Gamma X; \quad \{ C_{2y}, \sigma_z, T \}; \\
R_1; & \quad 1; 1, 1, 1; \\
R_2; & \quad 1; 1, -1, 1; \\
R_3; & \quad 1; -1, 1, 1; \\
R_4; & \quad 1; -1, -1, 1; \\
\Sigma; & \quad \Gamma M; \quad \{ \sigma_z, \Gamma T \}; \\
R_1; & \quad 1; 1, 1; \\
R_2; & \quad 1; -1, 1; \\
\Lambda; & \quad \Gamma R; \quad \{ C_{31}^+, \Gamma T \}; \\
R_1; & \quad 1; 1, 1; \\
\{ R_2, R_3 \}; & \quad 2; -\frac{i}{2} \left(-\sigma_0 + i\sqrt{3}\sigma_3\right), \sigma_1; \quad \text{WNL}; \quad \pi \\
S; & \quad X R; \quad \{ \sigma_z, \Gamma T \}; \\
\{ R_2, R_4 \}; & \quad 2; \sigma_3, \sigma_1; \quad \text{L-NS}_{XMR}; \\
Z; & \quad X M; \quad \{ C_{2x}, \sigma_z, \Gamma T \}; \\
\{ R_2, R_4 \}; & \quad 2; \sigma_3, \sigma_0, \sigma_1; \quad \text{L-NS}_{XMR}; \\
\{ R_6, R_8 \}; & \quad 2; \sigma_3, -\sigma_0, \sigma_1; \quad \text{L-NS}_{XMR}; \\
T; & \quad M R; \quad \{ C_{2x}, \sigma_z, T \}; \\
\{ R_5, R_5 \}; & \quad 4; \Gamma_{0,2}, -i\Gamma_{1,0}, -\Gamma_{2,2}; \quad \text{DNL}; \quad 0 \\
Z^{\alpha}; & \quad X M(\frac{1}{2} \alpha_0); \quad \{ \sigma_z, \Gamma T \}; \\
R_5; & \quad 2; \sigma_2, \sigma_3, -\sigma_0; \quad \text{L-NS}_{X'\Gamma_{MR}}; \\
\end{align*} \]

*For the notation, see Table 5.11, Fig. 5.4 and the text of section 5.5 in Ref. [17].*
Γ\(^v\): \{S^+_{01}[000], \{C_{2v}[\frac{1}{2}01\}\}, \{C_{2g}[0\frac{1}{2}1\}\}, T\}; Centrosymmetric; without SOC

\(\Gamma\): \((000)\); \(S^+_{01}, C_{2v}, C_{2g}, T\);  
\(R_3\); 1, 1, 1, 1;  
\{\(R_2, R_3\)\}; 2; \(-\frac{\sigma_0 - i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \sigma_1\); P-WNL\(_{FP}\);  
\(R_4\); 3; \(A_{11}, -\frac{A_0 + 2\sqrt{3}A_8}{3}, A_{10}, -\frac{i(\sqrt{3} - i)A_0}{2}\); QCTP; 0  
\(R_5\); 1; -1, 1, 1, 1;  
\{\(R_6, R_7\)\}; 2; \(-\sigma_0 + \sigma_0, \sigma_0, \sigma_0, \sigma_1\); P-WNL\(_{FP}\);  
\(R_8\); 3; \(-A_{11}, -\frac{A_0 + 2\sqrt{3}A_8}{3}, A_{10}, -\frac{i(\sqrt{3} - i)A_0}{2}\); QCTP; 0

\(H\): \((\frac{1}{2} \frac{1}{2} \frac{1}{2})\); \(C_{31}^-, C_{2s}, C_{2y}, I, T\);  
\(R_4\); 1; -1, -1, -1, 1, 1;  
\{\(R_5, R_6\)\}; 2; \(-\frac{2\sigma_0 - i\sqrt{3}\sigma_3}{2}, -\sigma_0, -\sigma_0, \sigma_0, \sigma_1\); P-WNL\(_{HP}\);  
\(R_8\); 3; \(-A_0, -A_{13}, -\frac{A_0 + 2\sqrt{3}A_8}{3}, A_0, -\frac{i(\sqrt{3} - i)A_0}{2}\); QCTP; 0  
\(R_{12}\); 1; -1, -1, -1, 1, 1;  
\{\(R_{13}, R_{14}\)\}; 2; \(-\frac{2\sigma_0 - i\sqrt{3}\sigma_3}{2}, -\sigma_0, -\sigma_0, -\sigma_0, \sigma_1\); P-WNL\(_{HP}\);  
\(R_{16}\); 3; \(-A_0, -A_{13}, -\frac{A_0 + 2\sqrt{3}A_8}{3}, A_0, -\frac{i(\sqrt{3} - i)A_0}{2}\); QCTP; 0

\(P\): \((\frac{1}{2} \frac{1}{2} \frac{1}{2})\); \(C_{31}^+, C_{2s}, C_{2g}, I, T\);  
\{\(R_7, R_8\)\}; 4; \(\Gamma_{T00,3} + i\Gamma_{00,0}, \Gamma_{30}, \Gamma_{31}, -\Gamma_{22}\); DP; 0  
\{\(R_8, R_9\)\}; 4; \(i\Gamma_8, \Gamma_32, \Gamma_33, \Gamma_{10}\); DP; 0

\(N\): \((00\frac{1}{2})\); \(\sigma_z, I, T\);  
\(R_8\); 2; \(i\sigma_2, \sigma_3, -\sigma_0\); P-WNL\(_NP\);  
\(\Sigma\): \(\Gamma_N\); \(\sigma_z, IT\);  
\(R_1\); 1; 1, 1;  
\(R_2\); 1; -1, 1;  
\(\Delta\): \(\Gamma_H\); \(C_{2y}, \sigma_z, IT\);  
\(R_1\); 1; 1, 1, 1;  
\(R_2\); 1; -1, 1, 1;  
\(R_3\); 1; -1, 1, 1;  
\(R_4\); 1; -1, -1, 1;  
\(\Lambda\): \(\Gamma_P\); \(C_{31}^+, IT\);  
\(R_1\); 1; 1, 1;  
\{\(R_2, R_3\)\}; 2; \(\frac{1}{2}(-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_1\); WNL; \(\pi\)  
\(D\): \(\Gamma_P\); \(C_{2s}, IT\);  
\{\(R_2, R_4\)\}; 2; \(\sigma_3, \sigma_1\); WNL; \(\pi\)  
\(G\): \(\Gamma_H\); \(\sigma_z, IT\);  
\(R_1\); 1; -i, 1;  
\(R_2\); 1; i, 1;  
\(F\): \(\Gamma_P\); \(C_{31}^+, IT\);  
\{\(R_2, R_6\)\}; 2; \(\frac{1}{2}(\sqrt{3}\sigma_3 - i\sigma_0), \sigma_1\); WNL; \(\pi\)  
\(R_4\); 1; i, 1;
\(\Gamma\); \(\{C_{31}^{+}000\}, \{C_{22}^{+}000\}, \{C_{22}^{+}000\}, \{C_{22}^{+}000\}, T\); Non-Centrosymmetric; without SOC

\(\Gamma\); \((000)\); \(C_{31}^{+}C_{22}^{+}C_{22}^{+}C_{22}^{+}T\)

\(R_1; 1, 1, 1, 1, 1;\)
\(R_2; 1, 1, 1, 1, 1;\)
\(R_3; 2, -\frac{a_0 + i\sqrt{3}a_2}{2}, \sigma_0, \sigma_0, \sigma_3, -\sigma_0;\) C-4 WP; 4
\(R_4; 3, A_{11}, -\frac{a_0 + 2\sqrt{3}a_2}{3}, A_{13}, A_{12}, -\frac{i(\sqrt{3} - 1)a_0}{2};\) C-2 TP; 2
\(R_5; 3, A_{11}, -\frac{a_0 + 2\sqrt{3}a_2}{3}, A_{13}, -A_{12}, -\frac{i(\sqrt{3} - 1)a_0}{2};\) C-2 TP; 2

\(X\); \((0\frac{1}{2}0)\); \(C_{4y}^{+}C_{22}^{+}T\)

\(R_1; 1, 1, 1;\)
\(R_2; 1, 1, 1;\)
\(R_3; 1, -1, 1;\)
\(R_4; 1, -1, 1;\)
\(R_5; 2, i\sigma_2, \sigma_3, -\sigma_0;\) C-2 WP; 2

\(M\); \((\frac{1}{2}\frac{1}{2}0)\); \(C_{4x}^{+}C_{22}^{+}T\)

\(R_1; 1, 1, 1;\)
\(R_2; 1, 1, 1;\)
\(R_3; 1, -1, 1;\)
\(R_4; 1, -1, 1;\)
\(R_5; 2, i\sigma_2, \sigma_3, -\sigma_0;\) C-2 WP; 2

\(R\); \((\frac{1}{2}\frac{1}{2}\frac{1}{2})\); \(C_{31}^{+}C_{22}^{+}C_{22}^{+}C_{22}^{+}T\)

\(R_1; 1, 1, 1, 1, 1;\)
\(R_2; 1, 1, 1, 1, 1;\)
\(R_3; 2, -\frac{a_0 + i\sqrt{3}a_2}{2}, \sigma_0, \sigma_0, \sigma_3, -\sigma_0;\) C-4 WP; 4
\(R_4; 3, A_{11}, -\frac{a_0 + 2\sqrt{3}a_2}{3}, A_{13}, A_{12}, -\frac{i(\sqrt{3} - 1)a_0}{2};\) C-2 TP; 2
\(R_5; 3, A_{11}, -\frac{a_0 + 2\sqrt{3}a_2}{3}, A_{13}, -A_{12}, -\frac{i(\sqrt{3} - 1)a_0}{2};\) C-2 TP; 2

\(\Delta\); \(\Gamma X\); \(C_{4y}^{+}C_{22}^{+}T\)

\(R_1; 1, 1, 1;\)
\(R_2; 1, 1, 1;\)
\(R_3; 1, -1, 1;\)
\(R_4; 1, -i, 1;\)

\(\Sigma\); \(\Gamma M\); \(C_{22}^{+}C_{22}^{+}T\)

\(R_1; 1, 1, 1;\)
\(R_2; 1, -1, 1;\)
\(R_3; 1, -i, 1;\)

\(\Lambda\); \(\Gamma R\); \(C_{31}^{+}C_{22}^{+}T\)

\(R_1; 1, 1, 1;\)
\(R_2; 1, -1, 1;\)
\(R_2; 1, (-1)^{2/3}, 1;\)
\(R_3; 1, -i, 1;\)

\(S\); \(\Gamma R\); \(C_{22}^{+}C_{22}^{+}T\)

\(R_1; 1, 1, 1;\)
\(R_2; 1, -1, 1;\)
\(R_3; 1, i, 1;\)
\(R_4; 1, -1, 1;\)

\(Z\); \(\Gamma M\); \(C_{22}^{+}T\)

\(R_1; 1, 1, 1;\)
\(R_2; 1, -1, 1;\)
\(R_3; 1, i, 1;\)

\(T\); \(\Gamma R\); \(C_{4y}^{+}T\)

\(R_1; 1, 1, 1;\)
\(R_2; 1, i, 1;\)
\(R_3; 1, -1, 1;\)
\(R_4; 1, -i, 1;\)
Γ; (000); \{C_{31}^1 |000\}, \{C_{2z}^1 |000\}, \{C_{2a}^2 |\frac{1}{2} \frac{1}{2} \frac{1}{2}\}; T; Non-Centrosymmetric; without SOC

Γ; (000); C_{31}^1, C_{2z}^1, C_{2a}^2, C_{2a}^2, T; R_1; 1, 1, 1, 1, 1;
R_2; 1, 1, 1, 1, 1;
R_3; 2, \frac{-a_0 + i\sqrt{3}a_x}{2}, \sigma_0, \sigma_0, \sigma_0, -\sigma_0; C-4 WP; 4
R_4; 3, A_{11}, -\frac{A_0 + 2\sqrt{3}A_x}{3}, A_{13}, A_{12}, -\frac{i(\sqrt{3}-1)A_0}{2}; C-2 TP; 2
R_5; 3, A_{11}, -\frac{A_0 + 2\sqrt{3}A_x}{3}, A_{13}, -A_{12}, -\frac{i(\sqrt{3}-1)A_0}{2}; C-2 TP; 2

X; (0\frac{1}{2}0); C_{2y}^1, C_{2a}^2, T;
R_1; 1, 1, 1;
R_2; 1, 1, 1;
R_3; 1, -1, 1;
R_4; 1, -1, 1;
R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; C-2 WP; 2

M; (\frac{1}{2} \frac{1}{2} 0); C_{4y}^+ , C_{2a}^2, T;
R_1; 1, 1, 1, 1;
R_2; 1, 1, 1, 1;
R_3; 1, -1, 1, 1;
R_4; 1, -1, -1, 1;
R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; C-2 WP; 2

R; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{31}^1, C_{2a}^2, C_{2a}^2, C_{2a}^2, T;
R_1; 1, 1, 1, 1, 1;
R_2; 1, 1, 1, 1, 1;
R_3; 2, \frac{-a_0 + i\sqrt{3}a_x}{2}, \sigma_0, \sigma_0, \sigma_0, -\sigma_0; C-4 WP; 4
R_4; 3, A_{11}, -\frac{A_0 + 2\sqrt{3}A_x}{3}, A_{13}, A_{12}, -\frac{i(\sqrt{3}-1)A_0}{2}; C-2 TP; 2
R_5; 3, A_{11}, -\frac{A_0 + 2\sqrt{3}A_x}{3}, A_{13}, -A_{12}, -\frac{i(\sqrt{3}-1)A_0}{2}; C-2 TP; 2

Δ; ΓX; C_{2y}^1, C_{2a}^2, T;
R_1; 1, 1, 1;
R_2; 1, i, 1;
R_3; 1, -1, 1;
R_4; 1, -i, 1;

Σ; ΓM; C_{2a}^2, C_{2a}^2, T;
R_1; 1, 1, 1;
R_2; 1, -1, 1;

Λ; ΓR; C_{31}^1, C_{2a}^2, T;
R_1; 1, 1, 1;
R_2; 1, -1, 1;
R_3; 2, (-1)^{2/3}, 1;
R_4; 1, -\sqrt[3]{\frac{2}{1}}, 1;

S; Xr; C_{2a}^2, C_{2a}^2, T;
R_2; 1, 1, 1;
R_4; 1, -1, 1;
R_2; 1, -1, 1;

Z; XM; C_{2a}^2, TM_{2a}^2;
R_1; 1, 1, 1;
R_2; 1, -1, 1;
R_6; 1, -i, 1, 1;
R_7; 1, 1, 1, 1;
R_8; 1, i, 1, 1;

T; MR; C_{4y}^1, E, TM_{2a}^2;
R_5; 1, -1, 1, 1;
R_6; 1, -i, 1, 1;
R_7; 1, 1, 1, 1;
R_8; 1, i, 1, 1;
Γ; (000); \(C_{3v}, C_{2v}, C_{2x}, C_{2o}, T\); R1; 1, 1, 1, 1, 1;
R2; 1, 1, 1, -1, 1;
R3; 2; \(-\sigma_0 + \frac{i}{\sqrt{3}}\sigma_2\), \(\sigma_0, \sigma_3, -\sigma_0\);
R4; 3; \(A_{11}, -\frac{\Delta_0 + 2\sqrt{3}\Delta_4}{3}, A_{13}, A_{12}, -\frac{i(\sqrt{3} - i)\Delta_0}{2}\);
R5; 3; \(A_{11}, -\frac{\Delta_0 + 2\sqrt{3}\Delta_4}{3}, A_{13}, -A_{12}, -\frac{i(\sqrt{3} - i)\Delta_0}{2}\);
R6; 2; \(i\sigma_2, \sigma_3, -\sigma_0\);

L; \(\frac{1}{2}\frac{1}{2}\frac{1}{2}\); \(C_{3v}, C_{2v}, T\);
R1; 1, 1, 1, 1;
R2; 1, -1, 1, 1;
R3; 1, -1, 1, 1;
R4; 1, -1, -1, 1;
R5; 2; \(i\sigma_2, \sigma_3, -\sigma_0\);

W; \(\frac{1}{2}\frac{1}{2}\frac{1}{2}\); \(C_{2x}, C_{2d}, C_{4x}^+, T\);
R1; 1, 1, 1, 1;
R2; 1, -1, -1, 1;
R3, R4; 2; \(-\sigma_0, \sigma_3, -i\sigma_2\);

Δ; \(\Gamma_X\); \(C_{4y}, C_{2x} T\);
R1; 1, 1, 1;
R2; 1, i, 1;
R3; 1, -1, 1;
R4; 1, -i, 1;
R5; 1, -1, 1;

Λ; \(\Gamma_L\); \(C_{3v}, C_{2v} T\);
R1; 1, 1, 1;
R2; 1, -1, 1;
R3; 1, \((-1)^{2/3}, 1\);
R4; 1, \(-\sqrt{-1}, 1\);

Σ; \(\Gamma_S\); \(C_{2a}, C_{2b} T\);
R1; 1, 1, 1;
R2; 1, -1, 1;

S; \(\times S\); \(C_{2x}, C_{2x} T\);
R1; 1, 1, 1;
R2; 1, -1, 1;

Z; \(\times W\); \(C_{2w}, T C_{2y}\);
R1; 1, 1, 1;
R2; 1, -1, 1;

Q; \(\times W\); \(C_{2f}\);
R1; 1, 1;
R2; 1, -1;
\( \Gamma f; \{ C_{31}^0 | 000 \}, \{ C_{2x} | 000 \}, \{ C_{2x} | 000 \}, \{ C_{2a} | \frac{1}{2} \frac{1}{2} \frac{1}{2} \} \); Non-Centrosymmetric; without SOC

\[ \Gamma; (000); \quad C_{31}^0, C_{2x}, C_{2x}, C_{2a}, T; \quad R_1; \quad 1, 1, 1, 1, 1; \]
\[ R_2; \quad 1, 1, 1, -1, 1; \]
\[ R_3; \quad 2, -\frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}, \sigma_0, \sigma_0, -\sigma_0; \quad C-4 \text{ WP}; \quad 4 \]
\[ R_4; \quad 3, A_{11}, -\frac{A_{0} + 2 \sqrt{3} A_{4x}}{3}, A_{13}, A_{12}, -\frac{i(\sqrt{3} - i) A_{0}}{2}; \quad C-2 \text{ TP}; \quad 2 \]
\[ X; (\frac{1}{2} 0 \frac{1}{2}); \quad C_{4y}^+ C_{2x}, T; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ R_3; \quad 1, -1, 1; \]
\[ R_4; \quad 1, -1, -1, 1; \]
\[ R_5; \quad 2, i \sigma_2, \sigma_3, -\sigma_0; \quad C-2 \text{ WP}; \quad 2 \]
\[ L; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad C_{31}^+, C_{2x}, T; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ R_3; \quad 2, -\frac{\sigma_0 - i \sqrt{3} \sigma_2}{2}, \sigma_3, -\sigma_0; \quad C-2 \text{ WP}; \quad 2 \]
\[ W; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad E, C_{2x}, C_{2f}, C_{4x}^+ T; \quad R_{10}; \quad 2, -i \sigma_0, \sigma_1, \sigma_3, \frac{\sigma_2 - \sigma_3}{\sqrt{2}}; \quad C-1 \text{ WP}; \quad 1 \]
\[ \Delta; \quad \Gamma X; \quad C_{4y}^+ C_{2x} T; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, i, 1; \]
\[ R_3; \quad 1, -1, 1; \]
\[ R_4; \quad 1, -i, 1; \]
\[ \Lambda; \quad \Gamma L; \quad C_{31}^+, C_{2x} T; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, (-1)^{2/3}, 1; \]
\[ R_3; \quad 1, -\sqrt[3]{1}, 1; \]
\[ \Sigma; \quad \Gamma \Sigma; \quad C_{2a}, C_{2b} T; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ S; \quad \Gamma S; \quad C_{2e}, C_{2e} T; \quad R_2; \quad 1, 1, 1; \]
\[ R_4; \quad 1, -1, 1; \]
\[ Z; \quad \Gamma W; \quad C_{2x}, TC_{2y}; \quad R_1; \quad 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1; \]
\[ Q; \quad \Gamma W; \quad C_{2f}; \quad R_4; \quad 1, 1; \]
\[ R_8; \quad 1, -1; \]
SG 211

Γ; \{C_{3v}|000\}, \{C_{2v}|000\}, \{C_{2v}|000\}, \{C_{2v}|000\}, T; Non-Centrosymmetric; without SOC

Γ; (000); \text{C}_{3v}, \text{C}_{2v}, \text{C}_{2v}, \text{C}_{2v}, T; R_1; 1; 1, 1, 1, 1;
R_2; 1; 1, 1, 1, 1, 1;
R_3; 2; \frac{-\sigma_0 + \sqrt{12}}{2}, \sigma_0, \sigma_0, \sigma_0, -\sigma_0; \text{C-4 WP}; 4
R_4; 3; A_{11}, -\frac{A_6 + 2\sqrt{3}A_8}{3}, A_{13}, A_{12}, -\frac{i(\sqrt{-3}i)A_0}{2}; \text{C-2 TP}; 2
R_5; 3; A_{11}, -\frac{A_6 + 2\sqrt{3}A_8}{3}, A_{13}, -A_{12}, -\frac{i(\sqrt{-3}i)A_0}{2}; \text{C-2 TP}; 2

H; \left(\frac{1}{2}, \frac{1}{2}, \frac{1}{2}\right); \text{C}_{3v}, \text{C}_{2v}, \text{C}_{2v}, \text{C}_{2v}, T; R_1; 1; 1, 1, 1, 1;
R_2; 1; 1, 1, 1, 1, 1;
R_3; 2; \frac{-\sigma_0 + \sqrt{12}}{2}, \sigma_0, \sigma_0, \sigma_0, -\sigma_0; \text{C-4 WP}; 4
R_4; 3; A_{11}, -\frac{A_6 + 2\sqrt{3}A_8}{3}, A_{13}, A_{12}, -\frac{i(\sqrt{-3}i)A_0}{2}; \text{C-2 TP}; 2
R_5; 3; A_{11}, -\frac{A_6 + 2\sqrt{3}A_8}{3}, A_{13}, -A_{12}, -\frac{i(\sqrt{-3}i)A_0}{2}; \text{C-2 TP}; 2

P; \left(\frac{1}{2}, \frac{1}{2}, \frac{1}{2}\right); \text{C}_{3v}, \text{C}_{2v}, \text{C}_{2v}, \text{C}_{2v}, T; R_1; 1; 1, 1, 1, 1;
R_2; 1; (-1)^{2/3}, 1, 1, 1;
R_3; 1; -\sqrt{-1}, 1, 1, 1;
R_4; 3; A_9, -\frac{A_6}{3} - \frac{2A_8}{3}, A_{10}, A_{15}; \text{C-2 TP}; 2

N; (00\frac{1}{2}); \text{C}_{2v}, \text{C}_{2v}T; R_1; 1; 1, 1, 1;
R_2; 1; 1, 1, 1, 1;
R_3; 1; -1, 1, 1;
R_4; 1; -1, 1, 1;

Σ; \text{GN}; \text{C}_{2v}, \text{C}_{2v}T; R_1; 1; 1, 1;
R_2; 1; -1, 1;

Δ; \text{GN}; \text{C}_{2v}^\prime; \text{C}_{2v}T; R_1; 1; 1, 1;
R_2; 1; i, 1;
R_3; 1; -1, 1;
R_4; 1; -i, 1;

Λ; \text{GP}; \text{C}_{3v}^\prime, \text{C}_{2v}T; R_1; 1; 1, 1;
R_2; 1; (-1)^{2/3}, 1;
R_3; 1; -\sqrt{-1}, 1, 1;

D; \text{NP}; \text{C}_{2v}, \text{C}_{2v}T; R_1; 1; 1, 1;
R_2; 1; -1, 1;

G; \text{HN}; \text{C}_{2v}T; R_1; 1; 1, 1;
R_2; 1; -1, 1;

F; \text{PH}; \text{C}_{3v}^\prime, \text{C}_{2v}T; R_1; 1; 1, 1;
R_2; 1; (-1)^{2/3}, 1;
R_3; 1; -\sqrt{-1}, 1;
\[ \Gamma (000); \quad C^+_y, C^+_z, C^+_2, C^+_1, T; R_1; 1, 1, 1, 1, 1; \]
\[ R_2; 1, 1, 1, -1, 1; \]
\[ R_3; 2; -\frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_0, \sigma_0, -\sigma_0; \]
\[ R_4; 3; A_{11}, -\frac{A_0 + 2\sqrt{3}A_4}{3}, A_{13}, A_{12} - \frac{i(\sqrt{3} - 1)A_0}{2}; \text{ C-4 WP; 4} \]
\[ R_5; 3; A_{11}, -\frac{A_0 + 2\sqrt{3}A_4}{3}, A_{13}, -A_{12} - \frac{i(\sqrt{3} - 1)A_0}{2}; \text{ C-2 TP; 2} \]
\[ X (0\frac{1}{2} 0); \quad C^+_y, C^+_z, T; R_6; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_3, -\sigma_0; \]
\[ R_7; 2; -\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_3, -\sigma_0; \]
\[ \{ R_5, R_6 \}; 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \]
\[ \{ R_7, R_8 \}; 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \]
\[ M (0\frac{1}{2} \frac{1}{2}); \quad C^+_y, C^+_z, C^+_1, C^+_0, T; \{ R_5, R_6 \}; 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \]
\[ \{ R_7, R_8 \}; 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \]
\[ R_9; 2; \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \]
\[ R_6; 4; -\frac{i(\Gamma_{0.2} + \Gamma_{3.3})}{\sqrt{2}}, -\frac{i(\Gamma_{0.2} - \Gamma_{3.3})}{\sqrt{2}}, \Gamma_1, \Gamma_0, -\Gamma_1, 0; \text{ C-2 DP; 2} \]
\[ \Delta; \quad \Gamma_X; \quad C^+_y, C^+_z, T; R_1; 1, 1, 1; \]
\[ R_2; 2, \Gamma; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, 1; \]
\[ \Sigma; \quad \Gamma_M; \quad C^+_2, C^+_0, T; R_1; 1, 1, 1; \]
\[ R_2; 2, \Gamma; \]
\[ R_3; 1, -1, 1; \]
\[ R_4; 1, -1, 1; \]
\[ \Lambda; \quad \Gamma_R; \quad C^+_3, C^+_1, T; R_1; 1, 1, 1; \]
\[ R_2; 1, -1, 1; \]
\[ R_3; (1)^{2/3}, 1; \]
\[ R_4; 1, -\sqrt{-1}, 1; \]
\[ S; \quad \chi; \quad C^+_2, C^+_0, T; \{ R_4, R_5 \}; 2; \sigma_3, \sigma_1; \]
\[ Z; \quad \chi; \quad C^+_2, TC^+_2; \{ R_2, R_4 \}; 2; \sigma_3, -\sigma_2; \]
\[ T; \quad \chi; \quad C^+_4, E, TC^+_2; \{ R_5, R_7 \}; 2, -\sigma_3, \sigma_0, -\sigma_2; \]
\[ \{ R_6, R_8 \}; 2; -i\sigma_3, \sigma_0, -\sigma_2; \]
\[ \{ R_5, R_7 \}; 2; -\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \{ R_6, R_8 \}; 2; -i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \text{Non-Centrosymmetric; without SOC} \]
\[ \Gamma_c; \{ C_{31}^0 \{000 \}, \{ C_{2z} \{10 \}, \{ C_{2z} \{1 \} \}, \{ C_{2a} \{3 \} \}, T; \text{Non-Centrosymmetric; without SOC} \] \\
\Gamma_r; (000); \quad C_{31}^0, C_{2z}, C_{2z}, C_{2a}, T; \quad R_1; \quad 1, 1, 1, 1, 1; \\
\quad R_2; \quad 1, 1, 1, 1, 1; \\
\quad R_3; \quad 2; -\frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, \sigma_0, \sigma_0, \sigma_0, -\sigma_0; \quad \text{C-4 WP; 4} \\
\quad R_4; \quad 3; A_{11}, -\frac{A_0 + 2\sqrt{3}A_4}{3}, A_{13}, A_{12}, -\frac{i\sqrt{3}}{2}A_0; \quad \text{C-2 TP; 2} \\
\quad R_5; \quad 3; A_{11}, -\frac{A_0 + 2\sqrt{3}A_4}{3}, A_{13}, -A_{12}, -\frac{i\sqrt{3}}{2}A_0; \quad \text{C-2 TP; 2} \\
X_r; (1\{1\};(0\{1\});\quad C_{4y}, C_{2z}, T; \quad R_6; \quad 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_3, -\sigma_0; \quad \text{P-NSXMR; } \\
\quad R_7; \quad 2; -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_3, -\sigma_0; \quad \text{P-NSXMR; } \\
M_r; (1\{1\};(1\{1\});\quad C_{2x}, C_{2z}, C_{2a}, T; \quad \{ R_5, R_6 \}; \quad 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \quad \text{P-NSs; } \\
\quad \{ R_7, R_8 \}; \quad 2; -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \quad \text{P-NSs; } \\
\quad R_9; \quad 2; \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \quad \text{P-NSs; } \\
R_r; (1\{1\};(1\{1\});\quad C_{2z}, C_{2y}, C_{31}, C_{2a}, T; \quad \{ R_4, R_5 \}; \quad 4; \Gamma_{35}, \Gamma_{35}, -\frac{\Gamma_{0,6} + i\sqrt{3}\Gamma_{3,3}}{2}, \Gamma_{0,1}, \Gamma_{1,0}; \quad \text{C-2 DP; 2} \\
\quad R_6; \quad 4; -\frac{i(\Gamma_{0,2} + \Gamma_{3,3})}{\sqrt{2}}, -\frac{i(\Gamma_{0,2} - \Gamma_{3,3})}{\sqrt{2}}, \Gamma_{1}, \Gamma_{0,3}, -\Gamma_{1,0}; \quad \text{C-2 DP; 2} \\
\Delta_r; \Gamma_X; \quad C_{4y}^0, C_{2z} T; \quad R_1; \quad 1, 1, 1; \\
\quad R_2; \quad 1, 1, 1; \\
\quad R_3; \quad 1, 1, 1; \\
\quad R_4; \quad 1, 1, 1; \\
\Sigma_r; \Gamma_M; \quad C_{2a}, C_{2b} T; \quad R_1; \quad 1, 1, 1; \\
\quad R_2; \quad 1, 1, 1; \\
\quad R_3; \quad 1, 1, 1; \\
\Lambda_r; \Gamma_R; \quad C_{31}^0, C_{2z} T; \quad R_1; \quad 1, 1, 1; \\
\quad R_2; \quad 1, 1, 1; \\
\quad R_3; \quad (-1)^{2/3}, 1; \\
\quad R_4; \quad 1, -\sqrt{-1}, 1; \\
S_r; \Gamma_X; \quad C_{2x}, C_{2z} T; \quad \{ R_2, R_6 \}; \quad 2; \sigma_3, \sigma_1; \quad \text{L-NSXMR; } \\
Z_r; \Gamma_M; \quad C_{2x}, T C_{2y}; \quad \{ R_2, R_4 \}; \quad 2; \sigma_3, -i\sigma_2; \quad \text{L-NSXMR; } \\
T_r; \Gamma_R; \quad C_{4z}^0, E, T C_{2y}; \quad \{ R_5, R_7 \}; \quad 2; \sigma_0, -i\sigma_2; \quad \text{L-NSs; } \\
\quad \{ R_6, R_8 \}; \quad 2; -i\sigma_3, \sigma_0, -i\sigma_2; \quad \text{L-NSs; }
Γ: \{C_{31}^{0}[000], \{C_{2z}[\frac{1}{2} 0 0] \}, \{C_{2x}[\frac{1}{2} 0 0] \}, \{C_{2a}[\frac{1}{2} 0 0] \}, \{C_{-2} TP; 2 \}, \{C_{-4} WP; 1 \} \};

R_1; \{C_{31}, C_{2z}, C_{2a}, C_{-2}, T \};

R_2; 1, 1, 1, 1, 1;
R_3; 2, -\frac{a_{0}+i\sqrt{3}a_{0}}{2}, \sigma_{0}, \sigma_{0}, \sigma_{3}, \sigma_{0};
R_4; 3, A_{11}, -\frac{A_{0}+2\sqrt{3}A_{0}}{3}, A_{13}, A_{12}, -\frac{i}{2}\sqrt{3}A_{0};
R_5; 3, A_{11}, -\frac{A_{0}+2\sqrt{3}A_{0}}{3}, A_{13}, -A_{12}, -\frac{i}{2}\sqrt{3}A_{0};

H: \{\frac{1}{2} \frac{1}{2} \frac{1}{2} \};

C_{32}, C_{2z}, C_{2a}, C_{-2}, T;\}

R_1; 1, -1, 1, 1, 1;
R_2; 1, -1, 1, 1, 1;
R_3; 2, \frac{a_{0}+i\sqrt{3}a_{0}}{2}, -\sigma_{0}, -\sigma_{0}, \frac{\sqrt{3}a_{0}}{3} - a_{3}, -\sigma_{0};
R_4; 3, -A_{9}, -A_{13}, -\frac{A_{0}+2\sqrt{3}A_{0}}{3}, A_{15}, -\frac{i}{2}\sqrt{3}A_{0};
R_5; 3, -A_{9}, -A_{13}, -\frac{A_{0}+2\sqrt{3}A_{0}}{3}, -A_{15}, -\frac{i}{2}\sqrt{3}A_{0};

P: \{\frac{1}{4} \frac{1}{4} \frac{1}{4} \};

C_{31}, C_{2z}, C_{2a}, C_{-2}, T;\}

R_2; 2, \frac{\sqrt{a_{0}+i\sqrt{3}a_{0}}}{2}, \sigma_{21}, \sigma_{22}, \sigma_{23};
R_3; 2, \sigma_{16}, \sigma_{21}, \sigma_{22}, \sigma_{23};
R_4; 2, \sigma_{19}, \sigma_{21}, \sigma_{22}, \sigma_{23};

N: (00\frac{1}{2});

C_{2a}, C_{2b}, T;\}

R_1; 1, 1, 1;
R_2; 1, 1, 1;
R_3; 1, 1, 1;
R_4; 1, 1, 1;

Σ; GN;

C_{2a}, C_{2b} T;\}

R_1; 1, 1, 1;
R_2; 1, 1, 1;
R_3; 1, 1, 1;
R_4; 1, 1, 1;

Δ; GN;

C_{4y}, C_{2c} T;\}

R_1; 1, 1, 1;
R_2; 1, 1, 1;
R_3; 1, 1, 1;
R_4; 1, 1, 1;

Λ; GP;

C_{31}, C_{2c} T;\}

R_1; 1, 1, 1;
R_2; 1, 1, 1;
R_3; 1, 1, 1;
R_4; 1, 1, 1;

D; NP;

C_{2x}, C_{2b} T;\}

R_1; 1, 1, 1;
R_2; 1, 1, 1;
R_3; 1, 1, 1;
R_4; 1, 1, 1;

G; HN;

C_{2b}, T C_{2x} ;

R_1; 1, 1, 1;
R_4; 1, 1, 1;

F; PH;

C_{34}, C_{2c} T;\}

R_2; 1, 1, 1, 1, 1, 1;
R_4; 1, 1, 1, 1, 1, 1;
R_6; 1, 1, 1, 1, 1, 1;
\[ \Gamma; \{000\}; \, C_{31}, C_{2x}, C_{2x}, \sigma_{da}, \mathcal{T}; \, R_1; \, 1, 1, 1, 1, 1; \]
\[ R_2; \, 1, 1, 1, -1, 1; \]
\[ R_3; \, 2; -\frac{a_s}{\sqrt{3}} , \sigma_0, \sigma_0, \sigma_3, -\sigma_0; \]
\[ R_4; \, 3; A_{11}, -\frac{A_z}{3} - \frac{2A_s}{\sqrt{3}}, A_{13}, A_{12}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad \text{P-WNLs} \]
\[ R_5; \, 3; A_{11}, -\frac{A_z}{3} - \frac{2A_s}{\sqrt{3}}, A_{13}, -A_{12}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad \text{QCTP} \]
\[ X; \{0\frac{1}{2}0\}; \, S_{4y}^+, C_{2x}, \mathcal{T}; \]
\[ R_1; \, 1, 1, 1; \]
\[ R_2; \, 1, 1, -1; \]
\[ R_3; \, 1, 1, 1; \]
\[ R_4; \, 1, -1, 1; \]
\[ R_5; \, 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-QNL_{FX}} \]
\[ M; \{\frac{1}{2} \frac{1}{2} 0\}; \, S_{4x}^+, C_{2x}, \mathcal{T}; \]
\[ R_1; \, 1, 1, 1; \]
\[ R_2; \, 1, 1, -1; \]
\[ R_3; \, 1, 1, 1; \]
\[ R_4; \, 1, -1, 1; \]
\[ R_5; \, 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-QNL_{MR}} \]
\[ R; \{\frac{1}{2} \frac{1}{2} \frac{1}{2}\}; \, C_{31}, C_{2x}, C_{2x}, \sigma_{da}, \mathcal{T}; \]
\[ R_1; \, 1, 1, 1, 1, 1; \]
\[ R_2; \, 1, 1, 1, -1, 1; \]
\[ R_3; \, 2; -\frac{a_s}{\sqrt{3}} , \sigma_0, \sigma_0, \sigma_3, -\sigma_0; \]
\[ R_4; \, 3; A_{11}, -\frac{A_z}{3} - \frac{2A_s}{\sqrt{3}}, A_{13}, A_{12}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad \text{QCTP} \]
\[ R_5; \, 3; A_{11}, -\frac{A_z}{3} - \frac{2A_s}{\sqrt{3}}, A_{13}, -A_{12}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad \text{QCTP} \]
\[ \Delta; \Gamma X; \, C_{2y}, \sigma_{dc}, S_{4y}^+ \mathcal{T}; \]
\[ R_1; \, 1, 1, 1; \]
\[ R_2; \, 1, -1, 1; \]
\[ \{R_3, R_4\}; \, 2; -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{QNL}; \quad 0 \]
\[ \Sigma; \Gamma M; \, \sigma_{dc}, \mathcal{T} C_{2x}; \]
\[ R_1; \, 1, 1; \]
\[ R_2; \, 1, -1; \]
\[ \Lambda; \Gamma R; \, C_{31}^+, \sigma_{dc}; \]
\[ R_1; \, 1, 1; \]
\[ R_2; \, 1, -1; \]
\[ R_3; \, 2; -\frac{a_s}{\sqrt{3}} , \sigma_3; \quad \text{WNL}; \quad \pi \]
\[ S; \Gamma R; \, \sigma_{dc}, \mathcal{T} \sigma_{dc}; \]
\[ R_1; \, 1, 1; \]
\[ R_2; \, 1, -1; \]
\[ Z; \Gamma M; \, C_{2x}, \mathcal{T} C_{2y}; \]
\[ R_1; \, 1, 1; \]
\[ R_2; \, 1, -1; \]
\[ T; \Gamma R; \, C_{2x}, \sigma_{dc}, S_{4x}^+ \mathcal{T}; \]
\[ R_1; \, 1, 1, 1; \]
\[ R_2; \, 1, -1, 1; \]
\[ \{R_3, R_4\}; \, 2; -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{QNL}; \quad 0 \]
Γ; (000); \( C_{31}^+, C_{2x}, C_{2x}, \sigma_{da}, T; \) R₁; 1, 1, 1, 1, 1;
R₂; 1, 1, 1, 1, 1;
R₃; 2; \( \frac{1}{2} \left( -\sigma_0 + i\sqrt{3}\sigma_2 \right) \), \( \sigma_0, \sigma_0, \sigma_3, -\sigma_0; \) P-WNLs
R₄; 3; \( A_{11}, -\frac{\Delta_0}{\sqrt{3}} \), \( A_{13}, A_{12}, -\frac{i(\sqrt{3}+1)\Delta_0}{2} \); QCTP;
R₅; 3; \( A_{11}, -\frac{\Delta_0}{\sqrt{3}} \), \( A_{13}, -A_{12}, -\frac{i(\sqrt{3}+1)\Delta_0}{2} \); QCTP;

X; (\( \frac{1}{2}0\frac{1}{2} \)); \( S_{4y}^+, C_{2x}, T; \) R₁; 1, 1, 1, 1;
R₂; 1, 1, 1, 1;
R₃; 1, 1, 1, 1;
R₄; 1, -1, 1, 1;
R₅; 2; \( i\sigma_2, \sigma_3, -\sigma_0; \) P-WNL₁X;}

L; (\( \frac{1}{2}1\frac{1}{2} \)); \( C_{d3}^+, \sigma_{da}, T; \) R₁; 1, 1, 1, 1;
R₂; 1, 1, 1, 1;
R₃; 2; \( -\sigma_0 - i\sqrt{3}\sigma_2 \), \( \sigma_3, -\sigma_0; \) P-WNLs;

W; (\( \frac{1}{2}1\frac{1}{2} \)); \( S_{4x}^+, T\sigma_{df}; \) R₁; 1, 1, 1;
R₂; 1, i, 1;
R₃; 1, -1, 1;
R₄; 1, i, 1;

Δ; ΓX; \( C_{2y}\sigma_{dc}, S_{4y}^+, T; \) R₁; 1, 1, 1, 1;
R₂; 1, 1, 1, 1;
\( \{ R₃, R₄ \}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \) QNL; 0

Λ; ΓL; \( C_{31}^+, \sigma_{da}; \) R₁; 1, 1, 1;
R₂; 1, 1, 1;
R₃; 2; \( \frac{1}{2} \left( -\sigma_0 - i\sqrt{3}\sigma_2 \right) \), \( \sigma_3; \) WNL; \( \pi \)

Σ; ΓΣ; \( \sigma_{db}, T C_{2x}; \) R₁; 1, 1, 1;
R₂; 1, 1, 1;
R₃; 2; \( \frac{1}{2} \left( -\sigma_0 - i\sqrt{3}\sigma_2 \right) \), \( \sigma_3; \) WNL; \( \pi \)

S; XS; \( \sigma_{dc}, T \sigma_{dc}; \) R₁; 1, 1, 1;
R₂; 1, 1, 1;
R₃; 1, 1, 1;

Z; XW; \( C_{2x}, T C_{2y}; \) R₁; 1, 1, 1;
R₂; 1, 1, 1;
R₃; 1, 1, 1;

Q; LW; \( E, T \sigma_{dy}; \) R₁; 1, 1, 1;
Γ0: \( C_{31}^+[000], C_{22}[000], C_{22}[000], \sigma_{da}[000], T; \) Non-Centrosymmetric; without SOC

\[ \begin{align*}
\Gamma; \quad (000); \quad C_{31}, C_{22}, C_{22}, \sigma, C_{da}, T; \quad R_3; \quad 1; 1, 1, 1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_2), \sigma_0, \sigma_3, -\sigma_0; \quad \text{P-WNLs} \\
&; \quad R_4; \quad 3; A_{13}, -\frac{A_3}{\sqrt{3}}, A_{13}, A_{12}, -\frac{i(\sqrt{3} - i)A_0}{2}; \quad \text{QCTP}; \\
&; \quad R_5; \quad 3; A_{11}, -\frac{A_3}{\sqrt{3}}, A_{13}, -A_{12}, -\frac{i(\sqrt{3} - i)A_0}{2}; \quad \text{QCTP}; \\
H; \quad \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); \quad C_{31}, C_{22}, C_{22}, \sigma_{da}, T; \quad R_3; \quad 1; 1, 1, 1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_2), \sigma_0, \sigma_0, -\sigma_0; \quad \text{P-WNLs} \\
&; \quad R_4; \quad 3; A_{13}, -\frac{A_3}{\sqrt{3}}, A_{13}, A_{12}, -\frac{i(\sqrt{3} - i)A_0}{2}; \quad \text{QCTP}; \\
&; \quad R_5; \quad 3; A_{11}, -\frac{A_3}{\sqrt{3}}, A_{13}, -A_{12}, -\frac{i(\sqrt{3} - i)A_0}{2}; \quad \text{QCTP}; \\
P; \quad \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); \quad C_{31}, C_{22}, C_{22}, \sigma_{da}; \quad R_3; \quad 1; 1, 1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_2), \sigma_0, \sigma_0, -\sigma_0; \quad \text{P-WNLs} \\
&; \quad R_4; \quad 3; A_{13}, -\frac{A_3}{\sqrt{3}}, A_{13}, A_{12}; \quad \text{TP}; \quad 0 \\
&; \quad R_5; \quad 3; A_{11}, -\frac{A_3}{\sqrt{3}}, A_{13}, -A_{12}; \quad \text{TP}; \quad 0 \\
N; \quad \left( 0 \frac{1}{2} \frac{1}{2} \right); \quad C_{22}, \sigma_{da}, T; \quad R_3; \quad 1; 1, 1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 2; -\sigma_0, \sigma_0, -i\sigma_2; \quad \text{QNL}; \quad 0 \\
\Sigma; \quad \Gamma N; \quad \sigma_{da}, TC_{22}; \quad R_3; \quad 1; 1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 1; 1, 1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 1; -1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 1; -1, 1; \\
\Delta; \quad \Gamma H; \quad C_{22}, \sigma_{da}, S_{1y}^+ T; \quad R_3; \quad 1; 1, 1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 1; 1, -1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 2; \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3; \quad \text{WNL}; \quad \pi \\
A; \quad \Gamma P; \quad C_{31}, \sigma_{da}; \quad R_3; \quad 1; 1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 1; 1, -1; \\
&; \quad \{ R_3, R_4 \}; \quad 2; \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3; \quad \text{WNL}; \quad \pi \\
D; \quad \Gamma P; \quad C_{22}, \sigma_{da}; \quad R_3; \quad 1; 1, 1; \\
&; \quad \{ R_3, R_4 \}; \quad 1; 1, -1; \\
&; \quad \{ R_3, R_4 \}; \quad 2; \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3; \quad \text{WNL}; \quad \pi
Non-Centrosymmetric; without SOC

\[ \Gamma; \{C_{31}[000], \{C_{2x}[000], \{C_{2y}[000], \{\sigma_{dc}, [1\ 1\ 1\ 1]\}\}; T; \]

\[ \Gamma; (000); C_{31}, C_{2x}, C_{2y}, \sigma_{dc}, T; R_1; 1, 1, 1, 1, 1; \]

\[ R_2; 1, 1, 1, -1, 1; \]

\[ R_3; 2, -\frac{i}{2} (\sigma_0 + i\sqrt{3}\sigma_2), \sigma_0, \sigma_0, \sigma_3, -\sigma_0; \]

\[ R_4; 3, A_{11} - \frac{4\hbar}{c} \frac{2\hbar}{\sqrt{3}}, A_{13}, A_{12}, -i\frac{(\sqrt{3} - i)A_0}{2}; \]

\[ R_5; 3, A_{11} - \frac{4\hbar}{c} \frac{2\hbar}{\sqrt{3}}, A_{13}, -A_{12}, -i\frac{(\sqrt{3} - i)A_0}{2}; \]

\[ X; (01\ 0); S_{4y}^+, C_{2y}, C_{2x}, T; \]

\[ \{R_5, R_6\}; 2, i\sigma_3, \sigma_0, \sigma_0, \sigma_1; \]

\[ \{R_7, R_8\}; 2, -i\sigma_3, \sigma_0, -\sigma_0, \sigma_1; \]

\[ R_9; 2, \sigma_1, -\sigma_0, \sigma_3, -\sigma_0; \]

\[ M; (1\ 1\ 0); S_{4x}^+, C_{2x}, T; \]

\[ R_1; 1, 1, 1, 1; \]

\[ R_2; 1, -1, 1; \]

\[ R_3; 1, -1, 1; \]

\[ R_4; 1, -1, 1; \]

\[ R_5; 2, i\sigma_2, \sigma_3, -\sigma_0; \]

\[ R_6; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); S_{4x}^+, \sigma_{dc}, C_{31}, T; \]

\[ \{R_3, R_4\}; 2, i\sigma_3, i\sigma_3, \sigma_0, \sigma_1; \]

\[ \{R_6, R_8\}; 4, i\frac{(\sqrt{3} + \Gamma_0.1 - \Gamma_0.2)}{2}, i\Gamma_0.2, -\Gamma_0.0 + i\sqrt{3}\Gamma_0.0, -\Gamma_2.2; \]

\[ \{R_9, R_{10}\}; 6, -S_{3,1} - \frac{i(S_{0,0} - \sqrt{3}S_{3,2})}{3}, S_{15}, -S_6, S_{1,0}; \]

\[ \Delta; \Gamma X; C_{2y}, \sigma_{dc}, S_{4y}^+, T; \]

\[ R_1; 1, 1, 1; \]

\[ R_2; 1, -1, 1; \]

\[ \{R_3, R_4\}; 2, -\sigma_0, \sigma_3, -i\sigma_2; \]

\[ \Sigma; \Gamma M; \sigma_{dc}, T C_{2x}; \]

\[ R_1; 1, 1; \]

\[ R_2; 1, -1, 1; \]

\[ \Lambda; \Gamma R; C_{31}^+, \sigma_{dc}; \]

\[ R_1; 1, 1, 1; \]

\[ R_2; 1, -1, 1; \]

\[ R_3; 2, -\frac{i}{2} (\sigma_0 + i\sqrt{3}\sigma_2), \sigma_3; \]

\[ S; X R; \sigma_{dc}, T \sigma_{dc}; \]

\[ \{R_1, R_2\}; 2, -i\sigma_3, -i\sigma_2; \]

\[ Z; X M; C_{2x}, T C_{2y}; \]

\[ R_1; 1, 1, 1; \]

\[ R_2; 1, -1, 1; \]

\[ T; M R; C_{2z}, \sigma_{dc}, S_{4x}^+, T; \]

\[ \{R_1, R_2\}; 2, \sigma_0, -\sigma_3, -i\sigma_2; \]

\[ R_3; 1, -1, -1, 1; \]

\[ R_4; 1, -1, 1, 1; \]
\( \Gamma_0; \{C_{3v}[000], C_{2v}[000], C_{2v}[000], \sigma_{db}[\begin{array}{c}000 \end{array}], \sigma_{dz}[\begin{array}{c}000 \end{array}], \} \), \( T \); Non-Centrosymmetric; without SOC

\( \Gamma; (000); C_{3v}^{\pm}, C_{2v}, \sigma_{db}, T; R_1; 1, 1, 1, 1, 1; \)

\( R_2; 1, 1, 1, -1, 1; \)

\( R_3; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_2), \sigma_0, \sigma_0, -\sigma_0; \quad \text{P-WNLs} \)

\( R_4; 3; A_{11}, -\frac{A_0}{3} - \frac{2A_1}{\sqrt{3}}, A_{13}, A_{12}, -\frac{1}{2}i (\sqrt{3} - i) A_0; \quad \text{QCTP} \)

\( R_5; 3; A_{11}, -\frac{A_0}{3} - \frac{2A_1}{\sqrt{3}}, A_{13}, -A_{12}, -\frac{1}{2}i (\sqrt{3} - i) A_0; \quad \text{QCTP} \)

\( X; (\frac{1}{4}0\frac{1}{2}); S_{4y}^{\pm}, C_{2v}, T; \)

\( R_1; 1, 1, 1, 1; \)

\( R_2; 1, -1, 1; \)

\( R_3; 1, -1, 1; \)

\( R_4; 1, -1, -1; \)

\( R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{P-QNL}_{\Gamma,X}; \)

\( L; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{3v}^{\pm}, \sigma_{db}, T; \)

\( \{R_3, R_4\}; 2; -\sigma_0, i\sigma_3, \sigma_1; \quad \text{P-WNLs} \)

\( \{R_6, R_6\}; 4; \frac{1}{2} (\Gamma_{0,0} - i\sqrt{3}\Gamma_{0,2}), i\Gamma_{0,2}, -\Gamma_{2,2}; \quad \text{DP}; \quad 0 \)

\( W; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); S_{4z}^{\pm}, T; \sigma_{df}; \)

\( \{R_1, R_3\}; 2; \sigma_3, -i\sigma_2; \quad \text{P-WNLs} \)

\( \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \quad \text{P-WNLs} \)

\( \Delta; \Gamma X; C_{2v}, \sigma_{dc}, S_{4y}^{\pm}, T; \)

\( R_1; 1, 1, 1, 1; \)

\( R_2; 1, -1, 1; \)

\( R_3, R_4; 2; -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{QNL}; \quad 0 \)

\( \Lambda; \Gamma L; C_{3v}^{+}, \sigma_{db}; \)

\( R_1; 1, 1, 1; \)

\( R_2; 1, 1, -1; \)

\( R_3; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3; \quad \text{WNL}; \quad \pi \)

\( \Sigma; \Gamma \Sigma; \sigma_{db}, TC; \)

\( R_1; 1, 1, 1; \)

\( R_2; 1, -1, 1; \)

\( S; \Gamma S; \sigma_{dc}, T \sigma_{dc}; \)

\( R_1; 1, -1, 1; \)

\( R_2; 1, 1, 1; \)

\( Z; \Gamma W; C_{2v}, TC_{2v}; \)

\( R_1; 1, 1, 1; \)

\( R_2; 1, -1, 1; \)

\( Q; \Gamma W; E, T \sigma_{df}; \)

\( \{R_1, R_1\}; 2; \sigma_0, -i\sigma_2; \quad \text{WNL}; \quad \pi \)
\[
\Gamma_{000}; C_{31}, C_{2z}, C_{2x}, \sigma_{da}, T; R_3; 1, 1, 1, 1, 1; \\
R_2; 1, 1, 1, -1, 1; \\
R_3; 2 \left( -\sigma_0 + i\sqrt{3}\sigma_2 \right), \sigma_0, \sigma_0, \sigma_3, -\sigma_0; \\
P-WNLs \\
R_4; 3; A_{11}, -\frac{d_{x^2}}{2} - \frac{2\sigma_3}{\sqrt{3}}, A_{13}, A_{12}, -\frac{1}{2}(\sqrt{3} - i)A_0; \\
QCTP; \\
\{R_3, R_4\}; 2; i\sigma_3, i\sigma_3, \sigma_0, \sigma_1; \\
\{R_5, R_6\}; 4; \frac{i(\sqrt{T}-\Gamma_{000})_{\sigma_0}}{2}, i\Gamma_{000}, -\Gamma_{000}, \sqrt{T}; \\
CCDP; 0 \\
\{R_9, R_{10}\}; 6; -S_{3,1} - i(S_{3,0} - \sqrt{T}S_{3,0}); S_{15}, S_{10}, S_{1}; \\
SP; 0 \\
P_{\frac{1}{2}(1.1.1)}; C_{32}^{+}, C_{2y}, C_{2x}, S_{4x}^+; \\
R_9; 2; -\sigma_0, -i\sigma_0; \\
P-WNLs; \\
R_{10}; 2; \frac{\sqrt{3}\sigma_3 - i\sigma_2}{2}, i\sigma_7, \sigma_{24}, \sigma_{25}; \\
P-WNLs; \\
R_{10}; 4; \Gamma_{00}, \Gamma_{01}, -\Gamma_{03}, \left( \frac{1}{2} + \frac{1}{2} \right)(\Gamma_{03} - i\Gamma_{23}); \\
DP; 0 \\
N_{\frac{1}{2}(0.0.0.0)}; \sigma_{db}, C_{2z}, T; \\
R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \\
P-WNLs; \\
\Sigma; \Gamma N; \sigma_{db}, TC_{2z}; \\
R_1; 1, 1, 1; \\
R_2; 1; -1, 1; \\
\Delta; \Gamma H; C_{2y}, \sigma_{da}, S_{4y}^+, T; \\
R_1; 1, 1, 1; \\
R_2; 1; 1, -1, 1; \\
\{R_3, R_4\}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \\
QNL; 0 \\
\Lambda; \Gamma P; C_{31}^{+}, \sigma_{db}; \\
R_1; 1, 1, 1; \\
R_2; 1; 1, -1; \\
R_3; 2; \frac{1}{2}( -\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3; \\
WNL; \pi \\
D; \Lambda P; C_{32}, \sigma_{db}; \\
R_5; 2; \sigma_2, -i\sigma_2; \\
WNL; \pi \\
G; \Lambda N; \sigma_{da}, T, \sigma_{db}; \\
\{R_1, R_2\}; 2; \sigma_3, -i\sigma_2; \\
WNL; \pi \\
F; \Phi H; C_{34}^+, \sigma_{da}; \\
R_3; 1; i, -(1)^{3/4}; \\
R_4; 1; i, (1)^{3/4}; \\
R_6; 2; -\frac{1}{2}i(\sigma_0 - i\sqrt{3}\sigma_2), -(1)^{3/4}\sigma_3; \\
WNL; \pi
SG 221

Γ; \{S^z_{61}|000\}, \{\sigma_x|000\}, \{\sigma_z|000\}, \{C_{2c}|000\}, \mathcal{T}; Centrosymmetric; without SOC

Γ; (000); \(S^-_{61}, \sigma_x, \sigma_z, C_{2c}, \mathcal{T}\); R_1; 1, 1, 1, 1, 1;
R_2; 1, 1, 1, 1, -1, 1;
R_3; 1, -1, -1, -1, 1, 1;
R_4; 1, -1, -1, -1, 1, 1;
R_5; \sigma_0, \sigma_0, \sigma_0, \frac{\sqrt{3}}{2} \sigma_0, \frac{\sqrt{3}}{2} \sigma_0, \sigma_0; \text{P-WNLs}
R_6; \sigma_0, \sigma_0, \frac{\sqrt{3}}{2} \sigma_0, \frac{\sqrt{3}}{2} \sigma_0, \sigma_0; \text{P-WNLs}
R_7; A_9, A_{13}, -A_9, -A_{13}, -A_{15}, -\frac{i(\sqrt{3} - i)A_0}{2}; \text{QCTP};
R_8; A_9, A_{13}, -A_9, -A_{13}, -A_{15}, -\frac{i(\sqrt{3} - i)A_0}{2}; \text{QCTP};
R_9; A_9, -A_{13}, A_9 + \frac{2\sqrt{3}}{3} A_0, A_{15}, -\frac{i(\sqrt{3} - i)A_0}{2}; \text{QCTP};
R_{10}; A_9, A_{13}, -A_9, -A_{13}, -A_{15}, -\frac{i(\sqrt{3} - i)A_0}{2}; \text{QCTP};

X; (0\frac{1}{2} 0); \(C^+_{4y}, C_{2g}, \mathcal{I}, \mathcal{T}\); R_1; 1, 1, 1, 1, 1;
R_2; 1, 1, -1, 1, 1;
R_3; 1, -1, 1, 1, 1;
R_4; 1, -1, -1, 1, 1;
R_5; i\sigma_3, \sigma_0, -\sigma_0; \text{P-QNL}_{\Gamma X}
R_6; 1, 1, -1, 1;
R_7; 1, -1, -1, 1;
R_8; 1, -1, 1, 1;
R_9; 1, 1, -1, -1, 1;
R_{10}; i\sigma_3, \sigma_0, -\sigma_0; \text{P-QNL}_{\Gamma X}

M; (\frac{1}{2} \frac{1}{2} 0); \(C^+_{4x}, C_{2g}, \mathcal{I}, \mathcal{T}\); R_1; 1, 1, 1, 1, 1;
R_2; 1, -1, 1, 1, 1;
R_3; 1, -1, 1, 1, 1;
R_4; 1, -1, -1, 1, 1;
R_5; i\sigma_3, \sigma_0, -\sigma_0; \text{P-QNL}_{\Gamma M R}
R_6; 1, 1, -1, 1;
R_7; 1, -1, -1, 1;
R_8; 1, -1, -1, 1;
R_9; 1, 1, -1, 1, 1;
R_{10}; i\sigma_3, \sigma_0, -\sigma_0; \text{P-QNL}_{\Gamma M R}

R; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \(S^-_{61}, \sigma_x, \sigma_z, C_{2c}, \mathcal{T}\); R_1; 1, 1, 1, 1, 1;
R_2; 1, 1, -1, 1, 1;
R_3; 1, -1, -1, 1, 1;
R_4; 1, -1, -1, 1, 1;
R_5; \sigma_0, \sigma_0, \sigma_0, \frac{\sqrt{3}}{2} \sigma_0, \frac{\sqrt{3}}{2} \sigma_0, \sigma_0; \text{P-WNLs}
R_6; \sigma_0, \sigma_0, \frac{\sqrt{3}}{2} \sigma_0, \frac{\sqrt{3}}{2} \sigma_0, \sigma_0; \text{P-WNLs}
R_7; A_9, A_{13}, -A_9, -A_{13}, -A_{15}, -\frac{i(\sqrt{3} - i)A_0}{2}; \text{QCTP};
R_8; A_9, A_{13}, -A_9, -A_{13}, -A_{15}, -\frac{i(\sqrt{3} - i)A_0}{2}; \text{QCTP};
R_9; A_9, -A_{13}, A_9 + \frac{2\sqrt{3}}{3} A_0, A_{15}, -\frac{i(\sqrt{3} - i)A_0}{2}; \text{QCTP};
R_{10}; A_9, -A_{13}, A_9 + \frac{2\sqrt{3}}{3} A_0, -A_{15}, -\frac{i(\sqrt{3} - i)A_0}{2}; \text{QCTP};
\[
\begin{array}{ll}
\Delta; \Gamma X; C_{4y\sigma_z I}\; & R_1; 1, 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
& R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{QNL; 0} \\
\Sigma; \Gamma M; C_{2a\sigma_z I}\; & R_1; 1, 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
\Lambda; \Gamma R; C_{31\sigma_{db} I}\; & R_1; 1, 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 2; \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0; \quad \text{WNL; } \pi \\
S; \Xi R; C_{2e\sigma_y I}\; & R_1; 1, 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
Z; \Xi M; C_{2x\sigma_z I}\; & R_1; 1, 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
T; \Xi R; C_{4z\sigma_y I}\; & R_1; 1, 1, 1, 1; \\
& R_2; 1, 1, -1, 1; \\
& R_3; 1, -1, 1, 1; \\
& R_4; 1, -1, -1, 1; \\
& R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \quad \text{QNL; 0}
\end{array}
\]
\begin{align*}
\Gamma_c \cap \{S_{31}\mid \frac{1}{2}, \frac{1}{2}\}, \{\sigma_x\mid \frac{1}{2}, \frac{1}{2}\}, \{\sigma_z\mid \frac{1}{2}, \frac{1}{2}\}, \{C_{2v}\mid \{000\}\}; T; \text{Centrosymmetric; without SOC} \\
\Gamma; \quad (000); \quad S_{31}^-; \sigma_x, \sigma_z, C_{2v}, T; \\
R_1; & \quad 1, 1, 1, 1, 1; \\
R_2; & \quad 1, 1, 1, 1, -1, 1; \\
R_3; & \quad 1, -1, -1, 1, -1, 1; \\
R_4; & \quad 1, -1, -1, 1, 1; \\
R_5; & \quad 2; \quad \frac{-\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, \frac{\sqrt{3}\sigma_1 - \sigma_3}{2}, -\sigma_0; \quad \text{P-WNLs} \\
R_6; & \quad 2; \quad \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, -\sigma_0, -\sigma_0, \frac{-\sqrt{3}\sigma_1 - \sigma_3}{2}, -\sigma_0; \quad \text{P-WNLs} \\
R_7; & \quad 3; \quad A_9, A_{13}, -\frac{A_0}{3} - \frac{2\sqrt{3}}{3}, A_{15}, -\frac{i(\sqrt{3}-i)A_0}{2}; \quad \text{QCTP} \\
R_8; & \quad 3; \quad A_9, A_{13}, -\frac{A_0}{3} - \frac{2\sqrt{3}}{3}, A_{15}, -\frac{-i(\sqrt{3}-i)A_0}{2}, \quad \text{QCTP} \\
R_9; & \quad 3; \quad -A_9, -A_{13}, \frac{A_0 + 2\sqrt{3}A_8}{3}, A_{15}, -\frac{i(\sqrt{3} + i)A_0}{2}; \quad \text{QCTP} \\
R_{10}; & \quad 3; \quad -A_9, -A_{13}, \frac{A_0 + 2\sqrt{3}A_8}{3}, A_{15}, -\frac{i(\sqrt{3} + i)A_0}{2}; \quad \text{QCTP} \\
X; \quad (0^{1/4}_2); \quad I, \sigma_x, C_{4y}, T; \\
R_{10}; & \quad 2; \quad -\sigma_3, i\sigma_2, \sigma_0, -\sigma_0; \quad \text{P-WNLs} \\
R_{11}; & \quad 2; \quad -\sigma_3, i\sigma_2, -\sigma_0, -\sigma_0; \quad \text{P-WNLs} \\
\{R_{12}, R_{13}\}; & \quad 4; \quad -\Gamma_{0,3}, \Gamma_{0,3}, -i\Gamma_{3,3}, \Gamma_{1,0}; \quad \text{QDP}; \quad 0 \\
M; \quad (1^{1/4}_2); \quad C_{4v}, \sigma_x, C_{2v}, T; \\
R_0; & \quad 2; \quad \sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs} \\
R_1; & \quad 2; \quad -i\sigma_2, \sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs} \\
R_{12}; & \quad 2; \quad -\sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs} \\
R_{13}; & \quad 2; \quad -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs} \\
R_{14}; & \quad 2; \quad -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs} \\
R_{15}; & \quad 2; \quad i\sigma_2, \sigma_3, -\sigma_0; \quad \text{QNL}; \quad 0 \\
\Delta; \quad \Gamma X; \quad C_{4y}, \sigma_x, I, T; \\
R_1; & \quad 1, 1, 1, 1; \\
R_2; & \quad 1, 1, -1, 1; \\
R_3; & \quad 1, -1, 1, 1; \\
R_4; & \quad 1, -1, 1, 1; \\
R_5; & \quad 2; \quad i\sigma_2, \sigma_3, -\sigma_0; \quad \text{QNL}; \quad 0 \\
\Sigma; \quad \Gamma M; \quad C_{2v}, \sigma_z, I, T; \\
R_1; & \quad 1, 1, 1, 1; \\
R_2; & \quad 1, 1, -1, 1; \\
R_3; & \quad 1, -1, 1, 1; \\
R_4; & \quad 1, -1, 1, 1; \\
R_5; & \quad 2; \quad \frac{1 - \sigma_0 - i\sqrt{3}\sigma_3}{2}, \sigma_3, -\sigma_0; \quad \text{WNL}; \quad \pi \\
S; \quad \Gamma R; \quad C_{2v}, \sigma_z, I, T; \\
R_5; & \quad 2; \quad \sigma_2, \sigma_3, -i\sigma_1; \quad \text{WNL}; \quad \pi \\
Z; \quad \Gamma R; \quad C_{2v}, \sigma_z, I, T; \\
R_5; & \quad 2; \quad \sigma_2, \sigma_3, -i\sigma_1; \quad \text{WNL}; \quad \pi \\
T; \quad MR; \quad C_{4v}, C_{2v}, \sigma_{da}, I, T; \\
R_5; & \quad 1; \quad i, -1, -1, 1; \\
R_6; & \quad 1, -1, -1, 1; \\
R_7; & \quad 1, -1, 1, 1; \\
R_8; & \quad 1, i, -1, 1; \\
R_9; & \quad 2; \quad \sigma_1, \sigma_0, -\sigma_3, -i\sigma_3; \quad \text{QNL}; \quad 0
\end{align*}
$\Gamma_c$: \{S^+_0, \sigma_x, \sigma_z, C_{2c}, T\}; Centrosymmetric; without SOC

$\Gamma$: (000); \( S^+_{0}, \sigma_x, \sigma_z, C_{2c}, T \);
\[ R_i: \]
1, 1, 1, 1, 1;
\[ R_2: \]
1, 1, 1, 1, 1;
\[ R_3: \]
1, 1, 1, 1, 1;
\[ R_4: \]
1, 1, 1, 1, 1;
\[ R_5: \]
2, \(-\sigma_0 + \sqrt{3} \sigma_2\), \(\sigma_0, \sigma_0, \sigma_0, \sigma_0, \sigma_0\);
P-WNLs
\[ R_6: \]
2, \(-\sigma_0 + \sqrt{3} \sigma_2\), \(-\sigma_0, \sigma_0, \sigma_0, \sigma_0, \sigma_0\);
P-WNLs
\[ R_7: \]
3, \(A_9, A_{13}, -\frac{A_9}{3} + \frac{2A_9}{\sqrt{3}}\), \(A_{15}, -\frac{3}{2}(\sqrt{3} - i)A_0\);
QCTP
\[ R_8: \]
3, \(A_9, A_{13}, -\frac{A_9}{3} + \frac{2A_9}{\sqrt{3}}\), \(-A_{15}, \frac{3}{2}(\sqrt{3} - i)A_0\);
QCTP
\[ R_9: \]
3, \(-A_9, -A_{13}, \frac{A_9 + 2\sqrt{3}A_9}{3}, A_{15}, -\frac{i(\sqrt{3} - i)A_0}{2}\);
QCTP
\[ R_{10}: \]
3, \(-A_9, -A_{13}, \frac{A_9 + 2\sqrt{3}A_9}{3}, -A_{15}, -\frac{i(\sqrt{3} - i)A_0}{2}\);
QCTP

$X$: (0\(\frac{1}{2}\)0); \( S^+_{49}, \sigma_{dc}, C_{2c}, T \);
\[ R_9: \]
2, \(\sigma_1, i\sigma_2, \sigma_1, -\sigma_0\);
P-WNLs
\[ R_{11}: \]
2, \(-i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0\);
P-WNLs
\[ R_{12}: \]
2, \(-\sigma_1, i\sigma_2, \sigma_1, -\sigma_0\);
P-WNLs
\[ R_{14}: \]
2, \(-i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0\);
P-WNLs

$M$: (\(\frac{1}{2}\frac{1}{2}\)0); \( C^+_{4s}, C_{2s}, l, T \);
\[ R_i: \]
1, 1, 1, 1, 1;
\[ R_2: \]
1, 1, 1, 1, 1;
\[ R_3: \]
1, 1, 1, 1, 1;
\[ R_4: \]
1, 1, 1, 1, 1;
\[ R_5: \]
2, \(i\sigma_2, \sigma_3, \sigma_0, -\sigma_0\);
P-QNL\text{MR}
\[ R_6: \]
1, 1, 1, 1, 1;
\[ R_7: \]
1, 1, 1, 1, 1;
\[ R_8: \]
1, 1, 1, 1, 1;
\[ R_9: \]
1, 1, 1, 1, 1;
\[ R_{10}: \]
2, \(i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0\);
P-QNL\text{MR}

$R$: (\(\frac{1}{2}\frac{1}{2}\)0); \( C^+_{32}, C_{2x}, C_{2y}, C_{2f}, l, T \);
\[ R_i: \]
2, \(-\sigma_0, \sigma_0, \sigma_0, \sigma_0, \sigma_0, \sigma_0\);
P-WNLs
\[ R_6: \]
4, \(\frac{1}{3}G_{0.6-\nu}, \frac{1}{3}G_{0.3}, \frac{1}{3}G_{0.3}, \frac{1}{3}G_{0.3}, \frac{1}{3}G_{0.6-\nu}\);
CCDP
\[ R_{14}: \]
6, \(S_1, S_2, S_3, S_4, S_5, -S_0\);
SP

$\Delta$: \( \Gamma X \); \( C^+_{4y}, \sigma_z, I, T \);
\[ R_i: \]
1, 1, 1, 1;
\[ R_2: \]
1, 1, 1, 1;
\[ R_3: \]
1, 1, 1, 1;
\[ R_4: \]
1, 1, 1, 1;
\[ R_5: \]
2, \(i\sigma_2, \sigma_3, -\sigma_0\);
QNL

$\Sigma$: \( \Gamma M \); \( C_{2s}, \sigma_z, I, T \);
\[ R_i: \]
1, 1, 1, 1;
\[ R_2: \]
1, 1, 1, 1;
\[ R_3: \]
1, 1, 1, 1;
\[ R_4: \]
1, 1, 1, 1;

$L$: \( \Gamma R \); \( C^+_{31}, \sigma_{dc}, I, T \);
\[ R_i: \]
1, 1, 1, 1;
\[ R_2: \]
1, 1, 1, 1;
\[ R_3: \]
2, \(\frac{1}{2}(-\sigma_0 - \sqrt{3}\sigma_2), \sigma_3, -\sigma_0\);
WNL

$S$: \( \Gamma R \); \( C_{2c}, \sigma_y, I, T \);
\[ R_i: \]
2, \(\sigma_2, \sigma_3, -\sigma_0\);
WNL

$Z$: \( \Gamma X \); \( C_{2s}, \sigma_z, I, T \);
\[ R_i: \]
1, 1, 1, 1;
\[ R_2: \]
1, 1, 1, 1;
\[ R_3: \]
1, 1, 1, 1;
\[ R_4: \]
1, 1, 1, 1;
$T; \text{MR}; C_{4z}^+; \sigma_x, E, J; T; R_6; 1; -1, 1, 1, 1;
R_7; 1; -1, -1, 1, 1;
R_8; 1; 1, 1, 1, 1;
R_9; 1; 1, -1, 1, 1;
R_{10}; 2; -i\sigma_2, \sigma_3, \sigma_0, -\sigma_0; \text{QNL}; 0$
\( \Gamma_c; \{ S_{\text{6}0}^- | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ \sigma_z | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ \sigma_s | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ C_{2c} | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}; T; \) Centrosymmetric; without SOC

\( \Gamma; \) (000); \( S_{\text{6}0}^- , \sigma_x , \sigma_z , C_{2c} ; T \); \( R_5 ; \) 1, 1, 1, 1, 1, 1;

\( R_2 ; \) 1, 1, 1, 1, −1, 1;
\( R_3 ; \) 1, −1, −1, −1, −1, 1;
\( R_4 ; \) 1, −1, −1, −1, 1, 1;
\( R_5 ; \) 2, \(- \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2\sqrt{3}} , \sigma_0 , \frac{\sqrt{3}\sigma_1 - \sigma_3}{2} , -\sigma_0 \); P-WNLs
\( R_6 ; \) 2, \(- \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2\sqrt{3}} , -\sigma_0 , -\sigma_0 , \frac{\sqrt{3}\sigma_1 - \sigma_3}{2} , -\sigma_0 \); P-WNLs

\( R_7 ; \) 3, \( A_9 , A_{13} , - \frac{A_0}{\sqrt{3}}, - \frac{2A_0}{\sqrt{3}}, A_{15} , - \frac{i(\sqrt{3} - i)A_0}{2} \); QCTP;
\( R_8 ; \) 3, \( A_9 , A_{13} , - \frac{A_0}{\sqrt{3}}, - \frac{2A_0}{\sqrt{3}}, - A_{15} , - \frac{i(\sqrt{3} - i)A_0}{2} \); QCTP;
\( R_9 ; \) 3, \(- A_9 , - A_{13} , \frac{4A_0 + 2i\sqrt{3}A_0}{3} , A_{15} , - \frac{i(\sqrt{3} - i)A_0}{2} \); QCTP;
\( R_{10}; \) 3, \(- A_9 , - A_{13} , \frac{4A_0 + 2i\sqrt{3}A_0}{3} , - A_{15} , - \frac{i(\sqrt{3} - i)A_0}{2} \); QCTP;

\( X; \) (0110); \( C_{4y}^- , \sigma_x , C_{2z} , T \);

\( R_{0}; \) 2, \( \sigma_1 , i\sigma_2 , \sigma_1 , - \sigma_0 \); P-WNLs;
\( R_{11}; \) 2, \( - i\sigma_2 , i\sigma_2 , \sigma_1 , - \sigma_0 \); P-WNLs;
\( R_{12}; \) 2, \( - \sigma_1 , i\sigma_2 , \sigma_1 , - \sigma_0 \); P-WNLs;
\( R_{13}; \) 2, \( - i\sigma_2 , - i\sigma_2 , \sigma_1 , - \sigma_0 \); P-WNLs;

\( M; \) (1 1 1 0); \( C_{4z}^- , \sigma_y , C_{2y} , T \);

\( R_{0}; \) 2, \( \sigma_1 , i\sigma_2 , \sigma_1 , - \sigma_0 \); P-WNLs;
\( R_{11}; \) 2, \( - i\sigma_2 , i\sigma_2 , \sigma_1 , - \sigma_0 \); P-WNLs;
\( R_{12}; \) 2, \( - \sigma_1 , i\sigma_2 , \sigma_1 , - \sigma_0 \); P-WNLs;
\( R_{13}; \) 2, \( - i\sigma_2 , - i\sigma_2 , \sigma_1 , - \sigma_0 \); P-WNLs;

\( R; \) (1 1 1 1); \( S_{\text{6}0}^- , \sigma_x , \sigma_z , C_{2c} ; T \);

\( R_{0}; \) 1, 1, 1, 1, 1, 1;
\( R_{2}; \) 1, 1, 1, 1, −1, 1;
\( R_{3}; \) 1, −1, −1, 1, 1, 1;
\( R_{4}; \) 1, −1, −1, 1, −1, 1;
\( R_{5}; \) 2, \(- \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2\sqrt{3}} , \sigma_0 , \frac{\sqrt{3}\sigma_1 - \sigma_3}{2} , -\sigma_0 \); P-WNLs
\( R_{6}; \) 2, \(- \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2\sqrt{3}} , -\sigma_0 , -\sigma_0 , \frac{\sqrt{3}\sigma_1 - \sigma_3}{2} , -\sigma_0 \); P-WNLs

\( R_{7}; \) 3, \( A_9 , A_{13} , - \frac{A_0}{\sqrt{3}}, - \frac{2A_0}{\sqrt{3}}, A_{15} , - \frac{i(\sqrt{3} - i)A_0}{2} \); QCTP;
\( R_{8}; \) 3, \( A_9 , A_{13} , - \frac{A_0}{\sqrt{3}}, - \frac{2A_0}{\sqrt{3}}, - A_{15} , - \frac{i(\sqrt{3} - i)A_0}{2} \); QCTP;
\( R_{9}; \) 3, \(- A_9 , - A_{13} , \frac{4A_0 + 2i\sqrt{3}A_0}{3} , A_{15} , - \frac{i(\sqrt{3} - i)A_0}{2} \); QCTP;
\( R_{10}; \) 3, \(- A_9 , - A_{13} , \frac{4A_0 + 2i\sqrt{3}A_0}{3} , - A_{15} , - \frac{i(\sqrt{3} - i)A_0}{2} \); QCTP;

\( \Delta; \) \( \Gamma X; \) \( C_{4y}^+ , \sigma_x , IT \);

\( R_{1}; \) 1, 1, 1, 1;
\( R_{2}; \) 1, 1, 1, −1, 1;
\( R_{3}; \) 1, −1, 1, 1;
\( R_{4}; \) 1, −1, 1, 1;
\( R_{5}; \) 2, \( i\sigma_2 , \sigma_3 , - \sigma_0 \); QNL; 0

\( \Sigma; \) \( \Gamma M; \) \( C_{2a} , \sigma_z , IT \);

\( R_{1}; \) 1, 1, 1, 1;
\( R_{2}; \) 1, 1, −1, 1;
\( R_{3}; \) 1, −1, −1, 1;
\( R_{4}; \) 1, −1, −1, 1;

\( \Lambda; \) \( \Gamma R; \) \( C_{31}^+ , \sigma_{dz} , IT \);

\( R_{1}; \) 1, 1, 1, 1;
\( R_{2}; \) 1, −1, 1, 1;
\( R_{3}; \) 1, −1, 1, 1;
\( R_{4}; \) 1, −1, 1, 1;
\( R_{5}; \) 2, \( \frac{1}{2} \left( - \sigma_0 - i\sqrt{3}\sigma_2 \right) , \sigma_3 , - \sigma_0 \); WNL; \( \pi \)

\( S; \) \( \Gamma R; \) \( C_{2a} , \sigma_{dz} , IT \);

\( R_{1}; \) 1, 1, 1, 1;
\( R_{4}; \) 1, −1, 1, 1;
\( R_{6}; \) 1, −1, −1, 1;
\( R_{8}; \) 1, −1, −1, 1;

\( Z; \) \( \Gamma M; \) \( \sigma_y , C_{2z} , IT \);

\( R_{5}; \) 2, \( \sigma_2 , \sigma_3 , - i\sigma_1 \); WNL; \( \pi \)
$T; \sigma_x, C_{2z}, \sigma_{db}, IT; R_5; 1; -i, 1, 1, 1$

$R_6; 1; i, 1, 1, 1$

$R_7; 1; i, 1, -1, 1$

$R_8; 1; -i, 1, -1, 1$

$R_{10}; 2; -i\sigma_2, -\sigma_0, \sigma_3, -i\sigma_3; QNL; 0$
$$\Gamma_l; \{S_{61}|000\}; \{\sigma_x|000\}; \{\sigma_z|000\}; \{C_{2v}|000\}; T; \text{Centrosymmetric; without SOC}$$

| $\Gamma$ | (000) | $S_{61}, \sigma_x, \sigma_z, C_{2v}, T$ | $R_1$ | $1, 1, 1, 1, 1$ |
|----------|--------|-----------------|------|----------------|
| $R_2$ | $1, 1, 1, -1, 1$ |
| $R_3$ | $1, -1, -1, -1, 1$ |
| $R_4$ | $1, -1, -1, -1, 1$ |
| $R_5$ | $\frac{-\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_0, \sigma_0, \sqrt{\sigma_1^2 - \sigma_2^2}, -\sigma_0$ | P-WNLs |
| $R_6$ | $\frac{-\sigma_0 + i\sqrt{3}\sigma_2}{2}, -\sigma_0, -\sigma_0, \sqrt{\sigma_1^2 - \sigma_2^2}, -\sigma_0$ | P-WNLs |
| $R_7$ | $3; A_9, A_13, -\frac{A_9}{3}, \frac{2A_9}{3}, A_{15}, -\frac{i(\sqrt{3} - 1)A_9}{2}$ | QCTP |
| $R_8$ | $3; A_9, A_{13}, -\frac{A_9}{3}, \frac{2A_9}{3}, -A_{15}, -\frac{i(\sqrt{3} - 1)A_9}{2}$ | QCTP |
| $R_9$ | $3; -A_9, -A_{13}, \frac{A_9}{3} + 2\sqrt{3}A_{15}, A_{15}, -\frac{i(\sqrt{3} - 1)A_9}{2}$ | QCTP |
| $R_{10}$ | $3; -A_9, -A_{13}, \frac{A_9}{3} + 2\sqrt{3}A_{15}, -A_{15}, -\frac{i(\sqrt{3} - 1)A_9}{2}$ | QCTP |

| $X; \frac{1}{2}0\frac{1}{2}$ | $C_{4y}, C_{2z}, I, T$ | $R_1$ | $1, 1, 1, 1$ |
| $R_2$ | $1, -1, 1, 1$ |
| $R_3$ | $1, -1, 1, 1$ |
| $R_4$ | $1, -1, -1, 1$ |
| $R_5$ | $2; i\sigma_2, \sigma_3, \sigma_0, -\sigma_0$ | P-QNL $\Gamma_X$ |
| $R_6$ | $1, 1, -1, 1$ |
| $R_7$ | $1, -1, -1, 1$ |
| $R_8$ | $1, -1, -1, 1$ |
| $R_9$ | $1, -1, -1, 1$ |
| $R_{10}$ | $2; i\sigma_2, \sigma_3, -\sigma_0, -\sigma_0$ | P-QNL $\Gamma_X$ |

| $L; \frac{1}{2}0\frac{1}{2}$ | $S_{61}, C_{28}, T$ | $R_1$ | $1, 1, 1, 1$ |
| $R_2$ | $1, -1, 1, 1$ |
| $R_3$ | $1, -1, 1, 1$ |
| $R_4$ | $1, -1, -1, 1$ |
| $R_5$ | $2; \frac{1}{2}( -\sigma_0 - i\sqrt{3}\sigma_2 ), \sigma_3, -\sigma_0$ | P-WNLs |
| $R_6$ | $2; \frac{1}{2}( \sigma_0 - i\sqrt{3}\sigma_2 ), \sigma_3, -\sigma_0$ | P-WNLs |

| $W; \frac{1}{2}0\frac{1}{2}$ | $S_{4v}, C_{2d}, I, T$ | $R_1$ | $1, 1, 1, 1$ |
| $R_2$ | $1, -1, 1, 1$ |
| $R_3$ | $1, -1, 1, 1$ |
| $R_4$ | $1, -1, 1, 1$ |
| $R_5$ | $2; i\sigma_2, \sigma_3, -\sigma_0$ | P-WNLs |

| $\Delta; \Gamma X$ | $C_{4y}, \sigma_z, I, T$ | $R_1$ | $1, 1, 1, 1$ |
| $R_2$ | $1, -1, 1, 1$ |
| $R_3$ | $1, -1, 1, 1$ |
| $R_4$ | $1, -1, 1, 1$ |
| $R_5$ | $2; i\sigma_2, \sigma_3, -\sigma_0$ | QNL; 0 |

| $\Lambda; \Gamma L$ | $C_{31}, \sigma_{db}, I, T$ | $R_1$ | $1, 1, 1, 1$ |
| $R_2$ | $1, -1, 1, 1$ |
| $R_3$ | $2; \frac{1}{2}( -\sigma_0 - i\sqrt{3}\sigma_2 ), \sigma_3, -\sigma_0$ | WNL; \pi |

| $\Sigma; \Gamma \Sigma$ | $C_{2a}, \sigma_z, I, T$ | $R_1$ | $1, 1, 1, 1$ |
| $R_2$ | $1, -1, 1, 1$ |
| $R_3$ | $1, -1, 1, 1$ |
| $R_4$ | $1, -1, -1, 1$ |
|   |   |   |   |   |
|---|---|---|---|---|
| $S$; $XS$; $C_{2c}, \sigma_y.IT$; | $R_1$; 1; 1, 1, 1; |
|   | $R_2$; 1; 1, -1, 1; |
|   | $R_3$; 1; -1, 1, 1; |
|   | $R_4$; 1; -1, -1, 1; |
| $Z$; $XW$; $C_{2s}, \sigma_z.IT$; | $R_1$; 1; 1, 1, 1; |
|   | $R_2$; 1; 1, -1, 1; |
|   | $R_3$; 1; -1, 1, 1; |
|   | $R_4$; 1; -1, -1, 1; |
| $Q$; $LW$; $C_{2f}.IT$; | $R_1$; 1; 1, 1; |
|   | $R_2$; 1; -1, 1; |
\[ \Gamma^f: \{S_{g1}^{v}, \sigma_z, \sigma_x, C_{2v}, T\}; \Gamma; (000); S_{g1}^{v}, \sigma_z, \sigma_x, C_{2v}, T; R_3; 1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, 1, 1, 1; \]
\[ R_3; 1, -1, -1, -1, 1; \]
\[ R_4; 1, -1, -1, 1, 1; \]
\[ R_5; 2, \frac{-\sigma_0 - \sqrt{3} \sigma_2}{2}, \sigma_0, \frac{\sqrt{3} \sigma_1 - \sigma_3}{2}, -\sigma_0; \text{ P-WNLs} \]
\[ R_6; 2, \frac{\sigma_0 + \sqrt{3} \sigma_2}{2}, -\sigma_0, -\sigma_0, \frac{\sqrt{3} \sigma_1 - \sigma_3}{2}, -\sigma_0; \text{ P-WNLs} \]
\[ R_7; 3, A_{9}, A_{13}, -\frac{\sigma_0 - \sqrt{3} \sigma_2}{2}, A_{15}, -i \left( \frac{\sqrt{3} \sigma_1 - \sigma_3}{2} \right) A_0; \text{ QCTP} \]
\[ R_8; 3, A_{9}, A_{13}, -\frac{\sigma_0 + \sqrt{3} \sigma_2}{2}, -A_{15}, -i \left( \frac{\sqrt{3} \sigma_1 - \sigma_3}{2} \right) A_0; \text{ QCTP} \]
\[ R_9; 3, -A_{9}, -A_{13}, -\frac{\sigma_0 + \sqrt{3} \sigma_2}{2}, A_{15}, -i \left( \frac{\sqrt{3} \sigma_1 - \sigma_3}{2} \right) A_0; \text{ QCTP} \]
\[ R_{10}; 3, -A_{9}, -A_{13}, A_{15}, -i \left( \frac{\sqrt{3} \sigma_1 - \sigma_3}{2} \right) A_0; \text{ QCTP} \]

\[ \Delta; \Gamma X; C_{4g}^{v}, \sigma_x, I, T; R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, 1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, 1, 1; \]
\[ R_5; 2, i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-QNL}_{\Gamma X} \]
\[ R_6; 1, 1, 1, 1; \]
\[ R_7; 1, 1, -1, 1; \]
\[ R_8; 1, -1, -1, 1; \]
\[ R_9; 1, -1, -1, 1; \]
\[ R_{10}; 2, i \sigma_2, \sigma_3, -\sigma_0, -\sigma_0; \text{ P-QNL}_{\Gamma X} \]

\[ \Lambda; \Gamma L; C_{31}^{v}, \sigma_x, I, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, 1, 1, 1; \]
\[ R_4; 1, -1, 1, 1; \]
\[ R_5; 2, i \sigma_2, \sigma_3, -\sigma_0; \text{ QNL}; 0 \]

\[ \Sigma; \Gamma \Sigma; C_{2a}, \sigma_z, I, T; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, 1, 1, 1; \]
\[ R_4; 1, -1, 1, 1; \]
\[ R_5; 2, \frac{1}{2} (\sigma_0 - i \sqrt{3} \sigma_2), \sigma_3, -\sigma_0; \text{ WNL}; \pi \]

\[ S; \Sigma; C_{2e}, \sigma_y, I, T; \]
\[ R_1; 1, 1, -1, 1; \]
\[ R_2; 1, 1, 1, 1; \]
\[ R_3; 1, -1, -1, 1; \]
\[ R_4; 1, -1, 1, 1; \]
$Z; \text{XW; } C_{2z}, \sigma_z, IT; R_1; \ 1; 1, -1, 1;$

$R_2; \ 1; 1, 1, 1;$

$R_3; \ 1; -1, -1, 1;$

$R_4; \ 1; -1, 1, 1;$

$Q; \text{LW; } C_{2f}, IT; \{R_1, R_2\}; \ 2; \sigma_3, \sigma_1; \text{ WNL; } \pi$
\[ \Gamma_\Sigma; \left\{ S_{61} \frac{1}{4} \frac{1}{4} \frac{1}{4} \right\}, \left\{ \sigma_x \frac{1}{4} \frac{1}{4} \frac{1}{4} \right\}, \left\{ \sigma_z \frac{1}{4} \frac{1}{4} \frac{1}{4} \right\}, \left\{ C_{2\sigma} \frac{1}{4} \frac{1}{4} \frac{1}{4} \right\}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; \ (000); \ S_{61}^-, \sigma_x, \sigma_z, C_{2\sigma}, T; R_3; \ 1, 1, 1, 1, 1; \]
\[ R_2; \ 1, 1, 1, 1, 1; \]
\[ R_3; \ 1, -1, -1, -1, 1; \]
\[ R_4; \ 1, -1, -1, -1, 1; \]
\[ R_5; \ 2, -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_0, \sigma_0, \frac{\sqrt{3}\sigma_1 + \sigma_3}{2}, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_6; \ 2, \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, -\sigma_0, -\sigma_0, \frac{\sqrt{3}\sigma_1 - \sigma_3}{2}, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_7; \ 3, A_9, A_{13}, -\frac{A_9}{3} - \frac{2A_3}{3\sqrt{3}}, A_{15}, -\frac{i(\sqrt{3} - 1)A_3}{2}; \quad \text{QCTP} \]
\[ R_8; \ 3, A_9, A_{13}, -\frac{A_9}{3} - \frac{2A_3}{3\sqrt{3}}, -A_{15}, -\frac{i(\sqrt{3} - 1)A_3}{2}; \quad \text{QCTP} \]
\[ R_9; \ 3, -A_9, -A_{13}, \frac{A_9 + 2\sqrt{3}A_3}{3}, A_{15}, -\frac{i(\sqrt{3} - 1)A_3}{2}; \quad \text{QCTP} \]
\[ R_{10}; \ 3, -A_9, -A_{13}, \frac{A_9 + 2\sqrt{3}A_3}{3}, -A_{15}, -\frac{i(\sqrt{3} - 1)A_3}{2}; \quad \text{QCTP} \]
\[ X; \ (\frac{1}{2} 0 \frac{1}{2}); \ \sigma_x, S_{4y}^+, C_{2\sigma}, T; R_{10}; \ 2, -i\sigma_2, \sigma_1, \sigma_1, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_{11}; \ 2, -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_{12}; \ 2, -i\sigma_2, -i\sigma_2, -\sigma_1, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_{13}; \ 2, -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_{14}; \ 2, -i\sigma_2, -i\sigma_2, -\sigma_1, -\sigma_0; \quad \text{P-WNLs} \]
\[ L; \ (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ S_{61}^+, C_{2\sigma}, T; R_3; \ 1, 1, 1, 1; \]
\[ R_2; \ 1, 1, 1, 1; \]
\[ R_3; \ 1, -1, 1, 1; \]
\[ R_4; \ 1, -1, 1, 1; \]
\[ R_5; \ 2, \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_6; \ 2, \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0; \quad \text{P-WNLs} \]
\[ W; \ (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ S_{4x}^+, E, C_{2f}, IT; R_{11}; \ 2, \frac{1}{2} \left( \frac{1}{2} - \frac{3}{2} \right) \left( \sigma_0 + i\sigma_3 \right), i\sigma_0, \sigma_1, -i\sigma_1; \quad \text{P-WNLs} \]
\[ R_{12}; \ 2, \frac{1}{2} \left( \frac{1}{2} + \frac{3}{2} \right) \left( \sigma_0 - i\sigma_3 \right), i\sigma_0, \sigma_1, -i\sigma_1; \quad \text{P-WNLs} \]
\[ \Delta; \ \Gamma_X; \ C_{4y}^+, \sigma_x, IT; R_3; \ 1, 1, 1, 1; \]
\[ R_2; \ 1, 1, 1, 1; \]
\[ R_3; \ 1, -1, 1, 1; \]
\[ R_4; \ 1, -1, 1, 1; \]
\[ R_5; \ 2, i\sigma_2, \sigma_3, -\sigma_0; \quad \text{QNL; } 0 \]
\[ \Lambda; \ \Gamma_L; \ C_{31}^+, \sigma_{db}, IT; R_3; \ 1, 1, 1, 1; \]
\[ R_2; \ 1, 1, -1, 1; \]
\[ R_3; \ 2, \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0; \quad \text{WNL; } \pi \]
\[ \Sigma; \ \Gamma_\Sigma; \ C_{2a}^+, \sigma_z, IT; R_3; \ 1, 1, 1, 1; \]
\[ R_2; \ 1, 1, 1, 1; \]
\[ R_3; \ 1, -1, 1, 1; \]
\[ R_4; \ 1, -1, 1, 1; \]
\[ R_5; \ 1, -1, 1, 1; \]
\[ S; \ \Gamma_X; \ \sigma_y, \sigma_{de}, IT; R_2; \ 1, 1, 1, 1; \]
\[ R_4; \ 1, -1, 1, 1; \]
\[ R_6; \ 1, -1, 1, 1; \]
\[ R_8; \ 1, -1, 1, 1; \]
\[ Z; \ \Gamma_X; \ \sigma_y, \sigma_z, IT; R_2; \ 2, \sigma_2, -i\sigma_3, -i\sigma_3; \quad \text{WNL; } \pi \]
\[ Q; \ \Gamma_W; \ C_{2f}, IT; R_4; \ 1, 1, 1; \]
\[ R_6; \ 1, -1, 1; \]
\[ \Gamma (000) S_{61}^-, \sigma_x, \sigma_z, C_{2c}, T; R_1; \]
\[ R_2; \]
\[ R_3; 1; -1, -1, 1, 1; \]
\[ R_4; -1, -1, 1, 1; R_5; 2; -s_0 - i\sqrt{3}s_2, \sigma_0, \sigma_0, \sigma_0, \sigma_0, -s_0; \]
\[ R_6; 2; s_0 + i\sqrt{3}s_2, -\sigma_0, -\sigma_0, \sigma_0, \sigma_0, -s_0; \]
\[ R_7; 3; A_9, A_{13}, -\frac{A_0}{\sqrt{3}}, \frac{\sqrt{3}s_1 - s_3}{2}, \frac{-i\sqrt{3}s_1 - s_3}{2}, \sigma_0, \sigma_0; \]
\[ R_8; 3; A_9, A_{13}, -\frac{A_0}{\sqrt{3}}, \frac{\sqrt{3}s_1 - s_3}{2}, \frac{-i\sqrt{3}s_1 - s_3}{2}, \sigma_0, \sigma_0; \]
\[ R_9; 3; -A_9, -A_{13}, A_0 + 2\sqrt{3}s_2, A_{15}, -\frac{i\sqrt{3}s_1 - s_3}{2}, \sigma_0, \sigma_0; \]
\[ R_{10}; 3; -A_9, -A_{13}, A_0 + 2\sqrt{3}s_2, A_{15}, -\frac{i\sqrt{3}s_1 - s_3}{2}, \sigma_0, \sigma_0; \]
\[ X; (\frac{1}{2} 0 \frac{1}{2}) C_{4y}^-, \sigma_x, C_{2x}, T; R_6; \]
\[ R_7; 2; \sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \]
\[ R_{11}; 2; -i\sigma_2, i\sigma_2, \sigma_1, -\sigma_0; \]
\[ R_{12}; 2; -\sigma_1, i\sigma_2, \sigma_1, -\sigma_0; \]
\[ R_{14}; 2; -i\sigma_2, -i\sigma_2, \sigma_1, -\sigma_0; \]
\[ L; (\frac{1}{2} \frac{1}{2} \frac{1}{2}) \sigma_{db}, C_{31}, \Gamma; \{R_7, R_8\}; \]
\[ R_4; 4; -i\Gamma_{3,1}, \frac{1}{2}, \sigma_0 + i\sqrt{3}\sigma_3, \sigma_0, \sigma_0, \sigma_0, \sigma_0; \]
\[ R_9; 2; i\sigma_1, \sigma_0, \sigma_3, -i\sigma_3; \]
\[ W; (\frac{1}{2} \frac{3}{2} \frac{1}{2}) S_{4x}^+, E, C_{2d}, \Gamma; \{R_{13}, R_{14}\}; \]
\[ R_4; 4; (\frac{1}{2} - \frac{1}{2}) \sigma_3, \sigma_3, \sigma_3, \sigma_3, \sigma_3, \sigma_3, \sigma_3; \]
\[ \Delta; \Gamma \chi; C_{4y}^+, \sigma_x, \Gamma; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, -1, 1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_5; 2; i\sigma_2, \sigma_3, -\sigma_0; \]
\[ \Lambda; \Gamma \ell; C_{31}^+, \sigma_{db}, \Gamma; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0; \]
\[ \Sigma; \Gamma \Sigma; C_{2a}, \sigma_z, \Gamma; \]
\[ R_1; 1, 1, 1, 1; \]
\[ R_2; 1, 1, -1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, 1, 1; \]
\[ S; \chi; \sigma_y, \Gamma; \]
\[ R_2; 1, -1, 1, 1; \]
\[ R_3; 1, -1, 1, 1; \]
\[ R_4; 1, -1, 1, 1; \]
\[ Z; \chi; \sigma_y, \Gamma; \]
\[ R_2; -\sigma_2, i\sigma_3, -i\sigma_3; \]
\[ Q; \Gamma \omega; C_{2f}, \Gamma; \{R_4, R_8\}; \]
\[ 2; \sigma_3, \sigma_1; \]
\[ W N L; \pi \]
\[ W N L; \pi \]
\[ \Gamma; (000): \quad S_{\overline{6}1}, \sigma_x, \sigma_z, C_{2c}, T; \]

\[ R_1; \quad 1, 1, 1, 1, 1; \]
\[ R_2; \quad 1, 1, 1, 1, 1; \]
\[ R_3; \quad 1, -1, -1, -1, 1; \]
\[ R_4; \quad 1, -1, 1, -1, 1; \]
\[ R_5; \quad 2, \frac{-\sigma_0 - (\sqrt{3} \sigma_0)}{2}, \sigma_0, \frac{\sqrt{3} \sigma_1 - \sigma_3}{2}, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_6; \quad 2, \frac{\sigma_0 + (\sqrt{3} \sigma_0)}{2}, -\sigma_0, -\frac{\sigma_0}{2}, \frac{\sqrt{3} \sigma_1 - \sigma_3}{2}, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_7; \quad 3, A_9, A_{13}, -\frac{A_0}{3} + \frac{2A_0}{\sqrt{3}}, A_{15}, -\frac{i(\sqrt{3} - i) A_0}{2}; \quad \text{QCTP}; \]
\[ R_8; \quad 3, A_9, A_{13}, -\frac{A_0}{3} - \frac{2A_0}{\sqrt{3}}, A_{15}, -\frac{i(\sqrt{3} + i) A_0}{2}; \quad \text{QCTP}; \]
\[ R_9; \quad 3, -A_9, -A_{13}, \frac{A_0 + 2\sqrt{3} A_2}{3}, A_{15}, -\frac{i(\sqrt{3} - i) A_0}{2}; \quad \text{QCTP}; \]
\[ R_{10}; \quad 3, -A_9, -A_{13}, \frac{A_0 + 2\sqrt{3} A_2}{3}, -A_{15}, -\frac{i(\sqrt{3} - i) A_0}{2}; \quad \text{QCTP}; \]

\[ H; \quad \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); \quad S_{\overline{6}1}, \sigma_x, \sigma_z, C_{2c}, T; \]

\[ R_1; \quad 1, 1, 1, 1, 1; \]
\[ R_2; \quad 1, 1, 1, -1, 1; \]
\[ R_3; \quad 1, -1, -1, -1, 1; \]
\[ R_4; \quad 1, -1, 1, 1, 1; \]
\[ R_5; \quad 2, \frac{-\sigma_0 - (\sqrt{3} \sigma_0)}{2}, \sigma_0, \frac{\sqrt{3} \sigma_1 - \sigma_3}{2}, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_6; \quad 2, \frac{\sigma_0 + (\sqrt{3} \sigma_0)}{2}, -\sigma_0, -\frac{\sigma_0}{2}, \frac{\sqrt{3} \sigma_1 - \sigma_3}{2}, -\sigma_0; \quad \text{P-WNLs} \]
\[ R_7; \quad 3, A_9, A_{13}, -\frac{A_0}{3} + \frac{2A_0}{\sqrt{3}}, A_{15}, -\frac{i(\sqrt{3} - i) A_0}{2}; \quad \text{QCTP}; \]
\[ R_8; \quad 3, A_9, A_{13}, -\frac{A_0}{3} - \frac{2A_0}{\sqrt{3}}, A_{15}, -\frac{i(\sqrt{3} + i) A_0}{2}; \quad \text{QCTP}; \]
\[ R_9; \quad 3, -A_9, -A_{13}, \frac{A_0 + 2\sqrt{3} A_2}{3}, A_{15}, -\frac{i(\sqrt{3} - i) A_0}{2}; \quad \text{QCTP}; \]
\[ R_{10}; \quad 3, -A_9, -A_{13}, \frac{A_0 + 2\sqrt{3} A_2}{3}, -A_{15}, -\frac{i(\sqrt{3} - i) A_0}{2}; \quad \text{QCTP}; \]

\[ P; \quad \left( \frac{1}{4} \frac{1}{4} \frac{1}{4} \right); \quad C_{31}, C_{2c}, C_{2c}, C_{2c}, T; \]

\[ R_1; \quad 1, 1, 1, 1, 1; \]
\[ R_2; \quad 1, 1, 1, 1, 1; \]
\[ R_3; \quad 2, \frac{-\sigma_0 - (\sqrt{3} \sigma_0)}{2}, \sigma_0, \sigma_0, \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \]
\[ R_4; \quad 3, A_{11}, -\frac{A_0}{3}, \frac{2A_0}{\sqrt{3}}, A_{13}, A_{12}, -\frac{i(\sqrt{3} - i) A_0}{2}; \quad \text{TP}; \quad 0 \]
\[ R_5; \quad 3, A_{11}, -\frac{A_0}{3}, \frac{2A_0}{\sqrt{3}}, A_{13}, -A_{12}, -\frac{i(\sqrt{3} - i) A_0}{2}; \quad \text{TP}; \quad 0 \]

\[ N; \quad \left( 0 \frac{1}{2} \right); \quad C_{2c}, C_{2c}, T; \]

\[ R_1; \quad 1, 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1, 1; \]
\[ R_3; \quad 1, -1, 1, 1; \]
\[ R_4; \quad 1, -1, -1, 1; \]
\[ R_5; \quad 1, 1, -1, 1; \]
\[ R_6; \quad 1, -1, -1, 1; \]
\[ R_7; \quad 1, 1, 1, 1; \]
\[ R_8; \quad 1, -1, -1, -1; \]

\[ \Sigma; \quad \Gamma N; \quad C_{2a}, \sigma_z, T; \]

\[ R_1; \quad 1, 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1, 1; \]
\[ R_3; \quad 1, -1, 1, 1; \]
\[ R_4; \quad 1, -1, -1, 1; \]

\[ \Delta; \quad \Gamma H; \quad C_{4a}, \sigma_z, T; \]

\[ R_1; \quad 1, 1, 1, 1; \]
\[ R_2; \quad 1, -1, 1, 1; \]
\[ R_3; \quad 1, -1, 1, 1; \]
\[ R_4; \quad 1, -1, 1, 1; \]
\[ R_5; \quad 2, i \sigma_2, \sigma_3, -\sigma_0; \quad \text{QNL}; \quad 0 \]
Λ; ΓP; $C_{31}^+, \sigma_{ab}, IT$; $R_1; 1; 1, 1, 1$;
   $R_2; 1; 1, -1, 1$;
   $R_3; 2; \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0$; WNL; π

D; NP; $C_{2s}, \sigma_{ab}, IT$; $R_1; 1; 1, 1, 1$;
   $R_2; 1; 1, -1, 1$;
   $R_3; 1; -1, 1, 1$;
   $R_4; 1; -1, -1, 1$;

G; HN; $C_{2b}, \sigma_{da}, IT$; $R_1; 1; 1, 1, 1$;
   $R_2; 1; 1, -1, 1$;
   $R_3; 1; -1, 1, 1$;
   $R_4; 1; -1, -1, 1$;

F; PH; $C_{34}^+, \sigma_{da}, IT$; $R_1; 1; 1, 1, 1$;
   $R_2; 1; 1, -1, 1$;
   $R_3; 2; \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0$; WNL; π
\( \Gamma \): (000); \( S_{0,1,3} \), \( \sigma_x, \sigma_y, C_{2x}, T \); 
\[ \begin{align*}
R_1 & : 1, 1, 1, 1, 1; \\
R_2 & : 1, 1, 1, 1, 1; \\
R_3 & : 1, 1, 1, 1, 1; \\
R_4 & : 1, 1, 1, 1, 1; \\
R_5 & : 2, -\sigma_0 - i\sqrt{3}\sigma_2, \sigma_0, \sqrt{\sigma_1 - \sigma_2} - \sigma_0; P-WNLs \\
R_6 & : 2, \sigma_0 + i\sqrt{3}\sigma_2, -\sigma_0, \sqrt{\sigma_1 - \sigma_2} - \sigma_0; P-WNLs \\
R_7 & : 3, \sigma_9, A_{13}, -\frac{\sqrt{3}}{2} A_4, A_{15}, -\frac{(\sqrt{3} - i)A_0}{2}; QCTP; \\
R_8 & : 3, \sigma_9, A_{13}, -\frac{\sqrt{3}}{2} A_4, A_{15}, -\frac{(\sqrt{3} + i)A_0}{2}; QCTP; \\
R_9 & : 3, -\sigma_9, A_{13}, \frac{\sqrt{3}}{2} A_4, A_{15}, -\frac{(\sqrt{3} - i)A_0}{2}; QCTP; \\
R_{10} & : 3, -\sigma_9, A_{13}, \frac{\sqrt{3}}{2} A_4, A_{15}, -\frac{(\sqrt{3} + i)A_0}{2}; QCTP; \\
\end{align*} \]

\( \Lambda \): \( \Gamma \); 
\( C_{4x}, \sigma_x, IT \); 
\[ \begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, 1, 1, 1; \\
R_3 & : 1, 1, 1, 1; \\
R_4 & : 1, 1, 1, 1; \\
R_5 & : 2, i\sigma_2, \sigma_3, -\sigma_0; P-WNLs; \\
R_{10} & : 2, i\sigma_2, \sigma_3, -\sigma_0; P-WNLs; \\
\end{align*} \]

\( \Lambda \): \( \Gamma \); 
\( C_{31}, \sigma_{dx}, IT \); 
\[ \begin{align*}
R_1 & : 1, 1, 1, 1; \\
R_2 & : 1, 1, 1, 1; \\
R_3 & : 2, \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0; WNL; \pi \\
R_4 & : 2, \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0; WNL; \pi \\
R_5 & : 2, \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0; WNL; \pi \\
R_6 & : 2, \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0; WNL; \pi \\
R_7 & : 2, \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -\sigma_0; WNL; \pi \\
\end{align*} \]
B. The accidental degeneracies on high-symmetry line

1. Notes to Sec. S7B

(i) For each table in Sec. S7B, the first line presents the SG number.
(ii) Below the first line, the columns from left to right (separated by the semicolons) are the high-symmetry momentum \( k \), the location of \( k \), the generating elements of the little group at \( k \) (only point-group operators are presented and a full expression of each generating element can be found in Sec. S5), the two distinct coreps (separated by the comma) of the bands forming the accidental degeneracy, the degeneracy of the accidental degeneracy, the matrix representations of the generating elements, the species and the topological charge of the accidental degeneracy.
(iii) We do not list the type II MSGs that do not exhibit symmetry-protected accidental degeneracies on high-symmetry line.

2. SG 1-10
Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma Z; C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 \text{ WP}; 1 \)
\( V; \text{ BD}; C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 \text{ WP}; 1 \)
\( W; \text{ YC}; C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 \text{ WP}; 1 \)
\( U; \text{ AE}; C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 \text{ WP}; 1 \)

Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma Z; C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 \text{ WP}; 1 \)
\( V; \text{ BD}; C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 \text{ WP}; 1 \)
\( W; \text{ YC}; C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 \text{ WP}; 1 \)
\( U; \text{ AE}; C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 \text{ WP}; 1 \)

Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma Z; C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 \text{ WP}; 1 \)
\( U; \text{ AM}; C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 \text{ WP}; 1 \)

Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma Z; C_{2z}, IT; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \)
\( V; \text{ BD}; C_{2z}, IT; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \)
\( W; \text{ YC}; C_{2z}, IT; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \)
\( U; \text{ AE}; C_{2z}, IT; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \)
SG 11

Accidental degeneracies on high symmetry line

Λ; ΓZ; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;
V; BD; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;
W; YC; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;
U; AE; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

SG 12

Accidental degeneracies on high symmetry line

Λ; ΓZ; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;
U; AM; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

SG 13

Accidental degeneracies on high symmetry line

Λ; ΓZ; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;
W; YC; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

SG 14

Accidental degeneracies on high symmetry line

Λ; ΓZ; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;
W; YC; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

SG 15

Accidental degeneracies on high symmetry line

Λ; ΓZ; \( C_{2z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;
Accidental degeneracies on high symmetry line

\[ \Delta; \; \Gamma Y; \; C_{2y}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ D; \; X S; \; C_{2y}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ P; \; U R; \; C_{2y}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ B; \; Z T; \; C_{2y}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ \Sigma; \; \Gamma X; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ C; \; Y S; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ E; \; T R; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ A; \; Z U; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ \Lambda; \; \Gamma Z; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ H; \; Y T; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ Q; \; S R; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ G; \; X U; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]

Accidental degeneracies on high symmetry line

\[ \Delta; \; \Gamma Y; \; C_{2y}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ D; \; X S; \; C_{2y}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ \Sigma; \; \Gamma X; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ C; \; Y S; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ A; \; Z U; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ \Lambda; \; \Gamma Z; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ H; \; Y T; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ Q; \; S R; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ G; \; X U; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]

Accidental degeneracies on high symmetry line

\[ \Delta; \; \Gamma Y; \; C_{2y}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ B; \; Z T; \; C_{2y}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ \Sigma; \; \Gamma X; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ A; \; Z U; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ \Lambda; \; \Gamma Z; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ Q; \; S R; \; C_{2x}, T C_{2x}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \; \text{C-1 WP}; \; 1 \]
\[ Q; \; S R; \; C_{2x}, T C_{2x}; \{ R_1, R_1 \}, \{ R_2, R_2 \}; \; 4; \; \Gamma_{3.0}, -i\Gamma_{0.2}; \; \text{C-2 DP}; \; 2 \]
Accidental degeneracies on high symmetry line

Δ; ΓY; \( C_{2y}, TC_{2x} \); \( \{R_1\}, \{R_2\} \); 2; \( \sigma_3, \sigma_0 \); C-1 WP; 1

P; UR; \( C_{2y}, TC_{2x} \); \( \{R_2, R_2\}, \{R_4, R_4\} \); 4; \( \Gamma_{3,0}, -i\Gamma_{0,2} \); C-2 DP; 2

Σ; ΓX; \( C_{2z}, TC_{2z} \); \( \{R_1\}, \{R_2\} \); 2; \( \sigma_3, \sigma_0 \); C-1 WP; 1

E; TR; \( C_{2x}, TC_{2z} \); \( \{R_2, R_3\}, \{R_4, R_4\} \); 4; \( \Gamma_{3,0}, -i\Gamma_{0,2} \); C-2 DP; 2

Λ; ΓZ; \( C_{2z}, TC_{2z} \); \( \{R_1\}, \{R_2\} \); 2; \( \sigma_3, \sigma_0 \); C-1 WP; 1

Q; SR; \( C_{2x}, TC_{2z} \); \( \{R_2, R_4\}, \{R_4, R_4\} \); 4; \( -\Gamma_{3,0}, -i\Gamma_{0,2} \); C-2 DP; 2

Accidental degeneracies on high symmetry line

Δ; ΓZ; \( C_{2z}, TC_{2x} \); \( \{R_1\}, \{R_2\} \); 2; \( \sigma_3, \sigma_0 \); C-1 WP; 1

H; YT; \( C_{2x}, TC_{2x} \); \( \{R_1\}, \{R_2\} \); 2; \( \sigma_3, \sigma_0 \); C-1 WP; 1

D; SR; \( C_{2z} \); \( \{R_1\}, \{R_2\} \); 2; \( \sigma_3 \); C-1 WP; 1

Σ; ΓY; \( C_{2x}, TC_{2x} \); \( \{R_1\}, \{R_2\} \); 2; \( \sigma_3, \sigma_0 \); C-1 WP; 1

Δ; ΓΛ; \( C_{2y}, TC_{2z} \); \( \{R_1\}, \{R_2\} \); 2; \( \sigma_3, \sigma_0 \); C-1 WP; 1

F; YF; \( C_{2y}, TC_{2x} \); \( \{R_1\}, \{R_2\} \); 2; \( \sigma_3, \sigma_0 \); C-1 WP; 1

C; YC; \( C_{2z}, TC_{2z} \); \( \{R_1\}, \{R_2\} \); 2; \( \sigma_3, \sigma_0 \); C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ H; \Gamma T; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ D; \Gamma S; C_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; C-1 WP; 1 \]
\[ A; \Gamma Z; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ \Sigma; \Gamma Y; C_{2y}, \bar{TC}_{2x}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ \Delta; \Gamma \Delta; C_{2y}, \bar{TC}_{2x}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ B; \Gamma Z; C_{2y}, \bar{TC}_{2x}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ G; \Gamma T; C_{2y}, \bar{TC}_{2x}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ F; \Gamma F; C_{2y}, \bar{TC}_{2x}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ E; \Gamma T; C_{2x}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ C; \Gamma C; C_{2x}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]

\[ \Lambda; \Gamma Z; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ G; \Gamma G; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ H; \Gamma H; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ Q; \Gamma Q; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ \Sigma; \Gamma \Sigma; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ C; \Gamma C; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ A; \Gamma A; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ U; \Gamma U; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ \Delta; \Gamma \Delta; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ D; \Gamma D; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ B; \Gamma B; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
\[ R; \Gamma R; C_{2z}, \bar{TC}_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 WP; 1 \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma \Lambda \cap \Gamma X; \begin{array}{l} C_{2z}, TC_{2x}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 \ WP; 1 \\ G; XG; \begin{array}{l} C_{2z}, TC_{2x}; \{ R_1 \}, \{ R_2 \}; 2; -\sigma_3, \sigma_0; C-1 \ WP; 1 \\ P; TW; \begin{array}{l} C_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; C-1 \ WP; 1 \\ \Sigma; \Gamma \Sigma \cap \Gamma X; \begin{array}{l} C_{2z}, TC_{2x}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 \ WP; 1 \\ F; XF; \begin{array}{l} C_{2z}, TC_{2x}; \{ R_1 \}, \{ R_2 \}; 2; -\sigma_3, \sigma_0; C-1 \ WP; 1 \\ D; SW; \begin{array}{l} C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; -\sigma_3; C-1 \ WP; 1 \\ \Delta; \Gamma \Delta \cap \Gamma X; \begin{array}{l} C_{2z}, TC_{2x}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 \ WP; 1 \\ U; XU; \begin{array}{l} C_{2z}, TC_{2x}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 \ WP; 1 \\ Q; RW; \begin{array}{l} C_{2y}; \{ R_2 \}, \{ R_4 \}; 2; \sigma_3; C-1 \ WP; 1 \end{array} \end{array} \end{array} \end{array} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; \sigma x, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ D; XS; \sigma x, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ P; UR; \sigma x, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ B; ZT; \sigma x, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ \Sigma; \Gamma X; \sigma_y, T\sigma_z; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ C; YS; \sigma_y, T\sigma_z; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ E; TR; \sigma_y, T\sigma_z; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ A; ZU; \sigma_y, T\sigma_z; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ \Lambda; \Gamma Z; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNLs; \]
\[ H; YT; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNLs; \]
\[ Q; SR; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNLs; \]
\[ G; XU; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNLs; \]
Accidental degeneracies on high symmetry line

$\Delta$: $\Gamma Y; \sigma_x, TC_{2z}; \{R_1\}, \{R_2\}; \Gamma X; \sigma_y, TC_{2z}; \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL};$

$D$: $\Gamma X; \sigma_x, TC_{2z}; \{R_1\}, \{R_2\}; \sigma_3, \sigma_0; \text{P-WNL};$

$P$: $\Gamma X; \sigma_x, TC_{2z}; \{R_1\}, \{R_2\}, \{R_2, R_4\}; 4; \Gamma_0, -i\Gamma_0, 0; \text{DP}; 0$

$B$: $\Gamma Z; \sigma_x, TC_{2z}; \{R_1\}, \{R_2\}, \{R_2, R_4\}; 4; \Gamma_0, -i\Gamma_0, 0; \text{DP}; 0$

$\Sigma$: $\Gamma X; \sigma_y, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL};$

$C$: $\Gamma Z; \sigma_x, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL};$

$\Lambda$: $\Gamma Z; \sigma_x, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL};$

$H$: $\Gamma T; \sigma_y, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNL};$

$Q$: $\Gamma T; \sigma_y, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNL};$

$G$: $\Gamma U; \sigma_x, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNL};$

$\{R_1\}, \{R_2\}, \{R_2\}, \{R_4\}, \{R_4\}, \{R_4\}, \{R_4\}, \{R_4\}, \{R_4\}, \{R_4\}$
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; \sigma_x T C_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ D; \Sigma; \Gamma X; \sigma_x T C_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Sigma; \Gamma X; \sigma_y T \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ C; \Sigma; \sigma_y T \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Lambda; \Gamma Z; C_{2z}, \sigma_y; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \text{Y}; T; C_{2z}, \sigma_y; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \text{Q}; \text{SR}; C_{2z}, \sigma_y; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \text{G}; \text{XU}; C_{2z}, \sigma_y; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \sigma_\gamma, T C_{2z}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ D; \sigma_x, T C_{2z}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ P; \sigma_x, T C_{2z}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ B; \sigma_x, T C_{2z}; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \Sigma; \Gamma X; \sigma_y, T Z; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ A; \Gamma Z; \sigma_y, T Z; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \Lambda; \Gamma Z; \sigma_y, T Z; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ G; \sigma_\gamma, T \sigma_z; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ E; \sigma_\gamma, T \sigma_z; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ A; \Gamma Z; \sigma_y, T Z; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ G; \sigma_\gamma, T \sigma_z; \{ R_1 \}, \{ R_2 \}; \; 2; \; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_Y; \sigma_x, T C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ D; \text{XS}; \sigma_x, T C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Sigma; \Gamma_X; \sigma_y, T \sigma_x; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ E; \text{TR}; \sigma_y, T \sigma_x; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Lambda; \Gamma_Z; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]

\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]

\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]

\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]

\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ G; \text{XU}; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]

\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]

\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]

\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]
### SG 31

Accidental degeneracies on high symmetry line

| $\Delta$; $\Gamma Y$ | $\sigma_z TC_{2z}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; P-WNL; |
|---------------------|-------------------------------------------------|
| $D$; $X S$ | $\sigma_z TC_{2s}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; P-WNL; |
| $\Sigma$; $\Gamma X$ | $\sigma_y T \sigma_z$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; P-WNL; |
| $A$; $Z U$ | $\sigma_y T \sigma_z$; $\{R_1, R_1\}, \{R_2, R_2\}$; 4; $\Gamma_{3.0}, -i\Gamma_{0.2}$; DP; 0 |
| $\Lambda$; $\Gamma Z$ | $C_{2s}, \sigma_y$; $\{R_1\}, \{R_2\}$; 2; $\sigma_0, \sigma_3$; P-WNLs; |
| | $\{R_1\}, \{R_3\}$; 2; $\sigma_3, \sigma_0$; P-WNL; |
| | $\{R_1\}, \{R_4\}$; 2; $\sigma_3, \sigma_3$; P-WNL; |
| | $\{R_2\}, \{R_3\}$; 2; $\sigma_3, -\sigma_0$; P-WNL; |
| | $\{R_2\}, \{R_4\}$; 2; $\sigma_3, -\sigma_3$; P-WNL; |
| | $\{R_3\}, \{R_4\}$; 2; $-\sigma_0, \sigma_3$; P-WNLs; |
| $G$; $X U$ | $C_{2s}, \sigma_y$; $\{R_1\}, \{R_2\}$; 2; $\sigma_0, \sigma_3$; P-WNLs; |
| | $\{R_1\}, \{R_3\}$; 2; $\sigma_3, \sigma_0$; P-WNL; |
| | $\{R_1\}, \{R_4\}$; 2; $\sigma_3, \sigma_3$; P-WNL; |
| | $\{R_2\}, \{R_3\}$; 2; $\sigma_3, -\sigma_3$; P-WNL; |
| | $\{R_2\}, \{R_4\}$; 2; $\sigma_3, -\sigma_0$; P-WNL; |
| | $\{R_3\}, \{R_4\}$; 2; $-\sigma_0, \sigma_3$; P-WNLs; |

### SG 32

Accidental degeneracies on high symmetry line

| $\Delta$; $\Gamma Y$ | $\sigma_z TC_{2z}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; P-WNL; |
|---------------------|-------------------------------------------------|
| $B$; $Z T$ | $\sigma_z TC_{2z}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; P-WNL; |
| $\Sigma$; $\Gamma X$ | $\sigma_y T \sigma_z$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; P-WNL; |
| $A$; $Z U$ | $\sigma_y T \sigma_z$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; P-WNL; |
| $\Lambda$; $\Gamma Z$ | $C_{2s}, \sigma_y$; $\{R_1\}, \{R_2\}$; 2; $\sigma_0, \sigma_3$; P-WNLs; |
| | $\{R_1\}, \{R_3\}$; 2; $\sigma_3, \sigma_0$; P-WNL; |
| | $\{R_1\}, \{R_4\}$; 2; $\sigma_3, \sigma_3$; P-WNL; |
| | $\{R_2\}, \{R_3\}$; 2; $\sigma_3, -\sigma_3$; P-WNL; |
| | $\{R_2\}, \{R_4\}$; 2; $\sigma_3, -\sigma_0$; P-WNL; |
| | $\{R_3\}, \{R_4\}$; 2; $-\sigma_0, \sigma_3$; P-WNLs; |
| $Q$; $S R$ | $C_{2s}, \sigma_y, E$; $\{R_3\}, \{R_6\}$; 2; $\sigma_3, -i\sigma_0, \sigma_0$; P-WNL; |
| | $\{R_3\}, \{R_7\}$; 2; $\sigma_0, -i\sigma_3, \sigma_0$; P-WNLs; |
| | $\{R_3\}, \{R_8\}$; 2; $\sigma_3, -i\sigma_3, \sigma_0$; P-WNL; |
| | $\{R_6\}, \{R_7\}$; 2; $-\sigma_3, -i\sigma_3, \sigma_0$; P-WNL; |
| | $\{R_6\}, \{R_8\}$; 2; $-\sigma_0, -i\sigma_3, \sigma_0$; P-WNLs; |
| | $\{R_7\}, \{R_8\}$; 2; $\sigma_3, i\sigma_0, \sigma_0$; P-WNL; |
Accidental degeneracies on high symmetry line

| Group | Representation | Degeneracies | Symmetry |
|-------|----------------|--------------|----------|
| Δ: ΓY | $\sigma_z TC_{2z}$ | {R₁}, {R₂}: 2; $\sigma_3, \sigma_0$; | P-WNL; |
| B: ZT | $\sigma_x TC_{2z}$ | {R₁}, {R₂}, {R₂, R₃}: 4; $\Gamma_3, -i\Gamma_0$; | DP; |
| Σ: ΓX | $\sigma_y TC_{2z}$ | {R₁}, {R₂}: 2; $\sigma_3, \sigma_0$; | P-WNL; |
| E: TR | $\sigma_x TC_{2z}$ | {R₁}, {R₂}, {R₂, R₃}: 4; $-i\Gamma_3, -i\Gamma_0$; | DP; |
| Λ: ΓZ | $C_{2x}, \sigma_y$ | {R₁}, {R₂}: 2; $\sigma_0, \sigma_3$; | P-WNLs; |
|     |                 | {R₁}, {R₃}: 2; $\sigma_3, \sigma_0$; | P-WNL; |
|     |                 | {R₃}, {R₄}: 2; $\sigma_3, \sigma_3$; | P-WNL; |
|     |                 | {R₂}, {R₃}: 2; $\sigma_3, -\sigma_3$; | P-WNL; |
|     |                 | {R₂}, {R₄}: 2; $\sigma_3, -\sigma_0$; | P-WNL; |
|     |                 | {R₃}, {R₄}: 2; $-\sigma_0, \sigma_3$; | P-WNLs; |
| Q: SR | $C_{2x}, \sigma_y, E$ | {R₅}, {R₆}: 2; $\sigma_3, -i\sigma_0, \sigma_0$; | P-WNL; |
|     |                 | {R₅}, {R₇}: 2; $\sigma_0, -i\sigma_3, \sigma_0$; | P-WNL; |
|     |                 | {R₅}, {R₆}: 2; $\sigma_3, -i\sigma_3, \sigma_0$; | P-WNL; |
|     |                 | {R₆}, {R₇}: 2; $-\sigma_3, -i\sigma_3, \sigma_0$; | P-WNL; |
|     |                 | {R₆}, {R₆}: 2; $-\sigma_0, -i\sigma_3, \sigma_0$; | P-WNLs; |
|     |                 | {R₇}, {R₆}: 2; $\sigma_3, i\sigma_0, \sigma_0$; | P-WNL; |
Accidental degeneracies on high symmetry line

\[ \{R_1\}, \{R_2\} ; 2; \sigma_0, \sigma_3; \text{ P-WNLs}; \]
\[ \{R_1\}, \{R_3\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_4\} ; 2; \sigma_3, \sigma_3; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_3\} ; 2; \sigma_3, -\sigma_3; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_4\} ; 2; \sigma_3, -\sigma_0; \text{ P-WNL}; \]
\[ \{R_3\}, \{R_4\} ; 2; -\sigma_0, \sigma_3; \text{ P-WNLs}; \]
\[ \{R_1\}, \{R_2\} ; 2; \sigma_0, \sigma_3; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_3\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_4\} ; 2; \sigma_3, \sigma_3; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_3\} ; 2; \sigma_3, -\sigma_3; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_4\} ; 2; \sigma_3, -\sigma_0; \text{ P-WNL}; \]
\[ \{R_3\}, \{R_4\} ; 2; -\sigma_0, \sigma_3; \text{ P-WNLs}; \]

D; SR; C_{2z};\{R_1\}, \{R_2\} ; 2; \sigma_3; \text{ C-1 WP; 1} \\
A; ZT; \sigma_y, T \sigma_x; \{R_1\}, \{R_2\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL};

\[ \{R_1\}, \{R_2\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_2\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_4\} ; 2; \sigma_3, -\sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_2\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_2\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_2\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_2\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_2\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_2\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_2\} ; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ H; \Gamma Y; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \delta; \Gamma Y; \sigma_x, T; \sigma_y, \{R_1\}, \{R_2\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNL}; \]
\[ \{R_1\}, \{R_3\}, \{R_2\}; 4; \Gamma_{3,0}, -i\Gamma_{0,2}; \text{DP}; \]
\[ \delta; \Gamma Y; \sigma_x, T; \sigma_y, \{R_1\}, \{R_2\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_3\}, \{R_2\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}, \{R_2\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}, \{R_2\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}, \{R_2\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \delta; \Gamma Y; \sigma_x, T; \sigma_y, \{R_1\}, \{R_2\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNL}; \]
\[ \{R_1\}, \{R_3\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}, \{R_2\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}, \{R_2\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}, \{R_2\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}, \{R_2\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \delta; \Gamma Y; \sigma_x, T; \sigma_y, \{R_1\}, \{R_2\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNL}; \]
\[ \{R_1\}, \{R_3\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}, \{R_2\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}, \{R_2\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}, \{R_2\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}, \{R_2\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ D; \delta; \Gamma Y; \sigma_x, T; \sigma_y, \{R_1\}, \{R_2\}, \{R_2\}; 2; \sigma_3; \text{C-1 WP}; 1 \]
\[ \delta; \Gamma Y; \sigma_x, T; \sigma_y, \{R_1\}, \{R_2\}, \{R_2\}; 2; \sigma_3; \text{P-WNL}; \]
\[ \{R_1\}, \{R_3\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}, \{R_2\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}, \{R_2\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}, \{R_2\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}, \{R_2\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ H; \Gamma Y; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ D; \delta; \Gamma Y; \sigma_x, T; \sigma_y, \{R_1\}, \{R_2\}, \{R_2\}; 2; \sigma_3; \text{C-1 WP}; 1 \]
\[ \delta; \Gamma Y; \sigma_x, T; \sigma_y, \{R_1\}, \{R_2\}, \{R_2\}; 2; \sigma_3; \text{P-WNL}; \]
\[ \{R_1\}, \{R_3\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}, \{R_2\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}, \{R_2\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}, \{R_2\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}, \{R_2\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ C; \gamma; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; \sigma_z, T \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ H; \Sigma Y; \sigma_z, T \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ A; \Delta T; \sigma_z, T C_{2y}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \Sigma; \Gamma \Delta; \sigma_z, T C_{2y}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \Delta; \Gamma \Delta; C_{2y}, \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{ P-WNLs;} \]
\[ B; \Sigma B; C_{2y}, \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{ P-WNLs;} \]
\[ G; \Sigma G; C_{2y}, \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{ P-WNLs;} \]
\[ F; \Sigma F; C_{2y}, \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{ P-WNLs;} \]
\[ E; \Sigma E; C_{2y}, \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ C; \Sigma C; C_{2y}, \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]
Accidental degeneracies on high symmetry line

Λ: ΓZ; \( \sigma_z, T \sigma_z \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

H: YT; \sigma_z, T \sigma_z \}; \{R_1\}, \{R_2\}; 2; -\sigma_3, \sigma_0; P-WNL;

A: ZT; \sigma_z, T \sigma_z \}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

Σ: ΥY; \sigma_z, T \sigma_{zy} \}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

Δ: ΓΔ; C_{2y}, \sigma_z \}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNLs;

{R_1}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNL;

{R_2}, \{R_4\}; 2; \sigma_3, \sigma_3; P-WNL;

{R_2}, \{R_3\}; 2; \sigma_3, -\sigma_3; P-WNL;

{R_2}, \{R_4\}; 2; \sigma_3, -\sigma_0; P-WNL;

{R_3}, \{R_4\}; 2; -\sigma_0, \sigma_3; P-WNLs;

B: ZB; C_{2y}, \sigma_z \}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNLs;

{R_1}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNL;

{R_1}, \{R_4\}; 2; \sigma_3, \sigma_3; P-WNL;

{R_2}, \{R_3\}; 2; \sigma_3, -\sigma_3; P-WNL;

{R_2}, \{R_4\}; 2; \sigma_3, -\sigma_0; P-WNL;

{R_3}, \{R_4\}; 2; -\sigma_0, \sigma_3; P-WNLs;

G: TG; C_{2y}, \sigma_z \}; \{R_1\}, \{R_2\}; 2; \sigma_0, -\sigma_3; P-WNLs;

{R_1}, \{R_3\}; 2; \sigma_3, -\sigma_0; P-WNL;

{R_1}, \{R_4\}; 2; \sigma_3, -\sigma_3; P-WNL;

{R_2}, \{R_3\}; 2; \sigma_3, \sigma_3; P-WNL;

{R_2}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNL;

{R_3}, \{R_4\}; 2; -\sigma_0, -\sigma_3; P-WNLs;

F: YF; C_{2y}, \sigma_z \}; \{R_1\}, \{R_2\}; 2; \sigma_0, -\sigma_3; P-WNLs;

{R_1}, \{R_3\}; 2; \sigma_3, -\sigma_0; P-WNL;

{R_1}, \{R_4\}; 2; \sigma_3, -\sigma_3; P-WNL;

{R_2}, \{R_3\}; 2; \sigma_3, \sigma_3; P-WNL;

{R_2}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNL;

{R_3}, \{R_4\}; 2; -\sigma_0, -\sigma_3; P-WNLs;

E: TE; \sigma_z, T \sigma_{zy} \}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

C: YC; \sigma_z, T \sigma_{zy} \}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; \sigma_z, T \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ H; \Psi T; \sigma_z, T \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Sigma; \Gamma Y; \sigma_z, T C_2 y; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Delta; \Gamma \Delta; C_{2y}, \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]

\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ C; \Psi F; C_{2y}, \sigma_z; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]

\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ C; \Psi C; T C_{2y}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

\begin{align*}
\Lambda; \; \Gamma Z; \; \sigma_x, T \sigma_z; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; & \quad \text{P-WNL;} \\
H; \; YT; \; \sigma_z, T \sigma_z; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; & \quad \text{P-WNL;} \\
\Sigma; \; \Gamma Y; \; \sigma_z, T C_{2y}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; & \quad \text{P-WNL;} \\
\Delta; \; \Gamma \Delta; \; C_{2y}, \sigma_x; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; & \quad \text{P-WNLS;} \\
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; & \quad \text{P-WNL;} \\
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; & \quad \text{P-WNL;} \\
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3; & \quad \text{P-WNL;} \\
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; & \quad \text{P-WNL;} \\
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; & \quad \text{P-WNLs;} \\
F; \; Y F; \; C_{2y}, \sigma_x; \{R_1\}, \{R_2\}; 2; \sigma_0, -\sigma_3; & \quad \text{P-WNLS;} \\
\{R_1\}, \{R_3\}; 2; \sigma_3, -\sigma_0; & \quad \text{P-WNL;} \\
\{R_1\}, \{R_4\}; 2; \sigma_3, -\sigma_3; & \quad \text{P-WNL;} \\
\{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_3; & \quad \text{P-WNL;} \\
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; & \quad \text{P-WNL;} \\
\{R_3\}, \{R_4\}; 2; -\sigma_0, -\sigma_3; & \quad \text{P-WNLs;} \\
C; \; Y C; \; \sigma_z, T C_{2y}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; & \quad \text{P-WNL;}
\end{align*}
Accidental degeneracies on high symmetry line

$\Lambda; \Gamma Z/\Gamma A; \quad C_{2z}, \sigma_y; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_0, \sigma_3; \quad P-WNLs;$
$\{R_1\}, \{R_3\}; \quad 2; \sigma_0, \sigma_3; \quad P-WNL;$
$\{R_1\}, \{R_4\}; \quad 2; \sigma_3, \sigma_3; \quad P-WNL;$
$\{R_2\}, \{R_3\}; \quad 2; \sigma_3, -\sigma_3; \quad P-WNL;$
$\{R_2\}, \{R_4\}; \quad 2; \sigma_3, -\sigma_0; \quad P-WNL;$
$\{R_3\}, \{R_4\}; \quad 2; -\sigma_0, \sigma_3; \quad P-WNLs;$

$G; \; XG/XY; \quad C_{2z}, \sigma_y; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_0, \sigma_3; \quad P-WNLs;$
$\{R_1\}, \{R_3\}; \quad 2; \sigma_0, \sigma_0; \quad P-WNL;$
$\{R_1\}, \{R_4\}; \quad 2; \sigma_3, \sigma_3; \quad P-WNL;$
$\{R_2\}, \{R_3\}; \quad 2; \sigma_3, -\sigma_3; \quad P-WNL;$
$\{R_2\}, \{R_4\}; \quad 2; \sigma_3, -\sigma_0; \quad P-WNL;$
$\{R_3\}, \{R_4\}; \quad 2; -\sigma_0, \sigma_3; \quad P-WNLs;$

$H; \; YH/YX; \quad C_{2z}, \sigma_y; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_0, \sigma_3; \quad P-WNLs;$
$\{R_1\}, \{R_3\}; \quad 2; \sigma_0, \sigma_0; \quad P-WNL;$
$\{R_1\}, \{R_4\}; \quad 2; \sigma_3, \sigma_3; \quad P-WNL;$
$\{R_2\}, \{R_3\}; \quad 2; \sigma_3, -\sigma_3; \quad P-WNL;$
$\{R_2\}, \{R_4\}; \quad 2; \sigma_3, -\sigma_0; \quad P-WNL;$
$\{R_3\}, \{R_4\}; \quad 2; -\sigma_0, \sigma_3; \quad P-WNLs;$

$Q; \; ZQ; \quad C_{2z}, \sigma_y; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_0, \sigma_3; \quad P-WNLs;$
$\{R_1\}, \{R_3\}; \quad 2; \sigma_0, \sigma_0; \quad P-WNL;$
$\{R_1\}, \{R_4\}; \quad 2; \sigma_3, \sigma_3; \quad P-WNL;$
$\{R_2\}, \{R_3\}; \quad 2; \sigma_3, -\sigma_3; \quad P-WNL;$
$\{R_2\}, \{R_4\}; \quad 2; \sigma_3, -\sigma_0; \quad P-WNL;$
$\{R_3\}, \{R_4\}; \quad 2; -\sigma_0, \sigma_3; \quad P-WNLs;$

$\Sigma; \; \Gamma X/\Gamma Z; \; \sigma_y,T \sigma_x; \; \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad P-WNL;$

$C; \; \Gamma Y/\Gamma Z; \; \sigma_y,T \sigma_x; \; \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad P-WNL;$

$A; \; \Gamma A/ZY; \; \sigma_y,T \sigma_x; \; \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad P-WNL;$

$U; \; \Gamma U/XU; \; \sigma_y,T \sigma_x; \; \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad P-WNL;$

$\Delta; \; \Gamma Y/\Gamma \Delta; \; \sigma_z,T C_{2z}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad P-WNL;$

$D; \; \Gamma D/XD; \; \sigma_z,T C_{2z}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad P-WNL;$

$B; \; \Gamma Z/XZ; \; \sigma_z,T C_{2z}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad P-WNL;$

$R; \; \Gamma R; \; \sigma_z,T C_{2z}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad P-WNL;$
Accidental degeneracies on high symmetry line

Λ; ΓZ/ΓΛ; $C_{2z,σ_y}$; $\{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3$; P-WNLs;
$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0$; P-WNL;
$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3$; P-WNL;
$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3$; P-WNL;
$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0$; P-WNL;
$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3$; P-WNLs;

Q; ZQ; $C_{2z,σ_y,E}$; $\{R_5\}, \{R_6\}; 2; \sigma_3, -i\sigma_0, \sigma_0$; P-WNL;
$\{R_5\}, \{R_7\}; 2; \sigma_0, -i\sigma_3, \sigma_0$; P-WNLs;
$\{R_5\}, \{R_8\}; 2; \sigma_3, -i\sigma_3, \sigma_0$; P-WNL;
$\{R_6\}, \{R_7\}; 2; -\sigma_3, -i\sigma_3, \sigma_0$; P-WNL;
$\{R_6\}, \{R_8\}; 2; -\sigma_0, -i\sigma_3, \sigma_0$; P-WNLs;
$\{R_7\}, \{R_8\}; 2; \sigma_3, i\sigma_0, \sigma_0$; P-WNL;

Σ; ΓX/ΓΣ; $σ_y, Tσ_x$; $\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; P-WNL;
$\{R_1\}, \{R_3\}; 2; -i\sigma_3, \sigma_0$; P-WNL;

U; XU; $σ_y, Tσ_x$; $\{R_1\}, \{R_2\}; 2; -i\sigma_3, \sigma_0$; P-WNL;

Δ; ΓY/ΓΔ; $σ_x, TC_{2z}$; $\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; P-WNL;

R; YR; $σ_x, TC_{2z}$; $\{R_1\}, \{R_2\}; 2; -i\sigma_3, \sigma_0$; P-WNL;

Accidental degeneracies on high symmetry line

Λ; ΓΛ/ΓX; $C_{2z,σ_y}$; $\{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3$; P-WNLs;
$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0$; P-WNL;
$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3$; P-WNL;
$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3$; P-WNL;
$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0$; P-WNL;
$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3$; P-WNLs;

G; XG; $C_{2z,σ_y}$; $\{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3$; P-WNLs;
$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0$; P-WNL;
$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3$; P-WNL;
$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3$; P-WNL;
$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0$; P-WNL;
$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3$; P-WNLs;

P; TW; $C_{2z}$; $\{R_1\}, \{R_2\}; 2; \sigma_3$; C-1 WP; 1

Σ; ΓΣ/ΓX; $σ_y, Tσ_x$; $\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; P-WNL;

F; XF; $σ_y, Tσ_x$; $\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; P-WNL;

Δ; ΓΔ/ΓX; $σ_x, TC_{2z}$; $\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; P-WNL;

U; XU; $σ_x, TC_{2z}$; $\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; P-WNL;
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma\Lambda/\Gamma X; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ G; \ XG; \ C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ P; \ TW; \ C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; \text{C-1 WP}; 1 \]

\[ \Sigma; \Gamma\Sigma/\Gamma X; \sigma_y, T\sigma_z; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ F; \ XF; \sigma_y, T\sigma_z; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Delta; \Gamma\Delta/\Gamma X; \sigma_z, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ U; \ XU; \sigma_z, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma\Lambda/\Gamma X; C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ G; \ XG; \ C_{2z}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]

\[ P; \ TW; \ C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3; \text{C-1 WP}; 1 \]

\[ \Sigma; \Gamma\Sigma/\Gamma X; \sigma_y, T\sigma_z; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ F; \ XF; \sigma_y, T\sigma_z; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Delta; \Gamma\Delta/\Gamma X; \sigma_z, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ U; \ XU; \sigma_z, TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

Δ; ΓY; C₅₂₉,σₓ,(IT; {R₁}, {R₂}; 2; σ₀,σ₃,σ₀; P-WNLs;
{R₁}, {R₃}; 2; σ₃,σ₀,σ₀; P-WNL;
{R₁}, {R₄}; 2; σ₃,σ₃,σ₀; P-WNL;
{R₂}, {R₃}; 2; σ₃,−σ₃,σ₀; P-WNL;
{R₂}, {R₄}; 2; σ₃,−σ₀,σ₀; P-WNL;
{R₃}, {R₄}; 2; −σ₀,σ₃,σ₀; P-WNLs;

D; XS; C₅₂₉,σₓ,IT; {R₁}, {R₂}; 2; σ₀,σ₃,σ₀; P-WNLs;
{R₁}, {R₃}; 2; σ₃,σ₀,σ₀; P-WNL;
{R₁}, {R₄}; 2; σ₃,σ₃,σ₀; P-WNL;
{R₂}, {R₃}; 2; σ₃,−σ₃,σ₀; P-WNL;
{R₂}, {R₄}; 2; σ₃,−σ₀,σ₀; P-WNL;
{R₃}, {R₄}; 2; −σ₀,σ₃,σ₀; P-WNLs;

P; UR; C₅₂₉,σₓ,IT; {R₁}, {R₂}; 2; σ₀,σ₃,σ₀; P-WNLs;
{R₁}, {R₃}; 2; σ₃,σ₀,σ₀; P-WNL;
{R₁}, {R₄}; 2; σ₃,σ₃,σ₀; P-WNL;
{R₂}, {R₃}; 2; σ₃,−σ₃,σ₀; P-WNL;
{R₂}, {R₄}; 2; σ₃,−σ₀,σ₀; P-WNL;
{R₃}, {R₄}; 2; −σ₀,σ₃,σ₀; P-WNLs;

B; ZT; C₅₂₉,σₓ,IT; {R₁}, {R₂}; 2; σ₀,σ₃,σ₀; P-WNLs;
{R₁}, {R₃}; 2; σ₃,σ₀,σ₀; P-WNL;
{R₁}, {R₄}; 2; σ₃,σ₃,σ₀; P-WNL;
{R₂}, {R₃}; 2; σ₃,−σ₃,σ₀; P-WNL;
{R₂}, {R₄}; 2; σ₃,−σ₀,σ₀; P-WNL;
{R₃}, {R₄}; 2; −σ₀,σ₃,σ₀; P-WNLs;

Σ; GX; C₅₂₉,σₓ,IT; {R₁}, {R₂}; 2; σ₀,σ₃,σ₀; P-WNLs;
{R₁}, {R₃}; 2; σ₃,σ₀,σ₀; P-WNL;
{R₁}, {R₄}; 2; σ₃,σ₃,σ₀; P-WNL;
{R₂}, {R₃}; 2; σ₃,−σ₃,σ₀; P-WNL;
{R₂}, {R₄}; 2; σ₃,−σ₀,σ₀; P-WNL;
{R₃}, {R₄}; 2; −σ₀,σ₃,σ₀; P-WNLs;

C; YS; C₅₂₉,σₓ,IT; {R₁}, {R₂}; 2; σ₀,σ₃,σ₀; P-WNLs;
{R₁}, {R₃}; 2; σ₃,σ₀,σ₀; P-WNL;
{R₁}, {R₄}; 2; σ₃,σ₃,σ₀; P-WNL;
{R₂}, {R₃}; 2; σ₃,−σ₃,σ₀; P-WNL;
{R₂}, {R₄}; 2; σ₃,−σ₀,σ₀; P-WNL;
{R₃}, {R₄}; 2; −σ₀,σ₃,σ₀; P-WNLs;

E; TR; C₂ₓ,σₓ,IT; {R₁}, {R₂}; 2; σ₀,σ₃,σ₀; P-WNLs;
{R₁}, {R₃}; 2; σ₃,σ₀,σ₀; P-WNL;
{R₁}, {R₄}; 2; σ₃,σ₃,σ₀; P-WNL;
{R₂}, {R₃}; 2; σ₃,−σ₃,σ₀; P-WNL;
{R₂}, {R₄}; 2; σ₃,−σ₀,σ₀; P-WNL;
{R₃}, {R₄}; 2; −σ₀,σ₃,σ₀; P-WNLs;
A: ZU; $C_{2x,\sigma_z,IT}$; \{R_1\},\{R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\},\{R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\},\{R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_2\},\{R_3\}; 2; $\sigma_3,-\sigma_3,\sigma_0$; P-WNL;
\{R_2\},\{R_4\}; 2; $\sigma_3,-\sigma_0,\sigma_0$; P-WNL;
\{R_3\},\{R_4\}; 2; $-\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

A: ΓZ; $C_{2x,\sigma_y,IT}$; \{R_1\},\{R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\},\{R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\},\{R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_2\},\{R_3\}; 2; $\sigma_3,-\sigma_3,\sigma_0$; P-WNL;
\{R_2\},\{R_4\}; 2; $\sigma_3,-\sigma_0,\sigma_0$; P-WNL;
\{R_3\},\{R_4\}; 2; $-\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

H: YT; $C_{2y,\sigma_y,IT}$; \{R_1\},\{R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\},\{R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\},\{R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_2\},\{R_3\}; 2; $\sigma_3,-\sigma_3,\sigma_0$; P-WNL;
\{R_2\},\{R_4\}; 2; $\sigma_3,-\sigma_0,\sigma_0$; P-WNL;
\{R_3\},\{R_4\}; 2; $-\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

Q: SR; $C_{2z,\sigma_y,IT}$; \{R_1\},\{R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\},\{R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\},\{R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_2\},\{R_3\}; 2; $\sigma_3,-\sigma_3,\sigma_0$; P-WNL;
\{R_2\},\{R_4\}; 2; $\sigma_3,-\sigma_0,\sigma_0$; P-WNL;
\{R_3\},\{R_4\}; 2; $-\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

G: XU; $C_{2z,\sigma_y,IT}$; \{R_1\},\{R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\},\{R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\},\{R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_2\},\{R_3\}; 2; $\sigma_3,-\sigma_3,\sigma_0$; P-WNL;
\{R_2\},\{R_4\}; 2; $\sigma_3,-\sigma_0,\sigma_0$; P-WNL;
\{R_3\},\{R_4\}; 2; $-\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_Y; C_{2y, \sigma_x, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL} \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs} \]

\[ P; \text{ UR}; \sigma_z, C_{2y, IT}; \{R_2\}, \{R_4\}; 2; -i\sigma_3, \sigma_0, \sigma_0; \text{ P-WNLs} \]
\[ \{R_2\}, \{R_6\}; 2; -i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_2\}, \{R_8\}; 2; -i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_4\}, \{R_6\}; 2; i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_4\}, \{R_8\}; 2; i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_6\}, \{R_8\}; 2; -i\sigma_3, -\sigma_0, \sigma_0; \text{ P-WNLs} \]

\[ \Sigma; \text{ GX}; C_{2x, \sigma_y, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL} \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs} \]

\[ E; \text{ TR}; \sigma_z, C_{2x, IT}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0, \sigma_0; \text{ P-WNLs} \]
\[ \{R_2\}, \{R_6\}; 2; i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_2\}, \{R_8\}; 2; i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_4\}, \{R_6\}; 2; -i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_4\}, \{R_8\}; 2; -i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_6\}, \{R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_0; \text{ P-WNLs} \]

\[ \Lambda; \text{ GZ}; C_{2x, \sigma_y, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL} \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs} \]

\[ Q; \text{ SR}; \sigma_z, C_{2x, IT}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0, \sigma_0; \text{ P-WNLs} \]
\[ \{R_2\}, \{R_6\}; 2; i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_2\}, \{R_8\}; 2; i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_4\}, \{R_6\}; 2; -i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_4\}, \{R_8\}; 2; -i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL} \]
\[ \{R_6\}, \{R_8\}; 2; i\sigma_3, -\sigma_0, \sigma_0; \text{ P-WNLs} \]
Accidental degeneracies on high symmetry line

| Symmetry | Group | Components | P-WNLs |
|----------|-------|------------|--------|
| Δ; ΓY; C_{2y,σ_z,IT} | \{R_1\}, \{R_2\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |
|           | \{R_1\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_1\}, \{R_4\} | \{2\}; \sigma_3, \sigma_3, \sigma_0; | P-WNL; |
|           | \{R_2\}, \{R_3\} | \{2\}; \sigma_3, \sigma_3, \sigma_0; | P-WNL; |
|           | \{R_2\}, \{R_4\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_3\}, \{R_4\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |

| Symmetry | Group | Components | P-WNLs |
|----------|-------|------------|--------|
| D; Xs; C_{2y,σ_z,IT} | \{R_1\}, \{R_2\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |
|           | \{R_1\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_1\}, \{R_4\} | \{2\}; \sigma_3, \sigma_3, \sigma_0; | P-WNL; |
|           | \{R_2\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_3\}, \{R_4\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |

| Symmetry | Group | Components | P-WNLs |
|----------|-------|------------|--------|
| Σ; Γx; C_{2x,σ_z,IT} | \{R_1\}, \{R_2\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |
|           | \{R_1\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_1\}, \{R_4\} | \{2\}; \sigma_3, \sigma_3, \sigma_0; | P-WNL; |
|           | \{R_2\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_3\}, \{R_4\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |

| Symmetry | Group | Components | P-WNLs |
|----------|-------|------------|--------|
| C; Ys; C_{2x,σ_z,IT} | \{R_1\}, \{R_2\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |
|           | \{R_1\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_1\}, \{R_4\} | \{2\}; \sigma_3, \sigma_3, \sigma_0; | P-WNL; |
|           | \{R_2\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_3\}, \{R_4\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |

| Symmetry | Group | Components | P-WNLs |
|----------|-------|------------|--------|
| Λ; Γz; C_{2x,σ_y,IT} | \{R_1\}, \{R_2\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |
|           | \{R_1\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_1\}, \{R_4\} | \{2\}; \sigma_3, \sigma_3, \sigma_0; | P-WNL; |
|           | \{R_2\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_3\}, \{R_4\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |

| Symmetry | Group | Components | P-WNLs |
|----------|-------|------------|--------|
| H; Yt; C_{2x,σ_y,IT} | \{R_1\}, \{R_2\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |
|           | \{R_1\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_1\}, \{R_4\} | \{2\}; \sigma_3, \sigma_3, \sigma_0; | P-WNL; |
|           | \{R_2\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_3\}, \{R_4\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |

| Symmetry | Group | Components | P-WNLs |
|----------|-------|------------|--------|
| Q; Sr; C_{2x,σ_y,IT} | \{R_1\}, \{R_2\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |
|           | \{R_1\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_1\}, \{R_4\} | \{2\}; \sigma_3, \sigma_3, \sigma_0; | P-WNL; |
|           | \{R_2\}, \{R_3\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_2\}, \{R_4\} | \{2\}; \sigma_3, \sigma_0, \sigma_0; | P-WNL; |
|           | \{R_3\}, \{R_4\} | \{2\}; \sigma_0, \sigma_3, \sigma_0; | P-WNLs; |
$G; \ XU; \ C_{2z}, \sigma_y, IT; \ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P$-WNLs;

$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P$-WNL;

$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P$-WNL;

$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P$-WNL;

$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P$-WNL;

$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P$-WNLs;
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma; C_{2y, \sigma_z, IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]

\[ \Lambda; Z; C_{2y, \sigma_z, IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]

\[ \Psi; \GammaX; C_{2x, \sigma_z, IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]

\[ \Lambda; \GammaZ; C_{2x, \sigma_y, IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]

\[ Q; SR; \sigma_y, C_{2y, IT}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_2 \}, \{ R_6 \}; 2; i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_8 \}; 2; i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_4 \}, \{ R_6 \}; 2; -i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_4 \}, \{ R_8 \}; 2; -i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_6 \}, \{ R_8 \}; 2; i\sigma_3, -\sigma_0, \sigma_0; \text{ P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[
\Delta; \Gamma Y; C_{2y,\sigma_x,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL};
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL};
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNL};
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\]
Accidental degeneracies on high symmetry line

\( \Delta: \Gamma Y; C_{2y, \sigma_z, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \)
\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \)
\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \)
\( \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \)
\( \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \)
\( \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \)

\( \Sigma: \Gamma X; C_{2x, \sigma_z, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \)
\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \)
\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \)
\( \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \)
\( \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \)
\( \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \)

\( \Lambda: \Gamma Z; C_{2x, \sigma_y, IT}; \{R_2\}, \{R_4\}, \{R_6, R_8\}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; 0 \)

\( \Lambda: \Gamma Z; C_{2x, \sigma_y, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \)
\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \)
\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \)
\( \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \)
\( \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \)
\( \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \)

\( Q: \sigma_y, C_{2x, IT}; \{R_2\}, \{R_4\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \)
\( \{R_2\}, \{R_6\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNL}; \)
\( \{R_2\}, \{R_8\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNL}; \)
\( \{R_4\}, \{R_6\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNL}; \)
\( \{R_4\}, \{R_8\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNL}; \)
\( \{R_6\}, \{R_8\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \)
Accidental degeneracies on high symmetry line

**Δ; ΓY; C_{2y,σ_z,IT}:** \[ \{R_1\}, \{R_2\}; \ 2; \ σ_0,σ_3,σ_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; \ 2; \ σ_3,σ_0,σ_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; \ 2; \ σ_3,σ_3,σ_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; \ 2; \ σ_3,−σ_3,σ_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; \ 2; \ σ_3,−σ_0,σ_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; \ 2; \ −σ_0,σ_3,σ_0; \ P-WNLs; \]

**D; XS; C_{2y,σ_z,IT}:** \[ \{R_1\}, \{R_2\}; \ 2; \ σ_0,σ_3,σ_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; \ 2; \ σ_3,σ_0,σ_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; \ 2; \ σ_3,σ_3,σ_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; \ 2; \ σ_3,−σ_3,σ_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; \ 2; \ σ_3,−σ_0,σ_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; \ 2; \ −σ_0,σ_3,σ_0; \ P-WNLs; \]

**Σ; ΓX; C_{2x,σ_z,IT}:** \[ \{R_1\}, \{R_2\}; \ 2; \ σ_0,σ_3,σ_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; \ 2; \ σ_3,σ_0,σ_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; \ 2; \ σ_3,σ_3,σ_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; \ 2; \ σ_3,−σ_3,σ_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; \ 2; \ σ_3,−σ_0,σ_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; \ 2; \ −σ_0,σ_3,σ_0; \ P-WNLs; \]

**Α; ZU; C_{2x,σ_y,IT}:** \[ \{R_2, R_4, \{R_6, R_8\}; \ 4; \ Γ_{0,3,1,3,0,1}; \ DP; \ 0 \]

**Λ; ΓZ; C_{2x,σ_y,IT}:** \[ \{R_1\}, \{R_2\}; \ 2; \ σ_0,σ_3,σ_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; \ 2; \ σ_3,σ_0,σ_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; \ 2; \ σ_3,σ_3,σ_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; \ 2; \ σ_3,−σ_3,σ_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; \ 2; \ σ_3,−σ_0,σ_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; \ 2; \ −σ_0,σ_3,σ_0; \ P-WNLs; \]

**G; XU; C_{2x,σ_y,IT}:** \[ \{R_1\}, \{R_2\}; \ 2; \ σ_0,σ_3,σ_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; \ 2; \ σ_3,σ_0,σ_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; \ 2; \ σ_3,σ_3,σ_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; \ 2; \ σ_3,−σ_3,σ_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; \ 2; \ σ_3,−σ_0,σ_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; \ 2; \ −σ_0,σ_3,σ_0; \ P-WNLs; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; C_{2y}, \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_4 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ \Sigma; \Gamma X; C_{2x}, \sigma_x, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ \Lambda; \Gamma Z; C_{2x}, \sigma_y, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ \Lambda; \Gamma Z; C_{2x}, \sigma_y, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ P; \text{UR}; \sigma_x, C_{2y}, IT; \{ R_2, R_6 \}, \{ R_4, R_8 \}; 4; -i \Gamma_{3,0}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; 0 \]

\[ \Sigma; \Gamma X; C_{2x}, \sigma_x, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; C_{2y}^2, \sigma_z, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_4, \sigma_0; P-WNLs; \]

\[ \Delta; \Gamma Z; \{R_1\}, \{R_2\}; \{R_3\}, \{R_6\}; \{R_8\}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \{R_3\}, \{R_4\}; \{R_6\}, \{R_8\}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \]

\[ D; \Gamma X; C_{2y}^2, \sigma_z, IT; \{R_2, R_4\}, \{R_6, R_8\}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; DP; 0 \]

\[ P; \Gamma R; C_{2y}^2, \sigma_z, IT; \{R_2, R_4\}, \{R_6, R_8\}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; DP; 0 \]

\[ B; \Gamma T; C_{2y}^2, \sigma_z, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_4, \sigma_0; P-WNLs; \]

\[ \Sigma; \Gamma X; C_{2z}^2, \sigma_z, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_4, \sigma_0; P-WNLs; \]

\[ C; \Gamma S; C_{2z}^2, \sigma_z, IT; \{R_2, R_4\}, \{R_6, R_8\}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; DP; 0 \]

\[ E; \Gamma R; C_{2z}^2, \sigma_z, IT; \{R_2, R_4\}, \{R_6, R_8\}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; DP; 0 \]

\[ A; \Gamma U; C_{2z}^2, \sigma_z, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_4, \sigma_0; P-WNLs; \]

\[ \Lambda; \Gamma Z; C_{2z}^2, \sigma_y, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_4, \sigma_0; P-WNLs; \]

\[ Q; SR; \sigma_y, C_{2z}^2, IT; \{R_2, R_4\}, \{R_6, R_8\}; 4; i\Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; DP; 0 \]
Accidental degeneracies on high symmetry line

\[ \Delta, \Gamma Y; C_{2y, \sigma_z IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_1, \sigma_0; \text{P-WNLs}; \]

\[ P, \text{UR}; C_{2y, \sigma_z IT}; \{ R_2, R_3 \}, \{ R_4, R_6 \}; 4; \Gamma_{3,3}, -i\Gamma_{0,3,3}; \text{DP}; 0 \]

\[ \Sigma, \Gamma X; C_{2x, \sigma_z IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_1, \sigma_0; \text{P-WNL}; \]

\[ E, \text{TR}; C_{2x, \sigma_y IT}; \{ R_2, R_3 \}, \{ R_4, R_6 \}; 4; -\Gamma_{3,3}, -i\Gamma_{0,3,3}; \text{DP}; 0 \]

\[ \Lambda, \Gamma Z; C_{2x, \sigma_y IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_1, \sigma_0; \text{P-WNLs}; \]

\[ H, \text{YT}; C_{2y, \sigma_y IT}; \{ R_1, R_4 \}, \{ R_2, R_3 \}; 4; \Gamma_{0,3,3,3}; \text{DP}; 0 \]

\[ Q, \text{SR}; C_{2y, \sigma_y IT}; \{ R_1, R_2 \}, \{ R_3, R_4 \}; 4; \Gamma_{3,0,3,3}; \text{DP}; 0 \]

\[ G, \text{XU}; C_{2x, \sigma_y IT}; \{ R_1, R_3 \}, \{ R_2, R_4 \}; 4; \Gamma_{0,3,3,3}; \text{DP}; 0 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \; \Gamma Y; \; C_2y, \sigma_x, IT; \{ R_1 \}, \{ R_2 \}; \; 2; \sigma_0, \sigma_3, \sigma_0; \; \text{P-WNLs}; \]
\{ R_1 \}, \{ R_3 \}; \; 2; \sigma_3, \sigma_0, \sigma_0; \; \text{P-WNL};
\{ R_1 \}, \{ R_4 \}; \; 2; \sigma_3, \sigma_3, \sigma_0; \; \text{P-WNL};
\{ R_2 \}, \{ R_3 \}; \; 2; \sigma_3, -\sigma_3, \sigma_0; \; \text{P-WNL};
\{ R_2 \}, \{ R_4 \}; \; 2; \sigma_3, -\sigma_0, \sigma_0; \; \text{P-WNL};
\{ R_3 \}, \{ R_4 \}; \; 2; -\sigma_0, \sigma_3, \sigma_0; \; \text{P-WNLs};

\[ B; \; ZT; \; C_2y, \sigma_x, IT; \{ R_1 \}, \{ R_2 \}; \; 2; \sigma_0, \sigma_3, \sigma_0; \; \text{P-WNLs}; \]
\{ R_1 \}, \{ R_3 \}; \; 2; \sigma_3, \sigma_0, \sigma_0; \; \text{P-WNL};
\{ R_1 \}, \{ R_4 \}; \; 2; \sigma_3, \sigma_3, \sigma_0; \; \text{P-WNL};
\{ R_2 \}, \{ R_3 \}; \; 2; \sigma_3, -\sigma_3, \sigma_0; \; \text{P-WNL};
\{ R_2 \}, \{ R_4 \}; \; 2; \sigma_3, -\sigma_0, \sigma_0; \; \text{P-WNL};
\{ R_3 \}, \{ R_4 \}; \; 2; -\sigma_0, \sigma_3, \sigma_0; \; \text{P-WNLs};

\[ \Sigma; \; \Gamma X; \; C_2x, \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; \; 2; \sigma_0, \sigma_3, \sigma_0; \; \text{P-WNLs}; \]
\{ R_1 \}, \{ R_3 \}; \; 2; \sigma_3, \sigma_0, \sigma_0; \; \text{P-WNL};
\{ R_1 \}, \{ R_4 \}; \; 2; \sigma_3, \sigma_3, \sigma_0; \; \text{P-WNL};
\{ R_2 \}, \{ R_3 \}; \; 2; \sigma_3, -\sigma_3, \sigma_0; \; \text{P-WNL};
\{ R_2 \}, \{ R_4 \}; \; 2; \sigma_3, -\sigma_0, \sigma_0; \; \text{P-WNL};
\{ R_3 \}, \{ R_4 \}; \; 2; -\sigma_0, \sigma_3, \sigma_0; \; \text{P-WNLs};

\[ C; \; YS; \; C_2x, \sigma_z, IT; \{ R_2, R_4 \}, \{ R_0, R_8 \}; \; 4; -\Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \; \text{DP}; \; 0 \]
\[ E; \; TR; \; C_2x, \sigma_z, IT; \{ R_2, R_4 \}, \{ R_0, R_8 \}; \; 4; -\Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \; \text{DP}; \; 0 \]

\[ A; \; ZU; \; C_2x, \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; \; 2; \sigma_0, \sigma_3, \sigma_0; \; \text{P-WNLs}; \]
\{ R_1 \}, \{ R_3 \}; \; 2; \sigma_3, \sigma_0, \sigma_0; \; \text{P-WNL};
\{ R_1 \}, \{ R_4 \}; \; 2; \sigma_3, \sigma_3, \sigma_0; \; \text{P-WNL};
\{ R_2 \}, \{ R_3 \}; \; 2; \sigma_3, -\sigma_3, \sigma_0; \; \text{P-WNL};
\{ R_2 \}, \{ R_4 \}; \; 2; \sigma_3, -\sigma_0, \sigma_0; \; \text{P-WNL};
\{ R_3 \}, \{ R_4 \}; \; 2; -\sigma_0, \sigma_3, \sigma_0; \; \text{P-WNLs};

\[ \Lambda; \; \Gamma Z; \; C_2x, \sigma_y, IT; \{ R_1 \}, \{ R_2 \}; \; 2; \sigma_0, \sigma_3, \sigma_0; \; \text{P-WNLs}; \]
\{ R_1 \}, \{ R_3 \}; \; 2; \sigma_3, \sigma_0, \sigma_0; \; \text{P-WNL};
\{ R_1 \}, \{ R_4 \}; \; 2; \sigma_3, \sigma_3, \sigma_0; \; \text{P-WNL};
\{ R_2 \}, \{ R_3 \}; \; 2; \sigma_3, -\sigma_3, \sigma_0; \; \text{P-WNL};
\{ R_2 \}, \{ R_4 \}; \; 2; \sigma_3, -\sigma_0, \sigma_0; \; \text{P-WNL};
\{ R_3 \}, \{ R_4 \}; \; 2; -\sigma_0, \sigma_3, \sigma_0; \; \text{P-WNLs};

\[ G; \; XU; \; C_2x, \sigma_y, IT; \{ R_1, R_3 \}, \{ R_2, R_4 \}; \; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \; \text{DP}; \; 0 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; C_{2y}, \sigma_x, \sigma_z, I_T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ D; X S; C_{2y}, \sigma_x, I_T; \{ R_2, R_4 \}, \{ R_6, R_8 \}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; 0 \]
\[ \Sigma; \Gamma X; C_{2x}, \sigma_z, I_T; \{ R_1 \}, \{ R_2 \}; \]
\[ \quad 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ C; Y S; C_{2y}, \sigma_z, I_T; \{ R_2, R_4 \}, \{ R_6, R_8 \}; 4; -\Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; 0 \]
\[ \Lambda; \Gamma Z; C_{2z}, \sigma_y, I_T; \{ R_1 \}, \{ R_2 \}; \]
\[ \quad 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ Q; S R; \sigma_y, C_{2z}, I_T; \{ R_2, R_4 \}, \{ R_6, R_8 \}; 4; i\Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; 0 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_Y; C_{2y}, \sigma_x, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]

\[ B; \Gamma_Z; C_{2y}, \sigma_x, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]

\[ \Sigma; \Gamma_X; C_{2x}, \sigma_z, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]

\[ \Lambda; \Gamma_Z; C_{2z}, \sigma_y, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]

\[ H; \Gamma_Y; C_{2z}, \sigma_y, IT; \{R_1, R_2\}, \{R_2, R_3\}; 4; \Gamma_{0,3}, \Gamma_{3,3}, \Gamma_{0,1}; DP; 0 \]
\[ Q; \Gamma_Z; C_{2x}, \sigma_y, IT; \{R_1, R_2\}, \{R_3, R_4\}; 4; \Gamma_{3,0}, \Gamma_{0,3}, \Gamma_{0,1}; DP; 0 \]
\[ G; \Gamma_Z; C_{2z}, \sigma_y, IT; \{R_1, R_3\}, \{R_2, R_4\}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; DP; 0 \]
Accidental degeneracies on high symmetry line

Δ; ΓY; $C_{2y, \sigma_z, IT}$; \{R_1\}, \{R_2\}; \begin{align*} & {\{R_1\}, \{R_3\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};} \\
& {\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};} \\
& {\{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};} \\
& {\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL};} \\
& {\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNL};} \\
\end{align*}

D; XS; $C_{2y, \sigma_z, IT}$; \{R_2, R_4\}, \{R_6, R_8\}; 4; Γ_{0,3}, Γ_{3,0}, Γ_{0,1}; DP; 0

Σ; ΓX; $C_{2z, \sigma_x, IT}$; \{R_1\}, \{R_2\}; \begin{align*} & {\{R_1\}, \{R_3\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};} \\
& {\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};} \\
& {\{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};} \\
& {\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL};} \\
& {\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNL};} \\
\end{align*}

C; YS; $C_{2y, \sigma_x, IT}$; \{R_3\}, \{R_5\}; 4; -Γ_{0,2}, iΓ_{0,3}, -iΓ_{0,3}; DP; 0

E; TR; $C_{2x, \sigma_y, IT}$; \{R_2, R_8\}, \{R_4, R_6\}; 4; -Γ_{3,3}, -iΓ_{0,3}, Γ_{0,1}; DP; 0

Λ; ΓZ; $C_{2z, \sigma_y, IT}$; \{R_1\}, \{R_2\}; \begin{align*} & {\{R_1\}, \{R_3\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};} \\
& {\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};} \\
& {\{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};} \\
& {\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL};} \\
& {\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNL};} \\
\end{align*}

H; YT; $C_{2z, \sigma_y, IT}$; \{R_1, R_4\}, \{R_2, R_3\}; 4; Γ_{0,3}, Γ_{3,3}, Γ_{0,1}; DP; 0
Accidental degeneracies on high symmetry line

- \( \Delta; \Gamma_Y; C_{2y}, \sigma_z, IT; \{ R_1 \}, \{ R_2 \} \); 2; \( \sigma_0, \sigma_3, \sigma_0 \); P-WNLs;
  \{ R_1 \}, \{ R_3 \} ; 2; \( \sigma_3, \sigma_0, \sigma_0 \); P-WNL;
  \{ R_1 \}, \{ R_4 \} ; 2; \( \sigma_3, \sigma_3, \sigma_0 \); P-WNL;
  \{ R_2 \}, \{ R_3 \} ; 2; \sigma_3, -\sigma_3, \sigma_0 \); P-WNL;
  \{ R_2 \}, \{ R_4 \} ; 2; \sigma_3, -\sigma_0, \sigma_0 \); P-WNL;
  \{ R_3 \}, \{ R_4 \} ; 2; -\sigma_0, \sigma_3, \sigma_0 \); P-WNLs;

- \( D; \Gamma_X; C_{2z}, \sigma_x, IT; \{ R_2, R_4 \}, \{ R_6, R_8 \} \); 4; \( \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1} \); DP; 0

- \( \Sigma; \Gamma_X; C_{2z}, \sigma_z, IT; \{ R_1 \}, \{ R_2 \} \); 2; \( \sigma_0, \sigma_3, \sigma_0 \); P-WNLs;
  \{ R_1 \}, \{ R_3 \} ; 2; \sigma_3, \sigma_0, \sigma_0 \); P-WNL;
  \{ R_1 \}, \{ R_4 \} ; 2; \sigma_3, \sigma_3, \sigma_0 \); P-WNL;
  \{ R_2 \}, \{ R_3 \} ; 2; \sigma_3, -\sigma_3, \sigma_0 \); P-WNL;
  \{ R_2 \}, \{ R_4 \} ; 2; \sigma_3, -\sigma_0, \sigma_0 \); P-WNL;
  \{ R_3 \}, \{ R_4 \} ; 2; -\sigma_0, \sigma_3, \sigma_0 \); P-WNLs;

- \( A; \Gamma_Z; C_{2z}, \sigma_y, IT; \{ R_2, R_4 \}, \{ R_6, R_8 \} \); 4; \( \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1} \); DP; 0

- \( \Lambda; \Gamma_Z; C_{2z}, \sigma_y, IT; \{ R_1 \}, \{ R_2 \} \); 2; \( \sigma_0, \sigma_3, \sigma_0 \); P-WNLs;
  \{ R_1 \}, \{ R_3 \} ; 2; \sigma_3, \sigma_0, \sigma_0 \); P-WNL;
  \{ R_1 \}, \{ R_4 \} ; 2; \sigma_3, \sigma_3, \sigma_0 \); P-WNL;
  \{ R_2 \}, \{ R_3 \} ; 2; \sigma_3, -\sigma_3, \sigma_0 \); P-WNL;
  \{ R_2 \}, \{ R_4 \} ; 2; \sigma_3, -\sigma_0, \sigma_0 \); P-WNL;
  \{ R_3 \}, \{ R_4 \} ; 2; -\sigma_0, \sigma_3, \sigma_0 \); P-WNLs;

- \( H; \Gamma_T; C_{2z}, \sigma_x, IT; \{ R_2, R_4 \}, \{ R_6, R_8 \} \); 4; \( -\Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1} \); DP; 0
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; C_{2y,\sigma_z,IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNL}s; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_4, \sigma_0; \text{P-WNL}s; \]

\[ P; \text{UR}; C_{2y,\sigma_z,IT}; \{ R_2, R_5 \}, \{ R_4, R_8 \}; 4; \Gamma_{3,0}, -i\Gamma_{0,3}, \Gamma_{0,1}; \text{DP}; 0 \]

\[ \Sigma; \Gamma X; C_{2x,\sigma_z,IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNL}s; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_4, \sigma_0; \text{P-WNL}s; \]

\[ C; \text{YS}; C_{2x,\sigma_z,IT}; \{ R_1, R_3 \}, \{ R_2, R_4 \}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; 0 \]

\[ E; \text{TR}; C_{2x,\sigma_y,IT}; \{ R_2, R_5 \}, \{ R_4, R_8 \}; 4; \Gamma_{3,0}, \Gamma_{0,3}, \Gamma_{0,1}; \text{DP}; 0 \]

\[ A; \text{ZU}; C_{2x,\sigma_y,IT}; \{ R_2, R_4 \}, \{ R_6, R_8 \}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; 0 \]

\[ \Lambda; \text{GZ}; C_{2x,\sigma_y,IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNL}s; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_4, \sigma_0; \text{P-WNL}s; \]

\[ G; \text{XU}; C_{2x,\sigma_y,IT}; \{ R_1, R_3 \}, \{ R_2, R_4 \}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; 0 \]
Accidental degeneracies on high symmetry line

Λ; ΓZ; \( C_{2y, \sigma_z, IT} \): \( \{R_1\}, \{R_2\} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;
\( \{R_1\}, \{R_3\} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \);
P-WNL;
\( \{R_1\}, \{R_4\} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_3\} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_4\} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \);
P-WNL;
\( \{R_3\}, \{R_4\} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;

H; YT; \( C_{2x, \sigma_y, IT} \): \( \{R_1\}, \{R_2\} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;
\( \{R_1\}, \{R_3\} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \);
P-WNL;
\( \{R_1\}, \{R_4\} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_3\} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_4\} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \);
P-WNL;
\( \{R_3\}, \{R_4\} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;

D; SR; \( C_{2z, IT} \): \( \{R_1\}, \{R_2\} \);
2; \( \sigma_3, \sigma_0 \);
P-WNL;

Σ; ΓY; \( C_{2x, \sigma_z, IT} \): \( \{R_1\}, \{R_2\} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;
\( \{R_1\}, \{R_3\} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \);
P-WNL;
\( \{R_1\}, \{R_4\} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_3\} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_4\} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \);
P-WNL;
\( \{R_3\}, \{R_4\} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;

Δ; ΓΔ; \( C_{2y, \sigma_x, IT} \): \( \{R_1\}, \{R_2\} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;
\( \{R_1\}, \{R_3\} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \);
P-WNL;
\( \{R_1\}, \{R_4\} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_3\} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_4\} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \);
P-WNL;
\( \{R_3\}, \{R_4\} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;

B; ZB; \( C_{2y, \sigma_z, IT} \): \( \{R_2, R_3\}, \{R_6, R_8\} \);
4; \( \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; DP \); 0

G; TG; \( C_{2y, \sigma_x, IT} \): \( \{R_2, R_4\}, \{R_6, R_8\} \);
4; \( \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; DP \); 0

F; YF; \( C_{2y, \sigma_x, IT} \): \( \{R_1\}, \{R_2\} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;
\( \{R_1\}, \{R_3\} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \);
P-WNL;
\( \{R_1\}, \{R_4\} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_3\} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_4\} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \);
P-WNL;
\( \{R_3\}, \{R_4\} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;

C; YC; \( C_{2x, \sigma_z, IT} \): \( \{R_1\}, \{R_2\} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;
\( \{R_1\}, \{R_3\} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \);
P-WNL;
\( \{R_1\}, \{R_4\} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_3\} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \);
P-WNL;
\( \{R_2\}, \{R_4\} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \);
P-WNL;
\( \{R_3\}, \{R_4\} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \);
P-WNLs;
Accidental degeneracies on high symmetry line

Λ; ΓZ; \( C_{2z,\sigma_y,IT} \): \( \{ R_1 \}, \{ R_2 \} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \); P-WNLs;
\( \{ R_1 \}, \{ R_3 \} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_3 \} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \); P-WNL;
\( \{ R_4 \}, \{ R_4 \} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \); P-WNLs;
\( \{ R_1 \}, \{ R_3 \} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_3 \} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_4 \} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \); P-WNLs;

\( H; \) YT; \( C_{2z,\sigma_y,IT} \): \( \{ R_1 \}, \{ R_2 \} \);
2; \( \sigma_0, -\sigma_3, \sigma_0 \); P-WNLs;
\( \{ R_1 \}, \{ R_3 \} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_4 \} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \); P-WNL;

\( \Sigma; \) ΥY; \( C_{2z,\sigma_z,IT} \): \( \{ R_1 \}, \{ R_2 \} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \); P-WNLs;
\( \{ R_1 \}, \{ R_3 \} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_3 \} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_4 \} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \); P-WNLs;

\( \Delta; \) ΓΔ; \( C_{2y,\sigma_z,IT} \): \( \{ R_1 \}, \{ R_2 \} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \); P-WNLs;
\( \{ R_1 \}, \{ R_3 \} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_3 \} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_4 \} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \); P-WNLs;

\( B; \) ZB; \( C_{2y,\sigma_x,IT} \): \( \{ R_2, R_4 \}, \{ R_6, R_8 \} \); 4; \( \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1} \); DP; 0

\( G; \) TG; \( C_{2y,\sigma_z,IT} \): \( \{ R_2, R_4 \}, \{ R_6, R_8 \} \); 4; \( -\Gamma_{0,3}, -\Gamma_{3,0}, -\Gamma_{0,1} \); DP; 0

\( F; \) YF; \( C_{2y,\sigma_x,IT} \): \( \{ R_1 \}, \{ R_2 \} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \); P-WNLs;
\( \{ R_1 \}, \{ R_3 \} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_3 \} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_4 \} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \); P-WNLs;

\( C; \) YC; \( C_{2x,\sigma_z,IT} \): \( \{ R_1 \}, \{ R_2 \} \);
2; \( \sigma_0, \sigma_3, \sigma_0 \); P-WNLs;
\( \{ R_1 \}, \{ R_3 \} \);
2; \( \sigma_3, \sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( \sigma_3, \sigma_3, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_3 \} \);
2; \( \sigma_3, -\sigma_3, \sigma_0 \); P-WNL;
\( \{ R_2 \}, \{ R_4 \} \);
2; \( \sigma_3, -\sigma_0, \sigma_0 \); P-WNL;
\( \{ R_3 \}, \{ R_4 \} \);
2; \( -\sigma_0, \sigma_3, \sigma_0 \); P-WNLs;
Accidental degeneracies on high symmetry line

$\Lambda; \Gamma Z; C_{2z,\sigma_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL;}
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL;}
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}

$H; YT; C_{2z,\sigma_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL;}
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL;}
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}

$D; SR; C_{2z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{ P-WNL;}

$A; ZT; C_{2z,\sigma_x,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL;}
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL;}
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}

$\Sigma; \Gamma Y; C_{2z,\sigma_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL;}
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL;}
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}

$\Delta; \Gamma \Delta; C_{2y,\sigma_x,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL;}
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL;}
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}

$B; ZB; C_{2y,\sigma_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL;}
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL;}
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}

$G; TG; C_{2y,\sigma_x,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL;}
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL;}
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL;}
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;}
\( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs

\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL

\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL

\( \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \) P-WNL

\( \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \) P-WNLs

\( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs

\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL

\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL

\( \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \) P-WNL

\( \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \) P-WNL

\( \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \) P-WNLs

\( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs

\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL

\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL

\( \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \) P-WNL

\( \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \) P-WNL

\( \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \) P-WNLs
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; C_{2x,\sigma_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_0, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_1\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ H; YT; C_{2x,\sigma_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_1\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ D; SR; C_{2z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Sigma; \Gamma Y; C_{2x,\sigma_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_1\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ \Delta; \Gamma \Delta; C_{2y,\sigma_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_1\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ F; YF; C_{2y,\sigma_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_1\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ C; YC; C_{2x,\sigma_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_1\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

Λ; ΓZ; \( C_{2\alpha, \sigma_y, IT} \): \{R_1\}, \{R_2\}; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

\{R_1\}, \{R_3\}; \sigma_3, \sigma_0, \sigma_0; P-WNL;

\{R_1\}, \{R_4\}; \sigma_3, \sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_3\}; \sigma_3, -\sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_4\}; \sigma_3, -\sigma_0, \sigma_0; P-WNL;

\{R_3\}, \{R_4\}; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

H; YT; \( C_{2\alpha, \sigma_y, IT} \): \{R_1\}, \{R_2\}; \sigma_0, -\sigma_3, \sigma_0; P-WNLs;

\{R_1\}, \{R_3\}; \sigma_3, -\sigma_0, \sigma_0; P-WNL;

\{R_1\}, \{R_4\}; \sigma_3, -\sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_3\}; \sigma_3, \sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_4\}; \sigma_0, \sigma_0, \sigma_0; P-WNL;

\{R_3\}, \{R_4\}; -\sigma_0, -\sigma_3, \sigma_0; P-WNLs;

Ξ; ΓY; \( C_{2\alpha, \sigma_z, IT} \): \{R_1\}, \{R_2\}; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

\{R_1\}, \{R_3\}; \sigma_3, \sigma_0, \sigma_0; P-WNL;

\{R_1\}, \{R_4\}; \sigma_3, \sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_3\}; \sigma_3, -\sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_4\}; \sigma_3, -\sigma_0, \sigma_0; P-WNL;

\{R_3\}, \{R_4\}; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;

Δ; ΓΔ; \( C_{2\gamma, \sigma_z, IT} \): \{R_1\}, \{R_2\}; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

\{R_1\}, \{R_3\}; \sigma_3, \sigma_0, \sigma_0; P-WNL;

\{R_1\}, \{R_4\}; \sigma_3, \sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_3\}; \sigma_3, -\sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_4\}; \sigma_3, -\sigma_0, \sigma_0; P-WNL;

\{R_3\}, \{R_4\}; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;

B; ZB; \( C_{2\gamma, \sigma_x, IT} \): \{R_1\}, \{R_2\}; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

\{R_1\}, \{R_3\}; \sigma_3, \sigma_0, \sigma_0; P-WNL;

\{R_1\}, \{R_4\}; \sigma_3, \sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_3\}; \sigma_3, -\sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_4\}; \sigma_3, -\sigma_0, \sigma_0; P-WNL;

\{R_3\}, \{R_4\}; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;

G; TG; \( C_{2\gamma, \sigma_x, IT} \): \{R_1\}, \{R_2\}; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

\{R_1\}, \{R_3\}; \sigma_3, \sigma_0, \sigma_0; P-WNL;

\{R_1\}, \{R_4\}; \sigma_3, \sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_3\}; \sigma_3, -\sigma_3, \sigma_0; P-WNL;

\{R_2\}, \{R_4\}; \sigma_3, -\sigma_0, \sigma_0; P-WNL;

\{R_3\}, \{R_4\}; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;
$F$; $YF$; $C_{2y, \sigma x, IT}$; $\{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0$; P-WNLs;
$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0$; P-WNL;
$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0$; P-WNL;
$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0$; P-WNL;
$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0$; P-WNL;
$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0$; P-WNLs;

$E$; $TE$; $C_{2x, \sigma x, IT}$; $\{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0$; P-WNLs;
$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0$; P-WNL;
$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0$; P-WNL;
$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0$; P-WNL;
$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0$; P-WNL;
$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0$; P-WNLs;

$C$; $YC$; $C_{2x, \sigma z, IT}$; $\{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0$; P-WNLs;
$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0$; P-WNL;
$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0$; P-WNL;
$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0$; P-WNL;
$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0$; P-WNL;
$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0$; P-WNLs;
Accidental degeneracies on high symmetry line

Λ; ΓZ; \( C_{2z, \sigma_y, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;

H; YT; \( C_{2z, \sigma_y, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_0, -\sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL;
\{R_1\}, \{R_4\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R_3\}, \{R_4\}; 2; -\sigma_0, -\sigma_3, \sigma_0; P-WNLs;

Σ; ΓY; \( C_{2z, \sigma_z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;

Δ; ΓΔ; \( C_{2y, \sigma_z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;

F; YF; \( C_{2y, \sigma_z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;

C; YC; \( C_{2z, \sigma_z, IT} \); \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;
Accidental degeneracies on high symmetry line

\[ \Lambda; \ \Gamma Z/\Gamma \Lambda; \ C_{2z,\sigma_y,IT}; \ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]

\[ G; \ \Sigma \ \Gamma X/\Sigma \ \Gamma \ Y; \ C_{2z,\sigma_y,IT}; \ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]

\[ H; \ \Sigma \ \Gamma Y/\Sigma \ \Gamma \ X; \ C_{2z,\sigma_y,IT}; \ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]

\[ Q; \ \Sigma \ \Gamma Z/\Sigma \ \Gamma \ Y; \ C_{2z,\sigma_y,IT}; \ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]

\[ \Sigma; \ \Sigma \ \Gamma X/\Sigma \ \Gamma \ X; \ C_{2z,\sigma_z,IT}; \ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]

\[ C; \ \Sigma \ \Gamma Z/\Sigma \ \Gamma \ Y; \ C_{2z,\sigma_z,IT}; \ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]

\[ A; \ \Sigma \ \Gamma Z/\Sigma \ \Gamma \ Y; \ C_{2z,\sigma_z,IT}; \ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]
\[ U; \text{XU}; C_{2x, \sigma_z, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ \Delta; \text{\GammaY}/\Gamma\Delta; C_{2y, \sigma_z, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ D; \text{XD}/\text{XZ}; C_{2y, \sigma_z, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ B; \text{ZB}/\text{ZX}; C_{2y, \sigma_z, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ R; \text{YR}; C_{2y, \sigma_z, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z/\Gamma \Lambda; C_{2z, \sigma_y, IT}; \{ R_1 \}, \{ R_2 \}: 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}: 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}: 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}: 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}: 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}: 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]

\[ \Omega; \text{ ZQ}; \sigma_z, C_{2z, IT}; \{ R_2 \}, \{ R_4 \}: 2; i\sigma_3, \sigma_0, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_2 \}, \{ R_5 \}: 2; i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_6 \}: 2; i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_4 \}, \{ R_6 \}: 2; -i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_4 \}, \{ R_5 \}: 2; -i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_5 \}, \{ R_6 \}: 2; i\sigma_3, -\sigma_0, \sigma_0; \text{ P-WNLs}; \]

\[ \Sigma; \Gamma X/\Gamma \Sigma; C_{2z, \sigma_z, IT}; \{ R_1 \}, \{ R_2 \}: 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}: 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}: 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}: 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}: 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}: 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]

\[ U; \text{ XU}; \sigma_y, C_{2z, IT}; \{ R_2 \}, \{ R_4 \}: 2; i\sigma_3, \sigma_0, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_2 \}, \{ R_5 \}: 2; i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_6 \}: 2; i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_4 \}, \{ R_5 \}: 2; -i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_4 \}, \{ R_6 \}: 2; -i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_5 \}, \{ R_6 \}: 2; i\sigma_3, -\sigma_0, \sigma_0; \text{ P-WNLs}; \]

\[ \Delta; \Gamma Y/\Gamma \Delta; C_{2y, \sigma_z, IT}; \{ R_1 \}, \{ R_2 \}: 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}: 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}: 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}: 2; \sigma_1, -\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}: 2; \sigma_1, -\sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}: 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]

\[ R; \text{ YR}; \sigma_x, C_{2y, IT}; \{ R_2 \}, \{ R_4 \}: 2; -i\sigma_3, \sigma_0, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_2 \}, \{ R_5 \}: 2; -i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_2 \}, \{ R_6 \}: 2; -i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_4 \}, \{ R_5 \}: 2; i\sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_4 \}, \{ R_6 \}: 2; i\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{ R_5 \}, \{ R_6 \}: 2; -i\sigma_3, -\sigma_0, \sigma_0; \text{ P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma\Lambda/\Gamma X; C_{2z},\sigma_y,IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0,\sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3,\sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0,\sigma_3,\sigma_0; \text{P-WNLs}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNLs}; \]
\[ G; \Gamma X; C_{2z},\sigma_y,IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0,\sigma_3,\sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3,\sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0,\sigma_3,\sigma_0; \text{P-WNLs}; \]
\[ P; TW; C_{2z},IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3,\sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0,\sigma_3,\sigma_0; \text{P-WNLs}; \]
\[ F; XF; C_{2z},\sigma_y,IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0,\sigma_3,\sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3,\sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3,\sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0,\sigma_3,\sigma_0; \text{P-WNLs}; \]
\[ D; SW; C_{2z},IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3,\sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3,\sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0,\sigma_3,\sigma_0; \text{P-WNLs}; \]
\[ U; XU; C_{2g},\sigma_y,IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0,\sigma_3,\sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3,\sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3,\sigma_3,\sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3,\sigma_0,\sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_3 \}; 2; \sigma_3,\sigma_3,\sigma_0; \text{P-WNLs}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0,\sigma_3,\sigma_0; \text{P-WNLs}; \]
\[ Q; RW; C_{2g},IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3,\sigma_0; \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

Λ; ΓΛ/ΓX; \( C_{2z,σ_y,IT} \); \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL;
\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_3\}; 2; \sigma_3, −\sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_4\}; 2; \sigma_3, −\sigma_0, \sigma_0; \) P-WNL;
\( \{R_3\}, \{R_4\}; 2; −\sigma_0, \sigma_3, \sigma_0; \) P-WNLs;

G; XG; \( C_{2z,σ_y,IT} \); \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL;
\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_3\}; 2; \sigma_1, −\sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_4\}; 2; \sigma_1, −\sigma_0, \sigma_0; \) P-WNL;
\( \{R_3\}, \{R_4\}; 2; −\sigma_0, \sigma_3, \sigma_0; \) P-WNLs;

P; TW; \( C_{2z,IT} \); \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) P-WNL;

Σ; ΓΣ/ΓX; \( C_{2z,σ_z,IT} \); \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL;
\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_3\}; 2; \sigma_3, −\sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_4\}; 2; \sigma_3, −\sigma_0, \sigma_0; \) P-WNL;
\( \{R_3\}, \{R_4\}; 2; −\sigma_0, \sigma_3, \sigma_0; \) P-WNLs;

F; XF; \( C_{2z,σ_z,IT} \); \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL;
\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_3\}; 2; \sigma_3, −\sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_4\}; 2; \sigma_3, −\sigma_0, \sigma_0; \) P-WNL;
\( \{R_3\}, \{R_4\}; 2; −\sigma_0, \sigma_3, \sigma_0; \) P-WNLs;

Δ; ΓΔ/ΓX; \( C_{2y,σ_z,IT} \); \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL;
\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_3\}; 2; \sigma_1, −\sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_4\}; 2; \sigma_1, −\sigma_0, \sigma_0; \) P-WNL;
\( \{R_3\}, \{R_4\}; 2; −\sigma_0, \sigma_3, \sigma_0; \) P-WNLs;

U; XU; \( C_{2y,σ_x,IT} \); \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL;
\( \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_3\}; 2; \sigma_1, −\sigma_3, \sigma_0; \) P-WNL;
\( \{R_2\}, \{R_4\}; 2; \sigma_1, −\sigma_0, \sigma_0; \) P-WNL;
\( \{R_3\}, \{R_4\}; 2; −\sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
Accidental degeneracies on high symmetry line

Λ; ΓΛ/ΓX; $C_{2z}, \sigma_y, IT$; \{R\}_1, \{R\}_2; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R\}_1, \{R\}_3; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_1, \{R\}_4; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_3; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_4; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_3, \{R\}_4; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

G; XG; $C_{2z}, \sigma_y, IT$; \{R\}_1, \{R\}_2; 2; \sigma_0, \sigma_5, \sigma_0; P-WNLs;
\{R\}_1, \{R\}_3; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_1, \{R\}_4; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_3; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_4; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_3, \{R\}_4; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

Σ; ΓΣ/ΓX; $C_{2z}, \sigma_z, IT$; \{R\}_1, \{R\}_2; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R\}_1, \{R\}_3; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_1, \{R\}_4; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_3; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_4; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_3, \{R\}_4; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

F; XF; $C_{2z}, \sigma_z, IT$; \{R\}_1, \{R\}_2; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R\}_1, \{R\}_3; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_1, \{R\}_4; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_3; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_4; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_3, \{R\}_4; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

Δ; ΓΔ/ΓX; $C_{2z}, \sigma_z, IT$; \{R\}_1, \{R\}_2; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R\}_1, \{R\}_3; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_1, \{R\}_4; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_3; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_4; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_3, \{R\}_4; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;

U; XU; $C_{2z}, \sigma_z, IT$; \{R\}_1, \{R\}_2; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R\}_1, \{R\}_3; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_1, \{R\}_4; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_3; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R\}_2, \{R\}_4; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R\}_3, \{R\}_4; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
Accidental degeneracies on high symmetry line

Λ; ΓΛ/ΓX; $C_{2z,\sigma_y,IT}$; \{R_1\}, {R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\}, {R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_2\}, {R_3\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_2\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_3\}, {R_4\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

G; XG; $C_{2z,\sigma_y,IT}$; \{R_1\}, {R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\}, {R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_2\}, {R_3\}; 2; $\sigma_0,\sigma_0,\sigma_0$; P-WNL;
\{R_2\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_3\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNLs;

Σ; ΓΣ/ΓX; $C_{2z,\sigma_z,IT}$; \{R_1\}, {R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\}, {R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_2\}, {R_3\}; 2; $\sigma_0,\sigma_0,\sigma_0$; P-WNL;
\{R_2\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_3\}, {R_4\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

F; XF; $C_{2z,\sigma_z,IT}$; \{R_1\}, {R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\}, {R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_2\}, {R_3\}; 2; $\sigma_0,\sigma_0,\sigma_0$; P-WNL;
\{R_2\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_3\}, {R_4\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

D; SW; $C_{2z,IT}$; \{R_2\}, {R_4\}; 2; $\sigma_0,\sigma_3$; P-WNL;

Δ; ΓΔ/ΓX; $C_{2y,\sigma_x,IT}$; \{R_1\}, {R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\}, {R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNLs;
\{R_1\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_2\}, {R_3\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_2\}, {R_4\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_3\}, {R_4\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

U; XU; $C_{2y,\sigma_y,IT}$; \{R_1\}, {R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\}, {R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\}, {R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_2\}, {R_3\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_2\}, {R_4\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_3\}, {R_4\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

Q; RW; $C_{2y,IT}$; \{R_2\}, {R_4\}; 2; $\sigma_3,\sigma_0$; P-WNL;
Accidental degeneracies on high symmetry line

Λ; ΓZ; \( C_{4z}^+ \): {\( R_1 \), \( R_2 \)}; 2; \( \left( \frac{1}{2} + \frac{3}{2} \right) (\sigma_0 - i\sigma_3) \); C-1 WP; 1
   \( \{ R_1 \}, \{ R_3 \} \); 2; \( \sigma_3 \); C-2 WP; 2
   \( \{ R_1 \}, \{ R_4 \} \); 2; \( \left( \frac{1}{2} - \frac{3}{2} \right) (\sigma_0 + i\sigma_3) \); C-1 WP; 1
   \( \{ R_2 \}, \{ R_3 \} \); 2; \( \left( -\frac{1}{2} + \frac{3}{2} \right) (\sigma_0 - i\sigma_3) \); C-1 WP; 1
   \( \{ R_2 \}, \{ R_4 \} \); 2; \( i\sigma_3 \); C-2 WP; 2
   \( \{ R_3 \}, \{ R_4 \} \); 2; \( \left( -\frac{1}{2} - \frac{3}{2} \right) (\sigma_0 - i\sigma_3) \); C-1 WP; 1

V; MA; \( C_{4z}^+ \): {\( R_1 \), \( R_2 \)}; 2; \( \left( \frac{1}{2} + \frac{3}{2} \right) (\sigma_0 - i\sigma_3) \); C-1 WP; 1
   \( \{ R_1 \}, \{ R_3 \} \); 2; \( \sigma_3 \); C-2 WP; 2
   \( \{ R_1 \}, \{ R_4 \} \); 2; \( \left( \frac{1}{2} - \frac{3}{2} \right) (\sigma_0 + i\sigma_3) \); C-1 WP; 1
   \( \{ R_2 \}, \{ R_3 \} \); 2; \( \left( -\frac{1}{2} + \frac{3}{2} \right) (\sigma_0 - i\sigma_3) \); C-1 WP; 1
   \( \{ R_2 \}, \{ R_4 \} \); 2; \( i\sigma_3 \); C-2 WP; 2
   \( \{ R_3 \}, \{ R_4 \} \); 2; \( \left( -\frac{1}{2} - \frac{3}{2} \right) (\sigma_0 - i\sigma_3) \); C-1 WP; 1

W; XR; \( C_{2z} \): {\( R_1 \), \( R_2 \)}; 2; \( \sigma_3 \); C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Gamma; \ \Lambda; C_{4z}^+; \{ R_1 \}, \{ R_2 \}; 2; \left( \frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3); \ C-1 \ WP; 1 \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3; \ C-2 \ WP; 2 \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \left( \frac{1}{2} - \frac{i}{2} \right) (\sigma_0 + i\sigma_3); \ C-1 \ WP; 1 \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \left( -\frac{1}{2} + \frac{i}{2} \right) (\sigma_0 - i\sigma_3); \ C-1 \ WP; 1 \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \ C-2 \ WP; 2 \]
\[ \{ R_3 \}, \{ R_4 \}; 2; \left( -\frac{1}{2} - \frac{i}{2} \right) (\sigma_0 - i\sigma_3); \ C-1 \ WP; 1 \]

\[ V; \ \text{MA}; C_{4z}^+; \{ R_1 \}, \{ R_2 \}; 2; \left( \frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3); \ C-1 \ WP; 1 \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3; \ C-2 \ WP; 2 \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \left( \frac{1}{2} - \frac{i}{2} \right) (\sigma_0 + i\sigma_3); \ C-1 \ WP; 1 \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \left( -\frac{1}{2} + \frac{i}{2} \right) (\sigma_0 - i\sigma_3); \ C-1 \ WP; 1 \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \ C-2 \ WP; 2 \]
\[ \{ R_3 \}, \{ R_4 \}; 2; \left( -\frac{1}{2} - \frac{i}{2} \right) (\sigma_0 - i\sigma_3); \ C-1 \ WP; 1 \]

\[ W; \ \text{XR}; C_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; \ C-1 \ WP; 1 \]
### SG 79

Accidental degeneracies on high symmetry line

| Line | Group | States | Expression | Weight |
|------|-------|--------|------------|--------|
| Λ; ΓΛ/ΓZ; C₄⁺; | \{R₁\}, \{R₂\}; 2; \left(\frac{1}{2} + \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |
| | \{R₁\}, \{R₃\}; 2; σ₃; | C-2 WP; 2 |
| | \{R₁\}, \{R₄\}; 2; \left(\frac{1}{2} − \frac{1}{2}\right) (σ₀ + iσ₃); | C-1 WP; 1 |
| | \{R₂\}, \{R₃\}; 2; \left(-\frac{1}{2} + \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |
| | \{R₂\}, \{R₄\}; 2; iσ₃; | C-2 WP; 2 |
| | \{R₃\}, \{R₄\}; 2; \left(-\frac{1}{2} − \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |

### SG 80

Accidental degeneracies on high symmetry line

| Line | Group | States | Expression | Weight |
|------|-------|--------|------------|--------|
| Λ; ΓΛ/ΓZ; C₄⁺; | \{R₁\}, \{R₂\}; 2; \left(\frac{1}{2} + \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |
| | \{R₁\}, \{R₃\}; 2; σ₃; | C-2 WP; 2 |
| | \{R₁\}, \{R₄\}; 2; \left(\frac{1}{2} − \frac{1}{2}\right) (σ₀ + iσ₃); | C-1 WP; 1 |
| | \{R₂\}, \{R₃\}; 2; \left(-\frac{1}{2} + \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |
| | \{R₂\}, \{R₄\}; 2; iσ₃; | C-2 WP; 2 |
| | \{R₃\}, \{R₄\}; 2; \left(-\frac{1}{2} − \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |

### SG 81

Accidental degeneracies on high symmetry line

| Line | Group | States | Expression | Weight |
|------|-------|--------|------------|--------|
| Λ; ΓΛ/ΓZ; C₄⁺; | \{R₁\}, \{R₂\}; 2; \left(\frac{1}{2} + \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |
| | \{R₁\}, \{R₃\}; 2; σ₃; | C-2 WP; 2 |
| | \{R₁\}, \{R₄\}; 2; \left(\frac{1}{2} − \frac{1}{2}\right) (σ₀ + iσ₃); | C-1 WP; 1 |
| | \{R₂\}, \{R₃\}; 2; \left(-\frac{1}{2} + \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |
| | \{R₂\}, \{R₄\}; 2; iσ₃; | C-2 WP; 2 |
| | \{R₃\}, \{R₄\}; 2; \left(-\frac{1}{2} − \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |

### SG 82

Accidental degeneracies on high symmetry line

| Line | Group | States | Expression | Weight |
|------|-------|--------|------------|--------|
| Λ; ΓΛ/ΓZ; C₄⁺; | \{R₁\}, \{R₂\}; 2; \left(\frac{1}{2} + \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |
| | \{R₁\}, \{R₃\}; 2; σ₃; | C-2 WP; 2 |
| | \{R₁\}, \{R₄\}; 2; \left(\frac{1}{2} − \frac{1}{2}\right) (σ₀ + iσ₃); | C-1 WP; 1 |
| | \{R₂\}, \{R₃\}; 2; \left(-\frac{1}{2} + \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |
| | \{R₂\}, \{R₄\}; 2; iσ₃; | C-2 WP; 2 |
| | \{R₃\}, \{R₄\}; 2; \left(-\frac{1}{2} − \frac{1}{2}\right) (σ₀ − iσ₃); | C-1 WP; 1 |
SG 81

Accidental degeneracies on high symmetry line

Λ: ΓZ; $C_{2z}, S_4^+ T$; \{R₁\}, \{R₂, R₂\}; 3; $A_{13}, A_{19}$; TP;
V: MA; $C_{2z}, S_4^+ T$; \{R₁\}, \{R₂, R₂\}; 3; $A_{13}, A_{19}$; TP;
W: XR; $C_{2z}$; \{R₁\}, \{R₂\}; 2; $σ_3$; C-1 WP; 1

SG 82

Accidental degeneracies on high symmetry line

Σ; ΓM; $σ_z, IT$; \{R₁\}, \{R₂\}; 2; $σ_3, σ_0$; P-WNL;
W; XR; $C_{2z}$, IT; \{R₁\}, \{R₂\}; 2; $σ_3, σ_0$; P-WNL;
T; RA; $σ_z, IT$; \{R₁\}, \{R₂\}; 2; $σ_3, σ_0$; P-WNL;
V; MA; $C_{4z}, IT$; \{R₁\}, \{R₃\}; 2; $σ_3, σ_0$; P-WNLs;
Λ: ΓZ; $C_{4z}, IT$; \{R₁\}, \{R₃\}; 2; $σ_3, σ_0$; P-WNLs;

SG 83

Accidental degeneracies on high symmetry line

Δ; ΓX; $σ_z, IT$; \{R₁\}, \{R₂\}; 2; $σ_3, σ_0$; P-WNL;
U; ZR; $σ_z, IT$; \{R₁\}, \{R₂\}; 2; $σ_3, σ_0$; P-WNL;
Λ: ΓZ; $C_{4z}, IT$; \{R₁\}, \{R₃\}; 2; $σ_3, σ_0$; P-WNLs;

Σ; ΓM; $σ_z, IT$; \{R₁\}, \{R₂\}; 2; $σ_3, σ_0$; P-WNL;
S; ZA; $σ_z, IT$; \{R₁\}, \{R₂\}; 2; $σ_3, σ_0$; P-WNL;
Y; XM; $σ_z, IT$; \{R₁\}, \{R₂\}; 2; $σ_3, σ_0$; P-WNL;
T; RA; $σ_z, IT$; \{R₁\}, \{R₂\}; 2; $σ_3, σ_0$; P-WNL;
W; XR; $C_{2z}, IT$; \{R₁\}, \{R₂\}; 2; $σ_3, σ_0$; P-WNL;
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ U; Z R; \sigma_z, IT; \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \Lambda; \Gamma Z; C_{4z}^{+}, IT; \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_1 \}, \{ R_2, R_4 \}; 3; A_{26}, A_{17}; \text{ TP}; \]
\[ \{ R_2, R_4 \}, \{ R_3 \}; 3; A_{27}, A_{20}; \text{ TP}; \]
\[ V; M A; C_{4z}^{+}, IT; \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_1 \}, \{ R_2, R_4 \}; 3; A_{26}, A_{17}; \text{ TP}; \]
\[ \{ R_2, R_4 \}, \{ R_3 \}; 3; A_{27}, A_{20}; \text{ TP}; \]
\[ \Sigma; \Gamma M; \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ S; Z A; \sigma_z, IT; \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ Y; X M; \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ T; R A; \sigma_z, IT; \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ W; X R; C_{2z}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ U; Z R; \sigma_z, IT; \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \Lambda; \Gamma Z; C_{4z}^{+}, IT; \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{ R_1 \}, \{ R_2, R_4 \}; 3; A_{26}, A_{17}; \text{ TP}; \]
\[ \{ R_2, R_4 \}, \{ R_3 \}; 3; A_{27}, A_{20}; \text{ TP}; \]
\[ V; M A; C_{4z}^{+}, E, IT; \{ R_5 \}, \{ R_7 \}; \{ R_8 \}; 3; iA_{27}, A_{0}, A_{20}; \text{ TP}; \]
\[ \{ R_3 \}, \{ R_7 \}; \{ R_8 \}; 3; A_{28}, A_{0}, A_{20}; \text{ TP}; \]
\[ \{ R_6 \}, \{ R_8 \}; 2; -i\sigma_3, \sigma_0, \sigma_0; \text{ P-WNLs}; \]
\[ \Sigma; \Gamma M; \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ S; Z A; \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ Y; X M; \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; -i\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ T; R A; \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; -i\sigma_3, \sigma_0; \text{ P-WNL}; \]
### Accidental degeneracies on high symmetry line

| Group | IR | Description |
|-------|----|-------------|
| \(\Delta\) | \(\Gamma, \sigma_{z,IT}\) | \(\{R_1\}, \{R_2\}\); \(2; \sigma_z, \sigma_0\); P-WNL; |
| \(U\) | \(\mathbf{Z}, \sigma_{z,IT}\) | \(\{R_2\}, \{R_4\}\); \(2; \sigma_z, \sigma_0\); P-WNL; |
| \(\Lambda\) | \(\Gamma Z, C_{4z}, \sigma\) | \(\{R_1\}, \{R_3\}\); \(2; \sigma_z, \sigma_0\); P-WNLs; |
| | | \(\{R_1, R_2, R_4\}\); \(3; A_{26}, A_{17}\); TP; |
| | | \(\{R_2, R_4\}, \{R_3\}\); \(3; A_{27}, A_{20}\); TP; |
| \(V\) | \(\mathbf{M}, C_{4z}, E, \sigma\) | \(\{R_5, R_7\}, \{R_6\}\); \(3; A_{27}, A_0, A_{20}\); TP; |
| | | \(\{R_5, R_7\}, \{R_8\}\); \(3; A_{28}, A_0, A_{20}\); TP; |
| \(\Sigma\) | \(\mathbf{M}, \sigma_{z,IT}\) | \(\{R_1\}, \{R_2\}\); \(2; -i\sigma_3, \sigma_0\); P-WNLs; |
| \(S\) | \(\mathbf{A}, \sigma_{z,IT}\) | \(\{R_2\}, \{R_4\}\); \(2; \sigma_3, \sigma_0\); P-WNL; |
| \(Y\) | \(\mathbf{M}, \sigma_{z,IT}\) | \(\{R_1\}, \{R_2\}\); \(2; -i\sigma_3, \sigma_0\); P-WNL; |
| \(T\) | \(\mathbf{A}, \sigma_{z,IT}\) | \(\{R_2\}, \{R_4\}\); \(2; -i\sigma_3, \sigma_0\); P-WNL; |

### Accidental degeneracies on high symmetry line

| Group | IR | Description |
|-------|----|-------------|
| \(\Lambda\) | \(\Gamma \Lambda, \Gamma, \mathbf{Z}, \sigma_{z,IT}\) | \(\{R_1\}, \{R_3\}\); \(2; \sigma_z, \sigma_0\); P-WNLs; |
| | | \(\{R_1, R_2, R_4\}\); \(3; A_{26}, A_{17}\); TP; |
| | | \(\{R_2, R_4\}, \{R_3\}\); \(3; A_{27}, A_{20}\); TP; |
| \(V\) | \(\mathbf{Z}, \sigma_{z,IT}\) | \(\{R_1\}, \{R_3\}\); \(2; \sigma_z, \sigma_0\); P-WNLs; |
| | | \(\{R_1, R_2, R_4\}\); \(3; A_{26}, A_{17}\); TP; |
| | | \(\{R_2, R_4\}, \{R_3\}\); \(3; A_{27}, A_{20}\); TP; |
| \(W\) | \(\mathbf{P}, \sigma_{z,IT}\) | \(\{R_1\}, \{R_2\}\); \(2; \sigma_z, \sigma_0\); P-WNL; |
| \(\Sigma\) | \(\mathbf{Z}, \Gamma, \Sigma, \sigma_{z,IT}\) | \(\{R_1\}, \{R_2\}\); \(2; \sigma_z, \sigma_0\); P-WNL; |
| \(F\) | \(\mathbf{Z}, \sigma_{z,IT}\) | \(\{R_1\}, \{R_2\}\); \(2; \sigma_z, \sigma_0\); P-WNL; |
| \(\Delta\) | \(\mathbf{X}, \sigma_{z,IT}\) | \(\{R_1\}, \{R_2\}\); \(2; \sigma_z, \sigma_0\); P-WNL; |
| \(U\) | \(\mathbf{Z}, \sigma_{z,IT}\) | \(\{R_1\}, \{R_2\}\); \(2; \sigma_z, \sigma_0\); P-WNL; |
| \(Y\) | \(\mathbf{X}, \mathbf{Z}, \mathbf{X}\), \(\sigma_{z,IT}\) | \(\{R_1\}, \{R_2\}\); \(2; \sigma_z, \sigma_0\); P-WNL; |
Accidental degeneracies on high symmetry line

Λ; Λ\(\Gamma\)/Z; \(C_{4z}^{+}, IT\); \(\{R_1\}, \{R_3\}\): \(2; \sigma_3, \sigma_0; \) P-WNLs;
\(\{R_1\}, \{R_2, R_4\}\): \(3; A_{20}, A_{17}; \) TP;
\(\{R_2, R_4\}, \{R_3\}\): \(3; A_{27}, A_{20}; \) TP;

V; ZV; \(C_{4z}^{+}, E, IT\); \(\{R_5, R_7\}, \{R_6\}\): \(-iA_{27}, A_{20}, A_{20}; \) P-WNLs;
\(\{R_5, R_7\}, \{R_6\}\): \(3; A_{28}, A_{26}, A_{20}; \) TP;
\(\{R_6\}\): \(2; i\sigma_3, \sigma_0, \sigma_0; \) TP;

Σ; Σ\(\Gamma\)/Σ; \(\sigma_z, IT\); \(\{R_1\}, \{R_2\}\): \(2; \sigma_3, \sigma_0; \) P-WNL;

F; ZF; \(\sigma_z, IT\); \(\{R_2\}, \{R_4\}\): \(2; \sigma_3, \sigma_0; \) P-WNL;

Δ; ΓX; \(\sigma_z, IT\); \(\{R_1\}, \{R_2\}\): \(2; \sigma_3, \sigma_0; \) P-WNL;

U; ZU; \(\sigma_z, IT\); \(\{R_2\}, \{R_4\}\): \(2; \sigma_3, \sigma_0; \) P-WNL;

Y; XZ/XY; \(\sigma_z, IT\); \(\{R_1\}, \{R_2\}\): \(2; -i\sigma_3, \sigma_0; \) P-WNL;

Accidental degeneracies on high symmetry line

Δ; ΓX; \(C_{2y}, TC_{2z}\); \(\{R_1\}, \{R_2\}\): \(2; \sigma_3, \sigma_0; \) C-1 WP; 1

U; ZR; \(C_{2y}, TC_{2z}\); \(\{R_1\}, \{R_2\}\): \(2; \sigma_3, \sigma_0; \) C-1 WP; 1

Λ; Λ\(\Gamma\)/Z; \(C_{4z}, TC_{2z}\); \(\{R_1\}, \{R_3\}\): \(2; \sigma_3, \sigma_0; \) C-1 WP; 1
\(\{R_1\}, \{R_4\}\): \(2; (\frac{3}{2} + \frac{1}{2}) (\sigma_0 - i\sigma_3), \sigma_0; \) C-2 WP; 2
\(\{R_2\}, \{R_3\}\): \(2; (\frac{1}{2} - \frac{1}{2}) (\sigma_0 + i\sigma_3), \sigma_0; \) C-1 WP; 1
\(\{R_2\}, \{R_4\}\): \((-\frac{1}{2} + \frac{1}{2}) (\sigma_0 - i\sigma_3), \sigma_0; \) C-1 WP; 1
\(\{R_4\}\): \(2; i\sigma_3, \sigma_0; \) C-2 WP; 2
\(\{R_4\}\): \(2; (-\frac{1}{2} - \frac{1}{2}) (\sigma_0 - i\sigma_3), \sigma_0; \) C-1 WP; 1

V; MA; \(C_{4z}, TC_{2z}\); \(\{R_1\}, \{R_2\}\): \(2; (\frac{1}{2} + \frac{1}{2}) (\sigma_0 - i\sigma_3), \sigma_0; \) C-1 WP; 1
\(\{R_1\}, \{R_3\}\): \(2; \sigma_3, \sigma_0; \) C-2 WP; 2
\(\{R_1\}, \{R_4\}\): \(2; (\frac{1}{2} - \frac{1}{2}) (\sigma_0 + i\sigma_3), \sigma_0; \) C-1 WP; 1
\(\{R_2\}, \{R_3\}\): \(2; (\frac{1}{2} - \frac{1}{2}) (\sigma_0 - i\sigma_3), \sigma_0; \) C-1 WP; 1
\(\{R_2\}, \{R_4\}\): \(2; i\sigma_3, \sigma_0; \) C-2 WP; 2
\(\{R_3\}, \{R_4\}\): \(2; (-\frac{1}{2} - \frac{1}{2}) (\sigma_0 - i\sigma_3), \sigma_0; \) C-1 WP; 1

Σ; ΓM; \(C_{2y}, C_{2z}\); \(\{R_2\}, \{R_3\}\): \(2; \sigma_3, \sigma_0; \) C-1 WP; 1

S; ZA; \(C_{2y}, C_{2z}\); \(\{R_2\}, \{R_3\}\): \(2; \sigma_3, \sigma_0; \) C-1 WP; 1

Y; XM; \(C_{2y}, TC_{2z}\); \(\{R_2\}\): \(2; \sigma_3, \sigma_0; \) C-1 WP; 1

T; RA; \(C_{2y}, TC_{2z}\); \(\{R_2\}\): \(2; \sigma_3, \sigma_0; \) C-1 WP; 1

W; XR; \(C_{2y}, TC_{2z}\); \(\{R_2\}\): \(2; \sigma_3, \sigma_0; \) C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y}, T C_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 \text{ WP; 1} \]

\[ U; Z R; C_{2y}, T C_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; C-1 \text{ WP; 1} \]

\[ \Lambda; \Gamma Z; C_{4z}^+, C_{2b} T; \{ R_1 \}, \{ R_2 \}; 2; \left( \frac{1}{2} + \frac{i}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{ C-2 WP; 2} \]

\[ \{ R_2 \}, \{ R_3 \}; 2; \left( \frac{1}{2} - \frac{i}{2} \right) (\sigma_0 + i\sigma_3), \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ C-2 WP; 2} \]

\[ \{ R_3 \}, \{ R_4 \}; 2; \left( \frac{1}{2} - \frac{i}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \text{ C-1 WP; 1} \]

\[ V; M A; C_{4z}^+, C_{2b} T; \{ R_1, R_3 \}, \{ R_2, R_4 \}; 4; \left( \frac{1}{2} + \frac{i}{2} \right) (\Gamma_{0,3} - i\Gamma_{3,0}), \Gamma_{0,1}; \text{ C-2 DP; 2} \]

\[ \Sigma; \Gamma M; C_{2a}, C_{2b} T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ S; Z A; C_{2a}, C_{2b} T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]
Accidental degeneracies on high symmetry line

Δ; ΓX; $C_{2y},TC_{2z}$; \{R₁\}, \{R₂\}; 2; $\sigma_3,\sigma_0$; C-1 WP; 1

Λ; ΓZ; $C_{4z}^{+},C_{2b}T$; \{R₁\}, \{R₂\}; 2; (\(\frac{1}{2} + \frac{i}{2}\)) (\(\sigma_0 - i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

\{R₁\}, \{R₃\}; 2; $\sigma_3,\sigma_0$; C-2 WP; 2

\{R₂\}, \{R₄\}; 2; (\(\frac{1}{2} - \frac{i}{2}\)) (\(\sigma_0 + i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

\{R₂\}, \{R₃\}; 2; (\(-\frac{1}{2} + \frac{i}{2}\)) (\(\sigma_0 - i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

\{R₁\}, \{R₄\}; 2; $i\sigma_3,\sigma_0$; C-2 WP; 2

\{R₁\}, \{R₃\}; 2; (\(-\frac{1}{2} - \frac{i}{2}\)) (\(\sigma_0 - i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

V; MA; $C_{4z}^{+},C_{2b}T$; \{R₁\}, \{R₂\}; 2; $\sigma_3,\sigma_0$; C-1 WP; 1

\{R₁\}, \{R₃\}; 2; $\sigma_3,\sigma_0$; C-2 WP; 2

\{R₂\}, \{R₄\}; 2; (\(\frac{1}{2} - \frac{i}{2}\)) (\(\sigma_0 + i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

\{R₂\}, \{R₃\}; 2; (\(-\frac{1}{2} + \frac{i}{2}\)) (\(\sigma_0 - i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

\{R₁\}, \{R₄\}; 2; $i\sigma_3,\sigma_0$; C-2 WP; 2

\{R₁\}, \{R₃\}; 2; (\(-\frac{1}{2} - \frac{i}{2}\)) (\(\sigma_0 - i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

Σ; ΓM; $C_{2a},C_{2b}T$; \{R₁\}, \{R₂\}; 2; $\sigma_3,\sigma_0$; C-1 WP; 1

Y; XM; $C_{2a},TC_{2y}$; \{R₁\}, \{R₂\}; 2; $\sigma_3,\sigma_0$; C-1 WP; 1

W; XR; $C_{2a},TC_{2y}$; \{R₁\}, \{R₂\}; 2; $\sigma_3,\sigma_0$; C-1 WP; 1

Accidental degeneracies on high symmetry line

Δ; ΓX; $C_{2y},TC_{2z}$; \{R₁\}, \{R₂\}; 2; $\sigma_3,\sigma_0$; C-1 WP; 1

Λ; ΓZ; $C_{4z}^{+},C_{2b}T$; \{R₁\}, \{R₂\}; 2; (\(\frac{1}{2} + \frac{i}{2}\)) (\(\sigma_0 - i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

\{R₁\}, \{R₃\}; 2; $\sigma_3,\sigma_0$; C-2 WP; 2

\{R₂\}, \{R₄\}; 2; (\(\frac{1}{2} - \frac{i}{2}\)) (\(\sigma_0 + i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

\{R₂\}, \{R₃\}; 2; (\(-\frac{1}{2} + \frac{i}{2}\)) (\(\sigma_0 - i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

\{R₂\}, \{R₄\}; 2; $i\sigma_3,\sigma_0$; C-2 WP; 2

\{R₁\}, \{R₄\}; 2; (\(-\frac{1}{2} - \frac{i}{2}\)) (\(\sigma_0 - i\sigma_3\), \(\sigma_0\)); C-1 WP; 1

V; MA; $C_{4z}^{+},C_{2b}T$; \{R₁, R₃\}, \{R₂, R₄\}; 4; (\(\frac{1}{2} + \frac{i}{2}\)) (\(\Gamma_{0.5} - i\Gamma_{3.3}\), \(\Gamma_{0.1}\)); C-2 DP; 2

Σ; ΓM; $C_{2a},C_{2b}T$; \{R₁\}, \{R₂\}; 2; $\sigma_3,\sigma_0$; C-1 WP; 1

T; RA; $C_{2a},TC_{2y}$; \{R₂, R₄\}, \{R₄, R₄\}; 4; $\Gamma_{3.0},\Gamma_{3.2}$; C-2 DP; 2
### Accidental degeneracies on high symmetry line

| | | |
|---|---|---|
| $\Delta$: $\Gamma X$: | $C_{2y} T C_{2z}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $U$: $Z R$: | $C_{2y} T C_{2z}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $\Lambda$: $\Gamma Z$: | $C_{2y}^+, C_{2z} T$; $\{R_1\}, \{R_2\}$; 2; $\left(\frac{1}{2} + \frac{i}{2}\right) (\sigma_0 - i \sigma_3), \sigma_0$; | C-1 WP; 1 |
| | | C-2 WP; 2 |
| | | C-1 WP; 1 |
| | | C-2 WP; 2 |
| | | C-1 WP; 1 |
| | | C-1 WP; 1 |
| $\Sigma$: $\Gamma M$: | $C_{2a}, C_{2b} T$; $\{R_2\}, \{R_3\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $S$: $Z A$: | $C_{2a}, C_{2b} T$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $Y$: $X M$: | $C_{2y} T C_{2z}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $T$: $R A$: | $C_{2x} T C_{2y}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $W$: $X R$: | $C_{2x} T C_{2y}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |

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### Accidental degeneracies on high symmetry line

| | | |
|---|---|---|
| $\Delta$: $\Gamma X$: | $C_{2y} T C_{2z}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $U$: $Z R$: | $C_{2y} T C_{2z}$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $\Lambda$: $\Gamma Z$: | $C_{2y}^+, C_{2z} T$; $\{R_1\}, \{R_2\}$; 2; $\left(\frac{1}{2} + \frac{i}{2}\right) (\sigma_0 - i \sigma_3), \sigma_0$; | C-1 WP; 1 |
| | | C-2 WP; 2 |
| | | C-1 WP; 1 |
| | | C-2 WP; 2 |
| | | C-1 WP; 1 |
| $\Sigma$: $\Gamma M$: | $C_{2a}, C_{2b} T$; $\{R_2\}, \{R_3\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $S$: $Z A$: | $C_{2a}, C_{2b} T$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $V$: $M A$: | $C_{2a}, C_{2b} T$; $\{R_1, R_3\}, \{R_2, R_4\}$; 4; $\left(\frac{1}{2} + \frac{i}{2}\right) (\Gamma_{0,3} - i \Gamma_{3,3}), \Gamma_{0,1}$; | C-2 DP; 2 |
| $\Sigma$: $\Gamma M$: | $C_{2a}, C_{2b} T$; $\{R_1\}, \{R_2\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
| $S$: $Z A$: | $C_{2a}, C_{2b} T$; $\{R_2\}, \{R_4\}$; 2; $\sigma_3, \sigma_0$; | C-1 WP; 1 |
Accidental degeneracies on high symmetry line

\[ \Delta; \quad \Gamma X; \quad C_{2y}, TC_{2y}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Lambda; \quad \Gamma Z; \quad C^+_{4z}, C_{2y} T; \{ R_1 \}, \{ R_2 \}; 2; \left( \frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{C-2 WP; 2} \]

\[ \{ R_1 \}, \{ R_2 \}; 2; \left( \frac{1}{2} - \frac{1}{2} \right) (\sigma_0 + i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_3 \}; 2; \left( -\frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad \text{C-2 WP; 2} \]

\[ \{ R_3 \}, \{ R_4 \}; 2; \left( -\frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ V; \quad \text{MA}; \quad C^+_{4z}, C_{2y} T; \{ R_1 \}, \{ R_2 \}; 2; \left( \frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \quad \text{C-2 WP; 2} \]

\[ \{ R_2 \}, \{ R_3 \}; 2; \left( \frac{1}{2} - \frac{1}{2} \right) (\sigma_0 + i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; 2; \left( -\frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad \text{C-2 WP; 2} \]

\[ \{ R_3 \}, \{ R_4 \}; 2; \left( -\frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Sigma; \quad \Gamma M; \quad C_{2a}, C_{2b} T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ Y; \quad \text{XM}; \quad C_{2z}, TC_{2y}; \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ W; \quad \text{XR}; \quad C_{2z}, TC_{2y}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \quad \Gamma X; \quad C_{2y}, TC_{2y}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Lambda; \quad \Gamma Z; \quad C^+_{4z}, C_{2y} T; \{ R_1 \}, \{ R_2 \}; 2; \left( \frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \quad \text{C-2 WP; 2} \]

\[ \{ R_1 \}, \{ R_4 \}; 2; \left( \frac{1}{2} - \frac{1}{2} \right) (\sigma_0 + i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_3 \}; 2; \left( -\frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad \text{C-2 WP; 2} \]

\[ \{ R_3 \}, \{ R_4 \}; 2; \left( -\frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ V; \quad \text{MA}; \quad C^+_{4z}, C_{2y} T; \{ R_1 \}, \{ R_2 \}, \{ R_3 \}, \{ R_4 \}; 4; \left( \frac{1}{2} + \frac{1}{2} \right) (\Gamma_{0,3} - i\Gamma_{3,3}), \Gamma_{0,1}; \quad \text{C-2 DP; 2} \]

\[ \Sigma; \quad \Gamma M; \quad C_{2a}, C_{2b} T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ T; \quad \text{RA}; \quad C_{2z}, TC_{2y}; \{ R_2 \}, \{ R_4 \}, \{ R_4 \}; 4; \Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{C-2 DP; 2} \]
Accidental degeneracies on high symmetry line

| Γ/Λ | Γ/Λ/C2bT | \( \{R_1\}, \{R_2\} \): | \((\frac{1}{2} + \frac{1}{2})\) (σ_0 - iσ_3), σ_0; | C-1 WP; 1 |
|-----|----------|-----------------|-----------------------------|----------|
| \( \{R_1\}, \{R_3\} \): | σ_3, σ_0; | C-2 WP; 2 |
| \( \{R_1\}, \{R_4\} \): | \((\frac{1}{2} - \frac{1}{2})\) (σ_0 + iσ_3), σ_0; | C-1 WP; 1 |
| \( \{R_2\}, \{R_3\} \): | \((\frac{1}{2} + \frac{1}{2})\) (σ_0 - iσ_3), σ_0; | C-1 WP; 1 |
| \( \{R_2\}, \{R_4\} \): | iσ_3, σ_0; | C-2 WP; 2 |
| \( \{R_3\}, \{R_4\} \): | \((\frac{1}{2} - \frac{1}{2})\) (σ_0 - iσ_3), σ_0; | C-1 WP; 1 |

Accidental degeneracies on high symmetry line

| Γ/Λ | Γ/Λ/C2bT | \( \{R_1\}, \{R_2\} \): | \((\frac{1}{2} + \frac{1}{2})\) (σ_0 - iσ_3), σ_0; | C-1 WP; 1 |
|-----|----------|-----------------|-----------------------------|----------|
| \( \{R_1\}, \{R_3\} \): | σ_3, σ_0; | C-2 WP; 2 |
| \( \{R_1\}, \{R_4\} \): | \((\frac{1}{2} - \frac{1}{2})\) (σ_0 + iσ_3), σ_0; | C-1 WP; 1 |
| \( \{R_2\}, \{R_3\} \): | \((\frac{1}{2} + \frac{1}{2})\) (σ_0 - iσ_3), σ_0; | C-1 WP; 1 |
| \( \{R_2\}, \{R_4\} \): | iσ_3, σ_0; | C-2 WP; 2 |
| \( \{R_3\}, \{R_4\} \): | \((\frac{1}{2} - \frac{1}{2})\) (σ_0 - iσ_3), σ_0; | C-1 WP; 1 |
Accidental degeneracies on high symmetry line

Δ: ΓX; \( \sigma_x, TC_{2z} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

U; ZR; \( \sigma_x, TC_{2z} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

Λ; ΓZ; \( C_{4z}^+, \sigma_y \); \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_0, \sigma_3; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_0, \sigma_3; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_0, \sigma_3; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_0, \sigma_3; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_0, \sigma_3; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_0, \sigma_3; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_0, \sigma_3; P-WNLs;

V; MA; \( C_{4z}^+, \sigma_y \); \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;

Σ; ΓM; \( \sigma_{db}, T \sigma_{da} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

S; ZA; \( \sigma_{db}, T \sigma_{da} \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

Y; XM; \( \sigma_y, T \sigma_z \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

T; RA; \( \sigma_y, T \sigma_x \); \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL;

W; XR; \( C_{2z}, \sigma_y \); \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNLs;
### Accidental degeneracies on high symmetry line

| Symbol | Description | Equations |
|--------|-------------|-----------|
| Δ; ΓX; $\sigma_x TC_{2z}$; | $\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; | $\text{P-WNL}$; |
| $U; ZR; \sigma_x TC_{2z}$; | $\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; | $\text{P-WNL}$; |
| Λ; ΓZ; $C_{4z}^+ \sigma_y$; | $\{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3$; | $\text{P-WNLs}$; |
| | $\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0$; | $\text{P-WNLs}$; |
| | $\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3$; | $\text{P-WNLs}$; |
| | $\{R_1\}, \{R_5\}; 3; A_{29}, \frac{1}{2} (A_0 + 2\sqrt{3} A_8)$; | $\text{TP}$; |
| | $\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3$; | $\text{P-WNLs}$; |
| | $\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0$; | $\text{P-WNLs}$; |
| | $\{R_2\}, \{R_5\}; 3; A_{29}, A_{10}$; | $\text{TP}$; |
| | $\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3$; | $\text{P-WNLs}$; |
| | $\{R_3\}, \{R_5\}; 3; -A_{19}, \frac{1}{2} (A_0 + 2\sqrt{3} A_8)$; | $\text{TP}$; |
| | $\{R_4\}, \{R_5\}; 3; -A_{19}, A_{10}$; | $\text{TP}$; |
| $V; MA; C_{4z}^+ C_{2z} \sigma_{da}$; | $\{R_5\}, \{R_6\}; 2; i \sigma_3, -\sigma_0, -\sigma_0$; | $\text{P-WNLs}$; |
| | $\{R_5\}, \{R_7\}; 2; i \sigma_3, -\sigma_0, -\sigma_3$; | $\text{P-WNLs}$; |
| | $\{R_5\}, \{R_8\}; 2; i \sigma_0, -\sigma_0, -\sigma_3$; | $\text{P-WNLs}$; |
| | $\{R_5\}, \{R_9\}; 3; A_{30}, -A_{13}, -\frac{A_8}{2} - \frac{2A_4}{\sqrt{3}}$; | $\text{TP}$; |
| | $\{R_6\}, \{R_7\}; 2; -i \sigma_0, -\sigma_0, -\sigma_3$; | $\text{P-WNLs}$; |
| | $\{R_6\}, \{R_8\}; 2; -i \sigma_3, -\sigma_0, -\sigma_3$; | $\text{P-WNLs}$; |
| | $\{R_6\}, \{R_9\}; 3; A_{31}, -A_{13}, -\frac{A_8}{2} - \frac{2A_4}{\sqrt{3}}$; | $\text{TP}$; |
| | $\{R_7\}, \{R_8\}; 2; -i \sigma_3, -\sigma_0, \sigma_0$; | $\text{P-WNLs}$; |
| | $\{R_7\}, \{R_9\}; 3; A_{31}, -A_{13}, -A_{10}$; | $\text{TP}$; |
| | $\{R_8\}, \{R_9\}; 3; A_{30}, -A_{13}, -A_{10}$; | $\text{TP}$; |
| $\Sigma; GM; \sigma_{db} T \sigma_{da}$; | $\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; | $\text{P-WNL}$; |
| $S; ZA; \sigma_{db} T \sigma_{da}$; | $\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; | $\text{P-WNL}$; |
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x T C_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad P-WNL; \]
\[ \Lambda; \Gamma Z; C_{4z}^+, \sigma_y; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad P-WNL_s; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \quad P-WNL_s; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3; \quad P-WNL_s; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3; \quad P-WNL_s; \]
\[ \{ R_1 \}, \{ R_2 \}; 3; A_{29}, \frac{1}{4} \left( A_0 + 2\sqrt{3} A_8 \right); \quad TP; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \quad P-WNL_s; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \quad P-WNL_s; \]
\[ \{ R_3 \}, \{ R_5 \}; 3; A_{29}, A_{10}; \quad TP; \]
\[ \{ R_3 \}, \{ R_6 \}; 3; -A_{29}, \frac{1}{4} \left( A_0 + 2\sqrt{3} A_8 \right); \quad TP; \]
\[ \{ R_4 \}, \{ R_5 \}; 3; -A_{29}, A_{10}; \quad TP; \]
\[ V; \quad \text{MA}; \quad C_{4z}^+, \sigma_y; \quad \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad P-WNL_s; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \quad P-WNL_s; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3; \quad P-WNL_s; \]
\[ \{ R_1 \}, \{ R_5 \}; 3; A_{29}, \frac{1}{2} \left( A_0 + 2\sqrt{3} A_8 \right); \quad TP; \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \sigma_3, -\sigma_3; \quad P-WNL_s; \]
\[ \{ R_2 \}, \{ R_7 \}; 2; \sigma_3, -\sigma_0; \quad P-WNL_s; \]
\[ \{ R_3 \}, \{ R_4 \}; 3; A_{29}, A_{10}; \quad TP; \]
\[ \{ R_3 \}, \{ R_5 \}; 3; -A_{29}, \frac{1}{4} \left( A_0 + 2\sqrt{3} A_8 \right); \quad TP; \]
\[ \{ R_4 \}, \{ R_5 \}; 3; -A_{29}, A_{10}; \quad TP; \]
\[ \Sigma; \quad \Gamma M; \quad \sigma_{db} T \sigma_{da}; \quad \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad P-WNL; \]
\[ S; \quad ZA; \quad \sigma_{db} T \sigma_{da}; \quad \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad P-WNL; \]
\[ Y; \quad XM; \quad \sigma_y T \sigma_z; \quad \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad P-WNL; \]
\[ W; \quad XR; \quad C_{2z}, \sigma_y; \quad \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad P-WNL_s; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \quad P-WNL_s; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3; \quad P-WNL_s; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \quad P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \quad P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \quad P-WNL_s; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x T C_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Lambda; \Gamma Z; C_{4z}^+ \sigma_y; \]
\[ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_3\}, \{R_5\}; 2; \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_6\}; 3; A_{29}, \frac{1}{8} (A_0 + 2\sqrt{3}A_8); \text{TP}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3; \text{P-WNLs}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNLs}; \]
\[ \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}; \text{TP}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_3\}, \{R_5\}; 3; -A_{19}, \frac{1}{8} (A_0 + 2\sqrt{3}A_8); \text{TP}; \]
\[ \{R_4\}, \{R_5\}; 3; -A_{19}, A_{10}; \text{TP}; \]

\[ V; \text{MA}; C_{4z}^+ C_{2z} \sigma_{da}; \{R_5\}, \{R_6\}; 2; i\sigma_3, -\sigma_0, -\sigma_0; \text{P-WNLs}; \]
\[ \{R_5\}, \{R_7\}; 2; i\sigma_3, -\sigma_0, -\sigma_3; \text{P-WNLs}; \]
\[ \{R_5\}, \{R_8\}; 2; i\sigma_0, -\sigma_0, -\sigma_3; \text{P-WNLs}; \]
\[ \{R_5\}, \{R_9\}; 3; A_{30}, -A_{13}, -\frac{\Delta_0}{3} - \frac{2A_8}{\sqrt{3}}; \text{TP}; \]
\[ \{R_6\}, \{R_7\}; 2; -i\sigma_0, -\sigma_0, -\sigma_3; \text{P-WNLs}; \]
\[ \{R_6\}, \{R_8\}; 2; -i\sigma_3, -\sigma_0, -\sigma_3; \text{P-WNLs}; \]
\[ \{R_6\}, \{R_9\}; 3; A_{31}, -A_{13}, -\frac{\Delta_0}{3} - \frac{2A_8}{\sqrt{3}}; \text{TP}; \]
\[ \{R_7\}, \{R_8\}; 2; -i\sigma_3, -\sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_7\}, \{R_9\}; 3; A_{31}, -A_{13}, -A_{10}; \text{TP}; \]
\[ \{R_8\}, \{R_9\}; 3; A_{30}, -A_{13}, -A_{10}; \text{TP}; \]

\[ \Sigma; \text{GM}; \sigma_{db} T \sigma_{da}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ S; \text{ZA}; \sigma_{db} T \sigma_{da}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ T; \text{RA}; \sigma_y T \sigma_x; \{R_2\}, \{R_4\}; 2; -i\sigma_3, \sigma_0; \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

∆: ΓX; \( \sigma_x, TC_{2z} \); \( \{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0 \); P-WNL;
Lambda; ΓZ; \( C_{4z}, \sigma_y \); \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3 \); P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0 \); P-WNLs;
\{R_3\}, \{R_4\}; 3; \( A_{20}, \frac{1}{4} (A_0 + 2\sqrt{3}A_8) \); TP;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_3 \); P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0 \); P-WNLs;
\{R_2\}, \{R_3\}; 3; \( A_{20}, A_{10} \); TP;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3 \); P-WNLs;
\{R_3\}, \{R_4\}; 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8) \); TP;
\{R_4\}, \{R_5\}; 3; -A_{19}, A_{10} \); TP;
V: MA; \( C_{4z}, \sigma_y \); \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3 \); P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0 \); P-WNLs;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_0 \); P-WNLs;
\{R_3\}, \{R_5\}; 3; \( A_{20}, \frac{1}{4} (A_0 + 2\sqrt{3}A_8) \); TP;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_3 \); P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0 \); P-WNLs;
\{R_2\}, \{R_3\}; 3; \( A_{20}, A_{10} \); TP;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3 \); P-WNLs;
\{R_3\}, \{R_4\}; 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8) \); TP;
\{R_4\}, \{R_5\}; 3; -A_{19}, A_{10} \); TP;
Sigma; GM; \( \sigma_{db}, T \sigma_{da} \); \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0 \); P-WNL;
Y: XM; \( \sigma_y, T \sigma_z \); \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0 \); P-WNL;
W: XR; \( C_{2z}, \sigma_y \); \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3 \); P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0 \); P-WNLs;
\{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0 \); P-WNLs;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3 \); P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0 \); P-WNLs;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3 \); P-WNLs;
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, TC_{2z}; (R_1 \cup R_2) \cap 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \Lambda; \Gamma Z; C_{4z}^+, \sigma_y; (R_1 \cup R_2) \cap 2; \sigma_0, \sigma_3; \quad \text{P-WNLs}; \]
\[ (R_1 \cup R_2) \cap 2; \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ (R_1 \cup R_2) \cap 2; \sigma_3, \sigma_3; \quad \text{P-WNLs}; \]
\[ (R_1 \cup R_2) \cap 3; A_{29}, \frac{A_0}{\sqrt{2}} (A_0 + 2\sqrt{3}A_8); \quad \text{TP}; \]
\[ (R_2 \cup R_3) \cap 2; \sigma_3, -\sigma_3; \quad \text{P-WNLs}; \]
\[ (R_2 \cup R_3) \cap 2; \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \]
\[ (R_2 \cup R_3) \cap 3; A_{29}, A_{10}; \quad \text{TP}; \]
\[ (R_3 \cup R_4) \cap 2; -\sigma_0, \sigma_3; \quad \text{P-WNLs}; \]
\[ (R_3 \cup R_4) \cap 3; -A_{10}, \frac{A_0}{\sqrt{2}} (A_0 + 2\sqrt{3}A_8); \quad \text{TP}; \]
\[ (R_4 \cup R_5) \cap 3; -A_{10}, A_{10}; \quad \text{TP}; \]
\[ V; \text{MA}; C_{4z}^+, C_{2z}, \sigma_{da}; \]
\[ (R_3 \cup R_6) \cap 2; i\sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs}; \]
\[ (R_3 \cup R_6) \cap 2; i\sigma_3, -\sigma_0, -\sigma_3; \quad \text{P-WNLs}; \]
\[ (R_3 \cup R_6) \cap 2; i\sigma_0, -\sigma_0, -\sigma_3; \quad \text{P-WNLs}; \]
\[ (R_3 \cup R_6) \cap 3; A_{30}, -A_{13}, -\frac{A_0}{2} - \frac{2A_8}{\sqrt{2}}; \quad \text{TP}; \]
\[ (R_6 \cup R_7) \cap 2; -i\sigma_0, -\sigma_0, -\sigma_3; \quad \text{P-WNLs}; \]
\[ (R_6 \cup R_7) \cap 2; -i\sigma_3, -\sigma_0, -\sigma_3; \quad \text{P-WNLs}; \]
\[ (R_6 \cup R_7) \cap 3; A_{31}, -A_{13}, -\frac{A_0}{2} - \frac{2A_8}{\sqrt{2}}; \quad \text{TP}; \]
\[ (R_7 \cup R_8) \cap 2; -i\sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNLs}; \]
\[ (R_7 \cup R_8) \cap 3; A_{31}, -A_{13}, -A_{10}; \quad \text{TP}; \]
\[ (R_8 \cup R_9) \cap 3; A_{30}, -A_{13}, -A_{10}; \quad \text{TP}; \]
\[ \Sigma; \Gamma M; \sigma_{db}, T \sigma_{da}; \quad \{R_1 \cup R_2\} \cap 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ T; \text{RA}; \sigma_y, T \sigma_x; \quad \{R_2 \cup R_4\} \cap 2; -i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x,TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \]

\[ U; Z R; \sigma_x,TC_{2z}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \]

\[ \Lambda; \Gamma Z; C_{4v}, \sigma_y; \{R_2\}, \{R_2\}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{R_3\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \quad \text{P-WNLs;} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{R_3\}, \{R_4\}; 2; -A_{19}, 4 (A_0 + 2\sqrt{3}A_8); \quad \text{TP;} \]
\[ \{R_4\}, \{R_5\}; 3; -A_{19}, A_{10}; \quad \text{TP;} \]

\[ V; M A; C_{4v}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 3; A_{20}, 3 (A_0 + 2\sqrt{3}A_8); \quad \text{TP;} \]
\[ \{R_2\}, \{R_3\}; 3; -A_{20}, A_{10}; \quad \text{TP;} \]
\[ \{R_3\}, \{R_4\}; 3; -A_{19}, 4 (A_0 + 2\sqrt{3}A_8); \quad \text{TP;} \]
\[ \{R_4\}, \{R_5\}; 3; -A_{19}, A_{10}; \quad \text{TP;} \]

\[ \Sigma; \Gamma M; \sigma_{db}, T \sigma_{da}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \]
\[ Y; X M; \sigma_y, T \sigma_x; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \]
\[ T; R A; \sigma_y, T \sigma_x; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \]
\[ W; X R; C_{2v}, \sigma_y; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3; \quad \text{P-WNL;} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \quad \text{P-WNL;} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma x, TC_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]

\[ U; \Gamma Z; \sigma, TC_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]

\[ \Lambda; \Gamma Z; C_{4v}^+, \sigma_y; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]

\[ \{ R_4 \}, \{ R_5 \}; 3; A_{29}, \frac{1}{3} (A_0 + 2 \sqrt{3} A_8); \quad \text{TP}; \]

\[ \{ R_2 \}, \{ R_5 \}; 2; \sigma_3, -\sigma_3; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_5 \}; 3; A_{29}, A_{10}; \quad \text{TP}; \]

\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \quad \text{P-WNLs}; \]

\[ \{ R_3 \}, \{ R_5 \}; 3; -A_{19}, \frac{1}{3} (A_0 + 2 \sqrt{3} A_8); \quad \text{TP}; \]

\[ \{ R_4 \}, \{ R_5 \}; 3; -A_{19}, A_{10}; \quad \text{TP}; \]

\[ V; \text{MA}; C_{4v}^+, C_{2v}, \sigma_{do}; \{ R_3 \}, \{ R_6 \}; 2; i\sigma_3, -\sigma_0, -\sigma_0; \quad \text{P-WNLs}; \]

\[ \{ R_3 \}, \{ R_2 \}; 2; i\sigma_3, -\sigma_0, -\sigma_3; \quad \text{P-WNLs}; \]

\[ \{ R_3 \}, \{ R_5 \}; 2; i\sigma_0, -\sigma_0, -\sigma_3; \quad \text{P-WNLs}; \]

\[ \{ R_5 \}, \{ R_6 \}; 3; A_{30}, -A_{13}, -\frac{A}{2} - \frac{4 A_8}{\sqrt{3}}; \quad \text{TP}; \]

\[ \{ R_6 \}, \{ R_5 \}; 2; -i\sigma_0, -\sigma_0, -\sigma_3; \quad \text{P-WNLs}; \]

\[ \{ R_6 \}, \{ R_8 \}; 2; -i\sigma_3, -\sigma_0, -\sigma_3; \quad \text{P-WNLs}; \]

\[ \{ R_8 \}, \{ R_6 \}; 3; A_{31}, -A_{13}, -\frac{A}{2} - \frac{4 A_8}{\sqrt{3}}; \quad \text{TP}; \]

\[ \{ R_7 \}, \{ R_8 \}; 2; -i\sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNLs}; \]

\[ \{ R_7 \}, \{ R_9 \}; 3; A_{31}, -A_{13}, -A_{10}; \quad \text{TP}; \]

\[ \{ R_8 \}, \{ R_7 \}; 3; A_{31}, -A_{13}, -A_{10}; \quad \text{TP}; \]

\[ \Sigma; \text{JM}; \sigma_{do}, T \sigma_{do}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

| Line | Group | Symmetry | Transformations | Operators | Degeneracy | Notes |
|------|-------|----------|----------------|-----------|------------|-------|
| Λ/Γ | ΓΛ/ΓZ | $\Gamma_{4z,\sigma_y}$ | $\{R_1\}, \{R_2\}$ | 2, $\sigma_0, \sigma_3$ | P-WNLs; | |
| | | | $\{R_1\}, \{R_3\}$ | 2, $\sigma_3, \sigma_0$ | P-WNLs; | |
| | | | $\{R_1\}, \{R_4\}$ | 2, $\sigma_3, \sigma_3$ | P-WNLs; | |
| | | | $\{R_3\}, \{R_5\}$ | 3, $A_{29, \frac{1}{2}} (A_0 + 2\sqrt{3}A_8)$ | TP; | |
| | | | $\{R_2\}, \{R_3\}$ | 2, $\sigma_3, -\sigma_3$ | P-WNLs; | |
| | | | $\{R_2\}, \{R_4\}$ | 2, $\sigma_3, -\sigma_0$ | P-WNLs; | |
| | | | $\{R_2\}, \{R_5\}$ | 3, $A_{29, A_{10}}$ | TP; | |
| | | | $\{R_3\}, \{R_4\}$ | 2, $-\sigma_0, \sigma_3$ | P-WNLs; | |
| | | | $\{R_3\}, \{R_5\}$ | 3, $-A_{19, \frac{1}{2}} (A_0 + 2\sqrt{3}A_8)$ | TP; | |
| | | | $\{R_4\}, \{R_5\}$ | 3, $-A_{19, A_{10}}$ | TP; | |
| | | | $\{R_1\}, \{R_2\}$ | 2, $\sigma_0, \sigma_3$ | P-WNLs; | |
| | | | $\{R_1\}, \{R_3\}$ | 2, $\sigma_3, \sigma_0$ | P-WNLs; | |
| | | | $\{R_1\}, \{R_4\}$ | 2, $\sigma_3, \sigma_3$ | P-WNLs; | |
| | | | $\{R_1\}, \{R_5\}$ | 3, $A_{29, \frac{1}{2}} (A_0 + 2\sqrt{3}A_8)$ | TP; | |
| | | | $\{R_2\}, \{R_3\}$ | 2, $\sigma_3, -\sigma_3$ | P-WNLs; | |
| | | | $\{R_2\}, \{R_4\}$ | 2, $\sigma_3, -\sigma_0$ | P-WNLs; | |
| | | | $\{R_2\}, \{R_5\}$ | 3, $A_{29, A_{10}}$ | TP; | |
| | | | $\{R_3\}, \{R_4\}$ | 2, $-\sigma_0, \sigma_3$ | P-WNLs; | |
| | | | $\{R_3\}, \{R_5\}$ | 3, $-A_{19, \frac{1}{2}} (A_0 + 2\sqrt{3}A_8)$ | TP; | |
| | | | $\{R_4\}, \{R_5\}$ | 3, $-A_{19, A_{10}}$ | TP; | |
| | | | $\{R_1\}, \{R_2\}$ | 2, $\sigma_0, \sigma_3$ | P-WNLs; | |
| | | | $\{R_1\}, \{R_3\}$ | 2, $\sigma_3, \sigma_0$ | P-WNLs; | |
| | | | $\{R_1\}, \{R_4\}$ | 2, $\sigma_3, \sigma_3$ | P-WNLs; | |
| | | | $\{R_3\}, \{R_4\}$ | 2, $-\sigma_0, \sigma_3$ | P-WNLs; | |
| | | | $\{R_3\}, \{R_5\}$ | 2, $-\sigma_0, \sigma_3$ | P-WNLs; | |
| | | | $\{R_3\}, \{R_4\}$ | 2, $-\sigma_0, \sigma_3$ | P-WNLs; | |
| | | | $\{R_3\}, \{R_5\}$ | 2, $-\sigma_0, \sigma_3$ | P-WNLs; | |
| | | | $\{R_3\}, \{R_4\}$ | 2, $-\sigma_0, \sigma_3$ | P-WNLs; | |
| | | | $\{R_3\}, \{R_5\}$ | 2, $-\sigma_0, \sigma_3$ | P-WNLs; | |
Accidental degeneracies on high symmetry line

Λ; ΓΛ/ΓZ; $C_{4z}^4 \sigma_y$;  
{R₁}, {R₂} : 2; $\sigma_0, \sigma_3$; 
{R₁}, {R₃} : 2; $\sigma_3, \sigma_0$; 
{R₁}, {R₄} : 2; $\sigma_3, \sigma_3$; 
{R₅} : 3; $A_{29, \frac{1}{2}} (A_0 + 2\sqrt{3}A_8)$; 
{R₂} : 2; $\sigma_3, -\sigma_3$; 
{R₂} : 2; $\sigma_3, -\sigma_0$; 
{R₃} : 3; $A_{29, A_{10}}$; 
{R₄} : 2; $-\sigma_0, \sigma_3$; 
{R₅} : 3; $-A_{19, \frac{1}{2}} (A_0 + 2\sqrt{3}A_8)$; 
{R₆} : 3; $-A_{19, A_{10}}$; 

V; ZV; $C_{4z}^4 \sigma_y$;  
{R₁}, {R₂} : 2; $\sigma_0, \sigma_3$; 
{R₁}, {R₃} : 2; $\sigma_3, \sigma_0$; 
{R₁}, {R₄} : 2; $\sigma_3, \sigma_3$; 
{R₅} : 3; $A_{29, \frac{1}{2}} (A_0 + 2\sqrt{3}A_8)$; 
{R₂} : 2; $\sigma_3, -\sigma_3$; 
{R₂} : 2; $\sigma_3, -\sigma_0$; 
{R₃} : 3; $A_{29, A_{10}}$; 
{R₄} : 2; $-\sigma_0, \sigma_3$; 
{R₅} : 3; $-A_{19, \frac{1}{2}} (A_0 + 2\sqrt{3}A_8)$; 
{R₆} : 3; $-A_{19, A_{10}}$; 

W; XP; $C_{2z} \sigma_{db}$;  
{R₁}, {R₂} : 2; $\sigma_0, \sigma_3$; 
{R₁}, {R₃} : 2; $\sigma_3, \sigma_0$; 
{R₁}, {R₄} : 2; $\sigma_3, \sigma_3$; 
{R₂} : 2; $\sigma_3, -\sigma_3$; 
{R₂} : 2; $\sigma_3, -\sigma_0$; 
{R₃} : 2; $-\sigma_0, \sigma_3$; 
{R₄} : 2; $-\sigma_0, \sigma_3$; 

Σ; ΓZ/ΓΣ; $\sigma_y, T\sigma_z$;  
{R₁}, {R₂} : 2; $\sigma_3, \sigma_0$; 

F; ZF; $\sigma_y, T\sigma_z$;  
{R₁}, {R₂} : 2; $-\sigma_3, \sigma_0$; 

Δ; ΓX; $\sigma_{db}, T\sigma_{da}$;  
{R₁}, {R₂} : 2; $\sigma_3, \sigma_0$; 

U; ZU; $\sigma_{db}, T\sigma_{da}$;  
{R₁}, {R₂} : 2; $-\sigma_3, \sigma_0$; 

Y; XZ/XY; $\sigma_{da}, TC_{2z}$;  
{R₁}, {R₂} : 2; $\sigma_3, \sigma_0$; 

P-WNLs;
Accidental degeneracies on high symmetry line

| \Lambda; \Gamma\Lambda/\Gamma Z; C_{4z}^+\sigma_y | \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; | P-WNLs; |
|---|---|---|
| \{R_1\}, \{R_5\}; 3; \frac{1}{3}(A_0 + 2\sqrt{3}A_8); | TP; |
| \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}; | P-WNLs; |
| \{R_3\}, \{R_4\}; 2; \sigma_0, \sigma_3; | P-WNLs; |
| \{R_4\}, \{R_5\}; 3; -A_{19}, \frac{1}{3}(A_0 + 2\sqrt{3}A_8); | TP; |
| \{R_6\}, \{R_7\}; 2; i\sigma_0, \sigma_0, \sigma_3; | P-WNLs; |
| \{R_8\}, \{R_9\}; 2; -i\sigma_0, \sigma_0, \sigma_3; | P-WNLs; |
| \{R_{10}\}, \{R_{11}\}; 3; A_{40}, A_{13}, \frac{1}{3}(A_0 + 2\sqrt{3}A_8); | TP; |
| \{R_{12}\}, \{R_{13}\}; 3; -A_{19}, A_{10}; | TP; |
| \{R_{14}\}, \{R_{15}\}; 3; -A_{19}, A_{10}; | TP; |
| \{R_{16}\}, \{R_{17}\}; 3; A_{41}, A_{13}, \frac{1}{3}(A_0 + 2\sqrt{3}A_8); | TP; |
| \{R_{18}\}, \{R_{19}\}; 3; A_{40}, A_{13}, A_{10}; | TP; |

\begin{align*}
\Sigma; \Gamma\Sigma/\Gamma\Sigma; \sigma_y, \Gamma \sigma_x; & \quad \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; & P-WNL; \\
F; \Gamma F; \sigma_y, \Gamma \sigma_z; & \quad \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; & P-WNL; \\
\Delta; \Gamma \Delta; \sigma_{db}, \Gamma \sigma_{da}; & \quad \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; & P-WNL;
\end{align*}
Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma\Lambda/\Gamma Z; C^+_{4z}\sigma_y; \)  
\{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3;  
P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0;  
P-WNLs;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3;  
P-WNLs;
\{R_1\}, \{R_5\}; 3; A_{29}, \frac{1}{3} \left( A_0 + 2\sqrt{3}A_8 \right);  
TP;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3;  
P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0;  
P-WNLs;
\{R_2\}, \{R_5\}; 3; A_{29}, A_{10};  
TP;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3;  
P-WNLs;
\{R_3\}, \{R_6\}; 3; -A_{19}, \frac{1}{2} \left( A_0 + 2\sqrt{3}A_8 \right);  
TP;
\{R_4\}, \{R_5\}; 3; -A_{19}, A_{10};  
TP;

\( V; ZV; C^+_{4z}C_{2z}\sigma_y; \)  
\{R_3\}, \{R_6\}; 2; i\sigma_3, \sigma_0, \sigma_0;  
P-WNLs;
\{R_3\}, \{R_7\}; 2; i\sigma_3, \sigma_0, \sigma_3;  
P-WNLs;
\{R_3\}, \{R_8\}; 2; i\sigma_0, \sigma_0, \sigma_3;  
P-WNLs;
\{R_3\}, \{R_9\}; 3; A_{40}, A_{13}, \frac{1}{2} \left( A_0 + 2\sqrt{3}A_8 \right);  
TP;
\{R_6\}, \{R_7\}; 2; -i\sigma_0, \sigma_0, \sigma_3;  
P-WNLs;
\{R_6\}, \{R_8\}; 2; -i\sigma_3, \sigma_0, \sigma_3;  
P-WNLs;
\{R_6\}, \{R_9\}; 3; A_{41}, A_{13}, \frac{1}{2} \left( A_0 + 2\sqrt{3}A_8 \right);  
TP;
\{R_7\}, \{R_8\}; 2; -i\sigma_3, \sigma_0, -\sigma_0;  
P-WNLs;
\{R_7\}, \{R_9\}; 3; A_{41}, A_{13}, A_{10};  
TP;
\{R_8\}, \{R_9\}; 3; A_{40}, A_{13}, A_{10};  
TP;

\( \Sigma; \Gamma Z/\Gamma \Sigma; \sigma_y, T\sigma_x; \)  
\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0;  
P-WNL;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0;  
P-WNL;
\{R_1\}, \{R_4\}; 2; -\sigma_3, \sigma_0;  
P-WNL;
\{R_1\}, \{R_5\}; 2; \sigma_3, \sigma_0;  
P-WNL;
Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma X; C_{2y}, T \Gamma C_{2z}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad C-1 \ WP; \quad 1 \]

\[ U; \ ZR; C_{2y}, T \Gamma C_{2z}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad C-1 \ WP; \quad 1 \]

\[ \Lambda; \ \Gamma Z; C_{2x}, \sigma_{db}, S_{4z}^z T; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_0, \sigma_3, \sigma_0; \quad P-WNLs; \]
\[ \{R_1\}, \{R_3, R_4\}; 3; \frac{A_{13} A_{10} + 2\sqrt{3} A_8}{4}, A_{19}; \quad TP; \]

\[ \{R_2\}, \{R_3, R_4\}; 3; A_{13}, A_{10}, A_{19}; \quad TP; \]

\[ V; \ MA; C_{2z}, \sigma_{db}, S_{4z}^z T; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_0, \sigma_3, \sigma_0; \quad P-WNLs; \]
\[ \{R_1\}, \{R_3, R_4\}; 3; \frac{A_{13} A_{10} + 2\sqrt{3} A_8}{4}, A_{19}; \quad TP; \]
\[ \{R_2\}, \{R_3, R_4\}; 3; A_{13}, A_{10}, A_{19}; \quad TP; \]

\[ \Sigma; \ \Gamma M; \sigma_{db}, T \sigma_{da}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad P-WNL; \]

\[ S; \ ZA; \sigma_{db}, T \sigma_{da}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad P-WNL; \]

\[ Y; \ XM; C_{2x}, T \Gamma C_{2y}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad C-1 \ WP; \quad 1 \]

\[ T; \ RA; C_{2x}, T \Gamma C_{2y}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad C-1 \ WP; \quad 1 \]

\[ W; \ XR; C_{2x}, T \Gamma C_{2y}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad C-1 \ WP; \quad 1 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y}, T C_{2z}; \{ R_1 \}, \{ R_2 \}; \quad 2; \sigma_3, \sigma_0; \quad C-1 \text{ WP }; 1 \]

\[ U; Z R; C_{2y}, T C_{2z}; \{ R_2 \}, \{ R_2 \}; \quad 2; \sigma_3, \sigma_0; \quad C-1 \text{ WP }; 1 \]

\[ \Lambda; \Gamma Z; C_{2x}, \sigma_{db}, S_{1y}^+, T; \{ R_1 \}, \{ R_2 \}; \quad 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_3, R_4 \}; \quad 3; A_{13}, \frac{\Delta_0 + 2\sqrt{3} \Delta_0}{3}, A_{19}; \quad \text{TP}; \]
\[ \{ R_2 \}, \{ R_3, R_4 \}; \quad 3; A_{13}, A_{10}, A_{19}; \quad \text{TP}; \]

\[ V; \text{MA}; C_{2x}, \sigma_{db}, S_{1y}^+, T; \{ R_1, R_2 \}, \{ R_3, R_4 \}; \quad 4; \Gamma_{3,0}, \Gamma_{18}, \Gamma_{19}; \quad \text{DP}; 0 \]
\[ \{ R_1, R_2 \}, \{ R_4, R_4 \}; \quad 4; \Gamma_{3,0}, \Gamma_{20}, \Gamma_{19}; \quad \text{DP}; 0 \]
\[ \{ R_3, R_4 \}, \{ R_4, R_4 \}; \quad 4; -\Gamma_{0,0}, -\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{QDP}; 0 \]

\[ \Sigma; \Gamma M; \sigma_{db}, T \sigma_{da}; \{ R_1 \}, \{ R_2 \}; \quad 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]

\[ S; Z A; \sigma_{db}, T \sigma_{da}; \{ R_1 \}, \{ R_2 \}; \quad 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, T \sigma_y; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]

\[ U; \Gamma R; \sigma_z, T \sigma_y; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]

\[ \Lambda; \Gamma Z; \Gamma_2, \sigma_y, S_4^+ T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;} \]
\[ \{ R_1 \}, \{ R_3, R_4 \}; 3; A_{13}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{19}; \text{ TP;} \]
\[ \{ R_2 \}, \{ R_3, R_4 \}; 3; A_{13}, A_{10}, A_{19}; \text{ TP;} \]

\[ V; \Gamma A; \Gamma_2, \sigma_y, S_4^+ T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs;} \]
\[ \{ R_1 \}, \{ R_3, R_4 \}; 3; A_{13}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{19}; \text{ TP;} \]
\[ \{ R_2 \}, \{ R_3, R_4 \}; 3; A_{13}, A_{10}, A_{19}; \text{ TP;} \]

\[ \Sigma; \Gamma M; \Gamma_2, \Gamma_2 T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ S; \Gamma A; \Gamma_2, \Gamma_2 T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ Y; \Gamma M; \sigma_y, T \Gamma_2 x; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]

\[ T; \Gamma A; \sigma_y, T \Gamma_2 x; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]

\[ W; \Gamma R; \Gamma_2, \sigma_y; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \text{ P-WNLs;} \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \text{ P-WNL;} \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \text{ P-WNL;} \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \text{ P-WNLs;} \]
Accidental degeneracies on high symmetry line

\( \Delta; \Gamma X; \sigma_x T \sigma_y; \) \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) P-WNL;

\( U; Z R; \sigma_x T \sigma_y; \) \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) P-WNL;

\( \Lambda; \Gamma Z; C_{2s}, \sigma_y S_{12}^+ T; \) \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;

\( \{R_1\}, \{R_3, R_4\}; 3; A_{13}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{19}; \) TP;

\( \{R_2\}, \{R_3, R_4\}; 3; A_{13}, A_{10}, A_{19}; \) TP;

\( V; M A; \sigma_x C_{2s}, S_{12}^+ T; \) \( \{R_2\}, \{R_4\}; 2; -i \sigma_3, \sigma_0, \sigma_0; \) P-WNLs;

\( \{R_2\}, \{R_6, R_8\}; 3; -\frac{1}{2} i (A_0 + 2\sqrt{3}A_8), A_{13}, A_{19}; \) TP;

\( \{R_4\}, \{R_6, R_8\}; 3; -i A_{10}, A_{13}, A_{19}; \) TP;

\( \Sigma; \Gamma M; C_{2a}, C_{2b} T; \) \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) C-1 WP; 1

\( S; Z A; C_{2a}, C_{2b} T; \) \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) C-1 WP; 1

\( T; R A; \sigma_y T C_{2z}; \) \( \{R_2\}, \{R_4\}; 2; -i \sigma_3, \sigma_0; \) P-WNL;

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Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma \Lambda / \Gamma Z; C_{2s}, \sigma_y S_{12}^+ T; \) \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;

\( \{R_1\}, \{R_3, R_4\}; 3; A_{13}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{19}; \) TP;

\( \{R_2\}, \{R_3, R_4\}; 3; A_{13}, A_{10}, A_{19}; \) TP;

\( V; Z V; C_{2s}, \sigma_y S_{12}^+ T; \) \( \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;

\( \{R_1\}, \{R_3, R_4\}; 3; A_{13}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{19}; \) TP;

\( \{R_2\}, \{R_3, R_4\}; 3; A_{13}, A_{10}, A_{19}; \) TP;

\( W; X P; C_{2a}, C_{2b} T; \) \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) C-1 WP; 1

\( \Sigma; \Gamma Z / \Gamma \Sigma; \sigma_y T C_{2z}; \) \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) P-WNL;

\( F; Z F; \sigma_y T C_{2z}; \) \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) P-WNL;

\( \Delta; \Gamma X; C_{2a}, C_{2b} T; \) \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) C-1 WP; 1

\( U; Z U; C_{2a}, C_{2b} T; \) \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) C-1 WP; 1

\( Y; X Z / X Y; C_{2a}, T C_{2z}; \) \( \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \) C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Lambda; \ \Gamma\Lambda/\Gamma Z; \ C_{2z}, \sigma_y, S_4^+ T; \ \{R_1\}, \{R_2\}; \ 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3, R_4\}; \ 3; A_{13}, \frac{1}{2} \left( A_0 + 2\sqrt{3}A_8 \right), A_{19}; \ TP; \]
\[ \{R_2\}, \{R_3, R_4\}; \ 3; A_{13}, A_{10}, A_{19}; \ TP; \]
\[ V; \ ZV; \ C_{2a}, \sigma_y, S_4^+ T; \ \{R_1\}, \{R_2\}; \ 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNLs; \]
\[ \{R_1\}, \{R_3, R_4\}; \ 3; A_{13}, \frac{1}{2} \left( A_0 + 2\sqrt{3}A_8 \right), A_{19}; \ TP; \]
\[ \{R_2\}, \{R_3, R_4\}; \ 3; A_{13}, A_{10}, A_{19}; \ TP; \]
\[ W; \ XP; \ C_{2a}, C_{2b} T; \ \{R_1\}, \{R_2\}; \ 2; \sigma_3, \sigma_0; \ C-1 \ WP; \ 1 \]
\[ \Sigma; \ \Gamma Z/\Gamma \Sigma; \ \sigma_y, T C_{2z}; \ \{R_1\}, \{R_2\}; \ 2; \sigma_3, \sigma_0; \ P-WNL; \]
\[ F; \ ZF; \ \sigma_y, T C_{2z}; \ \{R_1\}, \{R_2\}; \ 2; -\sigma_3, \sigma_0; \ P-WNL; \]
\[ \Delta; \ \Gamma X; \ C_{2a}, C_{2b} T; \ \{R_1\}, \{R_2\}; \ 2; \sigma_3, \sigma_0; \ C-1 \ WP; \ 1 \]
\[ U; \ ZU; \ C_{2a}, C_{2b} T; \ \{R_1\}, \{R_2\}; \ 2; -\sigma_3, \sigma_0; \ C-1 \ WP; \ 1 \]
\[ Y; \ XZ/XY; \ C_{2a}, T C_{2z}; \ \{R_1\}, \{R_2\}; \ 2; \sigma_3, \sigma_0; \ C-1 \ WP; \ 1 \]
Accidental degeneracies on high symmetry line

\[ \Lambda: \Gamma\Lambda/\Gamma\Sigma; \quad C_{2\varepsilon}, \sigma_{db}, S_{4z}^{+} T \; \{ R_{1} \}, \{ R_{2} \}; \quad 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]
\[ \{ R_{1} \}, \{ R_{3}, R_{4} \}; \quad 3; \; A_{13}, \frac{A_{8}+2\sqrt{3}A_{8}}{2}, A_{19}; \quad \text{TP}; \]
\[ \{ R_{2} \}, \{ R_{3}, R_{4} \}; \quad 3; \; A_{13}, A_{10}, A_{19}; \quad \text{TP}; \]

\[ V: \quad ZV; \quad C_{2\varepsilon}, \sigma_{db}, S_{4z}^{+} T \; \{ R_{1} \}, \{ R_{2} \}; \quad 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]
\[ \{ R_{1} \}, \{ R_{3}, R_{4} \}; \quad 3; \; A_{13}, \frac{A_{8}+2\sqrt{3}A_{8}}{2}, A_{19}; \quad \text{TP}; \]
\[ \{ R_{2} \}, \{ R_{3}, R_{4} \}; \quad 3; \; A_{13}, A_{10}, A_{19}; \quad \text{TP}; \]

\[ W: \quad XP; \quad C_{2\varepsilon}, \sigma_{db}; \quad \{ R_{1} \}, \{ R_{2} \}; \quad 2; \sigma_{0}, \sigma_{3}; \quad \text{P-WNLs}; \]
\[ \{ R_{1} \}, \{ R_{3} \}; \quad 2; \sigma_{3}, \sigma_{0}; \quad \text{P-WNL}; \]
\[ \{ R_{1} \}, \{ R_{4} \}; \quad 2; \sigma_{3}, \sigma_{3}; \quad \text{P-WNL}; \]
\[ \{ R_{2} \}, \{ R_{3} \}; \quad 2; \sigma_{3}, -\sigma_{3}; \quad \text{P-WNL}; \]
\[ \{ R_{2} \}, \{ R_{4} \}; \quad 2; \sigma_{3}, -\sigma_{0}; \quad \text{P-WNL}; \]
\[ \{ R_{3} \}, \{ R_{4} \}; \quad 2; -\sigma_{0}, \sigma_{3}; \quad \text{P-WNLs}; \]

\[ \Sigma: \quad \Gamma\varepsilon/\Gamma\Sigma; \quad C_{2\varepsilon}, TC_{2y}; \quad \{ R_{1} \}, \{ R_{2} \}; \quad 2; \sigma_{3}, \sigma_{0}; \quad \text{C-1 WP}; \quad 1 \]

\[ F: \quad ZF; \quad C_{2\varepsilon}, TC_{2y}; \quad \{ R_{1} \}, \{ R_{2} \}; \quad 2; \sigma_{3}, \sigma_{0}; \quad \text{C-1 WP}; \quad 1 \]

\[ Q: \quad NP; \quad C_{2y}; \quad \{ R_{1} \}, \{ R_{2} \}; \quad 2; \sigma_{3}; \quad \text{C-1 WP}; \quad 1 \]

\[ \Delta: \quad \Gamma\varepsilon; \quad \sigma_{db}, T \sigma_{da}; \quad \{ R_{1} \}, \{ R_{2} \}; \quad 2; \sigma_{3}, \sigma_{0}; \quad \text{P-WNL}; \]

\[ U: \quad ZU; \quad \sigma_{db}, T \sigma_{da}; \quad \{ R_{1} \}, \{ R_{2} \}; \quad 2; \sigma_{3}, \sigma_{0}; \quad \text{P-WNL}; \]

\[ Y: \quad XZ/XY; \quad \sigma_{da}, TC_{2z}; \quad \{ R_{1} \}, \{ R_{2} \}; \quad 2; \sigma_{3}, \sigma_{0}; \quad \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y, \sigma_x, I T}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \Lambda; \Gamma Z; C_{2y, \sigma_y, I T}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ V; \Gamma A; C_{4z, \sigma_y, I T}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \Sigma; \Gamma M; C_{2y, \sigma_y, I T}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ S; \Gamma A; C_{2y, \sigma_y, I T}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;

\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \] P-WNLs;
$Y; \text{XM}; C_{2x,\sigma_z,IT}; \{R_1\} \cup \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNL$s;
\{R_1\} \cup \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNL;
\{R_1\} \cup \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P-WNL;
\{R_2\} \cup \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P-WNL;
\{R_2\} \cup \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P-WNL;
\{R_3\} \cup \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P-WNL$s;

$T; \text{RA}; C_{2x,\sigma_z,IT}; \{R_1\} \cup \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNL$s;
\{R_1\} \cup \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNL;
\{R_1\} \cup \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P-WNL;
\{R_2\} \cup \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P-WNL;
\{R_2\} \cup \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P-WNL;
\{R_3\} \cup \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P-WNL$s;

$W; \text{XR}; C_{2x,\sigma_y,IT}; \{R_1\} \cup \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P-WNL$s;
\{R_1\} \cup \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P-WNL;
\{R_1\} \cup \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P-WNL;
\{R_2\} \cup \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P-WNL;
\{R_2\} \cup \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P-WNL;
\{R_3\} \cup \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P-WNL$s;
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y,\sigma_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_1\}, \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNL;

\[ \{R_1\}, \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNL;

\[ \{R_2\}, \{R_3\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNL;

\[ \{R_2\}, \{R_4\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNLs;

\[ \{R_3\}, \{R_4\}; 2; \sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \Lambda; \Gamma Z; C_{4z,\sigma_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_1\}, \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNLs;

\[ \{R_1\}, \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_1\}, \{R_5\}; 3; A_{29}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \]  
TP;

\[ \{R_2\}, \{R_3\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_2\}, \{R_4\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNLs;

\[ \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; \]  
TP;

\[ \{R_3\}, \{R_4\}; 2; \sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_3\}, \{R_5\}; 3; -A_{19}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \]  
TP;

\[ \{R_4\}, \{R_5\}; 3; -A_{19}, A_{10}, A_{13}; \]  
TP;

\[ V; \text{MA}; C_{4z,\sigma_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_1\}, \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNLs;

\[ \{R_1\}, \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_1\}, \{R_5\}; 3; A_{29}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \]  
TP;

\[ \{R_2\}, \{R_3\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_2\}, \{R_4\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNLs;

\[ \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; \]  
TP;

\[ \{R_3\}, \{R_4\}; 2; -\sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_3\}, \{R_5\}; 3; -A_{19}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \]  
TP;

\[ \{R_4\}, \{R_5\}; 3; -A_{19}, A_{10}, A_{13}; \]  
TP;

\[ \Sigma; \text{GM}; C_{2a,\sigma_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_1\}, \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNL;

\[ \{R_1\}, \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNL;

\[ \{R_2\}, \{R_3\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNL;

\[ \{R_2\}, \{R_4\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNL;

\[ \{R_3\}, \{R_4\}; 2; -\sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ Y; \text{XM}; C_{2x,\sigma_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_1\}, \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNL;

\[ \{R_1\}, \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNL;

\[ \{R_2\}, \{R_3\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNL;

\[ \{R_2\}, \{R_4\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNL;

\[ \{R_3\}, \{R_4\}; 2; -\sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ W; \text{XR}; C_{2z,\sigma_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;

\[ \{R_1\}, \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNL;

\[ \{R_1\}, \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNL;

\[ \{R_2\}, \{R_3\}; 2; \sigma_3,\sigma_3,\sigma_0; \]  
P-WNL;

\[ \{R_2\}, \{R_4\}; 2; \sigma_3,\sigma_0,\sigma_0; \]  
P-WNL;

\[ \{R_3\}, \{R_4\}; 2; -\sigma_0,\sigma_3,\sigma_0; \]  
P-WNLs;
Accidental degeneracies on high symmetry line

**Δ; ΓX; C_{2y,σ_x,IT}:**

\[ \{R_1\} \cap \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_1\} \cap \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_1\} \cap \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\} \cap \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\} \cap \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_3\} \cap \{R_4\}; 2; -\sigma_0,\sigma_3,\sigma_0; \quad \text{P-WNLs}; \]

**U; ZR; C_{2y,σ_x,IT}:**

\[ \{R_1\} \cap \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_1\} \cap \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_1\} \cap \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\} \cap \{R_3\}; 2; \sigma_3,\sigma_3,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\} \cap \{R_4\}; 2; -\sigma_0,\sigma_3,\sigma_0; \quad \text{P-WNLs}; \]

**Λ; ΓZ; C_{4z,σ_y,IT}:**

\[ \{R_1\} \cap \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_1\} \cap \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_1\} \cap \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_2\} \cap \{R_3\}; 3; \sigma_0,\sigma_3,\sigma_0; \quad \text{TP}; \]
\[ \{R_2\} \cap \{R_4\}; 3; A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3} A_8), A_{13}; \quad \text{TP}; \]
\[ \{R_3\} \cap \{R_4\}; 2; \sigma_3,\sigma_0,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_3\} \cap \{R_5\}; 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3} A_8), A_{13}; \quad \text{TP}; \]
\[ \{R_3\} \cap \{R_6\}; 3; -A_{19}, A_{10}, A_{13}; \quad \text{TP}; \]

**V; MA; C_{4z,σ_{d0},IT}:**

\[ \{R_5\} \cap \{R_6\}; 2; -i\sigma_3,\sigma_0,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_5\} \cap \{R_7\}; 2; -i\sigma_3,\sigma_0,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_5\} \cap \{R_8\}; 2; -i\sigma_0,\sigma_0,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_6\} \cap \{R_7\}; 3; -A_{30}, A_{13}, \frac{1}{3} (A_0 + 2\sqrt{3} A_8), A_{32}; \quad \text{TP}; \]
\[ \{R_6\} \cap \{R_8\}; 3; -i\sigma_0,\sigma_0,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_6\} \cap \{R_9\}; 3; -i\sigma_0,\sigma_0,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_7\} \cap \{R_8\}; 3; -A_{31}, A_{13}, \frac{1}{3} (A_0 + 2\sqrt{3} A_8), A_{32}; \quad \text{TP}; \]
\[ \{R_7\} \cap \{R_9\}; 3; -A_{31}, A_{10}, A_{32}; \quad \text{TP}; \]

**Σ; GM; C_{2y,σ_z,IT}:**

\[ \{R_1\} \cap \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_1\} \cap \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_1\} \cap \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\} \cap \{R_3\}; 2; \sigma_3,\sigma_3,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\} \cap \{R_4\}; 2; -\sigma_0,\sigma_3,\sigma_0; \quad \text{P-WNLs}; \]

**S; ZA; C_{2y,σ_z,IT}:**

\[ \{R_1\} \cap \{R_2\}; 2; \sigma_0,\sigma_3,\sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_1\} \cap \{R_3\}; 2; \sigma_3,\sigma_0,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_1\} \cap \{R_4\}; 2; \sigma_3,\sigma_3,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\} \cap \{R_3\}; 2; \sigma_3,\sigma_3,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\} \cap \{R_4\}; 2; \sigma_3,\sigma_0,\sigma_0; \quad \text{P-WNL}; \]
\[ \{R_3\} \cap \{R_4\}; 2; -\sigma_0,\sigma_3,\sigma_0; \quad \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \quad \text{ΓX: } \quad C_{2y, \sigma_x, IT}; \quad \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNL;} \]

\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNL;} \]

\[ \{R_2\}, \{R_3\}; 2; \sigma_0, -\sigma_3, \sigma_0; \quad \text{P-WNL;} \]

\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNL;} \]

\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_4\}, \{R_6\}; 2; i\sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_4\}, \{R_8\}; 2; i\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_6\}, \{R_8\}; 2; -i\sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNLs;} \]

\[ \Lambda; \quad \text{ΔZ: } \quad C_{4z, \sigma_y, IT}; \quad \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_2\}, \{R_3\}; 3; A_{29}, \frac{1}{3} \left(A_0 + 2\sqrt{3}A_8\right), A_{13}; \quad \text{TP;} \]

\[ \{R_2\}, \{R_4\}; 2; \sigma_0, -\sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; \quad \text{TP;} \]

\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_3\}, \{R_5\}; 3; -A_{19}, \frac{1}{3} \left(A_0 + 2\sqrt{3}A_8\right), A_{13}; \quad \text{TP;} \]

\[ \{R_4\}, \{R_5\}; 3; -A_{19}, A_{10}, A_{13}; \quad \text{TP;} \]

\[ V; \quad \text{MA: } \quad C_{4z}^{+}, C_{2z}, \sigma_{da}, IT; \quad \{R_5\}, \{R_6\}; 2; -i\sigma_3, \sigma_0, \sigma_0, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_6\}, \{R_7\}; 2; -i\sigma_3, \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_6\}, \{R_8\}; 2; -i\sigma_0, \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_6\}, \{R_9\}; 3; -A_{30}, A_{13}, \frac{1}{3} \left(A_0 + 2\sqrt{3}A_8\right), A_{32}; \quad \text{TP;} \]

\[ \{R_7\}, \{R_8\}; 2; i\sigma_0, \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_8\}, \{R_9\}; 2; i\sigma_3, \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_8\}, \{R_9\}; 3; -A_{31}, A_{13}, \frac{1}{3} \left(A_0 + 2\sqrt{3}A_8\right), A_{32}; \quad \text{TP;} \]

\[ \{R_9\}; \quad \text{TP;} \]

\[ \Sigma; \quad \text{ΔM; } \quad C_{2a, \sigma_z, IT}; \quad \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNL;} \]

\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNL;} \]

\[ \{R_2\}, \{R_3\}; 2; \sigma_0, -\sigma_3, \sigma_0; \quad \text{P-WNL;} \]

\[ \{R_2\}, \{R_4\}; 2; \sigma_0, -\sigma_0, \sigma_0; \quad \text{P-WNL;} \]

\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_5\}, \{R_6\}; 2; -i\sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_6\}, \{R_7\}; 2; -i\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_6\}, \{R_8\}; 2; -i\sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_6\}, \{R_8\}; 2; -i\sigma_0, -\sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_7\}, \{R_8\}; 2; i\sigma_3, \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \]

\[ \{R_8\}, \{R_8\}; 2; -i\sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNLs;} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y, \sigma x, IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ U; \text{ZR}; C_{2y, \sigma x, IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ \Lambda; \text{GZ}; C_{42, \sigma y, IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{29}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_3 \}, \{ R_4 \}; 3; A_{29}, A_{10}, A_{13}; \text{TP}; \]
\[ \{ R_3 \}, \{ R_5 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_4 \}, \{ R_6 \}; 3; -A_{19}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \]
\[ V; \text{MA}; \sigma_x, C_{2x, \sigma d x, IT}; \{ R_{5}, R_6 \}, \{ R_{10} \}; 4; \Gamma_{21}, \Gamma_{3,0}, \Gamma_{22}, \Gamma_{23}; \text{DP}; 0 \]
\[ \{ R_{5}, R_6 \}, \{ R_7, R_8 \}; 4; -i\Gamma_{3,3}, \Gamma_{0,0}, \Gamma_{3,0}, \Gamma_{0,1}; \text{QDP}; 0 \]
\[ \{ R_7, R_8 \}, \{ R_{10} \}; 4; \Gamma_{24}, \Gamma_{3,0}, \Gamma_{25}, \Gamma_{23}; \text{DP}; 0 \]

\[ \Sigma; \text{GM}; C_{2a, \sigma z, IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ S; \text{ZA}; C_{2a, \sigma z, IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ Y; \text{XM}; \sigma_y, \sigma_z, IT; \{ R_{2}, R_4 \}, \{ R_{6}, R_8 \}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; 0 \]

\[ T; \text{RA}; \sigma_y, \sigma_z, IT; \{ R_{2}, R_4 \}, \{ R_{6}, R_8 \}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; 0 \]
Accidental degeneracies on high symmetry line

| Group | Symmetry | Description |
|-------|----------|-------------|
| Δ; ΓX | $C_{2y,\sigma_x,IT}$ | $\{R_1\}, \{R_2\}$: 2; $\sigma_0, \sigma_3, \sigma_0$; P-WNLs; |
|       |          | $\{R_1\}, \{R_3\}$: 2; $\sigma_3, \sigma_0, \sigma_0$; P-WNL; |
|       |          | $\{R_1\}, \{R_4\}$: 2; $\sigma_3, \sigma_3, \sigma_0$; P-WNL; |
|       |          | $\{R_2\}, \{R_3\}$: 2; $\sigma_3, -\sigma_3, \sigma_0$; P-WNL; |
|       |          | $\{R_2\}, \{R_4\}$: 2; $\sigma_3, -\sigma_0, \sigma_0$; P-WNL; |
|       |          | $\{R_3\}, \{R_4\}$: 2; $-\sigma_0, \sigma_3, \sigma_0$; P-WNLs; |
| Λ; ΓZ | $C_{4z,\sigma_y,IT}$ | $\{R_1\}, \{R_2\}$: 2; $\sigma_0, \sigma_3, \sigma_0$; P-WNLs; |
|       |          | $\{R_1\}, \{R_3\}$: 2; $\sigma_3, \sigma_0, \sigma_0$; P-WNLs; |
|       |          | $\{R_1\}, \{R_4\}$: 2; $\sigma_3, \sigma_3, \sigma_0$; P-WNLs; |
|       |          | $\{R_2\}, \{R_3\}$: 3; $A_{29}, \frac{1}{3} \left(A_0 + 2\sqrt{3}A_8\right), A_{13}$; TP; |
|       |          | $\{R_2\}, \{R_4\}$: 2; $\sigma_3, -\sigma_3, \sigma_0$; P-WNLs; |
|       |          | $\{R_3\}, \{R_4\}$: 2; $\sigma_3, -\sigma_0, \sigma_0$; P-WNLs; |
|       |          | $\{R_3\}, \{R_5\}$: 3; $A_{29}, A_{10}, A_{13}$; TP; |
|       |          | $\{R_4\}, \{R_5\}$: 2; $-\sigma_0, \sigma_3, \sigma_0$; P-WNLs; |
| V; MA | $\sigma_x, C_{2x,\sigma_{dn},IT}$ | $\{R_5\}, \{R_6\}, \{R_{10}\}$: 4; $\Gamma_{21}, \Gamma_{3,0}, \Gamma_{22}, \Gamma_{23}$; DP; 0 |
|       |          | $\{R_5\}, \{R_6\}, \{R_7, R_8\}$: 4; $-i\Gamma_{3,3}, \Gamma_{0,0}, \Gamma_{3,0}, \Gamma_{0,1}$; QDP; 0 |
|       |          | $\{R_7, R_8\}, \{R_{10}\}$: 4; $\Gamma_{24}, \Gamma_{3,0}, \Gamma_{25}, \Gamma_{23}$; DP; 0 |
| Σ; ΓM | $C_{2a,\sigma_z,IT}$ | $\{R_1\}, \{R_2\}$: 2; $\sigma_0, \sigma_3, \sigma_0$; P-WNLs; |
|       |          | $\{R_1\}, \{R_3\}$: 2; $\sigma_3, \sigma_0, \sigma_0$; P-WNL; |
|       |          | $\{R_1\}, \{R_4\}$: 2; $\sigma_3, \sigma_3, \sigma_0$; P-WNL; |
|       |          | $\{R_2\}, \{R_3\}$: 2; $\sigma_3, -\sigma_3, \sigma_0$; P-WNL; |
|       |          | $\{R_2\}, \{R_4\}$: 2; $\sigma_3, -\sigma_0, \sigma_0$; P-WNL; |
|       |          | $\{R_3\}, \{R_4\}$: 2; $-\sigma_0, \sigma_3, \sigma_0$; P-WNLs; |
| Y; XM | $\sigma_y, \sigma_z, IT$ | $\{R_2, R_4\}, \{R_6, R_8\}$: 4; $\Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}$; DP; 0 |
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y}, \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]

\[ U; \ ZR; C_{2y}, \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]

\[ A; \ ZF; C_{4z}^+, \sigma_y, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs; \]
\[ \{ R_3 \}, \{ R_4 \}; 3; A_{20}, \frac{1}{3} \left( A_0 + 2\sqrt{3}A_8 \right), A_{13}; TP; \]
\[ \{ R_3 \}, \{ R_5 \}; 3; -A_{19}, \frac{1}{3} \left( A_0 + 2\sqrt{3}A_8 \right), A_{13}; TP; \]
\[ \{ R_4 \}, \{ R_5 \}; 3; -A_{19}, A_{10}, A_{13}; TP; \]

\[ V; \ MA; C_{4z}^+, \sigma_y, IT; \{ R_1 \}, \{ R_4 \}, \{ R_5 \}; 4; \Gamma_{20}, \Gamma_{0,3}, \left( \frac{1}{2} - \frac{i}{2} \right) \left( \Gamma_{0,1} + i\Gamma_{3,1} \right); DP; 0 \]
\[ \{ R_1 \}, \{ R_4 \}, \{ R_2 \}, \{ R_3 \}; 4; \Gamma_{0,3}, \Gamma_{3,3}, \Gamma_{0,1}; QDP; 0 \]
\[ \{ R_2 \}, \{ R_3 \}, \{ R_5 \}; 4; \Gamma_{26}, -\Gamma_{3,3}, \left( \frac{1}{2} - \frac{i}{2} \right) \left( \Gamma_{0,1} + i\Gamma_{3,1} \right); DP; 0 \]

\[ \Sigma; \ GM; C_{2y}, \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]

\[ S; \ ZA; C_{2y}, \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]

\[ W; \ XR; C_{2y}, \sigma_y, IT; \{ R_1 \}, \{ R_4 \}, \{ R_2, R_3 \}; 4; \Gamma_{0,3}, \Gamma_{3,3}, \Gamma_{0,1}; DP; 0 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma \chi; C_{2y,\sigma_2,IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNL; \]
\[ \Lambda; \Gamma \zeta; C_{4z,\sigma_9,IT}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_5 \}; 3; A_{29}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; TP; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_5 \}; 3; A_{29}, A_{10}, A_{13}; TP; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_5 \}; 3; -A_{19}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; TP; \]
\[ \{ R_4 \}, \{ R_5 \}; 3; -A_{19}, A_{10}, A_{13}; TP; \]
\[ V; \text{MA}; C_{4z,\sigma_9,IT}; \{ R_1 \}, \{ R_4 \}, \{ R_5 \}; 4; \Gamma_26, \Gamma_{0,3,0}; (\frac{3}{2} - \frac{i}{2}) (\Gamma_{0,1} + i\Gamma_{3,1}); DP; 0 \]
\[ \{ R_1 \}, \{ R_4 \}, \{ R_2 \}, \{ R_3 \}; 4; \Gamma_{0,3,3}, \Gamma_{0,3,0}, \Gamma_{0,1}; QDP; 0 \]
\[ \{ R_2 \}, \{ R_3 \}, \{ R_5 \}; 4; \Gamma_{26}, -\Gamma_{3,3,3}, (\frac{3}{2} - \frac{i}{2}) (\Gamma_{0,1} + i\Gamma_{3,1}); DP; 0 \]
\[ \Sigma; \Gamma \mu; C_{2z,\sigma_2,IT}; \{ R_1 \}, \{ R_4 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNL; \]
\[ T; \text{RA}; C_{2z,\sigma_9,IT}; \{ R_2 \}, \{ R_8 \}, \{ R_4 \}, \{ R_6 \}; 4; \Gamma_{3,3,3}, -i\Gamma_{0,3,0}, \Gamma_{0,1}; DP; 0 \]
\[ W; \text{XR}; C_{2z,\sigma_9,IT}; \{ R_1 \}, \{ R_4 \}, \{ R_2 \}, \{ R_3 \}; 4; \Gamma_{0,3,3}, \Gamma_{3,3,0}, \Gamma_{0,1}; DP; 0 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y, \sigma_x, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \] P-WNLs;
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNL;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;  

\[ \Lambda; \Gamma Z; C_{2y, \sigma_y, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;
\{R_2\}, \{R_5\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; 
\{R_3\}, \{R_5\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;  

\[ V; MA; C_{4s, \sigma_y, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_5\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;
\{R_2\}, \{R_5\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; 
\{R_3\}, \{R_5\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;  

\[ \Sigma; GM; C_{2s, \sigma_x, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL;
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL;
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;
\[ Y; \text{XM}; C_{2z, \sigma z}, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]

\[ T; \text{RA}; C_{2z, \sigma z}, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]

\[ W; \text{XR}; C_{2z, \sigma y}, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs}; \]
Accidental degeneracies on high symmetry line

$\Delta; \Gamma X; C_{2y, \sigma_x, IT}; \{R_1\}, \{R_2\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_3\}: 2; \sigma_3, \sigma_0, \sigma_0; P-WNL;$
$\{R_1\}, \{R_4\}: 2; \sigma_3, \sigma_3, \sigma_0; P-WNL;$
$\{R_2\}, \{R_3\}: 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL;$
$\{R_2\}, \{R_4\}: 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL;$
$\{R_1\}, \{R_4\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\Lambda; \Gamma Z; C_{4z, \sigma_y, IT}; \{R_1\}, \{R_2\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_3\}: 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_4\}: 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_5\}: 3; A_{29}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; TP;$
$\{R_2\}, \{R_3\}: 2; \sigma_1, -\sigma_3, \sigma_0; P-WNLs;$
$\{R_2\}, \{R_4\}: 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;$
$\{R_2\}, \{R_5\}: 3; A_{29}, A_{10}, A_{13}; TP;$
$\{R_3\}, \{R_4\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\{R_3\}, \{R_5\}: 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; TP;$
$\{R_4\}, \{R_5\}: 3; -A_{19}, A_{10}, A_{13}; TP;$
$V; MA; C_{4z, \sigma_y, IT}; \{R_1\}, \{R_2\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_3\}: 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_4\}: 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_5\}: 3; A_{29}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; TP;$
$\{R_2\}, \{R_3\}: 2; \sigma_1, -\sigma_3, \sigma_0; P-WNLs;$
$\{R_2\}, \{R_4\}: 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;$
$\{R_2\}, \{R_5\}: 3; A_{29}, A_{10}, A_{13}; TP;$
$\{R_3\}, \{R_4\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\{R_3\}, \{R_5\}: 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; TP;$
$\{R_4\}, \{R_5\}: 3; -A_{19}, A_{10}, A_{13}; TP;$
$\Sigma; GM; C_{2a, \sigma_z, IT}; \{R_1\}, \{R_2\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_3\}: 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_4\}: 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_5\}: 3; A_{29}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; TP;$
$\{R_2\}, \{R_3\}: 2; \sigma_1, -\sigma_3, \sigma_0; P-WNLs;$
$\{R_2\}, \{R_4\}: 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;$
$\{R_2\}, \{R_5\}: 3; A_{29}, A_{10}, A_{13}; TP;$
$\{R_3\}, \{R_4\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\{R_3\}, \{R_5\}: 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; TP;$
$\{R_4\}, \{R_5\}: 3; -A_{19}, A_{10}, A_{13}; TP;$
$S; ZA; C_{2a, \sigma_d, IT}; \{R_2\}, \{R_4\}: 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs;$
$\{R_2\}, \{R_6\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\{R_2\}, \{R_8\}: 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs;$
$\{R_4\}, \{R_6\}: 2; -\sigma_3, \sigma_3, \sigma_0; P-WNLs;$
$\{R_4\}, \{R_8\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\{R_6\}, \{R_8\}: 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;$
$Y; XM; C_{2x, \sigma_z, IT}; \{R_1\}, \{R_2\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_3\}: 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs;$
$\{R_1\}, \{R_4\}: 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs;$
$\{R_2\}, \{R_3\}: 2; \sigma_3, -\sigma_3, \sigma_0; P-WNLs;$
$\{R_2\}, \{R_4\}: 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;$
$\{R_3\}, \{R_4\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;$
$W; \ X \sigma_3, IT; \ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \ P\text{-WNLs}$;

$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \ P\text{-WNL}$;

$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \ P\text{-WNL}$;

$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \ P\text{-WNL}$;

$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \ P\text{-WNL}$;

$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \ P\text{-WNLs}$;
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y,\sigma_z, IT}; \]  
\[ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]

\[ U; ZR; C_{2y,\sigma_z, IT}; \]
\[ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]

\[ \Lambda; \Gamma Z; C_{4z^2,\sigma_y, IT}; \]
\[ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_5\}; 3; A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3} A_8), A_{13}; \text{TP;} \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNLs;} \]
\[ \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; \text{TP;} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_3\}, \{R_5\}; 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3} A_8), A_{13}; \text{TP;} \]
\[ \{R_4\}, \{R_5\}; 3; -A_{19}, A_{10}, A_{13}; \text{TP;} \]

\[ V; MA; C_{4z,\sigma_{ds}, IT}; \]
\[ \{R_5\}, \{R_6\}; 2; -i\sigma_3, \sigma_0, \sigma_0, \sigma_0; \text{P-WNLs;} \]
\[ \{R_5\}, \{R_7\}; 2; -i\sigma_3, \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_5\}, \{R_8\}; 2; -i\sigma_0, \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_5\}, \{R_9\}; 3; -A_{30}, A_{13}, \frac{1}{3} (A_0 + 2\sqrt{3} A_8), A_{13}; \text{TP;} \]
\[ \{R_6\}, \{R_7\}; 2; i\sigma_0, \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_6\}, \{R_8\}; 2; i\sigma_3, \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_6\}, \{R_9\}; 3; -A_{31}, A_{13}, \frac{1}{3} (A_0 + 2\sqrt{3} A_8), A_{13}; \text{TP;} \]
\[ \{R_7\}, \{R_8\}; 2; i\sigma_3, \sigma_0, -\sigma_0, \sigma_0; \text{P-WNLs;} \]
\[ \{R_7\}, \{R_9\}; 3; -A_{31}, A_{13}, A_{10}, A_{13}; \text{TP;} \]
\[ \{R_8\}, \{R_9\}; 3; -A_{30}, A_{13}, A_{10}, A_{13}; \text{TP;} \]

\[ \Sigma; \Gamma M; C_{2x,\sigma_z, IT}; \]
\[ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
Accidental degeneracies on high symmetry line

Δ; ΓX; $C_{2y,\sigma_x,IT}$; 
{R_1}, \{R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
{R_1}, \{R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
{R_1}, \{R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
{R_2}, \{R_3\}; 2; $\sigma_3, -\sigma_3,\sigma_0$; P-WNL;
{R_2}, \{R_4\}; 2; $\sigma_3, -\sigma_0,\sigma_0$; P-WNL;
{R_3}, \{R_4\}; 2; $-\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

Λ; ΓZ; $C_{4z^+},\sigma_y,IT$; 
{R_1}, \{R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
{R_1}, \{R_3\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\}, \{R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\}, \{R_3\}; 3; $A_{29}, \frac{1}{3} \left(A_0 + 2\sqrt{3}A_8\right), A_{13}$; TP;
\{R_2\}, \{R_3\}; 2; $\sigma_3, -\sigma_3,\sigma_0$; P-WNLs;
\{R_2\}, \{R_4\}; 2; $\sigma_3, -\sigma_0,\sigma_0$; P-WNLs;
\{R_2\}, \{R_3\}; 3; $A_{29}, A_{10}, A_{13}$; TP;
\{R_3\}, \{R_4\}; 2; $-\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_3\}, \{R_4\}; 3; $-A_{19}, \frac{1}{3} \left(A_0 + 2\sqrt{3}A_8\right), A_{13}$; TP;
\{R_4\}, \{R_3\}; 3; $-A_{19}, A_{10}, A_{13}$; TP;

V; MA; $C_{4z^+},C_{2z},\sigma_{da},IT$; 
\{R_5\}, \{R_6\}; 2; $-i\sigma_3,\sigma_0,\sigma_0$; P-WNLs;
\{R_5\}, \{R_7\}; 2; $-i\sigma_3,\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_5\}, \{R_8\}; 2; $-i\sigma_0,\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_5\}, \{R_9\}; 3; $-A_{30}, A_{13}, \frac{1}{3} \left(A_0 + 2\sqrt{3}A_8\right), A_{32}$; TP;
\{R_6\}, \{R_7\}; 2; $i\sigma_0,\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_6\}, \{R_8\}; 2; $i\sigma_3,\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_6\}, \{R_9\}; 3; $-A_{31}, A_{13}, A_{10}, A_{32}$; TP;
\{R_8\}, \{R_9\}; 3; $-A_{30}, A_{13}, A_{10}, A_{32}$; TP;

Σ; ΓM; $C_{2a},\sigma_z,IT$; 
\{R_1\}, \{R_2\}; 2; $\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_1\}, \{R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNL;
\{R_1\}, \{R_4\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNL;
\{R_2\}, \{R_3\}; 2; $\sigma_3, -\sigma_3,\sigma_0$; P-WNL;
\{R_2\}, \{R_4\}; 2; $\sigma_3, -\sigma_0,\sigma_0$; P-WNL;
\{R_3\}, \{R_4\}; 2; $-\sigma_0,\sigma_3,\sigma_0$; P-WNLs;

S; ZA; $C_{2a},\sigma_{db},IT$; 
\{R_2\}, \{R_3\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNLs;
\{R_2\}, \{R_4\}; 2; $\sigma_3,\sigma_0,\sigma_0$; P-WNLs;
\{R_2\}, \{R_5\}; 2; $\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_2\}, \{R_6\}; 2; $-\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_3\}, \{R_6\}; 2; $-\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_6\}, \{R_8\}; 2; $\sigma_3, -\sigma_0,\sigma_0$; P-WNLs;

T; RA; $\sigma_y,C_{2z},IT$; 
\{R_2\}, \{R_3\}; 2; $-i\sigma_3,\sigma_0,\sigma_0$; P-WNLs;
\{R_3\}, \{R_4\}; 2; $-i\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_3\}, \{R_5\}; 2; $-i\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_4\}, \{R_6\}; 2; $i\sigma_3,\sigma_3,\sigma_0$; P-WNLs;
\{R_6\}, \{R_5\}; 2; $i\sigma_0,\sigma_3,\sigma_0$; P-WNLs;
\{R_6\}, \{R_8\}; 2; $-i\sigma_3, -\sigma_0,\sigma_0$; P-WNLs;
**Accidental degeneracies on high symmetry line**

\[ \Delta; \Gamma X; C_{2y, \sigma_x, IT}; \]
\[ \{R_1\}, \{R_2\}; \quad 2; \; \sigma_0, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_1\}, \{R_3\}; \quad 2; \; \sigma_1, \sigma_0, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_1\}, \{R_4\}; \quad 2; \; \sigma_3, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_2\}, \{R_3\}; \quad 2; \; \sigma_3, -\sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_2\}, \{R_4\}; \quad 2; \; \sigma_3, -\sigma_0, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_3\}, \{R_4\}; \quad 2; \; -\sigma_0, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]

\[ U; \; ZR; \; C_{2y, \sigma_x, IT}; \]
\[ \{R_1\}, \{R_2\}; \quad 2; \; \sigma_0, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_1\}, \{R_3\}; \quad 2; \; \sigma_3, \sigma_0, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_1\}, \{R_4\}; \quad 2; \; \sigma_3, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_2\}, \{R_3\}; \quad 2; \; \sigma_3, -\sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_2\}, \{R_4\}; \quad 2; \; \sigma_3, -\sigma_0, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_3\}, \{R_4\}; \quad 2; \; -\sigma_0, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]

\[ \Lambda; \; \Gamma Z; \; C_{4z, \sigma_y, IT}; \]
\[ \{R_1\}, \{R_2\}; \quad 2; \; \sigma_0, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_1\}, \{R_3\}; \quad 2; \; \sigma_3, \sigma_0, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_1\}, \{R_4\}; \quad 2; \; \sigma_3, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_2\}, \{R_3\}; \quad 3; \; A_{29}, \frac{1}{2} (A_0 + 2\sqrt{3} A_8), A_{13}; \quad TP; \]
\[ \{R_2\}, \{R_4\}; \quad 2; \; \sigma_3, -\sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_2\}, \{R_4\}; \quad 2; \; \sigma_3, -\sigma_0, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_3\}, \{R_4\}; \quad 3; \; A_{29}, A_{10}, A_{13}; \quad TP; \]
\[ \{R_3\}, \{R_4\}; \quad 2; \; -\sigma_0, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_4\}, \{R_4\}; \quad 3; \; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3} A_8), A_{13}; \quad TP; \]

\[ V; \; MA; \; \sigma_x, C_{2x, \sigma_{dx}, IT}; \]
\[ \{R_5, R_6\}, \{R_{10}\}; \quad 4; \; \Gamma_{21}, \Gamma_{3,0}, \Gamma_{22}, \Gamma_{23}; \quad DP; \quad 0 \]
\[ \{R_5, R_6\}, \{R_7, R_8\}; \quad 4; \; -i\Gamma_{3,3,0,0}, \Gamma_{3,3,0,1}; \quad QDP; \quad 0 \]
\[ \{R_7, R_8\}, \{R_{10}\}; \quad 4; \; \Gamma_{24}, \Gamma_{3,0,0,25}, \Gamma_{23}; \quad DP; \quad 0 \]

\[ \Sigma; \; \Gamma M; \; C_{2x, \sigma_z, IT}; \]
\[ \{R_1\}, \{R_2\}; \quad 2; \; \sigma_0, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_1\}, \{R_3\}; \quad 2; \; \sigma_3, \sigma_0, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_1\}, \{R_4\}; \quad 2; \; \sigma_3, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_2\}, \{R_3\}; \quad 2; \; \sigma_3, -\sigma_3, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_2\}, \{R_4\}; \quad 2; \; \sigma_3, -\sigma_0, \sigma_0; \quad P\text{-WNLs}; \]
\[ \{R_3\}, \{R_4\}; \quad 2; \; -\sigma_0, \sigma_3, \sigma_0; \quad P\text{-WNLs}; \]

\[ Y; \; XM; \; C_{2x, \sigma_z, IT}; \]
\[ \{R_2, R_4\}, \{R_6, R_8\}; \quad 4; \; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \quad DP; \quad 0 \]

\[ T; \; RA; \; C_{2x, \sigma_z, IT}; \]
\[ \{R_2, R_4\}, \{R_6, R_8\}; \quad 4; \; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \quad DP; \quad 0 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y, \sigma_x, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]

\[ \Lambda; \Gamma Z; C_{4x}^{+}, \sigma_y, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_5\}; 3; A_{29}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; TP; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs; \]
\[ \{R_3\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; TP; \]
\[ \{R_4\}, \{R_5\}; 3; -A_{19}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; TP; \]

\[ V; \Gamma A; \sigma_z, C_{2z}, \sigma_{dz}, IT; \{R_5, R_6\}, \{R_{10}\}; 4; \Gamma_{21}, \Gamma_{3,0}, \Gamma_{22}, \Gamma_{23}; DP; 0 \]
\[ \{R_5, R_6\}, \{R_7, R_8\}; 4; -i\Gamma_{3,3}, \Gamma_{0,0}, \Gamma_{3,0}, \Gamma_{0,1}; QDP; 0 \]
\[ \{R_7, R_8\}, \{R_{10}\}; 4; \Gamma_{24}, \Gamma_{3,0}, \Gamma_{25}, \Gamma_{23}; DP; 0 \]

\[ \Sigma; \Gamma M; C_{2z}, \sigma_z, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNL; \]

\[ S; \Gamma A; C_{2z}, \sigma_{dz}, IT; \{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_6\}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_2\}, \{R_8\}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_4\}, \{R_6\}; 2; -\sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_4\}, \{R_8\}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_8\}, \{R_6\}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]

\[ Y; \Gamma M; C_{2x}, \sigma_x, IT; \{R_2, R_4\}, \{R_6, R_8\}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; DP; 0 \]
Accidental degeneracies on high symmetry line

$\Delta; \Gamma X; C_{2y,\sigma_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}$

$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}$

$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}$

$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}$

$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}$

$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}$

$U; \text{ZR; } C_{2y,\sigma_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}$

$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}$

$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}$

$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}$

$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}$

$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}$

$\Lambda; \text{NZ; } C_{4z}^{+},\sigma_9,IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}$

$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNLs}$

$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNLs}$

$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNLs}$

$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNLs}$

$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}$

$\{R_3\}, \{R_5\}; 3; A_{2}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}$

$\{R_2\}, \{R_5\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNLs}$

$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNLs}$

$\{R_3\}, \{R_4\}; 3; A_{2}, A_{10}, A_{13}; \text{TP}$

$\{R_3\}, \{R_5\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}$

$\{R_4\}, \{R_5\}; 3; -A_{19}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}$

$V; \text{MA; } C_{4z}^{+},\sigma_9,IT; \{R_1, R_4\}, \{R_5\}; 4; \Gamma_{26}, \Gamma_{0.3}, (\frac{1}{2} - \frac{1}{2}) (\Gamma_{0.1} + i\Gamma_{3.1}); \text{DP}; 0$

$\{R_1, R_4\}, \{R_2, R_3\}; 4; \Gamma_{0.3}, \Gamma_{3.3}, \Gamma_{0.1}; \text{QDP}; 0$

$\{R_2, R_3\}, \{R_5\}; 4; \Gamma_{26}, -\Gamma_{3.3}, (\frac{1}{2} - \frac{1}{2}) (\Gamma_{0.1} + i\Gamma_{3.1}); \text{DP}; 0$

$\Sigma; \text{GM; } C_{2a},\sigma_z,IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}$

$\{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}$

$\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}$

$\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}$

$\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}$

$\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}$

$W; \text{XR; } C_{2y,\sigma_9,IT}; \{R_1, R_4\}, \{R_2, R_3\}; 4; \Gamma_{0.3}, \Gamma_{3.3}, \Gamma_{0.1}; \text{DP}; 0$
Accidental degeneracies on high symmetry line

\( \Delta; \Gamma X; C_{2y,\sigma_z,IT}; \{ R_1 \}, \{ R_2 \} : 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{ R_1 \}, \{ R_3 \} : 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL;
\( \{ R_1 \}, \{ R_4 \} : 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL;
\( \{ R_2 \}, \{ R_3 \} : 2; \sigma_3, -\sigma_3, \sigma_0; \) P-WNL;
\( \{ R_2 \}, \{ R_4 \} : 2; \sigma_3, -\sigma_0, \sigma_0; \) P-WNL;
\( \{ R_3 \}, \{ R_4 \} : 2; -\sigma_0, \sigma_3, \sigma_0; \) P-WNLs;

\( \Lambda; \Gamma Z; C_{4z^,\sigma_y,IT}; \{ R_1 \}, \{ R_2 \} : 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{ R_1 \}, \{ R_3 \} : 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNLs;
\( \{ R_1 \}, \{ R_4 \} : 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNLs;
\( \{ R_1 \}, \{ R_5 \} : 3; A_{29}, \frac{i}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \) TP;
\( \{ R_2 \}, \{ R_3 \} : 2; \sigma_3, -\sigma_3, \sigma_0; \) P-WNLs;
\( \{ R_2 \}, \{ R_4 \} : 2; \sigma_3, -\sigma_0, \sigma_0; \) P-WNLs;
\( \{ R_2 \}, \{ R_5 \} : 3; A_{29}, A_{10}, A_{13}; \) TP;
\( \{ R_3 \}, \{ R_4 \} : 2; -\sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{ R_3 \}, \{ R_5 \} : 3; -A_{19}, \frac{i}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \) TP;
\( \{ R_4 \}, \{ R_5 \} : 3; -A_{19}, A_{10}, A_{13}; \) TP;

\( V; \Lambda A; C_{4z^,\sigma_y,IT}; \{ R_1 \}, \{ R_2 \}, \{ R_3 \} : 4; \Gamma_{26}, \Gamma_{0,3}, \left( \frac{1}{2} - \frac{i}{2} \right) (\Gamma_{0,1} + i\Gamma_{3,1}); \) DP; 0
\( \{ R_1 \}, \{ R_4 \}, \{ R_2, R_3 \} : 4; \Gamma_{0,3}, \Gamma_{3,3}, \Gamma_{0,1}; \) QDP; 0
\( \{ R_2 \}, \{ R_4 \}, \{ R_3 \} : 4; \Gamma_{26}, -\Gamma_{3,3}, \left( \frac{1}{2} - \frac{i}{2} \right) (\Gamma_{0,1} + i\Gamma_{3,1}); \) DP; 0

\( \Sigma; \Gamma M; C_{2a,\sigma_z,IT}; \{ R_1 \}, \{ R_2 \} : 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{ R_1 \}, \{ R_3 \} : 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL;
\( \{ R_1 \}, \{ R_4 \} : 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL;
\( \{ R_2 \}, \{ R_3 \} : 2; \sigma_3, -\sigma_3, \sigma_0; \) P-WNL;
\( \{ R_2 \}, \{ R_4 \} : 2; \sigma_3, -\sigma_0, \sigma_0; \) P-WNL;
\( \{ R_3 \}, \{ R_4 \} : 2; -\sigma_0, \sigma_3, \sigma_0; \) P-WNLs;

\( S; \Lambda A; C_{2a,\sigma_y,IT}; \{ R_2 \}, \{ R_3 \} : 2; \sigma_3, \sigma_0, \sigma_0; \) P-WNL;
\( \{ R_2 \}, \{ R_4 \} : 2; \sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{ R_2 \}, \{ R_5 \} : 2; \sigma_3, \sigma_3, \sigma_0; \) P-WNL;
\( \{ R_4 \}, \{ R_5 \} : 2; -\sigma_3, \sigma_3, \sigma_0; \) P-WNL;
\( \{ R_4 \}, \{ R_6 \} : 2; -\sigma_0, \sigma_3, \sigma_0; \) P-WNLs;
\( \{ R_5 \}, \{ R_6 \} : 2; \sigma_3, -\sigma_0, \sigma_0; \) P-WNL;

\( T; \Lambda A; C_{2x,\sigma_y,IT}; \{ R_2 \}, \{ R_4 \}, \{ R_6 \} : 4; \Gamma_{3,3}, -i\Gamma_{0,3}, \Gamma_{0,1}; \) DP; 0
\( W; \Lambda A; C_{2x,\sigma_y,IT}; \{ R_1 \}, \{ R_3 \}, \{ R_2, R_3 \} : 4; \Gamma_{0,3}, \Gamma_{3,3}, \Gamma_{0,1}; \) DP; 0
Accidental degeneracies on high symmetry line

Λ; ΓΛ/ΓΣ; $C_{4z,σ_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0$; P-WNLs;

{R_1}, {R_3}; 2; $\sigma_3, \sigma_0, \sigma_0$; P-WNLs;

{R_2}, {R_4}; 2; $\sigma_3, \sigma_3, \sigma_0$; P-WNLs;

{R_5}, {R_6}; 3; $A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13};$ TP;

{R_2}, {R_3}; 2; $\sigma_3, -\sigma_3, \sigma_0$; P-WNLs;

{R_2}, {R_4}; 2; $\sigma_3, -\sigma_0, \sigma_0$; P-WNLs;

{R_2}, {R_5}; 3; $A_{29}, A_{10}, A_{13};$ TP;

{R_3}, {R_4}; 2; $-\sigma_0, \sigma_3, \sigma_0$; P-WNLs;

{R_3}, {R_5}; 3; $-A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13};$ TP;

{R_4}, {R_5}; 3; $-A_{19}, A_{10}, A_{13};$ TP;

V; ZV; $C_{4x,σ_y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0$; P-WNLs;

{R_1}, {R_3}; 2; $\sigma_3, \sigma_0, \sigma_0$; P-WNLs;

{R_1}, {R_4}; 2; $\sigma_3, \sigma_3, \sigma_0$; P-WNLs;

{R_5}, {R_6}; 3; $A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13};$ TP;

{R_2}, {R_3}; 2; $\sigma_3, -\sigma_3, \sigma_0$; P-WNLs;

{R_2}, {R_4}; 2; $\sigma_3, -\sigma_0, \sigma_0$; P-WNLs;

{R_2}, {R_5}; 3; $A_{29}, A_{10}, A_{13};$ TP;

{R_3}, {R_4}; 2; $-\sigma_0, \sigma_3, \sigma_0$; P-WNLs;

{R_3}, {R_5}; 3; $-A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13};$ TP;

{R_4}, {R_5}; 3; $-A_{19}, A_{10}, A_{13};$ TP;

W; XP; $C_{2z,σ_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0$; P-WNLs;

{R_1}, {R_3}; 2; $\sigma_3, \sigma_0, \sigma_0$; P-WNL;

{R_1}, {R_4}; 2; $\sigma_3, \sigma_3, \sigma_0$; P-WNL;

{R_2}, {R_3}; 2; $\sigma_3, -\sigma_3, \sigma_0$; P-WNL;

{R_2}, {R_4}; 2; $\sigma_3, -\sigma_0, \sigma_0$; P-WNL;

{R_3}, {R_4}; 2; $-\sigma_0, \sigma_3, \sigma_0$; P-WNLs;

Σ; ΓΣ/ΓZ; $C_{2z,σ_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0$; P-WNLs;

{R_1}, {R_3}; 2; $\sigma_3, \sigma_0, \sigma_0$; P-WNL;

{R_1}, {R_4}; 2; $\sigma_3, \sigma_3, \sigma_0$; P-WNL;

{R_2}, {R_3}; 2; $\sigma_3, -\sigma_3, \sigma_0$; P-WNL;

{R_2}, {R_4}; 2; $\sigma_3, -\sigma_0, \sigma_0$; P-WNL;

{R_3}, {R_4}; 2; $-\sigma_0, \sigma_3, \sigma_0$; P-WNLs;

F; ZF; $C_{2z,σ_z,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0$; P-WNLs;

{R_1}, {R_3}; 2; $\sigma_3, \sigma_0, \sigma_0$; P-WNL;

{R_1}, {R_4}; 2; $\sigma_3, \sigma_3, \sigma_0$; P-WNL;

{R_2}, {R_3}; 2; $\sigma_3, -\sigma_3, \sigma_0$; P-WNL;

{R_2}, {R_4}; 2; $\sigma_3, -\sigma_0, \sigma_0$; P-WNL;

{R_3}, {R_4}; 2; $-\sigma_0, \sigma_3, \sigma_0$; P-WNLs;

Q; NP; $C_{2y,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0$; C-1 WP; 1
\[ \Delta; \Gamma X; C_{2a, \sigma_z, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ U; ZU; \quad C_{2a, \sigma_z, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ Y; XZ/XY; \quad C_{2b, \sigma_d, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma \Lambda/\Gamma Z; C_{4x}^+; \sigma, \sigma, \sigma; \{R_3\}, \{R_2\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_4\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_4\}, \{R_1\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_5\}; 3; A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \)

\( \{R_2\}, \{R_3\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_2\}, \{R_4\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; \text{TP}; \)

\( \{R_3\}, \{R_4\}; 2; -\sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_4\}, \{R_5\}; 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \)

\( V; \Gamma Z; C_{4x}^+; \sigma, \sigma, \sigma; \{R_3\}, \{R_2\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_4\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_4\}, \{R_1\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_5\}; 3; A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \)

\( \{R_2\}, \{R_3\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_2\}, \{R_4\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; \text{TP}; \)

\( \{R_3\}, \{R_4\}; 2; -\sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_5\}; 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \)

\( W; \Gamma Z; C_{2x}; \sigma, \sigma, \sigma; \{R_3\}, \{R_2\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_4\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_4\}, \{R_1\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_5\}; 3; A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \)

\( \{R_2\}, \{R_3\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_2\}, \{R_4\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; \text{TP}; \)

\( \{R_3\}, \{R_4\}; 2; -\sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_5\}; 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \)

\( \Sigma; \Gamma Z/\Gamma \Sigma; C_{2x}; \sigma, \sigma, \sigma; \{R_3\}, \{R_2\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_4\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_4\}, \{R_1\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_5\}; 3; A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \)

\( \{R_2\}, \{R_3\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_2\}, \{R_4\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; \text{TP}; \)

\( \{R_3\}, \{R_4\}; 2; -\sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_5\}; 3; -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \)

\( F; \Gamma Z; C_{2x}; \sigma, \sigma, \sigma; \{R_3\}, \{R_2\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_4\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_4\}, \{R_1\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_5\}; 3; A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \)

\( \{R_2\}, \{R_3\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_2\}, \{R_4\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; \text{TP}; \)

\( \{R_3\}, \{R_4\}; 2; -\sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_5\}; 3; -A_{19}, -\frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \text{TP}; \)

\( \Delta; \Gamma X; C_{2x}; \sigma, \sigma, \sigma; \{R_3\}, \{R_2\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_3\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_3\}, \{R_4\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_4\}, \{R_1\}; 2; \sigma, \sigma, \sigma; \text{P-WNLs}; \)

\( \{R_4\}, \{R_3\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)

\( \{R_4\}, \{R_4\}; 2; \sigma, -\sigma, \sigma; \text{P-WNLs}; \)
$U; ZU; C_{2a, \sigma_z, IT}; \{R_1\}, \{R_2\}; 2; -\sigma_0, -\sigma_0, \sigma_0; \text{P-WNLs};$
\{R_1\}, \{R_3\}; 2; -\sigma_3, -\sigma_0, \sigma_0; \text{P-WNL};
\{R_1\}, \{R_4\}; 2; -\sigma_3, -\sigma_3, \sigma_0; \text{P-WNL};
\{R_2\}, \{R_3\}; 2; -\sigma_3, \sigma_0, \sigma_0; \text{P-WNL};
\{R_2\}, \{R_4\}; 2; -\sigma_3, \sigma_0, \sigma_0; \text{P-WNL};
\{R_3\}, \{R_4\}; 2; \sigma_0, -\sigma_3, \sigma_0; \text{P-WNLs};

$Y; XZ/XY; C_{2b, \sigma_{da}, IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_0, \sigma_0; \text{P-WNLs};$
\{R_1\}, \{R_3\}; 2; \sigma_0, \sigma_0, \sigma_0; \text{P-WNL};
\{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};
\{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL};
\{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL};
\{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma\Lambda/\Gamma Z; C_{4z}^{+}\sigma_{y,IT}; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_3\}, \{R_4\}; \quad 2; \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_5\}, \{R_6\}; \quad 2; \sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_1\}, \{R_7\}; \quad 3; \ A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \quad \text{TP}; \]
\[ \{R_2\}, \{R_3\}; \quad 2; \sigma_3, -\sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_4\}, \{R_5\}; \quad 2; \sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_2\}, \{R_6\}; \quad 3; \ A_{29}, A_{10}, A_{13}; \quad \text{TP}; \]
\[ \{R_3\}, \{R_7\}; \quad 3; \ -\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_3\}, \{R_8\}; \quad 3; \ -A_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; \quad \text{TP}; \]
\[ \{R_4\}, \{R_9\}; \quad 3; \ -A_{19}, A_{10}, A_{13}; \quad \text{TP}; \]

\[ V; ZV; \quad C_{4z}^{+}\sigma_{y, E, IT}; \quad \{R_6\}, \{R_7\}; \quad 3; \ -iA_{29}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_0, A_{13}; \quad \text{TP}; \]
\[ \{R_6\}, \{R_8\}; \quad 2; \ -i\sigma_0, \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_7\}, \{R_9\}; \quad 2; \ -i\sigma_3, \sigma_0, \sigma_0, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_8\}, \{R_{10}\}; \quad 3; \ -iA_{29}, A_{10}, A_0, A_{13}; \quad \text{TP}; \]
\[ \{R_9\}, \{R_{10}\}; \quad 2; \ -i\sigma_3, -\sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_9\}, \{R_{10}\}; \quad 3; \ iA_{19}, A_{10}, A_0, A_{13}; \quad \text{TP}; \]

\[ \Sigma; \Gamma Z/\Gamma \Sigma; \quad C_{2x}\sigma_{z, IT}; \quad \{R_1\}, \{R_2\}; \quad 2; \ \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_3\}, \{R_4\}; \quad 2; \ \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_5\}, \{R_6\}; \quad 2; \ \sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_1\}, \{R_7\}; \quad 2; \ \sigma_3, -\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\}, \{R_8\}; \quad 2; \ \sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; \quad 2; \ -\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_7\}, \{R_{10}\}; \quad 3; \ iA_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_0, A_{13}; \quad \text{TP}; \]
\[ \{R_9\}, \{R_{10}\}; \quad 2; \ i\sigma_0, \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_9\}, \{R_{10}\}; \quad 3; \ iA_{19}, A_{10}, A_0, A_{13}; \quad \text{TP}; \]

\[ F; ZF; \quad C_{2z}\sigma_{z, IT}; \quad \{R_1\}, \{R_2\}; \quad 2; \ -\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_3\}, \{R_4\}; \quad 2; \ -\sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_1\}, \{R_7\}; \quad 2; \ -\sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\}, \{R_8\}; \quad 2; \ -\sigma_3, -\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\}, \{R_{10}\}; \quad 2; \ -\sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_3\}, \{R_{10}\}; \quad 2; \ \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]

\[ Q; NP; \quad C_{2y, IT}; \quad \{R_2\}, \{R_4\}; \quad 2; \ \sigma_3, \sigma_0; \quad \text{C-1 WP}; \quad 1 \]

\[ \Delta; \Gamma X; \quad C_{2a, \sigma_{z, IT}}; \quad \{R_1\}, \{R_2\}; \quad 2; \ \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; \quad 2; \ \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; \quad 2; \ \sigma_3, -\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; \quad 2; \ \sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; \quad 2; \ -\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma\Lambda/\Gamma Z; C_{4v}^+, \sigma_y, IT; \]
\{R_1\}, \{R_2\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}: 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs;
\{R_1\}, \{R_4\}: 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_5\}: 3; A_{29}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{13}; TP;
\{R_2\}, \{R_3\}: 2; \sigma_3, -\sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}: 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}: 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;
\{R_2\}, \{R_5\}: 3; A_{29}, A_{10}, A_{13}; TP;
\{R_3\}, \{R_5\}: 3; -A_{19}, A_{10}, A_{13}; TP;

\[ V; \Sigma V; C_{4v}^+, \sigma_z, E, IT; \]
\{R_6\}, \{R_7\}: 2; i\sigma_0, \sigma_3, \sigma_0, \sigma_0; P-WNLs;
\{R_6\}, \{R_8\}: 2; i\sigma_3, \sigma_0, \sigma_0, \sigma_0; P-WNLs;
\{R_6\}, \{R_9\}: 2; i\sigma_3, \sigma_3, \sigma_0, \sigma_0; P-WNLs;
\{R_7\}, \{R_{10}\}: 3; iA_{29}, A_{10}, A_{0}, A_{13}; TP;
\{R_7\}, \{R_8\}: 2; i\sigma_3, -\sigma_3, \sigma_0, \sigma_0; P-WNLs;
\{R_7\}, \{R_9\}: 2; i\sigma_3, -\sigma_0, \sigma_0, \sigma_0; P-WNLs;
\{R_8\}, \{R_{10}\}: 3; -iA_{19}, \frac{1}{3} (A_0 + 2\sqrt{3}A_8), A_{0}, A_{13}; TP;
\{R_9\}, \{R_{10}\}: 3; -iA_{19}, A_{10}, A_{0}, A_{13}; TP;

\[ \Sigma; \Gamma Z/\Gamma \Sigma; C_{2v}, \sigma_z, IT; \]
\{R_1\}, \{R_2\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_4\}: 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_3\}: 2; \sigma_3, -\sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}: 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;

\[ F; \Sigma F; C_{2v}, \sigma_z, IT; \]
\{R_1\}, \{R_2\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_4\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_3\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}: 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs;

\[ \Delta; \Gamma X; C_{2v}, \sigma_z, IT; \]
\{R_1\}, \{R_2\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_3\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_1\}, \{R_4\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_3\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_2\}, \{R_4\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
\{R_3\}, \{R_4\}: 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs;
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_+^3 \}: \{R_i\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right); \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

\[ P; \text{KH}; C_+^3 \}: \{R_i\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right); \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_+^3 \}: \{R_i\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right); \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_+^3 \}: \{R_i\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right); \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_+^3 \}: \{R_i\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right); \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_+^3 \}: \{R_i\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right); \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma \Lambda / \Gamma Z; C_+^3 \}: \{R_i\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right); \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ P; \text{ZP}; C_+^3 \}: \{R_i\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right); \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_4^+JT; \{R_1\}, \{R_2, R_3\}; 3; A_{33}, A_{17}; TP; \]

\[ P; KH; C_4^+, JT; \{R_1\}, \{R_2, R_3\}; 3; A_{33}, A_{17}; TP; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma A; C_4^+, JT; \{R_1\}, \{R_2, R_3\}; 3; A_{33}, A_{17}; TP; \]

\[ P; ZP; C_4^+, JT; \{R_1\}, \{R_2, R_3\}; 3; A_{33}, A_{17}; TP; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_2, \mathcal{T}; \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( (1 + \sqrt{3}) \sigma_3 - (\sqrt{3} - 1) \sigma_0 \right), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3} \sigma_3 \right), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ P; KH; C_2, \mathcal{T}; \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( (1 + \sqrt{3}) \sigma_3 - (\sqrt{3} - 1) \sigma_0 \right), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3} \sigma_3 \right), \sigma_0; \quad \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ \Sigma; \Gamma M; C_{21}^\prime; \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{C-1 WP; 1} \]

\[ R; AL; C_{21}^\prime; \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_3^+, \mathcal{C}_{22} T; \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( (1 + \sqrt{3}) \sigma_3 - (\sqrt{3} - 1) \sigma_0 \right), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3} \sigma_3 \right), \sigma_0; \quad \text{C-1 WP; 1} \]

\[ P; KH; C_3^+, \mathcal{C}_{22} T; \{R_1\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( (1 + \sqrt{3}) \sigma_3 - (\sqrt{3} - 1) \sigma_0 \right); \quad \text{C-1 WP; 1} \]

\[ \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3} \sigma_3 \right); \quad \text{C-1 WP; 1} \]

\[ T; \Gamma K; C_{22}^\prime; \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{C-1 WP; 1} \]

\[ S; AH; C_{22}^\prime; \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{C-1 WP; 1} \]

\[ T; MK; C_{21}^\prime; \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{C-1 WP; 1} \]

\[ S; LH; C_{21}^\prime; \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{C-1 WP; 1} \]
17. SG 151-160

SG 151

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_3^+; C_{22}^T; \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0 \right), \sigma_0; \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \]
\[ \text{C-1 WP; 1} \]

\[ P; K H; C_3^+; C_{22}^T; \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0 \right), \sigma_0; \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \]
\[ \text{C-1 WP; 1} \]

\[ \Sigma; \Gamma M; C_3''; \{R_1\}, \{R_2\}; 2; \sigma_3; \]
\[ \{R_3\}, \{R_3\}; 2; \sigma_3; \]
\[ \text{C-1 WP; 1} \]

SG 152

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_3^+; C_{22}^T; \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0 \right), \sigma_0; \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \]
\[ \text{C-1 WP; 1} \]

\[ P; K H; C_3^+; \]
\[ \{R_1\}, \{R_2\}; 2; -\sigma_{10}; \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0 \right); \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \]
\[ \text{C-1 WP; 1} \]

\[ T; \Gamma K; C_3''; \]
\[ \{R_1\}, \{R_2\}; 2; \sigma_3; \]
\[ \{R_3\}, \{R_3\}; 2; \sigma_3; \]
\[ \text{C-1 WP; 1} \]

\[ S; \Gamma H; C_{22}''; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3; \]
\[ \text{C-1 WP; 1} \]

\[ T''; \Gamma K; C_{22}''; \]
\[ \{R_1\}, \{R_2\}; 2; \sigma_3; \]
\[ \text{C-1 WP; 1} \]

\[ S''; \Gamma H; C_{22}''; \]
\[ \{R_3\}, \{R_3\}; 2; \sigma_3; \]
\[ \text{C-1 WP; 1} \]

SG 153

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_3^+; C_{22}^T; \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0 \right), \sigma_0; \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \]
\[ \text{C-1 WP; 1} \]

\[ P; K H; C_3^+; C_{22}^T; \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0 \right), \sigma_0; \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \]
\[ \text{C-1 WP; 1} \]

\[ \Sigma; \Gamma M; C_3''; \]
\[ \{R_1\}, \{R_2\}; 2; \sigma_3; \]
\[ \text{C-1 WP; 1} \]

\[ R; \Gamma L; C_3''; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3; \]
\[ \text{C-1 WP; 1} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \ \Gamma A; \ \Sigma 3, \Sigma'\prime \ \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \ C-1 \ WP; 1 \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0), \sigma_0; \ C-1 \ WP; 1 \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3} \sigma_3), \sigma_0; \ C-1 \ WP; 1 \]

\[ P; \ \Gamma H; \ \Sigma 3, \Sigma'\prime \ \{R_1\}, \{R_2\}; 2; -\sigma_{10}; \ C-1 \ WP; 1 \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0); \ C-1 \ WP; 1 \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3} \sigma_3); \ C-1 \ WP; 1 \]

\[ T; \ \Gamma K; \ \Sigma 22, \Sigma'' \ \{R_1\}, \{R_2\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
\[ S; \ \Gamma H; \ \Sigma 22, \Sigma'' \ \{R_3\}, \{R_6\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
\[ T'; \ \Gamma K; \ \Sigma 22, \Sigma'' \ \{R_3\}, \{R_6\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
\[ S'; \ \Gamma H; \ \Sigma 22, \Sigma'' \ \{R_2\}, \{R_5\}; 2; \sigma_3; \ C-1 \ WP; 1 \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \ \Gamma \Lambda/\Gamma Z; \ \Sigma 3, \Sigma'\prime T; \ \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \ C-1 \ WP; 1 \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0), \sigma_0; \ C-1 \ WP; 1 \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3} \sigma_3), \sigma_0; \ C-1 \ WP; 1 \]

\[ P; \ \Sigma P; \ \Sigma 3, \Sigma'\prime T; \ \{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \ C-1 \ WP; 1 \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0), \sigma_0; \ C-1 \ WP; 1 \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3} \sigma_3), \sigma_0; \ C-1 \ WP; 1 \]

\[ B; \ \Sigma B; \ \Sigma 21, \Sigma'' \ \{R_1\}, \{R_2\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
\[ \Sigma; \ \Gamma \Sigma/\Gamma \Sigma; \ \Sigma 21, \Sigma'' \ \{R_1\}, \{R_2\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
\[ Q; \ \Sigma Q; \ \Sigma 23, \Sigma'' \ \{R_1\}, \{R_2\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
\[ Y; \ \Sigma L/\Sigma Y; \ \Sigma 22, \Sigma'' \ \{R_1\}, \{R_2\}; 2; \sigma_3; \ C-1 \ WP; 1 \]

Accidental degeneracies on high symmetry line

\[ \Delta; \ \Gamma A; \ \Sigma 3, \Sigma'\prime; \ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \ C-1 \ WP; 1 \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{1}{2} (A_0 + 2\sqrt{3} A_8); \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}; \]
\[ U; \ \Sigma L; \ \sigma 31; \ \{R_1\}, \{R_2\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
\[ P; \ \Sigma P; \ \Sigma 3, \Sigma'\prime; \ \{R_1\}, \{R_2\}; 2; -\sigma_{10}; \ C-1 \ WP; 1 \]
\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0); \ C-1 \ WP; 1 \]
\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3} \sigma_3); \ C-1 \ WP; 1 \]
\[ \Sigma; \ \Sigma M; \ \sigma 31; \ \{R_1\}, \{R_2\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
\[ R; \ \Sigma R; \ \sigma 31; \ \{R_1\}, \{R_2\}; 2; \sigma_3; \ C-1 \ WP; 1 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_S, \sigma_{d1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{A_0 + 2 \sqrt{3} A_8}{3}; \quad \text{TP;} \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}; \quad \text{TP;} \]
\[ U; \text{ML}; \sigma_{d1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; \quad \text{P-WNL;} \]
\[ P; \text{KH}; C^+_S, \sigma_{d1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{A_0 + 2 \sqrt{3} A_8}{3}; \quad \text{TP;} \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}; \quad \text{TP;} \]
\[ T; \text{GH}; \sigma_{d2}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; \quad \text{P-WNL;} \]
\[ S; \text{AH}; \sigma_{d2}; \{ R_1 \}, \{ R_2 \}; 2; -i\sigma_3; \quad \text{P-WNL;} \]
\[ T'; \text{MK}; \sigma_{d1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; \quad \text{P-WNL;} \]
\[ S'; \text{LH}; \sigma_{d1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; \quad \text{P-WNL;} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_S, \sigma_{x1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{1}{2} (A_0 + 2 \sqrt{3} A_8); \quad \text{TP;} \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}; \quad \text{TP;} \]
\[ U; \text{ML}; \sigma_{x1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; \quad \text{P-WNL;} \]
\[ P; \text{KH}; C^+_S; \{ R_1 \}, \{ R_2 \}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \frac{1}{2} ((1 + \sqrt{3} \text{I}) \sigma_3 - (\sqrt{3} - 1) \sigma_0); \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3} \sigma_3); \quad \text{C-1 WP; 1} \]
\[ \Sigma; \text{GM}; \sigma_{x1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; \quad \text{P-WNL;} \]
\[ R; \text{AL}; \sigma_{x1}; \{ R_1 \}, \{ R_2 \}; 2; -i\sigma_3; \quad \text{P-WNL;} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_S, \sigma_{d1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{1}{2} (A_0 + 2 \sqrt{3} A_8); \quad \text{TP;} \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}; \quad \text{TP;} \]
\[ U; \text{ML}; \sigma_{d1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; \quad \text{P-WNL;} \]
\[ P; \text{KH}; C^+_S, \sigma_{d1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs;} \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{1}{2} (A_0 + 2 \sqrt{3} A_8); \quad \text{TP;} \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}; \quad \text{TP;} \]
\[ T; \text{GH}; \sigma_{d2}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; \quad \text{P-WNL;} \]
\[ S; \text{AH}; \sigma_{d2}; \{ R_1 \}, \{ R_2 \}; 2; -i\sigma_3; \quad \text{P-WNL;} \]
\[ T'; \text{MK}; \sigma_{d1}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3; \quad \text{P-WNL;} \]
\[ S'; \text{LH}; \sigma_{d1}; \{ R_1 \}, \{ R_2 \}; 2; -i\sigma_3; \quad \text{P-WNL;} \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma \Lambda/\Gamma Z; C_3^+; \sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \]  

P-WNLs;  
\{R_1\}, \{R_3\}; 3; A_{36}, \frac{4\sigma_0 + 2\sqrt{3}A_8}{3}; TP;  
\{R_2\}, \{R_3\}; 3; A_{36}, A_{10}; TP;  

\[ P; ZP; C_3^+; \sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \]  

P-WNLs;  
\{R_1\}, \{R_3\}; 3; A_{36}, \frac{4\sigma_0 + 2\sqrt{3}A_8}{3}; TP;  
\{R_2\}, \{R_3\}; 3; A_{36}, A_{10}; TP.
Accidental degeneracies on high symmetry line

$\Delta; \Gamma \Lambda / \Gamma Z; C_{3}^{+}, \sigma_{d1}; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3};$ P-WNLs;
\{R_{1}\}, \{R_{3}\}; 3; \Lambda_{36}, \frac{\Lambda_{0}^{2} + 2\sqrt{3} \Lambda_{8}}{3}; TP;
\{R_{2}\}, \{R_{3}\}; 3; \Lambda_{36}, A_{10}; TP;

$P; ZP; C_{3}^{+}, \sigma_{d1}; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, -i \sigma_{3};$ P-WNLs;
\{R_{1}\}, \{R_{3}\}; 3; \Lambda_{36}, -i \frac{\Lambda_{0}^{2} + 2\sqrt{3} \Lambda_{8}}{3}; TP;
\{R_{2}\}, \{R_{3}\}; 3; \Lambda_{36}, -i A_{10}; TP;

Accidental degeneracies on high symmetry line

$\Delta; \Gamma \Lambda / \Gamma Z; C_{3}^{+}, \sigma_{d1}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0};$ P-WNLs;
\{R_{1}\}, \{R_{3}\}; 3; \Lambda_{36}, \frac{\Lambda_{0}^{2} + 2\sqrt{3} \Lambda_{8}}{3}, A_{13}; TP;
\{R_{2}\}, \{R_{3}\}; 3; \Lambda_{36}, A_{10}, A_{13}; TP;

$U; ML; \sigma_{d1}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

$P; KH; C_{3}^{+}, \sigma_{d1}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0};$ P-WNLs;
\{R_{1}\}, \{R_{3}\}; 3; \Lambda_{36}, \frac{\Lambda_{0}^{2} + 2\sqrt{3} \Lambda_{8}}{3}, A_{13}; TP;
\{R_{2}\}, \{R_{3}\}; 3; \Lambda_{36}, A_{10}, A_{13}; TP;

$T; \Gamma K; \sigma_{d2}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

$S; AH; \sigma_{d2}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

$T^{'}; MK; \sigma_{d1}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

$S^{'}; LH; \sigma_{d1}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

$\Sigma; \Gamma M; C_{21}^{+}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

Accidental degeneracies on high symmetry line

$\Delta; \Gamma \Lambda / \Gamma Z; C_{3}^{+}, \sigma_{d1}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0};$ P-WNLs;
\{R_{1}\}, \{R_{3}\}; 3; \Lambda_{36}, \frac{\Lambda_{0}^{2} + 2\sqrt{3} \Lambda_{8}}{3}, A_{13}; TP;
\{R_{2}\}, \{R_{3}\}; 3; \Lambda_{36}, A_{10}, A_{13}; TP;

$U; ML; \sigma_{d1}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

$P; KH; C_{3}^{+}, \sigma_{d1}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0};$ P-WNLs;
\{R_{1}\}, \{R_{3}\}; 3; \Lambda_{36}, \frac{\Lambda_{0}^{2} + 2\sqrt{3} \Lambda_{8}}{3}, A_{13}; TP;
\{R_{2}\}, \{R_{3}\}; 3; \Lambda_{36}, A_{10}, A_{13}; TP;

$T; \Gamma K; \sigma_{d2}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

$S; AH; \sigma_{d2}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

$T^{'}; MK; \sigma_{d1}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

$S^{'}; LH; \sigma_{d1}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;

$\Sigma; \Gamma M; C_{21}^{+}, IT; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{3}, \sigma_{0};$ P-WNLs;
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_3, \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs; } \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{\Lambda_0 + 2 \sqrt{3} \Delta_0}{3}, A_{13}; \text{TP; } \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}, A_{13}; \text{TP; } \]
\[ U; \text{ML; } \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNLs; } \]
\[ P; \text{KH; } C^+_3, \sigma_{v1,IT}; \{R_1\}, \{R_2, R_3\}; 3; A_{33}, A_{17}; \text{TP; } \]
\[ T; \Gamma K; C^\prime_{21}, \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL; } \]
\[ S; \text{AH; } C^\prime_{22}, \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL; } \]
\[ T^\prime; \text{MK; } C^\prime_{21}, \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL; } \]
\[ \Sigma; \Gamma M; \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNLs; } \]
\[ R; \text{AL; } \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNLs; } \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_3, \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs; } \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{\Delta_0 + 2 \sqrt{3} \Lambda_0}{3}, A_{13}; \text{TP; } \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}, A_{13}; \text{TP; } \]
\[ U; \text{ML; } \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNLs; } \]
\[ P; \text{KH; } C^+_3, \sigma_{v1,IT}; \{R_1\}, \{R_2, R_3\}; 3; A_{33}, A_{17}; \text{TP; } \]
\[ T; \Gamma K; C^\prime_{22}, \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL; } \]
\[ T^\prime; \text{MK; } C^\prime_{21}, \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL; } \]
\[ \Sigma; \Gamma M; \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNLs; } \]
\[ R; \text{AL; } \sigma_{v1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNLs; } \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma A / \Gamma Z; C^+_3, \sigma_{d1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs; } \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{\Lambda_0 + 2 \sqrt{3} \Delta_0}{3}, A_{13}; \text{TP; } \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}, A_{13}; \text{TP; } \]
\[ P; \text{ZP; } C^+_3, \sigma_{d1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs; } \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{\Lambda_0 + 2 \sqrt{3} \Delta_0}{3}, A_{13}; \text{TP; } \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}, A_{13}; \text{TP; } \]
\[ B; \text{ZB; } C^\prime_{21}, \sigma_{d1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL; } \]
\[ \Sigma; \Gamma F / \Gamma Z; C^\prime_{21}, \sigma_{d1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL; } \]
\[ Q; \text{FQ; } C^\prime_{23}, \sigma_{d1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL; } \]
\[ Y; \text{LZ / LQ; } C^\prime_{22}, \sigma_{d1,IT}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL; } \]
Accidental degeneracies on high symmetry line

$\Lambda; \Gamma\Lambda/\Gamma Z; C_3^+, \sigma_{d_1}, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P$-WNLs;
$\{R_1\}, \{R_3\}; 3; A_{36}, A_{16} + 2\sqrt{-1} A_8, A_{13}; TP;$
$\{R_2\}, \{R_3\}; 3; A_{36}, A_{10}, A_{13}; TP;$

$P; ZP; C_3^+, \sigma_{d_1}, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; P$-WNLs;
$\{R_1\}, \{R_3\}; 3; A_{36}, A_{16} + 2\sqrt{-1} A_8, A_{13}; TP;$
$\{R_2\}, \{R_3\}; 3; A_{36}, A_{10}, A_{13}; TP;$

$\Sigma; \Gamma F/\Gamma \Sigma; C_3^*, \sigma_t, IT; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P$-WNL;

$Q; FQ; C_3^*, \sigma_t, IT; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P$-WNL;

Accidental degeneracies on high symmetry line

$\Delta; \Gamma A; C_3^+, \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_0 - (\sqrt{-1} - 1) \sigma_3 \right); C-1 WP; 1$
$\{R_1\}, \{R_3\}; 2; -\sigma_{10}; C-2 WP; 2$
$\{R_1\}, \{R_4\}; 2; \sigma_3; C-3 WP; 3$
$\{R_1\}, \{R_5\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right); C-2 WP; 2$
$\{R_1\}, \{R_6\}; 2; \frac{1}{2} \left( (1 + (-1)^{2/3}) \sigma_3 - ((-1)^{2/3} - 1) \sigma_0 \right); C-1 WP; 1$
$\{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_3 + i\sqrt{3}\sigma_0); C-1 WP; 1$
$\{R_2\}, \{R_4\}; 2; \sigma_9; C-2 WP; 2$
$\{R_2\}, \{R_5\}; 2; \sqrt{-1}\sigma_3; C-3 WP; 3$
$\{R_2\}, \{R_6\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); C-2 WP; 2$
$\{R_3\}, \{R_4\}; 2; \frac{1}{2} \left( (-1)^{2/3} - 1 \right) \sigma_0 + \left( 1 + (-1)^{2/3} \right) \sigma_3 \right); C-1 WP; 1$
$\{R_3\}, \{R_5\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); C-2 WP; 2$
$\{R_3\}, \{R_6\}; 2; (-1)^{2/3} \sigma_3; C-3 WP; 3$
$\{R_4\}, \{R_5\}; 2; \frac{1}{2} \left( (\sqrt{-1} - 1) \sigma_3 - (1 + \sqrt{-1}) \sigma_0 \right); C-1 WP; 1$
$\{R_4\}, \{R_6\}; 2; \sigma_{10}; C-2 WP; 2$
$\{R_5\}, \{R_6\}; 2; -\sigma_9 - \frac{1}{2} i\sqrt{3}\sigma_0; C-1 WP; 1$

$U; ML; C_3; \{R_1\}, \{R_2\}; 2; \sigma_3; C-1 WP; 1$

$P; KH; C_3^+, \{R_1\}, \{R_2\}; 2; -\sigma_{10}; C-1 WP; 1$
$\{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right); C-1 WP; 1$
$\{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); C-1 WP; 1$
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+; \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_0 - (\sqrt[3]{1} - 1) \sigma_3 \right); C-1 WP; 1 \]

\[ \{R_1\}, \{R_3\}; 2; -\sigma_{10}; \]

\[ \{R_1\}, \{R_4\}; 2; \sigma_3; \]

\[ \{R_1\}, \{R_5\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0 \right); C-2 WP; 2 \]

\[ \{R_1\}, \{R_6\}; 2; \frac{1}{2} \left( (1 + (1)^{2/3}) \sigma_3 - ((-1)^{2/3} - 1) \sigma_0 \right); C-1 WP; 1 \]

\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_3 + i\sqrt{3}\sigma_0); \]

\[ \{R_2\}, \{R_4\}; 2; \sqrt{-1}\sigma_3; \]

\[ \{R_2\}, \{R_5\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \]

\[ \{R_3\}, \{R_4\}; 2; \frac{1}{2} \left( (1)^{2/3} - 1 \right) \sigma_0 + \left( 1 + (1)^{2/3} \right) \sigma_3 \); C-1 WP; 1 \]

\[ \{R_3\}, \{R_5\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \]

\[ \{R_3\}, \{R_6\}; 2; \frac{1}{2} \left( (1)^{2/3} - 1 \right) \sigma_3 - (1 + \sqrt[3]{-1}) \sigma_0 \); C-2 WP; 2 \]

\[ \{R_4\}, \{R_5\}; 2; \frac{1}{2} \left( (\sqrt[3]{-1} - 1) \sigma_3 - (1 + \sqrt[3]{1}) \sigma_0 \right); C-1 WP; 1 \]

\[ \{R_4\}, \{R_6\}; 2; \frac{1}{2} \left( (1 + (1)^{2/3}) \sigma_3 - ((-1)^{2/3} - 1) \sigma_0 \right); C-1 WP; 1 \]

\[ \{R_5\}, \{R_6\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \]

\[ U; ML; C_{2d}; \{R_1\}, \{R_2\}; 2; \sigma_3; \]

\[ P; KH; C_{3h}^d; \{R_1\}, \{R_2\}; 2; -\sigma_{10}; \]

\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0); C-1 WP; 1 \]

\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \]
SG 170

Accidental degeneracies on high symmetry line

\[
\Delta; \Gamma A; C^+; \{R_1, R_2\}; 2; \frac{1}{2} \left((1 + \sqrt[3]{-1}) \sigma_0 - (\sqrt[3]{-1} - 1) \sigma_3\right); \quad \text{C-1 WP; 1}
\]
\[
\{R_1, R_3\}; 2; -\sigma_{10}; \quad \text{C-2 WP; 2}
\]
\[
\{R_1, R_4\}; 2; \sigma_3; \quad \text{C-3 WP; 3}
\]
\[
\{R_1, R_5\}; 2; \frac{1}{2} \left(((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0\right); \quad \text{C-2 WP; 2}
\]
\[
\{R_1, R_6\}; 2; \frac{1}{2} \left((1 + (-1)^{2/3}) \sigma_3 - ((-1)^{2/3} - 1) \sigma_0\right); \quad \text{C-1 WP; 1}
\]
\[
\{R_2, R_3\}; 2; \frac{1}{2} (\sigma_3 + i\sqrt{3}\sigma_0); \quad \text{C-1 WP; 1}
\]
\[
\{R_2, R_4\}; 2; \sigma_{9}; \quad \text{C-2 WP; 2}
\]
\[
\{R_2, R_5\}; 2; \sqrt[3]{1}\sigma_3; \quad \text{C-3 WP; 3}
\]
\[
\{R_2, R_6\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-2 WP; 2}
\]
\[
\{R_3, R_4\}; 2; \frac{1}{2} \left(((1)^{2/3} - 1) \sigma_0 + (1 + (1)^{2/3}) \sigma_3\right); \quad \text{C-1 WP; 1}
\]
\[
\{R_3, R_5\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-2 WP; 2}
\]
\[
\{R_3, R_6\}; 2; (1)^{2/3}\sigma_3; \quad \text{C-3 WP; 3}
\]
\[
\{R_4, R_5\}; 2; \frac{1}{2} \left((\sqrt[3]{-1} - 1) \sigma_3 - (1 + \sqrt[3]{-1}) \sigma_0\right); \quad \text{C-1 WP; 1}
\]
\[
\{R_4, R_6\}; 2; \sigma_{10}; \quad \text{C-2 WP; 2}
\]
\[
\{R_5, R_6\}; 2; -\frac{\sigma_3}{2} - \frac{i}{2}\sqrt{3}\sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\{R_1, R_2\}; 2; \frac{1}{2} \left(((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0\right); \quad \text{C-1 WP; 1}
\]
\[
\{R_2, R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1}
\]

U; ML; $C_\beta^+$; \{R_1\}; \{R_2\}; 2; \sigma_3; \quad \text{C-1 WP; 1}

P; KH; $C_\beta^+$; \{R_1\}; \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1}
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+; \{R_1\}, \{R_2\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_0 - (\sqrt[3]{-1} - 1) \sigma_3) \]

\[ \{R_1\}, \{R_3\}; 2; -\sigma_{10}; \]

\[ \{R_1\}, \{R_4\}; 2; \sigma_3; \]

\[ \{R_1\}, \{R_5\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0) \]

\[ \{R_1\}, \{R_6\}; 2; \frac{1}{2} \left( (1 + (-1)^{2/3}) \sigma_3 - ((-1)^{2/3} - 1) \sigma_0 \right) \]

\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_3 + i\sqrt{3}\sigma_0) \]

\[ \{R_2\}, \{R_4\}; 2; \sigma_9; \]

\[ \{R_2\}, \{R_5\}; 2; \sqrt[3]{-1}\sigma_3; \]

\[ \{R_2\}, \{R_6\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3) \]

\[ \{R_3\}, \{R_4\}; 2; \frac{1}{2} \left( (-1)^{2/3} - 1 \right) \sigma_0 + \left( 1 + (-1)^{2/3} \right) \sigma_3 \]

\[ \{R_3\}, \{R_5\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3) \]

\[ \{R_3\}, \{R_6\}; 2; (-1)^{2/3}\sigma_3; \]

\[ \{R_4\}, \{R_5\}; 2; \frac{1}{2} ((\sqrt[3]{-1} - 1) \sigma_3 - (1 + \sqrt[3]{-1}) \sigma_0) \]

\[ \{R_4\}, \{R_6\}; 2; \sigma_{16}; \]

\[ \{R_5\}, \{R_6\}; 2; -\frac{\sigma_9}{2} - \frac{1}{2} i\sqrt{3}\sigma_0; \]

\[ U; ML; C_2^+; \{R_1\}, \{R_2\}; 2; \sigma_3; \]

\[ P; KH; C_3^+; \{R_1\}, \{R_2\}; 2; -\sigma_{10}; \]

\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0) \]

\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \]

\[ \Delta; \Gamma A; C^+; \{R_1\}, \{R_2\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_0 - (\sqrt[3]{-1} - 1) \sigma_3) \]

\[ \{R_1\}, \{R_3\}; 2; -\sigma_{10}; \]

\[ \{R_1\}, \{R_4\}; 2; \sigma_3; \]

\[ \{R_1\}, \{R_5\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0) \]

\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \]

\[ U; ML; C_2^+; \{R_1\}, \{R_2\}; 2; \sigma_3; \]

\[ P; KH; C_3^+; \{R_1\}, \{R_2\}; 2; -\sigma_{10}; \]

\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0) \]

\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \]

\[ \Delta; \Gamma A; C^+; \{R_1\}, \{R_2\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_0 - (\sqrt[3]{-1} - 1) \sigma_3) \]

\[ \{R_1\}, \{R_3\}; 2; -\sigma_{10}; \]

\[ \{R_1\}, \{R_4\}; 2; \sigma_3; \]

\[ \{R_1\}, \{R_5\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0) \]

\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \]

\[ U; ML; C_2^+; \{R_1\}, \{R_2\}; 2; \sigma_3; \]

\[ P; KH; C_3^+; \{R_1\}, \{R_2\}; 2; -\sigma_{10}; \]

\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0) \]

\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_2; \{R_1\}, \{R_2\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_0 - (\sqrt[3]{-1} - 1) \sigma_3); \ C-1 \ WP; 1 \]

\[ \{R_1\}, \{R_3\}; 2; -\sigma_{10}; \quad \text{C-2 WP; 2} \]

\[ \{R_1\}, \{R_4\}; 2; \sigma_3; \quad \text{C-3 WP; 3} \]

\[ \{R_1\}, \{R_5\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0); \ C-2 \ WP; 2 \]

\[ \{R_1\}, \{R_6\}; 2; \frac{1}{2} \left( (1 + (-1)^{2/3}) \sigma_3 - ((-1)^{2/3} - 1) \sigma_0 \right); \ C-1 \ WP; 1 \]

\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} (\sigma_3 + i\sqrt{3}\sigma_0); \quad \text{C-1 WP; 1} \]

\[ \{R_2\}, \{R_4\}; 2; \sqrt[3]{-1}\sigma_3; \quad \text{C-3 WP; 3} \]

\[ \{R_2\}, \{R_5\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-2 WP; 2} \]

\[ \{R_3\}, \{R_4\}; 2; \frac{1}{2} \left( ((-1)^{2/3} - 1) \sigma_0 + (1 + (-1)^{2/3}) \sigma_3 \right); \ C-1 \ WP; 1 \]

\[ \{R_3\}, \{R_5\}; 2; \frac{1}{2} (\sigma_3 - (1 + \sqrt[3]{-1}) \sigma_0); \quad \text{C-2 WP; 2} \]

\[ \{R_3\}, \{R_6\}; 2; (1 + (1 + \sqrt[3]{-1}) = (\sqrt[3]{-1} - 1) \sigma_3); \quad \text{C-1 WP; 1} \]

\[ \{R_4\}, \{R_5\}; 2; \sigma_{10}; \quad \text{C-2 WP; 2} \]

\[ \{R_4\}, \{R_6\}; 2; -\frac{\sigma_3}{2} - \frac{1}{2} i\sqrt{3}\sigma_0; \quad \text{C-1 WP; 1} \]

\[ U; \text{ ML; } C_2; \quad \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{C-1 WP; 1} \]

\[ P; \text{ KH; } C^+_3; \quad \{R_1\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ \{R_1\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0); \ C-1 \ WP; 1 \]

\[ \{R_2\}, \{R_3\}; 2; \frac{1}{2} ((1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0); \ C-1 \ WP; 1 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_{3d}^+; \{R_1\}, \{R_2\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_0 - (\sqrt[3]{-1} - 1) \sigma_3 \right); \quad \text{C-1 WP; 1}\]

\{R_1\}, \{R_3\}; 2; -\sigma_{10}; \quad \text{C-2 WP; 2}\]

\{R_1\}, \{R_4\}; 2; \sigma_3; \quad \text{C-3 WP; 3}\]

\{R_1\}, \{R_5\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0 \right); \quad \text{C-2 WP; 2}\]

\{R_1\}, \{R_6\}; 2; \frac{1}{2} \left( \left( 1 + (-1)^{2/3} \right) \sigma_3 - \left( (-1)^{2/3} - 1 \right) \sigma_0 \right); \quad \text{C-1 WP; 1}\]

\{R_2\}, \{R_3\}; 2; \frac{1}{2} \left( \sigma_3 + i\sqrt{3}\sigma_0 \right); \quad \text{C-1 WP; 1}\]

\{R_2\}, \{R_4\}; 2; \sigma_9; \quad \text{C-2 WP; 2}\]

\{R_2\}, \{R_5\}; 2; \sqrt{-1}\sigma_3; \quad \text{C-3 WP; 3}\]

\{R_2\}, \{R_6\}; 2; \frac{1}{2} \left( \sigma_0 + i\sqrt{3}\sigma_3 \right); \quad \text{C-2 WP; 2}\]

\{R_3\}, \{R_4\}; 2; \frac{1}{2} \left( \left( (-1)^{2/3} - 1 \right) \sigma_0 + \left( 1 + (-1)^{2/3} \right) \sigma_3 \right); \quad \text{C-1 WP; 1}\]

\{R_3\}, \{R_6\}; 2; \frac{1}{2} \left( -(\sigma_0 + i\sqrt{3}\sigma_3) \right); \quad \text{C-2 WP; 2}\]

\{R_4\}, \{R_5\}; 2; \frac{1}{2} \left( (\sqrt[3]{-1} - 1) \sigma_3 - (1 + \sqrt[3]{-1}) \sigma_0 \right); \quad \text{C-1 WP; 1}\]

\{R_4\}, \{R_6\}; 2; \frac{1}{2} \left( \sigma_{10} \right); \quad \text{C-2 WP; 2}\]

\{R_5\}, \{R_6\}; 2; -\sigma_3 - \frac{1}{2}i\sqrt{3}\sigma_0; \quad \text{C-1 WP; 1}\]

\(U; \) ML; \(C_2; \) \{R_1\}, \{R_2\}; 2; \sigma_9; \quad \text{C-1 WP; 1}\]

\(P; \) KH; \(C_3^+; \) \{R_1\}, \{R_2\}; 2; -\sigma_{10}; \quad \text{C-1 WP; 1}\]

\{R_1\}, \{R_3\}; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1} - 1) \sigma_0 \right); \quad \text{C-1 WP; 1}\]

\{R_2\}, \{R_3\}; 2; \frac{1}{2} \left( -(\sigma_0 + i\sqrt{3}\sigma_3) \right); \quad \text{C-1 WP; 1}\]

\(T; \) \(\Gamma K; \) \(\sigma_h; \) \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{P-WNL;}\]

\(S; \) \(\Lambda H; \) \(\sigma_h; \) \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{P-WNL;}\]

\(T'; \) \(\Lambda K; \) \(\sigma_h; \) \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{P-WNL;}\]

\(S'; \) \(\Lambda H; \) \(\sigma_h; \) \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{P-WNL;}\]

\(\Sigma; \) \(\Gamma M; \) \(\sigma_h; \) \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{P-WNL;}\]

\(R; \) \(\Lambda L; \) \(\sigma_h; \) \{R_1\}, \{R_2\}; 2; \sigma_3; \quad \text{P-WNL;}\]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; \ C^+_6 \ IT; \ \{ R_1 \}, \{ R_4 \}; \ 2; \sigma_3, \sigma_0; \ P-WNLs; \]
\[ \{ R_1 \}, \{ R_2, R_6 \}; \ 3; \ A_{35}, A_{17}; \ TP; \]
\[ \{ R_1 \}, \{ R_3, R_5 \}; \ 3; \ A_{33}, A_{17}; \ QTP; \]
\[ \{ R_2, R_6 \}, \{ R_4 \}; \ 3; \ \sqrt{3} (A_{2x} + i A_5), A_{20}; \ QTP; \]
\[ \{ R_2, R_6 \}, \{ R_3, R_5 \}; \ 4; \ \frac{\sqrt{3} (A_{2x} + i A_5)}{2}, \Gamma_{0,1}; \ DP; \ 0 \]
\[ \{ R_3, R_5 \}, \{ R_4 \}; \ 3; \ \frac{3}{2} (A_{20} + \sqrt{3} (A_{2x} + i A_5)), A_{20}; \ TP; \]
\[ U; \ ML; \ C_2 \ IT; \ \{ R_1 \}, \{ R_2 \}; \ 2; \sigma_3, \sigma_0; \ P-WNL; \]
\[ P; \ KH; \ C^+_3 \ IT; \ \{ R_1 \}, \{ R_2, R_3 \}; \ 3; \ A_{33}, A_{17}; \ TP; \]
\[ T; \ GK; \ \sigma_b, \ IT; \ \{ R_1 \}, \{ R_2 \}; \ 2; \sigma_3, \sigma_0; \ P-WNLs; \]
\[ S; \ AH; \ \sigma_b, \ IT; \ \{ R_1 \}, \{ R_2 \}; \ 2; \sigma_3, \sigma_0; \ P-WNLs; \]
\[ T'; \ MK; \ \sigma_b, \ IT; \ \{ R_1 \}, \{ R_2 \}; \ 2; \sigma_3, \sigma_0; \ P-WNLs; \]
\[ S'; \ LH; \ \sigma_b, \ IT; \ \{ R_1 \}, \{ R_2 \}; \ 2; \sigma_3, \sigma_0; \ P-WNLs; \]
\[ \Sigma; \ GM; \ \sigma_b, \ IT; \ \{ R_1 \}, \{ R_2 \}; \ 2; \sigma_3, \sigma_0; \ P-WNLs; \]
\[ R; \ AL; \ \sigma_b, \ IT; \ \{ R_1 \}, \{ R_2 \}; \ 2; \sigma_3, \sigma_0; \ P-WNLs; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_{0}^{+}C_{20}^{T}; \{ R_{1} \}, \{ R_{2} \}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_{0} - (\sqrt{-1} - 1) \sigma_{3} \right), \sigma_{0}; \ C-1 \ WP; 1 \]
\[ \{ R_{1} \}, \{ R_{3} \}; 2; -\sigma_{10}, \sigma_{0}; \ C-2 \ WP; 2 \]
\[ \{ R_{1} \}, \{ R_{4} \}; 2; \sigma_{3}, \sigma_{0}; \ C-3 \ WP; 3 \]
\[ \{ R_{1} \}, \{ R_{5} \}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_{3} - (\sqrt{-1} - 1) \sigma_{0} \right), \sigma_{0}; \ C-2 \ WP; 2 \]
\[ \{ R_{1} \}, \{ R_{6} \}; 2; \frac{1}{2} \left( (1 + (-1)^{2/3}) \sigma_{3} - (1 + 2 \sqrt{-1}) \sigma_{0} \right), \sigma_{0}; \ C-1 \ WP; 1 \]
\[ \{ R_{2} \}, \{ R_{3} \}; 2; \frac{1}{2} \left( \sigma_{3} + i\sqrt{3} \sigma_{0} \right), \sigma_{0}; \ C-1 \ WP; 1 \]
\[ \{ R_{2} \}, \{ R_{4} \}; 2; \sigma_{9}, \sigma_{0}; \ C-2 \ WP; 2 \]
\[ \{ R_{2} \}, \{ R_{5} \}; 2; \sqrt{-1} \sigma_{3}, \sigma_{0}; \ C-3 \ WP; 3 \]
\[ \{ R_{2} \}, \{ R_{6} \}; 2; \frac{1}{2} \left( \sigma_{0} + i\sqrt{3} \sigma_{3} \right), \sigma_{0}; \ C-2 \ WP; 2 \]
\[ \{ R_{3} \}, \{ R_{4} \}; 2; \frac{1}{2} \left( \left( (-1)^{2/3} - 1 \right) \sigma_{0} + \left( 1 + (-1)^{2/3} \right) \sigma_{3} \right), \sigma_{0}; \ C-1 \ WP; 1 \]
\[ \{ R_{3} \}, \{ R_{5} \}; 2; \frac{1}{2} \left( -\sigma_{0} + i\sqrt{3} \sigma_{3} \right), \sigma_{0}; \ C-2 \ WP; 2 \]
\[ \{ R_{3} \}, \{ R_{6} \}; 2; (-1)^{2/3} \sigma_{3}, \sigma_{0}; \ C-3 \ WP; 3 \]
\[ \{ R_{4} \}, \{ R_{5} \}; 2; \frac{1}{2} \left( \left( \sqrt{-1} - 1 \right) \sigma_{3} - (1 + \sqrt{-1}) \sigma_{0} \right), \sigma_{0}; \ C-1 \ WP; 1 \]
\[ \{ R_{4} \}, \{ R_{6} \}; 2; \sigma_{10}, \sigma_{0}; \ C-2 \ WP; 2 \]
\[ \{ R_{5} \}, \{ R_{6} \}; 2; -\frac{\sigma_{9}}{2} - \frac{1}{2} i\sqrt{3} \sigma_{0}, \sigma_{0}; \ C-1 \ WP; 1 \]

U; ML; \ C_{2}C_{21}^{+}T; \{ R_{1} \}, \{ R_{2} \}; 2; \sigma_{3}, \sigma_{0}; \ C-1 \ WP; 1

P; KH; \ C_{3}^{+}C_{22}^{T}; \{ R_{1} \}, \{ R_{2} \}; 2; -\sigma_{10}, \sigma_{0}; \ C-1 \ WP; 1

\[ \{ R_{1} \}, \{ R_{3} \}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_{3} - (\sqrt{-1} - 1) \sigma_{0} \right), \sigma_{0}; \ C-1 \ WP; 1 \]
\[ \{ R_{2} \}, \{ R_{3} \}; 2; \frac{1}{2} \left( -\sigma_{0} + i\sqrt{3} \sigma_{3} \right), \sigma_{0}; \ C-1 \ WP; 1 \]

T; GK; \ C_{22}^{+}C_{22}^{T}; \{ R_{1} \}, \{ R_{2} \}; 2; \sigma_{3}, \sigma_{0}; \ C-1 \ WP; 1

S; AH; \ C_{22}^{+}C_{22}^{T}; \{ R_{1} \}, \{ R_{2} \}; 2; \sigma_{3}, \sigma_{0}; \ C-1 \ WP; 1

T'; MK; \ C_{21}^{+}C_{2}^{T}; \{ R_{1} \}, \{ R_{2} \}; 2; \sigma_{3}, \sigma_{0}; \ C-1 \ WP; 1

S'; LH; \ C_{21}^{+}C_{2}^{T}; \{ R_{1} \}, \{ R_{2} \}; 2; \sigma_{3}, \sigma_{0}; \ C-1 \ WP; 1

\[ \Sigma; \Gamma M; \ C_{21}^{+}C_{21}^{T}; \{ R_{1} \}, \{ R_{2} \}; 2; \sigma_{3}, \sigma_{0}; \ C-1 \ WP; 1 \]

R; AL; \ C_{21}^{+}C_{21}^{T}; \{ R_{1} \}, \{ R_{2} \}; 2; \sigma_{3}, \sigma_{0}; \ C-1 \ WP; 1
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma \Lambda; C_6^+, C_{22}^+ T; \{ R_1 \}, \{ R_2 \}; 2; \frac{1}{\sqrt{3}} \left( (1 + \sqrt{-1}) \sigma_0 - (\sqrt{-1} - 1) \sigma_3 \right), \sigma_0; \]  
C-1 WP; 1

\[ \{ R_1 \}, \{ R_3 \}; -\sigma_{10}, \sigma_0; \]  
C-2 WP; 2

\[ \{ R_1 \}, \{ R_4 \}; \sigma_3, \sigma_0; \]  
C-3 WP; 3

\[ \{ R_1 \}, \{ R_5 \}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right), \sigma_0; \]  
C-2 WP; 2

\[ \{ R_1 \}, \{ R_6 \}; 2; \frac{1}{2} \left( (1 + (1)^2/3) \sigma_3 - (1 - (1)^2/3) \sigma_0 \right), \sigma_0; \]  
C-1 WP; 1

\[ \{ R_2 \}, \{ R_3 \}; 2; \frac{1}{2} \left( \sigma_3 + i\sqrt{3} \sigma_0 \right), \sigma_0; \]  
C-1 WP; 1

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_9, \sigma_0; \]  
C-2 WP; 2

\[ \{ R_2 \}, \{ R_5 \}; 2; \sqrt{-1} \sigma_3, \sigma_0; \]  
C-3 WP; 3

\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{1}{2} \left( \sigma_0 + i\sqrt{3} \sigma_3 \right), \sigma_0; \]  
C-2 WP; 2

\[ \{ R_3 \}, \{ R_4 \}; 2; \frac{1}{2} \left( (-1)^2/3 - 1 \right) \sigma_0 + \left( 1 + (-1)^2/3 \right) \sigma_3 \right), \sigma_0; \]  
C-1 WP; 1

\[ \{ R_3 \}, \{ R_5 \}; 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3} \sigma_3 \right), \sigma_0; \]  
C-2 WP; 2

\[ \{ R_3 \}, \{ R_6 \}; 2; \left( 1 \right)^2/3 \sigma_3, \sigma_0; \]  
C-3 WP; 3

\[ \{ R_4 \}, \{ R_5 \}; 2; \frac{1}{2} \left( (\sqrt{-1} - 1) \sigma_3 - (1 + \sqrt{-1}) \sigma_0 \right), \sigma_0; \]  
C-1 WP; 1

\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10}, \sigma_0; \]  
C-2 WP; 2

\[ \{ R_5 \}, \{ R_6 \}; 2; -\frac{\sigma_9}{2} - \frac{1}{2}i\sqrt{3} \sigma_0, \sigma_0; \]  
C-1 WP; 1

U; ML; C_{22}^+, C_{22}' T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \]  
C-1 WP; 1

P; KH; C_{3}^+, C_{22}' T; \{ R_1 \}, \{ R_2 \}; 2; -\sigma_{10}, \sigma_0; \]  
C-1 WP; 1

\[ \{ R_1 \}, \{ R_3 \}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right), \sigma_0; \]  
C-1 WP; 1

\[ \{ R_2 \}, \{ R_3 \}; 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3} \sigma_3 \right), \sigma_0; \]  
C-1 WP; 1

T; GK; C_{22}^+, C_{22}' T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \]  
C-1 WP; 1

T'; MK; C_{22}^+, C_{22}' T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \]  
C-1 WP; 1

\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \]  
C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_A; C^+_6 \cdot C^+_{23} T; \{ R_1 \} \cdot \{ R_2 \} ; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_0 - (\sqrt[3]{-1}) \sigma_3 \right), \sigma_0; \] C-1 WP; 1

\[ \{ R_1 \} \cdot \{ R_3 \} ; 2; -\sigma_{10}, \sigma_0; \] C-2 WP; 2

\[ \{ R_1 \} \cdot \{ R_4 \} ; 2; \sigma_3, \sigma_0; \] C-3 WP; 3

\[ \{ R_1 \} \cdot \{ R_5 \} ; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1}) \sigma_0 \right), \sigma_0; \] C-2 WP; 2

\[ \{ R_1 \} \cdot \{ R_6 \} ; 2; \frac{1}{2} \left( (1 + (-1)^{2/3}) \sigma_3 - (1 + (-1)^{2/3}) \sigma_0 \right), \sigma_0; \] C-1 WP; 1

\[ \{ R_2 \} \cdot \{ R_3 \} ; 2; \frac{1}{2} \left( \sigma_3 + i\sqrt{3}\sigma_0 \right), \sigma_0; \] C-1 WP; 1

\[ \{ R_2 \} \cdot \{ R_4 \} ; 2; \sigma_9, \sigma_0; \] C-2 WP; 2

\[ \{ R_2 \} \cdot \{ R_5 \} ; 2; \sqrt{-1} \sigma_3, \sigma_0; \] C-3 WP; 3

\[ \{ R_2 \} \cdot \{ R_6 \} ; 2; \frac{1}{2} \left( \sigma_0 + i\sqrt{3}\sigma_3 \right), \sigma_0; \] C-2 WP; 2

\[ \{ R_3 \} \cdot \{ R_4 \} ; 2; \frac{1}{2} \left( (1 + (-1)^{2/3}) \sigma_3 + (1 + (-1)^{2/3}) \sigma_0 \right), \sigma_0; \] C-1 WP; 1

\[ \{ R_3 \} \cdot \{ R_5 \} ; 2; \frac{1}{2} \left( \sigma_3 + i\sqrt{3}\sigma_0 \right), \sigma_0; \] C-1 WP; 1

\[ \{ R_3 \} \cdot \{ R_6 \} ; 2; -\sigma_{10} - \frac{1}{2}i\sqrt{3}\sigma_0, \sigma_0; \] C-1 WP; 1

\[ U; \text{ML}; C_2 \cdot C_{21}^0 T; \{ R_1 \} \cdot \{ R_2 \} ; 2; \sigma_3, \sigma_0; \] C-1 WP; 1

\[ P; \text{KH}; C_{3}^+ \cdot C_{22}^+ T; \{ R_1 \} \cdot \{ R_2 \} ; 2; -\sigma_{10}, \sigma_0; \] C-1 WP; 1

\[ \{ R_1 \} \cdot \{ R_3 \} ; 2; \frac{1}{2} \left( (1 + \sqrt[3]{-1}) \sigma_3 - (\sqrt[3]{-1}) \sigma_0 \right), \sigma_0; \] C-1 WP; 1

\[ \{ R_2 \} \cdot \{ R_4 \} ; 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3}\sigma_3 \right), \sigma_0; \] C-1 WP; 1

\[ T; \text{ΓK}; C_{22}^0 \cdot C_{22}^+ T; \{ R_1 \} \cdot \{ R_2 \} ; 2; \sigma_3, \sigma_0; \] C-1 WP; 1

\[ T'; \text{MK}; C_{21}^0 \cdot C_{22}^+ T; \{ R_1 \} \cdot \{ R_2 \} ; 2; \sigma_3, \sigma_0; \] C-1 WP; 1

\[ \Sigma; \Gamma M; C_{21}^0 \cdot C_{21}^+ T; \{ R_1 \} \cdot \{ R_2 \} ; 2; \sigma_3, \sigma_0; \] C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_6^+ C_{22}^T; \{ R_1 \}, \{ R_2 \}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_0 - (\sqrt{-1} - 1) \sigma_3 \right), \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_2 \}; 2; -\sigma_{10}, \sigma_0; \text{ C-2 WP; 2} \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{ C-3 WP; 3} \]

\[ \{ R_1 \}, \{ R_4 \}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right), \sigma_0; \text{ C-2 WP; 2} \]

\[ \{ R_1 \}, \{ R_5 \}; 2; \frac{1}{2} \left( (1 + (-1)^{2/3}) \sigma_3 - (1 - 1)^{2/3} - 1 \right) \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_3 \}; 2; \frac{1}{2} \left( \sigma_3 + i\sqrt{3} \sigma_0 \right), \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_9, \sigma_0; \text{ C-2 WP; 2} \]

\[ \{ R_2 \}, \{ R_5 \}; 2; \frac{1}{2} \left( \sigma_3 + i\sqrt{3} \sigma_0 \right), \sigma_0; \text{ C-3 WP; 3} \]

\[ \{ R_3 \}, \{ R_4 \}; 2; \frac{1}{2} \left( (1 + (-1)^{2/3} - 1) \sigma_0 + (1 + (-1)^{2/3}) \sigma_3 \right), \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_3 \}, \{ R_5 \}; 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3} \sigma_3 \right), \sigma_0; \text{ C-2 WP; 2} \]

\[ \{ R_5 \}, \{ R_6 \}; 2; \frac{1}{2} \left( (1 + (-1)^{2/3} - 1) \sigma_3 - (1 - 1)^{2/3} - 1 \right) \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_7 \}; \frac{3}{2}; \sigma_{10}, \sigma_0; \text{ C-2 WP; 2} \]

\[ \{ R_5 \}, \{ R_6 \}; 2; -\frac{\sigma_0}{2} - \frac{1}{3} i\sqrt{3} \sigma_0, \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_3 \}; 2; -\sigma_{10}, \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_3 \}, \{ R_4 \}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right), \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_3 \}; 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3} \sigma_3 \right), \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_3 \}, \{ R_5 \}; 2; \frac{1}{2} \left( (1 + \sqrt{-1}) \sigma_3 - (\sqrt{-1} - 1) \sigma_0 \right), \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \frac{1}{2} \left( -\sigma_0 + i\sqrt{3} \sigma_3 \right), \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_5 \}, \{ R_6 \}; 2; -\frac{\sigma_0}{2} - \frac{1}{3} i\sqrt{3} \sigma_0, \sigma_0; \text{ C-1 WP; 1} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \ \Gamma A; \ C_{181}^{\pm} , C_{21}^{\pm} T; \ {\{R_1\}, \{R_2\}}; 2; \frac{(1+\sqrt{-1})\sigma_0 - (\sqrt{-1} - 1)\sigma_3}{2}, \sigma_0; \ C-1 \ WP; 1 \]

\{R_1\}, \{R_2\}; 2; -\sigma_{10}, \sigma_0; \ C-2 \ WP; 2

\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \ C-3 \ WP; 3

\{R_1\}, \{R_3\}; 2; \frac{(1+\sqrt{-1})\sigma_3 - (\sqrt{-1} - 1)\sigma_0}{2}, \sigma_0; \ C-2 \ WP; 2

\{R_1\}, \{R_6\}; 2; \frac{(1+(-1)^{2/3})\sigma_3 - (\sqrt{-1} + 1)\sigma_0}{2}, \sigma_0; \ C-1 \ WP; 1

\{R_2\}, \{R_3\}; 2; \sqrt{-1}\sigma_3, \sigma_0; \ C-3 \ WP; 3

\{R_2\}, \{R_6\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \ C-2 \ WP; 2

\{R_3\}, \{R_4\}; 2; \frac{(-1)^{2/3}\sigma_3, \sigma_0; \ C-1 \ WP; 1

\{R_3\}, \{R_6\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \ C-2 \ WP; 2

\{R_3\}, \{R_6\}; 2; \frac{(-1)^{2/3}\sigma_3, \sigma_0; \ C-3 \ WP; 3

\{R_4\}, \{R_3\}; 2; \frac{(\sqrt{-1} - 1)\sigma_3 - (\sqrt{-1} + 1)\sigma_0}{2}, \sigma_0; \ C-1 \ WP; 1

\{R_4\}, \{R_6\}; 2; \sigma_{10}, \sigma_0; \ C-2 \ WP; 2

\{R_5\}, \{R_6\}; 2; -\frac{\sigma_2^2}{2} - \frac{1}{2} i\sqrt{3}\sigma_0, \sigma_0; \ C-1 \ WP; 1

\{R_5\}, \{R_6\}; 2; \sigma_3, \sigma_0; \ C-1 \ WP; 1

\{R_6\}, \{R_6\}; 2; -\sigma_{10}, \sigma_0; \ C-1 \ WP; 1

\{R_6\}, \{R_3\}; 2; \frac{1+\sqrt{-1})\sigma_3 - (\sqrt{-1} - 1)\sigma_0}{2}, \sigma_0; \ C-1 \ WP; 1

\{R_6\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \ C-1 \ WP; 1

U; ML; \ C_{21}^{\pm}, C_{21}^{\pm} T; \ {\{R_1\}, \{R_2\}}; 2; \sigma_3, \sigma_0; \ C-1 \ WP; 1

P; KH; \ C_{21}^{\pm}, C_{21}^{\pm} T; \ {\{R_1\}, \{R_2\}}; 2; -\sigma_{10}, \sigma_0; \ C-1 \ WP; 1

\{R_1\}, \{R_3\}; 2; \frac{(1+\sqrt{-1})\sigma_3 - (\sqrt{-1} - 1)\sigma_0}{2}, \sigma_0; \ C-1 \ WP; 1

\{R_2\}, \{R_3\}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \ C-1 \ WP; 1

T; \ \Gamma K; \ C_{21}^{\pm}, C_{21}^{\pm} T; \ {\{R_1\}, \{R_2\}}; 2; \sigma_3, \sigma_0; \ C-1 \ WP; 1

S; \ \Lambda H; \ C_{21}^{\pm}, C_{21}^{\pm} T; \ {\{R_1\}, \{R_2\}}; 2; \sigma_3, \sigma_0; \ C-1 \ WP; 1

T'; \ \Lambda K; \ C_{21}^{\pm}, C_{21}^{\pm} T; \ {\{R_1\}, \{R_2\}}; 2; \sigma_3, \sigma_0; \ C-1 \ WP; 1

\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \ C-1 \ WP; 1

\{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_0; \ C-1 \ WP; 1

\{R_3\}, \{R_3\}; 2; \sigma_3, \sigma_0; \ C-1 \ WP; 1

\{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_0; \ C-1 \ WP; 1

\{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \ C-1 \ WP; 1
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_6^+; C_{22}^* T; \{ R_1 \}, \{ R_2 \}; 2; \frac{1 + \sqrt{-1}}{2} \sigma_3 - \frac{\sqrt{-1}}{2} \sigma_0, \sigma_0; \] C-1 WP; 1

\[ \{ R_1 \}, \{ R_3 \}; 2; -\sigma_{10}, \sigma_0; \] C-2 WP; 2

\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0; \] C-3 WP; 3

\[ \{ R_1 \}, \{ R_5 \}; 2; \frac{1 + \sqrt{-1}}{2} \sigma_3, \sigma_0; \] C-2 WP; 2

\[ \{ R_1 \}, \{ R_6 \}; 2; \frac{1 + \sqrt{-1}}{2} \sigma_3 - \frac{\sqrt{-1}}{2} \sigma_0, \sigma_0; \] C-1 WP; 1

\[ \{ R_2 \}, \{ R_3 \}; 2; \frac{1}{2} (\sigma_3 + i \sqrt{3} \sigma_0), \sigma_0; \] C-1 WP; 1

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_9, \sigma_0; \] C-2 WP; 2

\[ \{ R_2 \}, \{ R_5 \}; 2; \frac{1}{2} (\sigma_0 + i \sqrt{3} \sigma_3), \sigma_0; \] C-2 WP; 2

\[ \{ R_3 \}, \{ R_4 \}; 2; \frac{1}{2} \sigma_3, \sigma_0; \] C-3 WP; 3

\[ \{ R_3 \}, \{ R_5 \}; 2; \frac{1}{2} (\sigma_0 + i \sqrt{3} \sigma_3), \sigma_0; \] C-2 WP; 2

\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10}, \sigma_0; \] C-2 WP; 2

\[ \{ R_5 \}, \{ R_6 \}; 2; -\frac{\sigma_3}{2} - \frac{1}{2} i \sqrt{3} \sigma_0, \sigma_0; \] C-1 WP; 1

\[ U; \text{ML;} C_2; C_{21}^* T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \] C-1 WP; 1

\[ P; \text{KH;} C_3^+; C_{22}^* T; \{ R_1 \}, \{ R_2 \}; 2; -\sigma_{10}, \sigma_0; \] C-1 WP; 1

\[ \{ R_1 \}, \{ R_3 \}; 2; \frac{1 + \sqrt{-1}}{2} \sigma_3 - \frac{\sqrt{-1}}{2} \sigma_0, \sigma_0; \] C-1 WP; 1

\[ \{ R_2 \}, \{ R_3 \}; 2; \frac{1}{2} (\sigma_0 + i \sqrt{3} \sigma_3), \sigma_0; \] C-1 WP; 1

\[ T; \text{ΓK;} C_{22}; C_{22}^* T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \] C-1 WP; 1

\[ T'; \text{MK;} C_{21}; C_{21}^* T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \] C-1 WP; 1

\[ \Sigma; \text{ΓM;} C_{21}; C_{21}^* T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \] C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_A; C_6^+; \sigma_{v1}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNL; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; P-WNL; \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{1}{3}(A_0 + 2\sqrt{3}A_b); QTP; \]
\[ \{R_2\}, \{R_3\}; 3; A_{39}, \frac{1}{3}(A_0 + 2\sqrt{3}A_b); TP; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_3; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; P-WNL; \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}; QTP; \]
\[ \{R_2\}, \{R_6\}; 3; A_{39}, A_{10}; TP; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; P-WNL; \]
\[ \{R_3\}, \{R_5\}; 3; A_{40}, \frac{1}{3}(A_0 + 2\sqrt{3}A_b); TP; \]
\[ \{R_3\}, \{R_6\}; 3; A_{24}, \frac{1}{3}(A_0 + 2\sqrt{3}A_b); QTP; \]
\[ \{R_4\}, \{R_3\}; 3; A_{40}, A_{10}; TP; \]
\[ \{R_4\}, \{R_6\}; 3; A_{24}, A_{10}; QTP; \]
\[ \{R_5\}, \{R_6\}; 4; -\frac{\Gamma_{0,0}}{2} - \frac{i}{2}i\sqrt{3}\Gamma_{0,2}, \Gamma_{0,3}; TP; \]

\[ U; \text{ML}; C_2; \sigma_{v1}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_3; P-WNL; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; P-WNL; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; P-WNL; \]

\[ P; \text{KH}; C_3^+; \sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; P-WNL; \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{1}{3}(A_0 + 2\sqrt{3}A_b); TP; \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}; TP; \]

\[ T; \Gamma_K; \sigma_{d2}, T\sigma_{d2}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ S; \text{AH}; \sigma_{d2}, T\sigma_{d2}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ T'; \text{MK}; \sigma_{d1}, C_2T; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ S'; \text{LH}; \sigma_{d1}, C_2T; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ \Sigma; \Gamma_M; \sigma_{v1}, T\sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
\[ R; \text{AL}; \sigma_{v1}, T\sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; P-WNL; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_6^+ \sigma_1; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_2\}; 3; A_{36}, \frac{1}{3} (A_0 + 2\sqrt{3}A_\delta); \text{QTP;} \]
\[ \{R_1\}, \{R_6\}; 3; A_{39}, \frac{1}{3} (A_0 + 2\sqrt{3}A_\delta); \text{TP;} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, -\sigma_3; \text{P-WNLs;} \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_0; \text{P-WNLs;} \]
\[ \{R_2\}, \{R_5\}; 3; A_{36}, A_{10}; \text{QTP;} \]
\[ \{R_2\}, \{R_6\}; 3; A_{39}, A_{10}; \text{TP;} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs;} \]
\[ \{R_3\}, \{R_6\}; 3; A_{40}, \frac{1}{3} (A_0 + 2\sqrt{3}A_\delta); \text{TP;} \]
\[ \{R_3\}, \{R_5\}; 3; A_{24}, \frac{1}{3} (A_0 + 2\sqrt{3}A_\delta); \text{QTP;} \]
\[ \{R_4\}, \{R_2\}; 3; A_{40}, A_{10}; \text{TP;} \]
\[ \{R_4\}, \{R_6\}; 3; A_{24}, A_{10}; \text{QTP;} \]
\[ \{R_5\}, \{R_6\}; 4; -\frac{\Gamma_0}{2} - \frac{1}{2} i\sqrt{3}\Gamma_0, \Gamma_{0,3}; \text{DP;} \]

\[ \Upsilon; \text{ML;} C_2 \sigma_1; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL;} \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3; \text{P-WNL;} \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0; \text{P-WNL;} \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3; \text{P-WNLs;} \]

\[ \Phi; \text{KH;} C_3^+ \sigma_3; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs;} \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{A_0 + 2\sqrt{3}A_\delta}{3}; \text{TP;} \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}; \text{TP;} \]

\[ \Theta; \text{Ga;} \sigma_{2d}, T \sigma_{2s}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \Theta'; \text{MK;} \sigma_{d1}, C_2 T; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \Sigma; \text{GM;} \sigma_{e1}, T \sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL;} \]
Accidental degeneracies on high symmetry line

| Action | Symmetry | Operation | Orbit | Level | Description |
|--------|----------|-----------|-------|-------|-------------|
| Δ; ΓA; $C^+_{6\sigma_v}$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_v, \sigma_3$ | P-WNLs; |
| $\{R_1\}, \{R_3\}$ | 2; $\sigma_3, \sigma_0$ | P-WNLs; |
| $\{R_1\}, \{R_4\}$ | 2; $\sigma_3, \sigma_3$ | P-WNLs; |
| $\{R_1\}, \{R_5\}$ | 3; $A_{36}, \frac{1}{3} (A_0 + 2\sqrt{3}A_s)$ | QTP; |
| $\{R_3\}, \{R_6\}$ | 3; $A_{39}, \frac{1}{3} (A_0 + 2\sqrt{3}A_s)$ | TP; |
| $\{R_1\}, \{R_3\}$ | 2; $\sigma_3, -\sigma_3$ | P-WNLs; |
| $\{R_2\}, \{R_4\}$ | 2; $\sigma_3, -\sigma_0$ | P-WNLs; |
| $\{R_2\}, \{R_6\}$ | 3; $A_{36}, A_{10}$ | QTP; |
| $\{R_3\}, \{R_4\}$ | 3; $A_{36}, A_{10}$ | TP; |
| $\{R_3\}, \{R_5\}$ | 3; $A_{39}, A_{10}$ | QTP; |
| $\{R_4\}, \{R_6\}$ | 3; $A_{24}, A_{10}$ | QTP; |
| $\{R_5\}, \{R_6\}$ | 4; $-\frac{\Gamma_0}{2} - \frac{1}{2}i\sqrt{3}\Gamma_{0,3}$ | DP; 0 |

| Action | Symmetry | Operation | Orbit | Level | Description |
|--------|----------|-----------|-------|-------|-------------|
| U; ML; $C_{2\sigma_v}$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_v, \sigma_3$ | P-WNLs; |
| $\{R_1\}, \{R_3\}$ | 2; $\sigma_3, \sigma_0$ | P-WNL; |
| $\{R_1\}, \{R_4\}$ | 2; $\sigma_3, \sigma_3$ | P-WNLs; |
| $\{R_2\}, \{R_3\}$ | 2; $\sigma_3, -\sigma_3$ | P-WNLs; |
| $\{R_2\}, \{R_4\}$ | 2; $\sigma_3, -\sigma_0$ | P-WNLs; |
| $\{R_3\}, \{R_4\}$ | 2; $-\sigma_0, \sigma_3$ | P-WNLs; |
| $\{R_3\}, \{R_5\}$ | 3; $A_{40}, \frac{1}{3} (A_0 + 2\sqrt{3}A_s)$ | TP; |
| $\{R_3\}, \{R_6\}$ | 3; $A_{24}, \frac{1}{3} (A_0 + 2\sqrt{3}A_s)$ | QTP; |
| $\{R_4\}, \{R_5\}$ | 3; $A_{40}, A_{10}$ | TP; |
| $\{R_4\}, \{R_6\}$ | 3; $A_{24}, A_{10}$ | QTP; |
| $\{R_5\}, \{R_6\}$ | 4; $-\frac{\Gamma_0}{2} - \frac{1}{2}i\sqrt{3}\Gamma_{0,3}$ | DP; 0 |

| Action | Symmetry | Operation | Orbit | Level | Description |
|--------|----------|-----------|-------|-------|-------------|
| P; KH; $C^+_{3\sigma_1}$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3$ | P-WNLs; |
| $\{R_1\}, \{R_3\}$ | 3; $A_{36}, \frac{A_{24} + 2\sqrt{3}A_s}{3}$ | TP; |
| $\{R_2\}, \{R_3\}$ | 3; $A_{36}, A_{10}$ | TP; |
| $\{R_3\}, \{R_4\}$ | 2; $\sigma_3, \sigma_0$ | P-WNLs; |
| $\{R_4\}, \{R_5\}$ | 2; $\sigma_3, \sigma_3$ | P-WNLs; |
| $\{R_5\}, \{R_6\}$ | 3; $A_{36}, \frac{A_{24} + 2\sqrt{3}A_s}{3}$ | TP; |
| $\{R_1\}, \{R_5\}$ | 4; $\Gamma_{3,0}, -i\Gamma_{0,2}$ | DP; 0 |
| $\{R_1\}, \{R_6\}$ | 4; $\Gamma_{3,0}, -i\Gamma_{0,2}$ | DP; 0 |

| Action | Symmetry | Operation | Orbit | Level | Description |
|--------|----------|-----------|-------|-------|-------------|
| $\Sigma$; GM; $\sigma_0, T\sigma_0$; | $\{R_1\}, \{R_2\}$ | 2; $\sigma_3, \sigma_0$ | P-WNL; |
Accidental degeneracies on high symmetry line

| $\Delta$; $\Gamma A$; $C_6^+ \sigma_{v1}$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3$ | P-WNLs; |
|-----------------------------------------|---------------------|-----------------|-------------|
| $\{R_1\}, \{R_3\}$                     | 2; $\sigma_3, \sigma_0$ | P-WNLs;         |
| $\{R_1\}, \{R_4\}$                     | 2; $\sigma_3, \sigma_3$ | P-WNLs;         |
| $\{R_1\}, \{R_5\}$                     | 3; $A_{36}, \frac{1}{3} (A_0 + 2\sqrt{3}A_2)$ | QTP;          |
| $\{R_2\}, \{R_6\}$                     | 3; $A_{39}, \frac{1}{3} (A_0 + 2\sqrt{3}A_2)$ | TP;           |
| $\{R_2\}, \{R_3\}$                     | 2; $\sigma_3, -\sigma_3$ | P-WNLs;        |
| $\{R_2\}, \{R_4\}$                     | 2; $\sigma_3, \sigma_0$ | P-WNLs;        |
| $\{R_2\}, \{R_5\}$                     | 3; $A_{40}, A_{10}$ | QTP;          |
| $\{R_2\}, \{R_6\}$                     | 3; $A_{39}, A_{10}$ | TP;            |
| $\{R_3\}, \{R_4\}$                     | 2; $-\sigma_0, \sigma_3$ | P-WNLs;       |
| $\{R_3\}, \{R_5\}$                     | 3; $A_{40}, \frac{1}{3} (A_0 + 2\sqrt{3}A_2)$ | TP;          |
| $\{R_3\}, \{R_6\}$                     | 3; $A_{24}, \frac{1}{3} (A_0 + 2\sqrt{3}A_2)$ | QTP;         |
| $\{R_4\}, \{R_5\}$                     | 3; $A_{40}, A_{10}$ | TP;            |
| $\{R_4\}, \{R_6\}$                     | 3; $A_{24}, A_{10}$ | QTP;          |
| $\{R_5\}, \{R_6\}$                     | 4; $-\frac{1}{2} \sqrt{3} \Gamma_{0,2}, \Gamma_{0,3}$ | DP; 0         |

$U$; ML; $C_2 \sigma_{v1}$

| $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3$ | P-WNLs; |
|---------------------|-----------------|-------------|
| $\{R_1\}, \{R_3\}$ | 2; $\sigma_3, \sigma_0$ | P-WNLs; |
| $\{R_1\}, \{R_4\}$ | 2; $\sigma_3, \sigma_3$ | P-WNL;  |
| $\{R_2\}, \{R_3\}$ | 2; $\sigma_3, \sigma_3$ | P-WNL;  |
| $\{R_2\}, \{R_4\}$ | 2; $\sigma_3, -\sigma_3$ | P-WNL;  |
| $\{R_3\}, \{R_4\}$ | 2; $-\sigma_0, \sigma_3$ | P-WNLs; |

$P$; KH; $C_3^+ \sigma_{d1}$

| $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3$ | P-WNLs; |
|---------------------|-----------------|-------------|
| $\{R_1\}, \{R_3\}$ | 3; $A_{36}, \frac{A_0 + 2\sqrt{3}A_2}{3}$ | TP;  |
| $\{R_2\}, \{R_3\}$ | 3; $A_{36}, A_{10}$ | TP;  |

$T$; GK; $\sigma_{d2}, T \sigma_{d2}$

| $\{R_1\}, \{R_2\}$ | 2; $\sigma_3, \sigma_0$ | P-WNLs; |

$T'$; MK; $\sigma_{d1}, C_2 T$

| $\{R_1\}, \{R_2\}$ | 2; $\sigma_3, \sigma_0$ | P-WNLs; |

$\Sigma$; GM; $\sigma_{v1}, T \sigma_{d1}$

| $\{R_1\}, \{R_2\}$ | 2; $\sigma_3, \sigma_0$ | P-WNLs; |

$R$; AL; $\sigma_{v1}, T \sigma_{d1}$

| $\{R_1, R_3\}, \{R_2, R_4\}$ | 4; $\Gamma_{3,0}, -i\Gamma_{0,2}$ | DP; 0 |
Accidental degeneracies on high symmetry line

\[
\begin{align*}
\Delta; \; \Gamma A; \; C_3^+, \sigma_{v1}, S_{v1}^+ T; & \quad \{ R_1 \}, \{ R_2 \} ; 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \\
\{ R_1 \}, \{ R_2 \} ; 3; A_{36}, \frac{A_1 + 2\sqrt{3}A_2}{3} A_{36}; \quad \text{TP;} \\
\{ R_2 \}, \{ R_3 \} ; 3; A_{36}, A_{10}, A_{36}; \quad \text{TP;} \\
U; \; ML; \; \sigma_{v1}, T \sigma_{h}; & \quad \{ R_1 \}, \{ R_2 \} ; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \\
P; \; KH; \; C_3^+, C_{23}^+ T; & \quad \{ R_1 \}, \{ R_2 \} ; 2; -\sigma_{10}, \sigma_0; \quad \text{C-1 WP;} ; 1 \\
\{ R_1 \}, \{ R_3 \} ; 2; \left( 1 + \frac{\sqrt{3}}{2} \right) \sigma_3 - \left( \frac{\sqrt{3}}{2} - 1 \right) \sigma_0, \sigma_0; \quad \text{C-1 WP;} ; 1 \\
\{ R_2 \}, \{ R_3 \} ; 2; -\frac{\sigma_0 + \sqrt{3} \sigma_3}{2}, \sigma_0; \quad \text{C-1 WP;} ; 1 \\
T; \; \Gamma K; \; \sigma_0, T \sigma_{v2}; & \quad \{ R_1 \}, \{ R_2 \} ; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \\
S; \; \Delta H; \; \sigma_0, T \sigma_{v2}; & \quad \{ R_1 \}, \{ R_2 \} ; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \\
T^\prime; \; \Delta K; \; \sigma_0, T \sigma_{v1}; & \quad \{ R_1 \}, \{ R_2 \} ; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \\
S^\prime; \; \Delta H; \; \sigma_0, T \sigma_{v1}; & \quad \{ R_1 \}, \{ R_2 \} ; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \\
\Sigma; \; \Gamma M; \; C_{21}^+, \sigma_{v1}; & \quad \{ R_1 \}, \{ R_2 \} ; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs;} \\
\{ R_1 \}, \{ R_3 \} ; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \\
\{ R_1 \}, \{ R_4 \} ; 2; \sigma_3, \sigma_3; \quad \text{P-WNL;} \\
\{ R_2 \}, \{ R_3 \} ; 2; \sigma_3, -\sigma_3; \quad \text{P-WNL;} \\
\{ R_2 \}, \{ R_4 \} ; 2; \sigma_3, -\sigma_0; \quad \text{P-WNL;} \\
\{ R_3 \}, \{ R_4 \} ; 2; -\sigma_0, \sigma_3; \quad \text{P-WNLs;} \\
R; \; \Delta L; \; C_{21}^+, \sigma_{v1}; & \quad \{ R_1 \}, \{ R_2 \} ; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs;} \\
\{ R_1 \}, \{ R_3 \} ; 2; \sigma_3, \sigma_0; \quad \text{P-WNL;} \\
\{ R_1 \}, \{ R_4 \} ; 2; \sigma_3, \sigma_3; \quad \text{P-WNL;} \\
\{ R_2 \}, \{ R_3 \} ; 2; \sigma_3, -\sigma_3; \quad \text{P-WNL;} \\
\{ R_2 \}, \{ R_4 \} ; 2; \sigma_3, -\sigma_0; \quad \text{P-WNL;} \\
\{ R_3 \}, \{ R_4 \} ; 2; -\sigma_0, \sigma_3; \quad \text{P-WNLs;} \\
\end{align*}
\]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_3; \sigma_{d1}, S^+_3; T; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, A_{10}, A_{36}; \text{TP}; \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}, A_{36}; \text{TP}; \]

\[ U; \text{ML}; \sigma_{d1}, T \sigma_h; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ P; \text{KH}; C^+_3; \sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, A_{10}, A_{36}; \text{TP}; \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}; \text{TP}; \]

\[ T; \text{ΓK}; C^r_{22}; \sigma_{d2}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ S; \text{AH}; C^r_{22}; \sigma_{d2}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ T'; \text{MK}; C^r_{21}; \sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ S'; \text{LH}; C^r_{21}; \sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Sigma; \text{ΓM}; \sigma_{h}, T \sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

\[ R; \text{AL}; \sigma_{h}, T \sigma_{d1}; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_A; C_3^+ \sigma_{d1}, S^+ T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \]  
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, A_{10}, A_{36}; \]  
\[ \{ R_2 \}, \{ R_3 \}; 3; \frac{A_0 + 2\sqrt{3}A_8}{3} A_{36}; \]  
\[ \text{P-WNLs}; \]  
\[ \]  
\[ U; \text{ML}; \sigma_{d1}, T \sigma_h; \]  
\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \]  
\[ \{ R_2 \}, \{ R_3 \}; 3; \frac{A_0 + 2\sqrt{3}A_8}{3} A_{36}; \]  
\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \]  
\[ \{ R_4 \}, \{ R_5 \}; 2; -\sigma_0, \sigma_3; \]  
\[ \text{P-WNLs}; \]  
\[ \]  
\[ P; \text{KH}; C_3^+ \sigma_{d1}; \]  
\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \]  
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \]  
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \]  
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \]  
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \]  
\[ \text{P-WNLs}; \]  
\[ \]  
\[ T; \Gamma_K; C_{22}^\prime \sigma_{d2}; \]  
\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \]  
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \]  
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \]  
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \]  
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \]  
\[ \text{P-WNLs}; \]  
\[ \]  
\[ T'; \text{MK}; C_{21}^\prime \sigma_{d1}; \]  
\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \]  
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \]  
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \]  
\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \]  
\[ \{ R_4 \}, \{ R_5 \}; 2; -\sigma_0, \sigma_3; \]  
\[ \text{P-WNLs}; \]  
\[ \]  
\[ \Sigma; \Gamma_M; \sigma_h, T \sigma_{d1}; \]  
\[ \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \]  
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \]  
\[ \{ R_3 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_3; \]  
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \]  
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \]  
\[ \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma A; \quad C_{0}^{+}, \sigma_{v1}, IT; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_{3}, \sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_{3}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_5 \}; \quad 3; \quad A_{36}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \quad \text{QTP}; \]

\[ \{ R_1 \}, \{ R_6 \}; \quad 3; \quad A_{39}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \quad \text{TP}; \]

\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_{3}, -\sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_{3}, -\sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_5 \}; \quad 3; \quad A_{36}, A_{10}, A_{13}; \quad \text{QTP}; \]

\[ \{ R_2 \}, \{ R_6 \}; \quad 3; \quad A_{39}, A_{10}, A_{13}; \quad \text{TP}; \]

\[ \{ R_3 \}, \{ R_4 \}; \quad 2; \quad -\sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_3 \}, \{ R_5 \}; \quad 3; \quad A_{40}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \quad \text{TP}; \]

\[ \{ R_3 \}, \{ R_6 \}; \quad 3; \quad A_{24}, \frac{1}{2} (A_0 + 2\sqrt{3}A_8), A_{13}; \quad \text{QTP}; \]

\[ \{ R_4 \}, \{ R_5 \}; \quad 3; \quad A_{40}, A_{10}, A_{13}; \quad \text{TP}; \]

\[ \{ R_4 \}, \{ R_6 \}; \quad 3; \quad A_{24}, A_{10}, A_{13}; \quad \text{QTP}; \]

\[ \{ R_5 \}, \{ R_6 \}; \quad 4; \quad \frac{\sqrt{3}}{2}, \frac{\sqrt{3}}{2}, -\sigma_{0}, -\sigma_{0}; \quad \text{DP}; \quad 0 \]

\[ U: \quad \text{ML; } \quad C_{2}, \sigma_{v1}, IT; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_{3}, \sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_{3}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_{3}, -\sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_{3}, -\sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_3 \}, \{ R_4 \}; \quad 2; \quad -\sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ P: \quad \text{KH; } \quad C_{3}^{+}, \sigma_{d1}, IT; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_{3}, \sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_{3}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_{3}, -\sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_{3}, -\sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_3 \}, \{ R_4 \}; \quad 2; \quad -\sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ T: \quad \text{ГК; } \quad C_{22}^{+}, \sigma_{d2}, IT; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_{3}, \sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_{3}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_{3}, -\sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_{3}, -\sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_3 \}, \{ R_4 \}; \quad 2; \quad -\sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ S: \quad \text{AH; } \quad C_{22}^{+}, \sigma_{d2}, IT; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_{3}, \sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_{3}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_{3}, -\sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_4 \}; \quad 2; \quad -\sigma_{0}, \sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_3 \}, \{ R_4 \}; \quad 2; \quad -\sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ T': \quad \text{MK; } \quad C_{21}^{+}, \sigma_{d1}, IT; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_{3}, \sigma_{0}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_{3}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_{3}, -\sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_2 \}, \{ R_4 \}; \quad 2; \quad -\sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]

\[ \{ R_3 \}, \{ R_4 \}; \quad 2; \quad -\sigma_{0}, \sigma_{3}, \sigma_{0}; \quad \text{P-WNLs}; \]
\[ S'; \text{ LH; } C_{21,\sigma v,1,IT}^\prime \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs; } \]
\[ \{ R_3 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_4 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_2 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_3 \}, \{ R_3 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs; } \]
\[ \Sigma; \text{ GM; } C_{21,\sigma v,1,IT}^\prime \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs; } \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_4 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_3 \}, \{ R_3 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs; } \]
\[ R'; \text{ AL; } C_{21,\sigma v,1,IT}^\prime \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs; } \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_4 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{ P-WNL; } \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{ P-WNLs; } \]
Accidental degeneracies on high symmetry line

$\Delta; \Gamma_2; C_{6}^{+}\sigma_{v,1,IT}; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{3}\}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{4}\}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{5}\}; 3; A_{36}, \frac{1}{3}(A_{0} + 2\sqrt{3}A_{3}), A_{13}; \text{QTP};$

$(R_{1}), \{R_{6}\}; 3; A_{39}, \frac{1}{3}(A_{0} + 2\sqrt{3}A_{3}), A_{13}; \text{TP};$

$(R_{2}), \{R_{4}\}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{2}), \{R_{5}\}; 3; A_{36}, A_{10}, A_{13}; \text{QTP};$

$(R_{2}), \{R_{6}\}; 3; A_{39}, A_{10}, A_{13}; \text{TP};$

$(R_{3}), \{R_{4}\}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{3}), \{R_{5}\}; 3; A_{40}, \frac{1}{3}(A_{0} + 2\sqrt{3}A_{3}), A_{13}; \text{TP};$

$(R_{3}), \{R_{6}\}; 3; A_{24}, \frac{1}{3}(A_{0} + 2\sqrt{3}A_{3}), A_{13}; \text{QTP};$

$(R_{4}), \{R_{5}\}; 3; A_{40}, A_{10}, A_{13}; \text{TP};$

$(R_{4}), \{R_{6}\}; 3; A_{24}, A_{10}, A_{13}; \text{QTP};$

$(R_{5}), \{R_{6}\}; 4; \Gamma_{0,0}^{\sigma_{1}+\sqrt{3}\sigma_{2}}, \Gamma_{0,3}, \Gamma_{0,0}; \text{DP}; 0$

$U; \text{ML}; C_{2}, \sigma_{v,1,IT}; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{3}\}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{4}\}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{2}), \{R_{3}\}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{2}), \{R_{4}\}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \text{P-WNLs};$

$(R_{3}), \{R_{4}\}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$P; \text{KH}; C_{3}^{+}\sigma_{d,1,IT}; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{3}\}; 3; A_{36}, \frac{A_{0} + 2\sqrt{3}A_{3}}{3}, A_{13}; \text{TP};$

$(R_{2}), \{R_{3}\}; 3; A_{36}, A_{10}, A_{13}; \text{TP};$

$T; \text{KK}; C_{22}^{+}\sigma_{d,2,IT}; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{3}\}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{4}\}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{2}), \{R_{3}\}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{2}), \{R_{4}\}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \text{P-WNLs};$

$(R_{3}), \{R_{4}\}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$T'; \text{MK}; C_{21}^{+}\sigma_{d,1,IT}; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{3}\}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{4}\}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{2}), \{R_{3}\}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{2}), \{R_{4}\}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \text{P-WNLs};$

$(R_{3}), \{R_{4}\}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$\Sigma; \text{GM}; C_{21}^{+}\sigma_{v,1,IT}; \{R_{1}\}, \{R_{2}\}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{3}\}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \text{P-WNLs};$

$(R_{1}), \{R_{4}\}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{2}), \{R_{3}\}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \text{P-WNLs};$

$(R_{2}), \{R_{4}\}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \text{P-WNLs};$

$(R_{3}), \{R_{4}\}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \text{P-WNLs};$
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_{0}^{+}, \sigma_{v1}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_5 \}; 3; \ A_{36}, \frac{1}{3} (A_{0} + 2\sqrt{3}A_{8}), A_{13}; \ QTP; \]
\[ \{ R_1 \}, \{ R_6 \}; 3; \ A_{39}, \frac{1}{3} (A_{0} + 2\sqrt{3}A_{8}), A_{13}; \ TP; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_2 \}, \{ R_5 \}; 3; A_{36}, A_{10}, A_{13}; \ QTP; \]
\[ \{ R_2 \}, \{ R_6 \}; 3; A_{39}, A_{10}, A_{13}; \ TP; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_3 \}, \{ R_5 \}; 3; A_{40}, \frac{1}{3} (A_{0} + 2\sqrt{3}A_{8}), A_{13}; \ TP; \]
\[ \{ R_3 \}, \{ R_6 \}; 3; A_{42}, \frac{1}{3} (A_{0} + 2\sqrt{3}A_{8}), A_{13}; \ QTP; \]
\[ \{ R_4 \}, \{ R_5 \}; 3; A_{40}, A_{10}, A_{13}; \ TP; \]
\[ \{ R_4 \}, \{ R_6 \}; 3; A_{42}, A_{10}, A_{13}; \ QTP; \]
\[ \{ R_1 \}, \{ R_6 \}; 4; \Gamma_{0,0}^3 + 4\sqrt{3}\Gamma_{0,2}^1, \Gamma_{0,3}, -\Gamma_{0,0}; \ DP; \]

\[ U; \ ML; C_{2}, \sigma_{v1}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]

\[ P; \ KH; C_{3}^{+}, \sigma_{d1}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \ A_{0} + 2\sqrt{3}A_{8}, A_{13}; \ TP; \]
\[ \{ R_1 \}, \{ R_5 \}; 3; A_{36}, A_{10}, A_{13}; \ TP; \]

\[ T; \ GK; C_{22}^{+}, \sigma_{d3}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]

\[ S; \ AH; C_{22}^{+}, \sigma_{d2}, IT; \{ R_2, R_4 \}, \{ R_6, R_8 \}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \ DP; \]

\[ T'; \ MK; C_{21}^{+}, \sigma_{d1}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]

\[ S'; \ LH; C_{21}^{+}, \sigma_{d1}, IT; \{ R_2, R_4 \}, \{ R_6, R_8 \}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \ DP; \]

\[ \Sigma; \ GM; C_{21}^{+}, \sigma_{e1}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \ P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \ P-WNL; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_v, IT; \{ R_1 \}, \{ R_2 \} ; \begin{array}{c}
2; \sigma_0, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_0, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
3; A_{36}, \frac{1}{4} \left( A_0 + 2\sqrt{3} A_8 \right), A_{13}; \\
3; A_{39}, \frac{1}{4} \left( A_0 + 2\sqrt{3} A_8 \right), A_{13}; \\
2; \sigma_3, -\sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_0, \sigma_0; \\
3; A_{36}, A_{10}, A_{13}; \\
3; A_{39}, A_{10}, A_{13}; \\
3; A_{24}, A_{10}, A_{13}; \\
3; A_{24}, A_{10}, A_{13}; \\
4; \Gamma_{0,3}^{\pm}, \Gamma_{0,3}, -\Gamma_{0,0}; \\
\end{array} P\text{-WNLs;} \]

\[ U; ML; C_{2, v}, IT; \{ R_1 \}, \{ R_2 \} ; \begin{array}{c}
2; \sigma_0, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_0, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_0, \sigma_0; \\
2; -\sigma_0, \sigma_3, \sigma_0; \\
2; -\sigma_0, \sigma_0, \sigma_0; \\
3; A_{36}, A_{10}, A_{13}; \\
3; A_{36}, A_{10}, A_{13}; \\
3; A_{24}, A_{10}, A_{13}; \\
3; A_{24}, A_{10}, A_{13}; \\
4; \Gamma_{0,3}^{\pm}, \Gamma_{0,3}, -\Gamma_{0,0}; \\
\end{array} P\text{-WNLs;} \]

\[ P; KH; C_{3, v}, IT; \{ R_1 \}, \{ R_2 \} ; \begin{array}{c}
2; \sigma_0, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_0, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_0, \sigma_0; \\
2; -\sigma_0, \sigma_3, \sigma_0; \\
2; -\sigma_0, \sigma_0, \sigma_0; \\
3; A_{36}, A_{10}, A_{13}; \\
3; A_{36}, A_{10}, A_{13}; \\
3; A_{24}, A_{10}, A_{13}; \\
3; A_{24}, A_{10}, A_{13}; \\
\end{array} P\text{-WNLs;} \]

\[ T; GK; C_{2, v}, IT; \{ R_1 \}, \{ R_2 \} ; \begin{array}{c}
2; \sigma_0, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_0, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_0, \sigma_0; \\
2; -\sigma_0, \sigma_3, \sigma_0; \\
2; -\sigma_0, \sigma_0, \sigma_0; \\
2; \sigma_0, \sigma_3, \sigma_0; \\
2; \sigma_0, \sigma_0, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_0, \sigma_0; \\
2; -\sigma_0, \sigma_3, \sigma_0; \\
2; -\sigma_0, \sigma_0, \sigma_0; \\
\end{array} P\text{-WNLs;} \]

\[ T'; MK; C_{3, v}, IT; \{ R_1 \}, \{ R_2 \} ; \begin{array}{c}
2; \sigma_0, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_0, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_0, \sigma_0; \\
2; -\sigma_0, \sigma_3, \sigma_0; \\
2; -\sigma_0, \sigma_0, \sigma_0; \\
2; \sigma_0, \sigma_3, \sigma_0; \\
2; \sigma_0, \sigma_0, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_0, \sigma_0; \\
2; -\sigma_0, \sigma_3, \sigma_0; \\
2; -\sigma_0, \sigma_0, \sigma_0; \\
\end{array} P\text{-WNLs;} \]

\[ \Sigma; GM; C_{2, v}, IT; \{ R_1 \}, \{ R_2 \} ; \begin{array}{c}
2; \sigma_0, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_0, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_0, \sigma_0; \\
2; -\sigma_0, \sigma_3, \sigma_0; \\
2; -\sigma_0, \sigma_0, \sigma_0; \\
2; \sigma_0, \sigma_3, \sigma_0; \\
2; \sigma_0, \sigma_0, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, \sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_3, \sigma_0; \\
2; \sigma_3, -\sigma_0, \sigma_0; \\
2; -\sigma_0, \sigma_3, \sigma_0; \\
2; -\sigma_0, \sigma_0, \sigma_0; \\
\end{array} P\text{-WNLs;} \]

\[ R; AL; \sigma_0, \sigma_1, IT; \{ R_2, R_4 \}, \{ R_6, R_8 \} ; \begin{array}{c}
4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \\
\end{array} P\text{-WNLs;} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \ C_{2y}, \mathcal{T}C_{2z}; \ \{R_1\}, \{R_2\}; \ 2; \ \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Lambda; \ \Gamma R; \ C_{3z}^+; \ \{R_1\}, \{R_2\}; \ 2; \ -\sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ \quad \{R_1\}, \{R_3\}; \ 2; \ \frac{(1+\sqrt{3})\sigma_3-(\sqrt{3}-1)\sigma_0}{2}; \quad \text{C-1 WP; 1} \]

\[ \quad \{R_2\}, \{R_3\}; \ 2; \ \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

\[ Z; \ \Xi M; \ C_{2x}, \mathcal{T}C_{2z}; \ \{R_1\}, \{R_2\}; \ 2; \ \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ T; \ \Xi M R; \ C_{2z}, \mathcal{T}C_{2x}; \ \{R_2,R_2\}, \{R_4,R_4\}; \ 4; \ \Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{C-2 DP; 2} \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \ C_{2y}, \mathcal{T}C_{2z}; \ \{R_1\}, \{R_2\}; \ 2; \ \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Lambda; \ \Gamma L; \ C_{3z}^+; \ \{R_1\}, \{R_2\}; \ 2; \ -\sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ \quad \{R_1\}, \{R_3\}; \ 2; \ \frac{(1+\sqrt{3})\sigma_3-(\sqrt{3}-1)\sigma_0}{2}; \quad \text{C-1 WP; 1} \]

\[ \quad \{R_2\}, \{R_3\}; \ 2; \ \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

\[ Z; \ \Xi W; \ C_{2x}, \mathcal{T}C_{2z}; \ \{R_1\}, \{R_2\}; \ 2; \ \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma H; \ C_{2y}, \mathcal{T}C_{2z}; \ \{R_1\}, \{R_2\}; \ 2; \ \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Lambda; \ \Gamma P; \ C_{3z}^+; \ \{R_1\}, \{R_2\}; \ 2; \ -\sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ \quad \{R_1\}, \{R_3\}; \ 2; \ \frac{(1+\sqrt{3})\sigma_3-(\sqrt{3}-1)\sigma_0}{2}; \quad \text{C-1 WP; 1} \]

\[ \quad \{R_2\}, \{R_3\}; \ 2; \ \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

\[ D; \ \Xi P; \ C_{2z}; \ \{R_2\}, \{R_3\}; \ 2; \ \sigma_3; \quad \text{C-1 WP; 1} \]

\[ F; \ \Xi P H; \ C_{3z}^+; \ \{R_1\}, \{R_2\}; \ 2; \ -\sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ \quad \{R_1\}, \{R_3\}; \ 2; \ \frac{(1+\sqrt{3})\sigma_3-(\sqrt{3}-1)\sigma_0}{2}; \quad \text{C-1 WP; 1} \]

\[ \quad \{R_2\}, \{R_3\}; \ 2; \ \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \ C_{2y}, \mathcal{T}C_{2z}; \ \{R_1\}, \{R_2\}; \ 2; \ \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Lambda; \ \Gamma R; \ C_{3z}^+; \ \{R_1\}, \{R_2\}; \ 2; \ -\sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ \quad \{R_1\}, \{R_3\}; \ 2; \ \frac{(1+\sqrt{3})\sigma_3-(\sqrt{3}-1)\sigma_0}{2}; \quad \text{C-1 WP; 1} \]

\[ \quad \{R_2\}, \{R_3\}; \ 2; \ \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3); \quad \text{C-1 WP; 1} \]

\[ T; \ \Xi M R; \ C_{2z}, \mathcal{T}C_{2x}; \ \{R_2,R_2\}, \{R_4,R_4\}; \ 4; \ \Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{C-2 DP; 2} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \text{GH}; C_{2y}, JC_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{C-1 WP; 1} \]
\[ \Lambda; \text{GP}; C_{31}^+; \{ R_1 \}, \{ R_2 \}; 2; -\sigma_0; \text{C-1 WP; 1} \]
\[ \quad \{ R_1 \}, \{ R_3 \}; 2; \frac{1 + \sqrt{3} \sigma_3}{2} - \frac{(\sqrt{3} - 1) \sigma_0}{2}; \text{C-1 WP; 1} \]
\[ \quad \{ R_2 \}, \{ R_3 \}; 2; \frac{1}{2} (-\sigma_0 + i \sqrt{3} \sigma_3); \text{C-1 WP; 1} \]
\[ D; \text{NP}; C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; \sigma_3; \text{P-WNL; 1} \]
\[ F; \text{PH}; C_{34}^+; \{ R_2 \}, \{ R_4 \}; 2; \frac{(\sqrt{3} + 1) \sigma_0 + (\sqrt{3} - 1) \sigma_3}{4}; \text{C-1 WP; 1} \]
\[ \quad \{ R_2 \}, \{ R_5 \}; 2; \frac{1}{2} (\sqrt{3} \sigma_3 - i \sigma_0); \text{C-1 WP; 1} \]
\[ \quad \{ R_3 \}, \{ R_4 \}; 2; \sigma_{14}; \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \text{GX}; C_{2y}, \sigma_x, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \quad \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \Sigma; \text{GM}; \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \Lambda; \text{GR}; C_{31}^+, IT; \{ R_1 \}, \{ R_2, R_3 \}; 3; A_{33}, A_{17}; \text{TP;} \]
\[ S; \text{XR}; \sigma_y, IT; \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0; \text{P-WNL;} \]
\[ Z; \text{XM}; C_{2x}, \sigma_x, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \quad \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]

\[ T; \text{MR}; C_{2x}, \sigma_y, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
\[ \quad \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL;} \]
\[ \quad \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs;} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \quad C_{2y}\sigma_x IT; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; \quad 2; \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; \quad 2; \sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_5\}, \{R_3\}; \quad 2; \sigma_3, -\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; \quad 2; \sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; \quad 2; -\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]

\[ \Sigma; \Gamma M; \quad \sigma_z IT; \quad \{R_1\}, \{R_2\}; \quad 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \Lambda; \Gamma R; \quad C_{31}^+ IT; \quad \{R_1\}, \{R_2, R_3\}; \quad 3; \ A_{33}, A_{17}; \quad \text{TP}; \]
\[ S; \ X R; \quad \sigma_y IT; \quad \{R_3\}, \{R_4\}; \quad 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ T; \ M R; \quad \sigma_y C_{2z}, IT; \quad \{R_2\}, \{R_4\}; \quad 2; -i\sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{R_2\}, \{R_6\}; \quad 2; -i\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_4\}, \{R_8\}; \quad 2; -i\sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_1\}, \{R_6\}; \quad 2; i\sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_1\}, \{R_8\}; \quad 2; i\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{R_5\}, \{R_8\}; \quad 2; -i\sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y}\sigma_z I T; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_2, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \Lambda; \Gamma L; C_{31}^+ I T; \{R_1\}, \{R_2, R_3\}; 3; A_{33}, A_{17}; \text{TP}; \]
\[ \Sigma; \Gamma \Sigma; \sigma_z I T; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ S; X S; \sigma_y I T; \{R_2\}, \{R_4\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]

SG 204

Accidental degeneracies on high symmetry line

\[ \Sigma; \Gamma N; \sigma_z I T; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \Delta; \Gamma H; C_{2y}\sigma_z I T; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \Lambda; \Gamma P; C_{31}^+ I T; \{R_1\}, \{R_2, R_3\}; 3; A_{33}, A_{17}; \text{TP}; \]
\[ D; N P; C_{2z} I T; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ G; H N; \sigma_z I T; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ F; P H; C_{31}^+ I T; \{R_1\}, \{R_2, R_3\}; 3; A_{33}, A_{17}; \text{TP}; \]

SG 205

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y}\sigma_z I T; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \Sigma; \Gamma M; \sigma_z I T; \{R_1\}, \{R_2\}; 2; \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \Lambda; \Gamma R; C_{31}^+ I T; \{R_1\}, \{R_2, R_3\}; 3; A_{33}, A_{17}; \text{TP}; \]
\[ Z; X M; C_{2z}\sigma_z I T; \{R_2, R_4\}, \{R_6, R_8\}; 4; \Gamma_{0,3}, \Gamma_{3,0}, \Gamma_{0,1}; \text{DP}; \]
\[ 0 \]
Accidental degeneracies on high symmetry line

\( \Sigma; \Gamma_N; \sigma_z, IT; \{R_1\}, \{R_2\}; \begin{array}{c} 2; \sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{P-WNL;} \end{array} \)

\( \Delta; \Gamma_H; C_{2y}, \sigma_z, IT; \{R_1\}, \{R_2\}; \begin{array}{c} 2; \sigma_0, \sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{P-WNL;} \end{array} \)

\( \{R_1\}, \{R_3\}; \begin{array}{c} 2; \sigma_3, \sigma_0, \sigma_0; \end{array} \begin{array}{c} \text{P-WNL;} \end{array} \)

\( \{R_1\}, \{R_4\}; \begin{array}{c} 2; \sigma_3, \sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{P-WNL;} \end{array} \)

\( \{R_2\}, \{R_3\}; \begin{array}{c} 2; \sigma_3, -\sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{P-WNL;} \end{array} \)

\( \{R_2\}, \{R_4\}; \begin{array}{c} 2; \sigma_3, -\sigma_0, \sigma_0; \end{array} \begin{array}{c} \text{P-WNL;} \end{array} \)

\( \{R_3\}, \{R_4\}; \begin{array}{c} 2; -\sigma_0, \sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{P-WNL;} \end{array} \)

\( \Lambda; \Gamma_P; C_{31}^+, IT; \{R_1\}, \{R_2, R_3\}; \begin{array}{c} 3; A_{33}, A_{17}; \end{array} \begin{array}{c} \text{TP;} \end{array} \)

\( G; \Gamma_N; \sigma_z, IT; \{R_1\}, \{R_2\}; \begin{array}{c} 2; -i\sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{P-WNL;} \end{array} \)

\( F; \Gamma_H; C_{34}^+, IT; \{R_2, R_6\}, \{R_4\}; \begin{array}{c} 3; \sqrt{1/2(A_0 - iA_4)}, A_{20}; \end{array} \begin{array}{c} \text{TP;} \end{array} \)

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Accidental degeneracies on high symmetry line

\( \Delta; \Gamma_X; C_{4z}, C_{2z}T; \{R_1\}, \{R_2\}; \begin{array}{c} 2; \left( \frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( \{R_1\}, \{R_3\}; \begin{array}{c} 2; \sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{C-2 WP;} \end{array} \)

\( \{R_1\}, \{R_4\}; \begin{array}{c} 2; \left( \frac{1}{2} - \frac{i}{2} \right)(\sigma_0 + i\sigma_3), \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( \{R_2\}, \{R_3\}; \begin{array}{c} 2; \left( -\frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( \{R_2\}, \{R_4\}; \begin{array}{c} 2; i\sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{C-2 WP;} \end{array} \)

\( \{R_3\}, \{R_4\}; \begin{array}{c} 2; \left( -\frac{1}{2} - \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( \Sigma; \Gamma_M; C_{2a}, C_{2a}T; \{R_1\}, \{R_2\}; \begin{array}{c} 2; \sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( \Lambda; \Gamma_R; C_{31}^+, C_{2z}T; \{R_1\}, \{R_2\}; \begin{array}{c} 2; -\sigma_{10}, \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( \{R_1\}, \{R_3\}; \begin{array}{c} 2; \left( \frac{1}{2} + \frac{i}{2} \right)\sigma_3 - \left( \frac{1}{2} - \frac{i}{2} \right)\sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( \{R_2\}, \{R_3\}; \begin{array}{c} 2; \frac{1}{2}(-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( S; \Gamma_R; C_{2z}, C_{2z}T; \{R_1\}, \{R_4\}; \begin{array}{c} 2; \sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( Z; \Gamma_M; C_{2z}, T; \{R_1\}, \{R_3\}; \begin{array}{c} 2; \sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( T; \Gamma_R; C_{4z}, T; \{R_1\}, \{R_2\}; \begin{array}{c} 2; \left( \frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( \{R_1\}, \{R_3\}; \begin{array}{c} 2; \sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{C-2 WP;} \end{array} \)

\( \{R_1\}, \{R_4\}; \begin{array}{c} 2; \left( \frac{1}{2} - \frac{i}{2} \right)(\sigma_0 + i\sigma_3), \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( \{R_2\}, \{R_3\}; \begin{array}{c} 2; \left( -\frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)

\( \{R_2\}, \{R_4\}; \begin{array}{c} 2; i\sigma_3, \sigma_0; \end{array} \begin{array}{c} \text{C-2 WP;} \end{array} \)

\( \{R_3\}, \{R_4\}; \begin{array}{c} 2; \left( -\frac{1}{2} - \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \end{array} \begin{array}{c} \text{C-1 WP;} \end{array} \)
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{3y}^+, C_{2c} T; \{ R_1 \}, \{ R_2 \}; 2; \left( \frac{1}{2} + \frac{i}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \quad C-2 \text{ WP; 2} \]

\[ \{ R_1 \}, \{ R_4 \}; 2; \left( \frac{1}{2} - \frac{i}{2} \right) (\sigma_0 + i\sigma_3), \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \{ R_2 \}, \{ R_3 \}; 2; \left( -\frac{1}{2} + \frac{i}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad C-2 \text{ WP; 2} \]

\[ \{ R_3 \}, \{ R_4 \}; 2; \left( -\frac{1}{2} - \frac{i}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \Sigma; \Gamma M; C_{2a}, C_{2b} T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \Lambda; \Gamma R; C_{3z}^+, C_{2c} T; \{ R_1 \}, \{ R_2 \}; 2; -\sigma_{10}, \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; 2; \frac{(1 + \sqrt{3})\sigma_3 - (\sqrt{3} - 1)\sigma_0}{2}, \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \{ R_2 \}, \{ R_3 \}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ S; \chi R; C_{2c}, C_{2c} T; \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ Z; \chi M; C_{2b}, T C_{2y}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ T; \chi R; C_{3z}^+, E, T C_{2y}; \{ R_5 \}, \{ R_6 \}; 2; \left( -\frac{1}{2} - \frac{i}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0, \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \{ R_5 \}, \{ R_7 \}; 2; \left( \frac{1}{2} - \frac{1}{2} \right) (\sigma_0 + i\sigma_3), \sigma_0, \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \{ R_6 \}, \{ R_7 \}; 2; \left( \frac{1}{2} - \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0, \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \left( -\frac{1}{2} - \frac{i}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0, \sigma_0; \quad C-1 \text{ WP; 1} \]

\[ \{ R_7 \}, \{ R_8 \}; 2; \left( \frac{1}{2} - \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0, \sigma_0; \quad C-1 \text{ WP; 1} \]
Accidental degeneracies on high symmetry line

\[
\Delta; \quad \Gamma X; \quad \text{C}_2^+; \quad 4y, \text{C}_2 c T; \quad \{R_1\}, \{R_2\}; \quad 2; \quad \left(\frac{1}{2} + i\frac{3}{2}\right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\{R_1\}, \{R_3\}; \quad 2; \quad \sigma_3, \sigma_0; \quad \text{C-2 WP; 2}
\]

\[
\{R_2\}, \{R_4\}; \quad 2; \quad \left(\frac{1}{2} - \frac{3}{2}\right)(\sigma_0 + i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\{R_2\}, \{R_5\}; \quad 2; \quad \left(-\frac{1}{2} + \frac{1}{2}\right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3, \sigma_0; \quad \text{C-2 WP; 2}
\]

\[
\{R_3\}, \{R_4\}; \quad 2; \quad \left(-\frac{1}{2} - \frac{1}{2}\right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\Lambda; \quad \Gamma L; \quad \text{C}_{31}^+; \quad \text{C}_2 T; \quad \{R_1\}, \{R_2\}; \quad 2; \quad -\sigma_{10}, \sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\{R_1\}, \{R_3\}; \quad 2; \quad \frac{1}{2}(\sqrt{3} - 1\sigma_3 - \sqrt{3} - 1\sigma_0); \quad \text{C-1 WP; 1}
\]

\[
\{R_2\}, \{R_3\}; \quad 2; \quad \frac{1}{2}(-\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\Sigma; \quad \Gamma \Sigma; \quad \text{C}_2; \quad \text{C}_2 T; \quad \{R_1\}, \{R_2\}; \quad 2; \quad \sigma_3, \sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\{R_1\}, \{R_4\}; \quad 2; \quad \sigma_3, \sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\text{S}; \quad \text{XS}; \quad \text{C}_2; \quad \text{C}_2 T; \quad \{R_1\}, \{R_4\}; \quad 2; \quad \sigma_3, \sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\text{Z}; \quad \text{XW}; \quad \text{C}_2 x, \text{T} \text{C}_2 y; \quad \{R_1\}, \{R_2\}; \quad 2; \quad \sigma_3, \sigma_0; \quad \text{C-1 WP; 1}
\]

\[
\text{Q}; \quad \text{LW}; \quad \text{C}_2 f; \quad \{R_4\}, \{R_8\}; \quad 2; \quad \sigma_3; \quad \text{C-1 WP; 1}
\]
SG 211

Accidental degeneracies on high symmetry line

\[ \Sigma; \Gamma N; C_{2a}, C_{2b} T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \Delta; \Gamma H; C_{2g}^+, C_{2c} T; \{ R_1 \}, \{ R_2 \}; 2; \left( \frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \quad \text{C-2 WP; 2} \]
\[ \{ R_3 \}, \{ R_4 \}; 2; \left( \frac{1}{2} - \frac{i}{2} \right)(\sigma_0 + i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \left( \frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_3 \}, \{ R_4 \}; 2; \left( \frac{1}{2} - \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \Lambda; \Gamma P; C_{3v}^+, C_{2c} T; \{ R_1 \}, \{ R_3 \}; 2; -\sigma_{10}, \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}; \{ R_4 \}; 2; \left( \frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}; \{ R_3 \}; 2; \left( \frac{1}{2} - \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]

SG 212

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2g}^+, C_{2c} T; \{ R_1 \}, \{ R_2 \}; 2; \left( \frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \quad \text{C-2 WP; 2} \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \left( \frac{1}{2} - \frac{i}{2} \right)(\sigma_0 + i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \left( \frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad \text{C-2 WP; 2} \]
\[ \{ R_3 \}, \{ R_4 \}; 2; \left( \frac{1}{2} - \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \Sigma; \Gamma M; C_{2a}, C_{2b} T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \Lambda; \Gamma R; C_{3v}^+, C_{2c} T; \{ R_1 \}, \{ R_2 \}; 2; -\sigma_{10}, \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}; \{ R_3 \}; 2; \left( \frac{1}{2} + \frac{i}{2} \right)(\sigma_0 - i\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}; \{ R_4 \}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0; \quad \text{C-1 WP; 1} \]
\[ T; \text{MR; } C_{4v}^+, C_{2c} T; \{ R_5, R_7 \}, \{ R_6, R_8 \}; 4; -\frac{(1+i)(\Gamma_{0,0} - i\Gamma_{0,2})}{2}, \Gamma_{0,0}, -i\Gamma_{0,2}; \quad \text{C-2 DP; 2} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \ \Gamma X; \ C^+_{4y}, C_{2y} T; \ \{ R_1 \}, \{ R_2 \}; \ 2; \left( \frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; \ 2; \sigma_3, \sigma_0; \ \text{C-2 WP; 2} \]

\[ \{ R_1 \}, \{ R_4 \}; \ 2; \left( \frac{1}{2} - \frac{1}{2} \right) (\sigma_0 + i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; \ 2; \left( -\frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; \ 2; i\sigma_3, \sigma_0; \ \text{C-2 WP; 2} \]

\[ \{ R_2 \}, \{ R_3 \}; \ 2; \left( -\frac{1}{2} - \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \Sigma; \ \Gamma M; \ C_{2y}, C_{2y} T; \ \{ R_1 \}, \{ R_2 \}; \ 2; \sigma_3, \sigma_0; \ \text{C-1 WP; 1} \]

\[ \Lambda; \ \Gamma R; \ C^+_{31}, C_{2y} T; \ \{ R_1 \}, \{ R_2 \}; \ 2; -\sigma_{10}, \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; \ 2; \left( 1 + \frac{1}{2} \right) \left( \frac{1+\sqrt{3}}{2} \right) \sigma_0, \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_4 \}; \ 2; \left( 1 + \frac{1}{2} \right) \sigma_0, \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_3 \}; \ 2; \left( -\frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; \ 2; i\sigma_3, \sigma_0; \ \text{C-2 WP; 2} \]

\[ \{ R_3 \}, \{ R_4 \}; \ 2; \left( -\frac{1}{2} - \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ T; \ \text{MR; } C^+_{4y}, E, T C_{2y}; \ \{ R_5, R_7 \}, \{ R_6, R_8 \}; \ 4; -\frac{(1+i)(\Gamma_{0,3} - i\Gamma_{3,0})}{2}, \Gamma_{0,0}, -i\Gamma_{0,2}; \ \text{C-2 DP; 2} \]

Accidental degeneracies on high symmetry line

\[ \Sigma; \ \Gamma N; \ C_{2y}, C_{2y} T; \ \{ R_1 \}, \{ R_3 \}; \ 2; \sigma_3, \sigma_0; \ \text{C-1 WP; 1} \]

\[ \Delta; \ \Gamma H; \ C^+_{4y}, C_{2y} T; \ \{ R_1 \}, \{ R_2 \}; \ 2; \left( \frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; \ 2; \sigma_3, \sigma_0; \ \text{C-2 WP; 2} \]

\[ \{ R_1 \}, \{ R_4 \}; \ 2; \left( \frac{1}{2} - \frac{1}{2} \right) (\sigma_0 + i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_3 \}; \ 2; \left( -\frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; \ 2; i\sigma_3, \sigma_0; \ \text{C-2 WP; 2} \]

\[ \{ R_3 \}, \{ R_4 \}; \ 2; \left( -\frac{1}{2} - \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \Lambda; \ \Gamma P; \ C_{31}, C_{2y} T; \ \{ R_1 \}, \{ R_2 \}; \ 2; -\sigma_{10}, \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_3 \}; \ 2; \left( 1 + \frac{1}{2} \right) \left( \frac{1+\sqrt{3}}{2} \right) \sigma_0, \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_1 \}, \{ R_4 \}; \ 2; \left( 1 + \frac{1}{2} \right) \sigma_0, \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_3 \}; \ 2; \left( -\frac{1}{2} + \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; \ 2; i\sigma_3, \sigma_0; \ \text{C-2 WP; 2} \]

\[ \{ R_3 \}, \{ R_4 \}; \ 2; \left( -\frac{1}{2} - \frac{1}{2} \right) (\sigma_0 - i\sigma_3), \sigma_0; \ \text{C-1 WP; 1} \]

\[ D; \ \text{NP; } C_{2y}, C_{2y} T; \ \{ R_2 \}, \{ R_4 \}; \ 2; \sigma_3, \sigma_0; \ \text{C-1 WP; 1} \]

\[ G; \ \text{HN; } C_{2y}, T C_{2y}; \ \{ R_2 \}, \{ R_3 \}; \ 2; \sigma_3, \sigma_0; \ \text{C-1 WP; 1} \]

\[ F; \ \text{PH; } C^+_{31}, C_{2y} T; \ \{ R_2 \}, \{ R_3 \}; \ 2; \left( \frac{1+\sqrt{3}}{2} + i\frac{1-\sqrt{3}}{2} \right) \sigma_0, \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_2 \}, \{ R_4 \}; \ 2; \left( \frac{1}{2} (\sqrt{3} \sigma_3 + i\sigma_0) \right), \sigma_0; \ \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_5 \}; \ 2; \sigma_{14}, \sigma_0; \ \text{C-1 WP; 1} \]
Accidental degeneracies on high symmetry line

| 
| \( \Delta; \Gamma X; C_{2y, \sigma_{dc}, S_{4y}^+ T}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_0, \sigma_3, \sigma_0; \) & P-WNLs; \\
| \{R_1\}, \{R_3, R_4\} & 3 & \( A_{13}, \frac{A_0 + 2v \sqrt{A_0}}{3}, A_{19}; \) & TP; \\
| \{R_2\}, \{R_3, R_4\} & 3 & \( A_{13}, A_{10}, A_{19}; \) & TP; \\
| \( \Sigma; \Gamma M; \sigma_{db}, T C_{2z}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_3, \sigma_0; \) & P-WNL; \\
| \( \Lambda; \Gamma R; C_{31}^+, \sigma_{dc}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_0, \sigma_3; \) & P-WNLs; \\
| \{R_1\}, \{R_3\} & 3 & \( A_{36}, \frac{A_0 + 2v \sqrt{A_0}}{3}; \) & TP; \\
| \{R_2\}, \{R_3\} & 3 & \( A_{36}, A_{10}; \) & TP; \\
| \( S; XR; \sigma_{dc}, T \sigma_{dc}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_3, \sigma_0; \) & P-WNL; \\
| \( Z; XM; C_{2z}, T C_{2y}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_3, \sigma_0; \) & C-1 WP; 1; \\
| \( T; MR; C_{2z, \sigma_{da}, S_{4z}^+ T}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_0, \sigma_3, \sigma_0; \) & P-WNLs; \\
| \{R_1\}, \{R_3, R_4\} & 3 & \( A_{13}, \frac{A_0 + 2v \sqrt{A_0}}{3}, A_{19}; \) & TP; \\
| \{R_2\}, \{R_3, R_4\} & 3 & \( A_{13}, A_{10}, A_{19}; \) & TP; \\

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Accidental degeneracies on high symmetry line

| 
| \( \Delta; \Gamma X; C_{2y, \sigma_{dc}, S_{4y}^+ T}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_0, \sigma_3, \sigma_0; \) & P-WNLs; \\
| \{R_1\}, \{R_3, R_4\} & 3 & \( A_{13}, \frac{A_0 + 2v \sqrt{A_0}}{3}, A_{19}; \) & TP; \\
| \{R_2\}, \{R_3, R_4\} & 3 & \( A_{13}, A_{10}, A_{19}; \) & TP; \\
| \( \Lambda; \Gamma L; C_{31}^+, \sigma_{db}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_0, \sigma_3; \) & P-WNLs; \\
| \{R_1\}, \{R_3\} & 3 & \( A_{36}, \frac{A_0 + 2v \sqrt{A_0}}{3}; \) & TP; \\
| \{R_2\}, \{R_3\} & 3 & \( A_{36}, A_{10}; \) & TP; \\
| \( \Sigma; \Gamma \Sigma; \sigma_{db}, T C_{2z}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_3, \sigma_0; \) & P-WNL; \\
| \( S; XS; \sigma_{dc}, T \sigma_{dc}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_3, \sigma_0; \) & P-WNL; \\
| \( Z; XW; C_{2z}, T C_{2y}; \) & \( \{R_1\}, \{R_2\} \) & 2 & \( \sigma_3, \sigma_0; \) & C-1 WP; 1; 

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Accidental degeneracies on high symmetry line

\[ \Sigma; \Gamma_N; \sigma_{db}, TC_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]

\[ \Delta; \Gamma_H; C_{2y}, \sigma_{dc}, S_{3y}^+ T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3, R_4 \}; 3; A_{13}, \frac{A_0 + 2\sqrt{3} A_8}{3}, A_{19}; \quad \text{TP}; \]
\[ \{ R_2 \}, \{ R_3, R_4 \}; 3; A_{13}, A_{10}, A_{19}; \quad \text{TP}; \]

\[ \Lambda; \Gamma_P; C_{31}^+, \sigma_{db}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3; \quad \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3; \quad \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0; \quad \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3; \quad \text{P-WNLs}; \]

\[ G; \Gamma_N; \sigma_{da}, TC_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]

\[ F; \Gamma_H; C_{34}^+, \sigma_{da}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{A_0 + 2\sqrt{3} A_8}{3}; \quad \text{TP}; \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}; \quad \text{TP}; \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_X; C_{2y}, \sigma_{dc}, S_{3y}^+ T; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3, R_4 \}; 3; A_{13}, \frac{A_0 + 2\sqrt{3} A_8}{3}, A_{19}; \quad \text{TP}; \]
\[ \{ R_2 \}, \{ R_3, R_4 \}; 3; A_{13}, A_{10}, A_{19}; \quad \text{TP}; \]

\[ \Sigma; \Gamma_M; \sigma_{db}, TC_{2z}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{P-WNL}; \]

\[ \Lambda; \Gamma_R; C_{31}^+, \sigma_{db}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3; \quad \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{A_0 + 2\sqrt{3} A_8}{3}; \quad \text{TP}; \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}; \quad \text{TP}; \]

\[ Z; \Gamma_M; C_{2x}, TC_{2y}; \{ R_1 \}, \{ R_2 \}; 2; \sigma_3, \sigma_0; \quad \text{C-1 WP}; \quad 1 \]

\[ T; \Gamma_R; C_{2x}, \sigma_{da}, S_{3y}^+ T; \{ R_1, R_2 \}, \{ R_3 \}; 3; \frac{A_0 + 2\sqrt{3} A_8}{3}, A_{10}, -A_{16}; \quad \text{TP}; \]
\[ \{ R_1, R_2 \}, \{ R_3 \}; 3; \frac{A_0 + 2\sqrt{3} A_8}{3}, -A_{13}, -A_{16}; \quad \text{TP}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; -\sigma_0, -\sigma_3, \sigma_0; \quad \text{P-WNLs}; \]
### Accidental degeneracies on high symmetry line

| Symbol | Line | Action | Condition | Notes |
|--------|------|--------|-----------|-------|
| Δ; ΓX; | $C_{2y}, \sigma_{dc}, S_{4y}^+ T$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3, \sigma_0$ | P-WNLs; |
| | | $\{R_1\}, \{R_3, R_4\}$ | 3; $A_{13}, \frac{A_0 + 2\sqrt{3}A_8}{3}, A_{19}$ | TP; |
| | | $\{R_2\}, \{R_3, R_4\}$ | 3; $A_{13}, A_{10}, A_{19}$ | TP; |
| Λ; ΓL; | $C_{31}^+, \sigma_{db}$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3$ | P-WNLs; |
| | | $\{R_1\}, \{R_3\}$ | 3; $A_{36}, \frac{A_0 + 2\sqrt{3}A_8}{3}$ | TP; |
| | | $\{R_2\}, \{R_3\}$ | 3; $A_{36}, A_{10}$ | TP; |
| Σ; ΓΣ; | $\sigma_{db}, TC_{2z}$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_3, \sigma_0$ | P-WNL; |
| S; XS; | $\sigma_{dc}, T \sigma_{dc}$ | $\{R_1\}, \{R_2\}$ | 2; $-\sigma_3, \sigma_0$ | P-WNL; |
| Z; XW; | $C_{2z}, TC_{2y}$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_3, \sigma_0$ | C-1 WP; 1 |

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**SG 220**

### Accidental degeneracies on high symmetry line

| Symbol | Line | Action | Condition | Notes |
|--------|------|--------|-----------|-------|
| Σ; ΓN; | $\sigma_{db}, TC_{2z}$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_3, \sigma_0$ | P-WNL; |
| Δ; ΓH; | $C_{2y}, \sigma_{dc}, S_{4y}^+ T$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3, \sigma_0$ | P-WNLs; |
| | | $\{R_1\}, \{R_3, R_4\}$ | 3; $A_{13}, \frac{A_0 + 2\sqrt{3}A_8}{3}, A_{19}$ | TP; |
| | | $\{R_2\}, \{R_3, R_4\}$ | 3; $A_{13}, A_{10}, A_{19}$ | TP; |
| Λ; ΓP; | $C_{31}^+, \sigma_{db}$ | $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3$ | P-WNLs; |
| | | $\{R_1\}, \{R_3\}$ | 3; $A_{36}, \frac{A_0 + 2\sqrt{3}A_8}{3}$ | TP; |
| | | $\{R_2\}, \{R_3\}$ | 3; $A_{36}, A_{10}$ | TP; |
| F; PH; | $C_{34}^+, \sigma_{da}$ | $\{R_3\}, \{R_4\}$ | 2; $i\sigma_0, -(1)^{3/4}\sigma_3$ | P-WNLs; |
| | | $\{R_3\}, \{R_6\}$ | 3; $-iA_{24}, -(1)^{3/4}(A_0 + 2\sqrt{3}A_8)$ | TP; |
| | | $\{R_4\}, \{R_6\}$ | 3; $-iA_{24}, \frac{1 - iA_{10}}{\sqrt{2}}$ | TP; |
Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma X; C_{4y}^{+}, \sigma_s, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_5\}; 3; A_{29}, \frac{\Delta_{10}+2\sqrt{3}A_8}{3}, A_{13}; TP; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \]
\[ \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; TP; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_3\}, \{R_5\}; 3; -A_{10}, \frac{\Delta_{10}+2\sqrt{3}A_8}{3}, A_{13}; TP; \]
\[ \{R_4\}, \{R_5\}; 3; -A_{10}, A_{10}, A_{13}; TP; \]

\[ \Sigma: \Gamma M; C_{2a}, \sigma_s, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \]
\[ \{R_2\}, \{R_5\}; 3; A_{36}, A_{10}, A_{13}; TP; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_3\}, \{R_5\}; 3; -A_{10}, \frac{\Delta_{10}+2\sqrt{3}A_8}{3}, A_{13}; TP; \]

\[ \Lambda: \Gamma R; C_{31}^{+}, \sigma_d, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{\Delta_{10}+2\sqrt{3}A_8}{3}, A_{13}; TP; \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}, A_{13}; TP; \]

\[ S: \text{XR}; C_{2c}, \sigma_y, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{\Delta_{10}+2\sqrt{3}A_8}{3}, A_{13}; TP; \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}, A_{13}; TP; \]

\[ Z: \text{XM}; C_{2s}, \sigma_s, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \]
\[ \{R_2\}, \{R_5\}; 2; -\sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_3\}, \{R_5\}; 2; -\sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_4\}, \{R_5\}; 2; -\sigma_0, \sigma_3, \sigma_0; \]

\[ T: \text{MR}; C_{4z}^{+}, \sigma_y, IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_5\}; 3; A_{29}, \frac{\Delta_{10}+2\sqrt{3}A_8}{3}, A_{13}; TP; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \]
\[ \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; TP; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_3\}, \{R_5\}; 3; -A_{10}, \frac{\Delta_{10}+2\sqrt{3}A_8}{3}, A_{13}; TP; \]
\[ \{R_4\}, \{R_5\}; 3; -A_{10}, A_{10}, A_{13}; TP; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C^+_4, \sigma_z, IT; \]
\[ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_5\}; 3; A_{29}, \frac{4u + 2v \sqrt{3}A_s}{3}, A_{13}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \]
\[ \{R_2\}, \{R_5\}; 3; A_{29}, A_{10}, A_{13}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_3\}, \{R_9\}; 3; -A_{19}, \frac{4u + 2v \sqrt{3}A_s}{3}, A_{13}; \]
\[ \{R_4\}, \{R_5\}; 3; -A_{19}, A_{10}, A_{13}; \]
\[ \Sigma; \Gamma M; C_{2a}, \sigma_z, IT; \]
\[ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \]
\[ \{R_2\}, \{R_5\}; 3; A_{36}, A_{10}, A_{13}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \]
\[ \Lambda; \Gamma R; C^+_3, \sigma_{d_3}, IT; \]
\[ \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{4u + 2v \sqrt{3}A_s}{3}, A_{13}; \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{10}, A_{13}; \]
\[ T; \Gamma R; C^+_4, C_{2a}, \sigma_{d_3}, IT; \]
\[ \{R_5\}, \{R_6\}; 2; i\sigma_0, -\sigma_0, -\sigma_0, \sigma_0; \]
\[ \{R_5\}, \{R_7\}; 2; i\sigma_3, -\sigma_0, -\sigma_3, \sigma_0; \]
\[ \{R_5\}, \{R_8\}; 2; -i\sigma_0, -\sigma_0, -\sigma_3, \sigma_0; \]
\[ \{R_5\}, \{R_9\}; 3; A_{30}, -A_{13}, -\frac{4u}{3} + \frac{2A_s}{\sqrt{3}}, A_{32}; \]
\[ \{R_6\}, \{R_7\}; 2; -i\sigma_0, -\sigma_0, -\sigma_3, \sigma_0; \]
\[ \{R_6\}, \{R_8\}; 2; -i\sigma_3, -\sigma_0, -\sigma_3, \sigma_0; \]
\[ \{R_6\}, \{R_9\}; 3; A_{31}, -A_{13}, -\frac{4u}{3} + \frac{2A_s}{\sqrt{3}}, A_{32}; \]
\[ \{R_7\}, \{R_8\}; 2; -i\sigma_3, -\sigma_0, -\sigma_3, \sigma_0; \]
\[ \{R_7\}, \{R_9\}; 3; A_{31}, -A_{13}, -A_{10}, A_{32}; \]
\[ \{R_8\}, \{R_9\}; 3; A_{30}, -A_{13}, -A_{10}, A_{32}; \]
Accidental degeneracies on high symmetry line

| Group | Symmetry | States | Note |
|-------|----------|--------|------|
| Δ; ΓX; $C^{++}_{4y}, \sigma_x, IT$; | | | |
| $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3, \sigma_6$; | P-WNLs; |
| $\{R_3\}, \{R_4\}$ | 2; $\sigma_0, \sigma_3, \sigma_6$; | P-WNLs; |
| $\{R_5\}, \{R_6\}$ | 3; $A_{29}, \frac{\Delta_4 + 2\sqrt{3}\Delta_6}{3}, A_{13}$; | TP; |
| $\{R_7\}, \{R_8\}$ | 2; $\sigma_3, -\sigma_3, \sigma_0$; | P-WNLs; |
| $\{R_9\}, \{R_{10}\}$ | 3; $A_{19}, \frac{\Delta_4 + 2\sqrt{3}\Delta_6}{3}, A_{13}$; | TP; |

| Σ; ΓM; $C_{2a}, \sigma_z, IT$; | | | |
| $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3, \sigma_6$; | P-WNLs; |
| $\{R_3\}, \{R_4\}$ | 2; $\sigma_3, \sigma_0, \sigma_6$; | P-WNLs; |
| $\{R_5\}, \{R_6\}$ | 2; $\sigma_3, \sigma_0, \sigma_6$; | P-WNLs; |
| $\{R_7\}, \{R_8\}$ | 2; $\sigma_3, -\sigma_3, \sigma_0$; | P-WNLs; |
| $\{R_9\}, \{R_{10}\}$ | 2; $\sigma_3, -\sigma_3, \sigma_0$; | P-WNLs; |

| Λ; ΓR; $C^{++}_{31}, \sigma_{db}, IT$; | | | |
| $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3, \sigma_6$; | P-WNLs; |
| $\{R_3\}, \{R_4\}$ | 3; $A_{36}, \frac{\Delta_4 + 2\sqrt{3}\Delta_6}{3}, A_{13}$; | TP; |
| $\{R_5\}, \{R_6\}$ | 3; $A_{36}, A_{10}, A_{13}$; | TP; |

| Z; XM; $C_{2x}, \sigma_z, IT$; | | | |
| $\{R_1\}, \{R_2\}$ | 2; $\sigma_0, \sigma_3, \sigma_6$; | P-WNLs; |
| $\{R_3\}, \{R_4\}$ | 2; $\sigma_3, \sigma_0, \sigma_6$; | P-WNLs; |
| $\{R_5\}, \{R_6\}$ | 2; $\sigma_3, \sigma_0, \sigma_6$; | P-WNLs; |
| $\{R_7\}, \{R_8\}$ | 2; $\sigma_3, -\sigma_3, \sigma_0$; | P-WNLs; |
| $\{R_9\}, \{R_{10}\}$ | 2; $\sigma_3, -\sigma_3, \sigma_0$; | P-WNLs; |

| T; MR; $C^{++}_{4z}, \sigma_x, E, IT$; | | | |
| $\{R_6\}, \{R_{10}\}$ | 3; $-A_{29}, \frac{\Delta_4 + 2\sqrt{3}\Delta_6}{3}, A_0, A_{13}$; | TP; |
| $\{R_7\}, \{R_8\}$ | 2; $\sigma_0, \sigma_3, \sigma_0, \sigma_6$; | P-WNLs; |
| $\{R_9\}, \{R_{10}\}$ | 2; $\sigma_3, \sigma_0, \sigma_0, \sigma_6$; | P-WNLs; |
| $\{R_1\}, \{R_3\}$ | 3; $-A_{29}, A_{10}, A_0, A_{13}$; | TP; |
| $\{R_2\}, \{R_4\}$ | 2; $\sigma_3, -\sigma_3, \sigma_0, \sigma_0$; | P-WNLs; |
| $\{R_5\}, \{R_6\}$ | 2; $\sigma_3, -\sigma_3, \sigma_0, \sigma_0$; | P-WNLs; |
| $\{R_7\}, \{R_8\}$ | 3; $A_{19}, \frac{\Delta_4 + 2\sqrt{3}\Delta_6}{3}, A_0, A_{13}$; | TP; |
| $\{R_9\}, \{R_{10}\}$ | 3; $A_{19}, A_{10}, A_0, A_{13}$; | TP; |
Accidental degeneracies on high symmetry line

Δ; ΓX; \( C_{4y}^+, \sigma_x, IT \);
\[
\{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNLs};
\{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_1 \}, \{ R_5 \}; 3; A_{29}, \frac{A_0 + 2\sqrt{7}A_8}{3}, A_{13}; \text{TP};
\{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNLs};
\{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNLs};
\{ R_2 \}, \{ R_5 \}; 3; A_{29}, A_{10}, A_{13}; \text{TP};
\{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_3 \}, \{ R_5 \}; 3; -A_{19}, \frac{A_0 + 2\sqrt{7}A_8}{3}, A_{13}; \text{TP};
\{ R_4 \}, \{ R_5 \}; 3; -A_{19}, A_{10}, A_{13}; \text{TP};
\]

Σ; ΓM; \( C_{2a}, \sigma_z, IT \);
\[
\{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};
\{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL};
\{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL};
\{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL};
\{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_4 \}, \{ R_5 \}; 3; -A_{19}, A_{10}, A_{13}; \text{TP};
\]

Λ; ΓR; \( C_{31}^+, \sigma_{db}, IT \);
\[
\{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{A_0 + 2\sqrt{7}A_8}{3}, A_{13}; \text{TP};
\{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}, A_{13}; \text{TP};
\]

S; XR; \( C_{2c}, \sigma_{dc}, IT \);
\[
\{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL};
\{ R_2 \}, \{ R_6 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_2 \}, \{ R_8 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL};
\{ R_4 \}, \{ R_6 \}; 2; -\sigma_3, \sigma_3, \sigma_0; \text{P-WNL};
\{ R_4 \}, \{ R_8 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_6 \}, \{ R_8 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL};
\]

T; MR; \( \sigma_z, C_{2a}, \sigma_{db}, IT \);
\[
\{ R_5 \}, \{ R_{10} \}; 3; A_{37}, A_{13}, \frac{A_0 + 2\sqrt{7}A_8}{3}, A_{32}; \text{TP};
\{ R_5 \}, \{ R_6 \}; 2; -i\sigma_3, \sigma_0, \sigma_0, \sigma_0; \text{P-WNLs};
\{ R_5 \}, \{ R_7 \}; 2; -i\sigma_3, \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_5 \}, \{ R_8 \}; 2; -i\sigma_0, \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_6 \}, \{ R_{10} \}; 3; A_{38}, A_{13}, A_{10}, A_{32}; \text{TP};
\{ R_6 \}, \{ R_7 \}; 2; i\sigma_0, \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs};
\{ R_6 \}, \{ R_8 \}; 2; i\sigma_3, \sigma_0, -\sigma_0, \sigma_0; \text{P-WNLs};
\{ R_7 \}, \{ R_{10} \}; 3; A_{38}, A_{13}, A_{10}, A_{32}; \text{TP};
\{ R_7 \}, \{ R_8 \}; 2; i\sigma_3, \sigma_0, -\sigma_0, \sigma_0; \text{P-WNLs};
\{ R_8 \}, \{ R_{10} \}; 3; A_{37}, A_{13}, A_{10}, A_{32}; \text{TP};
\]
Accidental degeneracies on high symmetry line

\[
\begin{align*}
\Delta; \Gamma X; \quad & C_{4y}^+; \sigma_x; IT; \quad \{R_1\}, \{R_2\} : 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \\
& \{R_1\}, \{R_3\} : 2; \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNLs;} \\
& \{R_1\}, \{R_4\} : 2; \sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \\
& \{R_1\}, \{R_5\} : 3; A_{29}, A_{\frac{1}{3}+\frac{2\sqrt{3}}{3}A_{13}}, A_{13}; \quad \text{TP;} \\
& \{R_2\}, \{R_4\} : 2; \sigma_3, -\sigma_3, \sigma_0; \quad \text{P-WNLs;} \\
& \{R_2\}, \{R_4\} : 2; \sigma_3, -\sigma_0, \sigma_0; \quad \text{P-WNLs;} \\
& \{R_2\}, \{R_5\} : 3; A_{29}, A_{10}, A_{13}; \quad \text{TP;} \\
& \{R_3\}, \{R_4\} : 2; -\sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \\
& \{R_3\}, \{R_5\} : 3; -A_{19}, A_{\frac{1}{3}+\frac{2\sqrt{3}}{3}A_{13}}, A_{13}; \quad \text{TP;} \\
& \{R_4\}, \{R_5\} : 3; -A_{19}, A_{10}, A_{13}; \quad \text{TP;} \\
\Lambda; \Gamma L; \quad & C_{31}^+; \sigma_{db}; IT; \quad \{R_1\}, \{R_2\} : 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \\
& \{R_1\}, \{R_3\} : 3; A_{36}, A_{\frac{1}{3}+\frac{2\sqrt{3}}{3}A_{13}}, A_{13}; \quad \text{TP;} \\
S; \quad & X S; \quad \{R_1\}, \{R_2\} : 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \\
& \{R_1\}, \{R_3\} : 2; \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNL; } \\
& \{R_1\}, \{R_4\} : 2; \sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNL; } \\
& \{R_2\}, \{R_3\} : 2; \sigma_3, -\sigma_3, \sigma_0; \quad \text{P-WNL; } \\
Z; \quad & X W; \quad \{R_1\}, \{R_2\} : 2; \sigma_0, \sigma_3, \sigma_0; \quad \text{P-WNLs;} \\
& \{R_1\}, \{R_3\} : 2; \sigma_3, \sigma_0, \sigma_0; \quad \text{P-WNL; } \\
& \{R_1\}, \{R_4\} : 2; \sigma_3, \sigma_3, \sigma_0; \quad \text{P-WNL; } \\
Q; \quad & L W; \quad \{R_1\}, \{R_2\} : 2; \sigma_3, \sigma_0; \quad \text{P-WNL; } \\
\end{align*}
\]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{4y}^+; \sigma_x, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_4, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_5 \}; 3; A_{29}, \frac{\Delta_0 + 2\sqrt{3}\Delta_k}{3}, A_{13}; \text{TP}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_2 \}, \{ R_5 \}; 3; A_{29}, A_{10}, A_{13}; \text{TP}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_3 \}, \{ R_5 \}; 3; -A_{19}, \frac{\Delta_0 + 2\sqrt{3}\Delta_k}{3}, A_{13}; \text{TP}; \]
\[ \{ R_4 \}, \{ R_5 \}; 3; -A_{19}, A_{10}, A_{13}; \text{TP}; \]

\[ \Lambda; \Gamma L; C_{31}^+; \sigma_{db}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{\Delta_0 + 2\sqrt{3}\Delta_k}{3}, A_{13}; \text{TP}; \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}, A_{13}; \text{TP}; \]

\[ \Sigma; \Gamma \Sigma; C_{2x}\sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ S; \Gamma S; C_{2y}\sigma_y, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, -\sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, -\sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ Z; \Gamma W; C_{2x}\sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, -\sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, -\sigma_3, \sigma_0; \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{4y}^+; IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_5\}; 3; A_{20}, \frac{4\sigma_0 + 2\sqrt{3}\sigma_3}{3}, A_{13}; \text{TP}; \]
\[ \{R_2\}, \{R_6\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_2\}, \{R_7\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{R_2\}, \{R_8\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_3\}, \{R_6\}; 3; A_{20}, A_{19}, A_{13}; \text{TP}; \]
\[ \{R_3\}, \{R_7\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_3\}, \{R_8\}; 3; -A_{19}, \frac{4\sigma_0 + 2\sqrt{3}\sigma_3}{3}, A_{13}; \text{TP}; \]
\[ \{R_4\}, \{R_5\}; 3; -A_{19}, A_{19}, A_{13}; \text{TP}; \]

\[ \Lambda; \Gamma L; C_{3z}^+; \sigma_{ab}; IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 3; A_{36}, \frac{4\sigma_0 + 2\sqrt{3}\sigma_3}{3}, A_{13}; \text{TP}; \]
\[ \{R_2\}, \{R_3\}; 3; A_{36}, A_{19}, A_{13}; \text{TP}; \]

\[ \Sigma; \Gamma \Sigma; C_{2x}; \sigma_x; IT; \{R_1\}, \{R_2\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_3\}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{R_1\}, \{R_4\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_2\}, \{R_3\}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_3\}, \{R_5\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]

\[ S; \Gamma S; \sigma_y, \sigma_{dx}; IT; \{R_2\}, \{R_3\}; 2; \sigma_1, \sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{R_2\}, \{R_4\}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_2\}, \{R_5\}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_3\}, \{R_4\}; 2; -\sigma_3, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_3\}, \{R_5\}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_4\}, \{R_5\}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNLs}; \]

\[ Q; \Gamma W; \sigma_{2y}; IT; \{R_4\}, \{R_8\}; 2; \sigma_3, \sigma_0; \text{P-WNLs}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{4y}^{+}, \sigma_{z}, IT; \{ R_{1} \}, \{ R_{2} \}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{1} \}, \{ R_{3} \}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{1} \}, \{ R_{4} \}; 2; \sigma_{3}, \sigma_{3}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{2} \}, \{ R_{3} \}; 3; A_{29}, \begin{array}{c} A_{0} + 2\sqrt{3} A_{13} \end{array}, A_{13}; \quad TP; \]
\[ \{ R_{2} \}, \{ R_{4} \}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{2} \}, \{ R_{4} \}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{2} \}, \{ R_{3} \}; 3; A_{29}, A_{10}, A_{13}; \quad TP; \]
\[ \{ R_{3} \}, \{ R_{4} \}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{4} \}, \{ R_{3} \}; 3; -A_{19}, \begin{array}{c} A_{0} + 2\sqrt{3} A_{13} \end{array}, A_{13}; \quad TP; \]
\[ \{ R_{4} \}, \{ R_{5} \}; 3; -A_{19}, A_{10}, A_{13}; \quad TP; \]

\[ \Lambda; \Gamma I L; C_{3z}^{+}, \sigma_{0}, IT; \{ R_{1} \}, \{ R_{2} \}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{1} \}, \{ R_{3} \}; 3; A_{30}, \begin{array}{c} A_{0} + 2\sqrt{3} A_{13} \end{array}, A_{13}; \quad TP; \]
\[ \{ R_{2} \}, \{ R_{3} \}; 3; A_{30}, A_{10}, A_{13}; \quad TP; \]

\[ \Sigma; \Gamma \Sigma; C_{2z}, \sigma_{z}, IT; \{ R_{1} \}, \{ R_{2} \}; 2; \sigma_{0}, \sigma_{3}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{1} \}, \{ R_{3} \}; 2; \sigma_{3}, \sigma_{0}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{2} \}, \{ R_{3} \}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{2} \}, \{ R_{4} \}; 2; \sigma_{3}, -\sigma_{0}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{4} \}, \{ R_{3} \}; 2; -\sigma_{0}, \sigma_{3}, \sigma_{0}; \quad P-WNLs; \]

\[ S; \Gamma S; \sigma_{y}, \sigma_{d_{c}}, IT; \{ R_{4} \}, \{ R_{5} \}; 2; -\sigma_{3}, -\sigma_{0}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{2} \}, \{ R_{6} \}; 2; -\sigma_{0}, -\sigma_{3}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{2} \}, \{ R_{6} \}; 2; -\sigma_{3}, -\sigma_{3}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{4} \}, \{ R_{6} \}; 2; \sigma_{3}, -\sigma_{3}, \sigma_{0}; \quad P-WNLs; \]
\[ \{ R_{6} \}, \{ R_{6} \}; 2; -\sigma_{3}, -\sigma_{0}, \sigma_{0}; \quad P-WNLs; \]
Accidental degeneracies on high symmetry line

\[ \Sigma; \Gamma N; C_{2a}, \sigma_x, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \Delta; \Gamma H; C_{4g}^+, \sigma_x, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_5 \}; 3; A_{29}, \frac{A_0 + 2 \sqrt{3} A_8}{3}, A_{13}; TP; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNLs; \]
\[ \{ R_2 \}, \{ R_5 \}; 3; A_{29}, A_{10}, A_{13}; TP; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_3 \}, \{ R_5 \}; 3; -A_{19}, \frac{A_0 + 2 \sqrt{3} A_8}{3}, A_{13}; TP; \]
\[ \{ R_4 \}, \{ R_5 \}; 3; -A_{19}, A_{10}, A_{13}; TP; \]
\[ \Lambda; \Gamma P; C_{31}^+, \sigma_{db}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{A_0 + 2 \sqrt{3} A_8}{3}, A_{13}; TP; \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}, A_{13}; TP; \]
\[ D; \Gamma P; C_{2g}, \sigma_{ab}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ G; \Gamma N; C_{2b}, \sigma_{da}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; P-WNL; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; P-WNL; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ F; \Gamma H; C_{34}^+, \sigma_{da}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; P-WNLs; \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{A_0 + 2 \sqrt{3} A_8}{3}, A_{13}; TP; \]
\[ \{ R_2 \}, \{ R_3 \}; 3; A_{36}, A_{10}, A_{13}; TP; \]
Accidental degeneracies on high symmetry line

\[ \Sigma; \Gamma N; C_{2a}, \sigma_z, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNL}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \Delta; \Gamma H; C_{4v}^+, \sigma_x, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 2; \sigma_3, \sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_4 \}; 2; \sigma_3, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_5 \}; 3; A_{20}, \frac{A_0 + 2\sqrt{3}A_8}{3}, A_{13}; \text{TP}; \]
\[ \{ R_2 \}, \{ R_3 \}; 2; \sigma_3, -\sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_3, -\sigma_0, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_2 \}, \{ R_6 \}; 3; A_{20}, A_{10}, A_{13}; \text{TP}; \]
\[ \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_3 \}, \{ R_5 \}; 3; -A_{19}, \frac{A_0 + 2\sqrt{3}A_8}{3}, A_{13}; \text{TP}; \]
\[ \{ R_3 \}, \{ R_6 \}; 3; -A_{19}, A_{10}, A_{13}; \text{TP}; \]
\[ \Lambda; \Gamma P; C_{4v}^+, \sigma_{db}, IT; \{ R_1 \}, \{ R_2 \}; 2; \sigma_0, \sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_1 \}, \{ R_3 \}; 3; A_{36}, \frac{A_0 + 2\sqrt{3}A_8}{3}, A_{13}; \text{TP}; \]
\[ \{ R_3 \}, \{ R_4 \}; 3; A_{36}, A_{10}, A_{13}; \text{TP}; \]
\[ F; \text{PH}; C_{4v}^+, \sigma_{da}, IT; \{ R_3 \}, \{ R_4 \}; 2; i\sigma_0, -(1)^{3/4}\sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{ R_3 \}, \{ R_6 \}; 3; -iA_{24}, \frac{(-1)^{3/4}(A_0 + 2\sqrt{3}A_8)}{3}, A_{13}; \text{TP}; \]
\[ \{ R_4 \}, \{ R_6 \}; 3; -iA_{24}, \frac{(1-i)A_{10}}{\sqrt{2}}, A_{13}; \text{TP}; \]
C. **Effective Hamiltonian of both essential and accidental degeneracies**

1. **Notes to Sec. S7C**

   (i) The top and bottom part of the tables in Sec. S7C lists the essential and accidental degeneracy, respectively.
   (ii) For each table in Sec. S7C, the first two lines present the SG number, the BZ type, the generating elements of the type II MSG (translations are not included here), whether centrosymmetry is contained in the group, and whether SOC is considered.
   (iii) Below the first two lines, the columns from left to right (separated by the semicolons) are the high-symmetry momentum $\mathbf{k}$, the corep and the effective Hamiltonian of the symmetry-protected degeneracies.
   (iv) In effective Hamiltonian, we use Roman letters (such as $c_i$ and $c_{i,j}$) and Greek letter (such as $\alpha_i$) to denote the real and complex parameters, respectively.
   (v) We do not list the type II MSGs that do not exhibit symmetry-protected degeneracies at high-symmetry point and high-symmetry line.

2. **SG 1-10**
Accidental degeneracies on high symmetry line

\[ \Lambda: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]
\[ \nu: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]
\[ \omega: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]
\[ \upsilon: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]

Accidental degeneracies on high symmetry line

\[ \Lambda: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]
\[ \nu: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]
\[ \omega: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]
\[ \upsilon: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]

Accidental degeneracies on high symmetry line

\[ \Lambda: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]
\[ \nu: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]
\[ \omega: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]
\[ \upsilon: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) ; \]
SG 7
\[ \Gamma_m; \{\sigma_z|\frac{1}{2}00\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \begin{array}{ll}
B: \{R_2, R_4\}; & c_4 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_3; \\
D: \{R_2, R_4\}; & c_4 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_3; \\
A: \{R_2, R_4\}; & c_4 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_3; \\
E: \{R_2, R_4\}; & c_4 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_3; \\
V: \{R_1, R_1\}; & (c_1 + c_2 k_z) \sigma_0 + \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \\
U: \{R_1, R_1\}; & (c_1 + c_2 k_z) \sigma_0 + \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \\
\end{array} \]

SG 9
\[ \Gamma^0_m; \{\sigma_z|\frac{1}{2}00\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \begin{array}{ll}
A: \{R_2, R_4\}; & c_4 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_3; \\
M: \{R_2, R_4\}; & c_4 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_3; \\
U: \{R_1, R_1\}; & (c_1 + c_2 k_z) \sigma_0 + \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \\
\end{array} \]

SG 10
\[ \Gamma_m; \{C_{2z}|000\}, \{I|000\}, T; \text{Centrosymmetric; without SOC} \]

Accidental degeneracies on high symmetry line

\[ \begin{array}{ll}
A: \{R_1\}, \{R_2\}; & \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_{4} k_x + c_{5} k_y); \\
V: \{R_1\}, \{R_2\}; & \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_{4} k_x + c_{5} k_y); \\
W: \{R_1\}, \{R_2\}; & \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_{4} k_x + c_{5} k_y); \\
U: \{R_1\}, \{R_2\}; & \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_{4} k_x + c_{5} k_y); \\
\end{array} \]
SG 11
\[ \Gamma_{m}: \{C_{2z}[000\frac{1}{2}]\}, \{I[000\frac{1}{2}]\}, T; \text{Centrosymmetric; without SOC} \]

\[ Z: \quad R_{5}; \quad c_{1}\sigma_{0} + c_{2}\sigma_{2}k_{z}; \]

\[ C: \quad R_{5}; \quad c_{1}\sigma_{0} + c_{2}\sigma_{2}k_{z}; \]

\[ D: \quad R_{5}; \quad c_{1}\sigma_{0} + c_{2}\sigma_{2}k_{z}; \]

\[ E: \quad R_{5}; \quad c_{1}\sigma_{0} + c_{2}\sigma_{2}k_{z}; \]

Accidental degeneracies on high symmetry line

\[ \Lambda: \{R_{1}\}, \{R_{2}\}; \quad \sigma_{0} (c_{1} + c_{2}k_{z}) + c_{3}\sigma_{3}k_{z} + \sigma_{1} (c_{4}k_{x} + c_{5}k_{y}); \]

\[ V: \{R_{1}\}, \{R_{2}\}; \quad \sigma_{0} (c_{1} + c_{2}k_{z}) + c_{3}\sigma_{3}k_{z} + \sigma_{1} (c_{4}k_{x} + c_{5}k_{y}); \]

\[ W: \{R_{1}\}, \{R_{2}\}; \quad \sigma_{0} (c_{1} + c_{2}k_{z}) + c_{3}\sigma_{3}k_{z} + \sigma_{1} (c_{4}k_{x} + c_{5}k_{y}); \]

\[ U: \{R_{1}\}, \{R_{2}\}; \quad \sigma_{0} (c_{1} + c_{2}k_{z}) + c_{3}\sigma_{3}k_{z} + \sigma_{1} (c_{4}k_{x} + c_{5}k_{y}); \]

SG 12
\[ \Gamma_{m}^{0}: \{C_{2z}[000]\}, \{I[000]\}, T; \text{Centrosymmetric; without SOC} \]

Accidental degeneracies on high symmetry line

\[ \Lambda: \{R_{1}\}, \{R_{2}\}; \quad \sigma_{0} (c_{1} + c_{2}k_{z}) + c_{3}\sigma_{3}k_{z} + \sigma_{1} (c_{4}k_{x} + c_{5}k_{y}); \]

\[ U: \{R_{1}\}, \{R_{2}\}; \quad \sigma_{0} (c_{1} + c_{2}k_{z}) + c_{3}\sigma_{3}k_{z} + \sigma_{1} (c_{4}k_{x} + c_{5}k_{y}); \]

SG 13
\[ \Gamma_{m}: \{C_{2z}[000]\}, \{I[\frac{1}{2}00]\}, T; \text{Centrosymmetric; without SOC} \]

\[ B: \quad R_{5}; \quad c_{1}\sigma_{0} + (c_{2}k_{x} + c_{3}k_{y})\sigma_{2}; \]

\[ D: \quad R_{5}; \quad c_{1}\sigma_{0} + (c_{2}k_{x} + c_{3}k_{y})\sigma_{2}; \]

\[ A: \quad R_{5}; \quad c_{1}\sigma_{0} + (c_{2}k_{x} + c_{3}k_{y})\sigma_{2}; \]

\[ E: \quad R_{5}; \quad c_{1}\sigma_{0} + (c_{2}k_{x} + c_{3}k_{y})\sigma_{2}; \]

\[ V: \{R_{1}, R_{2}\}; \quad (c_{1} + c_{2}k_{z})\sigma_{0} + \sum_{i=1}^{2} \sigma_{i}(c_{i,1}k_{x} + c_{i,2}k_{y}); \]

\[ U: \{R_{1}, R_{2}\}; \quad (c_{1} + c_{2}k_{z})\sigma_{0} + \sum_{i=1}^{2} \sigma_{i}(c_{i,1}k_{x} + c_{i,2}k_{y}); \]

Accidental degeneracies on high symmetry line

\[ \Lambda: \{R_{1}\}, \{R_{2}\}; \quad \sigma_{0} (c_{1} + c_{2}k_{z}) + c_{3}\sigma_{3}k_{z} + \sigma_{1} (c_{4}k_{x} + c_{5}k_{y}); \]

\[ W: \{R_{1}\}, \{R_{2}\}; \quad \sigma_{0} (c_{1} + c_{2}k_{z}) + c_{3}\sigma_{3}k_{z} + \sigma_{1} (c_{4}k_{x} + c_{5}k_{y}); \]
Accidental degeneracies on high symmetry line

\( \Lambda: \{ R_4 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_4 k_x + c_5 k_y) ; \)

\( W: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_4 k_x + c_5 k_y) ; \)

Accidental degeneracies on high symmetry line

\( \Lambda: \{ R_4 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_4 k_x + c_5 k_y) ; \)

\( W: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_4 k_x + c_5 k_y) ; \)
Accidental degeneracies on high symmetry line

Δ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
D: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
P: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
B: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
Σ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
C: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
H: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
Q: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
G: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;

SG 17
\Gamma_o: \{C_{2v}^{00}\}, \{C_{2v}^{00}\}, \{T\}; Non-Centrosymmetric; without SOC

Z: \{R_5\}; c_1 \sigma_0 + c_2 \sigma_2 k_z;
U: \{R_5\}; c_1 \sigma_0 + c_2 \sigma_2 k_z;
T: \{R_5\}; c_1 \sigma_0 + c_2 \sigma_2 k_z;
R: \{R_5\}; c_1 \sigma_0 + c_2 \sigma_2 k_z;

D:
P: \{R_1, R_2\}; (c_1 + c_2 k_y)\sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2)k_z;
B: \{R_1, R_2\}; (c_1 + c_2 k_y)\sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2)k_z;
E: \{R_2, R_4\}; (c_1 + c_2 k_y)\sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2)k_z;
A: \{R_2, R_4\}; (c_1 + c_2 k_y)\sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2)k_z;

Accidental degeneracies on high symmetry line

Δ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
D: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
Σ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
C: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
H: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
Q: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
G: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
\[ \Gamma_0; \{C_2z,000\}, \{C_{2y},1/4,0\}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\begin{align*}
Y; R_5: & \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
X; R_5: & \quad c_1 \sigma_0 + c_2 \sigma_2 k_x; \\
U; R_5: & \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \\
T; R_5: & \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
S; \{R_2, R_4\}: & \quad (c_1 + \sum_{i=1}^2 c_i k_i^2) \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_x k_y; \\
{R_6, R_8}: & \quad (c_1 + \sum_{i=1}^2 c_i k_i^2) \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z k_y; \\
R; \{R_2, R_4\}: & \quad (c_1 + \sum_{i=1}^2 c_i k_i^2) \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_x k_y; \\
{R_6, R_8}: & \quad (c_1 + \sum_{i=1}^2 c_i k_i^2) \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z k_y; \\
D; \{R_2, R_4\}: & \quad (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \\
P; \{R_2, R_4\}: & \quad (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \\
C; \{R_2, R_4\}: & \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \\
E; \{R_2, R_4\}: & \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \\
H; \{R_1, R_2\}: & \quad (c_1 + c_2 k_z) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \\
Q; \{R_2, R_4\}: & \quad (c_1 + c_2 k_z) \sigma_0 + \sum_{i=1}^3 c_i \sigma_i k_y; \\
\{R_2, R_4\}: & \quad (c_1 + c_2 k_z) \sigma_0 + \sum_{i=1}^3 c_i \sigma_i k_y; \\
G; \{R_1, R_2\}: & \quad (c_1 + c_2 k_z) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \\
\end{align*}

Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_z + c_5 \sigma_1 k_z; \]

\[ B; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_z + c_5 \sigma_1 k_z; \]

\[ \Sigma; \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]

\[ A; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]

\[ \Lambda; \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]

\[ Q; \{R_1, R_4\}, \{R_2, R_2\}; \Gamma_{0,0} (c_1 + c_2 k_z) + c_3 \Gamma_{3,0} k_z + c_4 \Gamma_{1,0} k_y + c_5 \Gamma_{2,0} k_x + \sum_{i=1}^3 (c_{i,1} k_x \Gamma_{1,i} + c_{i,2} k_y \Gamma_{2,i}); \]
Γ₀: \{C₂₁, |\frac{1}{2}0\frac{1}{2}\}, \{C₂₂, |\frac{3}{2}\frac{3}{2}\}, T; Non-Centrosymmetric; without SOC

Y; R₅; \ c₁σ₀ + c₂σ₂k_y;

X; R₅; \ c₁σ₀ + c₂σ₂k_y;

Z; R₅; \ c₁σ₀ + c₂σ₂k_z;

U; \{R₂, R₄\}; \ (c₁ + \sum_{i=x} z_i c_i k_i^2) σ₀ + (c₂ σ₁ + c₃ σ₂) k_x k_z;

{R₆, R₈}; \ (c₁ + \sum_{i=x} z_i c_i k_i^2) σ₀ + (c₂ σ₁ + c₃ σ₂) k_x k_z;

T; \{R₂, R₄\}; \ (c₁ + \sum_{i=x} z_i c_i k_i^2) σ₀ + (c₂ σ₁ + c₃ σ₂) k_y k_z;

{R₆, R₈}; \ (c₁ + \sum_{i=x} z_i c_i k_i^2) σ₀ + (c₂ σ₁ + c₃ σ₂) k_y k_z;

S; \{R₂, R₄\}; \ (c₁ + \sum_{i=x} z_i c_i k_i^2) σ₀ + (c₂ σ₁ + c₃ σ₂) k_x k_y;

{R₆, R₈}; \ (c₁ + \sum_{i=x} z_i c_i k_i^2) σ₀ + (c₂ σ₁ + c₃ σ₂) k_x k_y;

R; \{R₅, R₃\}; \ c₁Γ₀,₀ + c₂Γ₀,₃ k_x + c₃Γ₀,₀ k_y + c₄Γ₀,₂ k_z;

D; \{R₂, R₄\}; \ (c₁ + c₂ k_y) σ₀ + (c₃ σ₁ + c₄ σ₂) k_x;

P; \{R₂, R₄\}; \ (c₁ + c₂ k_y + \sum_{i=x} z_i c_i k_i^2) σ₀ + \sum_{i=1}^3 c_i σ_i k_x k_y;

{R₄, R₈}; \ (c₁ + c₂ k_y + \sum_{i=x} z_i c_i k_i^2) σ₀ + \sum_{i=1}^3 c_i σ_i k_x k_y;

B; \{R₁, R₅\}; \ (c₁ + c₂ k_y) σ₀ + (c₃ σ₁ - c₄ σ₂) k_z;

Σ;

C; \{R₁, R₂\}; \ (c₁ + c₂ k_x) σ₀ + (c₃ σ₁ + c₄ σ₂) k_y;

E; \{R₂, R₄\}; \ (c₁ + c₂ k_x + \sum_{i=x} z_i c_i k_i^2) σ₀ + \sum_{i=1}^3 c_i σ_i k_y k_z;

{R₄, R₈}; \ (c₁ + c₂ k_x + \sum_{i=x} z_i c_i k_i^2) σ₀ + \sum_{i=1}^3 c_i σ_i k_y k_z;

A; \{R₂, R₄\}; \ (c₁ + c₂ k_x) σ₀ + (c₃ σ₁ + c₄ σ₂) k_z;

H; \{R₂, R₄\}; \ (c₁ + c₂ k_x) σ₀ + (c₃ σ₁ + c₄ σ₂) k_y;

Q; \{R₂, R₄\}; \ (c₁ + c₂ k_z + \sum_{i=x} z_i c_i k_i^2) σ₀ + \sum_{i=1}^3 c_i σ_i k_x k_y;

{R₄, R₈}; \ (c₁ + c₂ k_z + \sum_{i=x} z_i c_i k_i^2) σ₀ + \sum_{i=1}^3 c_i σ_i k_x k_y;

G; \{R₁, R₃\}; \ (c₁ + c₂ k_z) σ₀ + (c₃ σ₁ + c₄ σ₂) k_x;

| Accidental degeneracies on high symmetry line |

Δ; \{R₁\}, \{R₂\}; \ \ σ₀ (c₁ + c₂ k_y) + c₃ σ₃ k_y + c₄ σ₂ k_x + c₅ σ₁ k_z;

P; \{R₂, R₄\}, \{R₄, R₈\}; \ Γ₀,₀ (c₁ + c₂ k_y) + c₃ Γ₃,₀ k_x + c₄ Γ₂,₀ k_x + c₅ Γ₁,₀ k_z + \sum_{i=1}^3 (c_i k_z Γ₁, i + c_i k_z Γ₂, i);

Σ; \{R₁\}, \{R₄\}; \ \ σ₀ (c₁ + c₂ k_z) + c₃ σ₃ k_z + c₄ σ₁ k_y + c₅ σ₂ k_x;

E; \{R₂, R₄\}, \{R₄, R₈\}; \ Γ₀,₀ (c₁ + c₂ k_x) + c₃ Γ₃,₀ k_x + c₄ Γ₁,₀ k_y + c₅ Γ₂,₀ k_z + \sum_{i=1}^3 (c_i k_x Γ₁, i + c_i k_y Γ₂, i);

Λ; \{R₅\}, \{R₈\}; \ \ σ₀ (c₁ + c₂ k_z) + c₃ σ₃ k_z + c₄ σ₁ k_y + c₅ σ₂ k_x;

Q; \{R₂, R₄\}, \{R₄, R₈\}; \ Γ₀,₀ (c₁ + c₂ k_x) + c₃ Γ₃,₀ k_x + c₄ Γ₁,₀ k_y + c₅ Γ₂,₀ k_z + \sum_{i=1}^3 (c_i k_x Γ₁, i + c_i k_y Γ₂, i);
\( \Gamma^0; \{ C_{2x}|00\frac{1}{2}\}, \{ C_{2y}|00\frac{1}{2}\}, \nonumber \)

\( Z; \quad R_5; \quad c_1\sigma_0 + c_2\sigma_2k_z; \)

\( T; \quad R_5; \quad c_1\sigma_0 + c_2\sigma_2k_z; \)

\( R; \quad \{ R_2, R_4 \}; \quad c_1\sigma_0 + c_2\sigma_2k_z; \)

\( A; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \)

\( \Delta; \quad B; \quad \{ R_2, R_4 \}; \quad (c_1 + c_2k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \)

\( G; \quad \{ R_2, R_4 \}; \quad (c_1 + c_2k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \)

\( E; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \)

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Accidental degeneracies on high symmetry line

\( \Lambda; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_4\sigma_1k_y + c_5\sigma_2k_z; \)

\( H; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_4\sigma_1k_y + c_5\sigma_2k_z; \)

\( D; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1}k_x + c_{i,2}k_y); \)

\( \Sigma; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_4\sigma_1k_y + c_5\sigma_2k_z; \)

\( \Delta; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_4\sigma_2k_z + c_5\sigma_1k_z; \)

\( F; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_4\sigma_2k_z + c_5\sigma_1k_z; \)

\( C; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_4\sigma_1k_y + c_5\sigma_2k_z; \)
Accidental degeneracies on high symmetry line

\[ L: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z); \]
\[ H: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z); \]
\[ D: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y)); \]
\[ A: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z); \]
\[ \Sigma: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z); \]
\[ \Delta: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z); \]
\[ B: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z); \]
\[ G: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z); \]
\[ F: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z); \]
\[ E: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z); \]
\[ C: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z); \]
Accidental degeneracies on high symmetry line

\( \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)

\( G; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)

\( P; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \)

\( \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)

\( F; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)

\( D; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_z); \)

\( \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z; \)

\( U; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z; \)

\( Q; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_z); \)

\[ \sum_{i=1}^{2} \sigma_i = 1 \]

\( W; \sigma_0 + c_2 \sigma_2 k_x + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z; \)

SG 24
\[ \Gamma_{\omega}; \{ C_{2z} | \frac{1}{2} \frac{1}{2} \}, \{ C_{2y} | \frac{1}{2} \frac{1}{2} \}; T \text{; Non-Centrosymmetric; without SOC} \]

Accidental degeneracies on high symmetry line

\( \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)

\( G; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)

\( P; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \)

\( \Sigma; \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)

\( F; \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)

\( D; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \)

\( \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z; \)

\( U; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z; \)

\( Q; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_z); \)

SG 25
\[ \Gamma_{\omega}; \{ C_{2z} | 000 \}, \{ \sigma_y | 000 \}; T \text{; Non-Centrosymmetric; without SOC} \]
Accidental degeneracies on high symmetry line

$\Delta$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z;
\nonumber

$D$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z;
\nonumber

$P$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_1 k_y + c_1 \sigma_1 k_z;
\nonumber

$B$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z;
\nonumber

$\Sigma$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_2 k_y;
\nonumber

$C$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_2 k_y;
\nonumber

$E$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_2 k_y;
\nonumber

$A$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 \sigma_2 k_y;
\nonumber

$\Lambda$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\nonumber

$H$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\nonumber

$Q$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\nonumber

$G$: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
SG 26

$\Gamma_0; \{C_2z|00\frac{1}{2}\}, \{\sigma_y|00\frac{1}{2}\}, T; \text{Non-Centrosymmetric; without SOC}$

$Z; \{R_2, R_4\}; c_2\sigma_3 k_z + c_1 \sigma_0;
{R_6, R_8}; c_2\sigma_3 k_z + c_1 \sigma_0;

U; \{R_2, R_4\}; c_2\sigma_3 k_z + c_1 \sigma_0;
{R_6, R_8}; c_2\sigma_3 k_z + c_1 \sigma_0;

T; \{R_2, R_4\}; c_2\sigma_3 k_z + c_1 \sigma_0;
{R_6, R_8}; c_2\sigma_3 k_z + c_1 \sigma_0;

R; \{R_2, R_4\}; c_2\sigma_3 k_z + c_1 \sigma_0;
{R_6, R_8}; c_2\sigma_3 k_z + c_1 \sigma_0;

P; \{R_1, R_3\}; (c_1 + c_2 k_y)\sigma_0 + \sum_{i=1}^{3} c_{1,i}\sigma_i k_z;
{R_2, R_2}; (c_1 + c_2 k_y)\sigma_0 + \sum_{i=1}^{3} c_{1,i}\sigma_i k_z;

B; \{R_1, R_3\}; (c_1 + c_2 k_y)\sigma_0 + \sum_{i=1}^{3} c_{1,i}\sigma_i k_z;
{R_2, R_2}; (c_1 + c_2 k_y)\sigma_0 + \sum_{i=1}^{3} c_{1,i}\sigma_i k_z;

E; \{R_1, R_2\}; (c_1 + c_2 k_x)\sigma_0 + c_3 \sigma_3 k_z;
A; \{R_1, R_2\}; (c_1 + c_2 k_x)\sigma_0 + c_3 \sigma_3 k_z;
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_x; \]

\[ D: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_x; \]

\[ P: \{ R_1, R_1 \}, \{ R_2, R_2 \} ; \quad \Gamma_{1,0} (c_1 + c_2 k_y) + c_3 \Gamma_{3,0} k_y + c_1 \Gamma_{1,0} k_x + \sum_{i=1}^{n} (c_{i,1} \Gamma_{2,1} k_x + c_{i,2} \Gamma_{0,1} k_x + c_{i,3} \Gamma_{3,1} k_x); \]

\[ B: \{ R_1, R_1 \}, \{ R_2, R_2 \} ; \quad \Gamma_{1,0} (c_1 + c_2 k_y) + c_3 \Gamma_{3,0} k_y + c_1 \Gamma_{1,0} k_x + \sum_{i=1}^{n} (c_{i,1} \Gamma_{2,1} k_x + c_{i,2} \Gamma_{0,1} k_x + c_{i,3} \Gamma_{3,1} k_x); \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_1 \sigma_1 k_\Gamma; \]

\[ C: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_1 \sigma_2 k_\Gamma; \]

\[ \Lambda: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ H: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ Q: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ G: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
SG 27

\[ \Gamma_0; \{C_2^z|000\}, \{\sigma_y|00\frac{1}{2}\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[
\begin{align*}
Z: \{R_2, R_4\}: & \; c_1 \sigma_0 + c_2 \sigma_3 k_z; \\
\{R_6, R_8\}: & \; c_1 \sigma_0 + c_2 \sigma_3 k_z; \\
U: \{R_2, R_4\}: & \; c_1 \sigma_0 + c_2 \sigma_3 k_z; \\
\{R_6, R_8\}: & \; c_1 \sigma_0 + c_2 \sigma_3 k_z; \\
T: \{R_2, R_4\}: & \; c_1 \sigma_0 + c_2 \sigma_3 k_z; \\
\{R_6, R_8\}: & \; c_1 \sigma_0 + c_2 \sigma_3 k_z; \\
R: \{R_2, R_4\}: & \; c_1 \sigma_0 + c_2 \sigma_3 k_z; \\
\{R_6, R_8\}: & \; c_1 \sigma_0 + c_2 \sigma_3 k_z; \\
P: \{R_1, R_3\}: & \; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x + c_5 \sigma_3 k_z; \\
B: \{R_1, R_3\}: & \; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x + c_5 \sigma_3 k_z; \\
E: \{R_1, R_3\}: & \; (c_1 + c_2 k_z) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z; \\
A: \{R_1, R_3\}: & \; (c_1 + c_2 k_z) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z;
\end{align*}
\]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z; \]

\[ D: \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z; \]

\[ \Sigma: \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_1 \sigma_2 k_y; \]

\[ C: \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_1 \sigma_2 k_y; \]

\[ \Lambda: \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_1 \sigma_3 k_z; \]

\[ \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ D: \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \Sigma: \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ C: \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ H: \{R_5\} : (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ Q: \{R_5\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ G: \{R_5\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_1\} , \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ \{R_1\} , \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ \{R_2\} , \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

SG 28

\( \Gamma_0: \{C_{2v}\, [\frac{1}{2}00], \{\sigma_y\,[000]\}, T; \text{Non-Centrosymmetric; without SOC} \)

\[ Y: R_5^z; \quad c_2 \sigma_2 k_y + c_1 \sigma_0; \]

\[ T: R_5^z; \quad c_2 \sigma_2 k_y + c_1 \sigma_0; \]

\[ S: R_5^z; \quad c_2 \sigma_2 k_y + c_1 \sigma_0; \]

\[ R: R_5; \quad c_2 \sigma_2 k_y + c_1 \sigma_0; \]

\[ \Delta: \]

\[ C: \{R_1, R_2\} : (c_1 + c_2 k_z) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z; \]

\[ E: \{R_1, R_2\} : (c_1 + c_2 k_z) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z; \]

\[ H: R_5^z; \quad (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_z + c_6 \sigma_1 k_y; \]

\[ Q: R_5^z; \quad (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z; \]

\[ D; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z; \]

\[ P; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z; \]

\[ B; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_1 \sigma_2 k_y; \]

\[ A; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_1 \sigma_2 k_y; \]

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{R_2\}, \{R_1\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{R_2\}, \{R_1\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]

\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_4\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_4\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]

\[ \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{R_6\}, \{R_5\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{R_6\}, \{R_5\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]

\[ Y; \{R_5\}; c_2 \sigma_2 k_y + c_1 \sigma_0; \]

\[ Z; \{R_6\}, \{R_5\}; c_2 \sigma_3 k_z + c_1 \sigma_0; \]

\[ U; \{R_2\}, \{R_4\}; c_2 \sigma_3 k_z + c_1 \sigma_0; \]

\[ T; \{R_3\}, \{R_5\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,1} k_x + c_3 \Gamma_{0,3} k_y + \sum_{i=1}^{3} c_i \Gamma_{i,0} k_z; \]

\[ S; \{R_5\}; c_2 \sigma_2 k_y + c_1 \sigma_0; \]

\[ R; \{R_5\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,1} k_x + c_3 \Gamma_{0,3} k_y + \sum_{i=1}^{3} c_i \Gamma_{i,0} k_z; \]

\[ P; \{R_1\}, \{R_1\}; (c_1 + c_2 k_y) \sigma_0 + \sum_{i=1}^{3} c_i \sigma_i k_z; \]

\[ E; \{R_1\}, \{R_1\}; (c_1 + c_2 k_x) \sigma_0 + \sum_{i=1}^{3} c_i \sigma_i k_z; \]

\[ A; \{R_1\}, \{R_2\}; (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_z; \]

\[ H; \{R_5\}; (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y; \]

\[ Q; \{R_5\}; (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ D; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ P; \{ R_1, R_2 \}, \{ R_2, R_2 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + c_3 \Gamma_{3,0} k_y + c_4 \Gamma_{1,0} k_z + \sum_{i=1}^3 (c_{i,1} \Gamma_{2,1} k_x + c_{i,2} \Gamma_{0,0} k_z + c_{i,3} \Gamma_{3,1} k_z); \]

\[ B; \{ R_1, R_1 \}, \{ R_2, R_2 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + c_3 \Gamma_{3,0} k_y + c_4 \Gamma_{1,0} k_z + \sum_{i=1}^3 (c_{i,1} \Gamma_{2,1} k_x + c_{i,2} \Gamma_{0,0} k_z + c_{i,3} \Gamma_{3,1} k_z); \]

\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_3 k_y; \]

\[ E; \{ R_1, R_2 \}, \{ R_2, R_2 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + c_3 \Gamma_{3,0} k_x + c_4 \Gamma_{2,0} k_y + \sum_{i=1}^3 (c_{i,1} \Gamma_{1,1} k_y + c_{i,2} \Gamma_{0,0} k_x + c_{i,3} \Gamma_{3,1} k_z); \]

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ \{ R_1 \}, \{ R_1 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{ R_2 \}, \{ R_1 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{ R_2 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]

\[ \{ R_3 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ G; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ \{ R_1 \}, \{ R_1 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{ R_2 \}, \{ R_1 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{ R_2 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]

\[ \{ R_3 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ Y; \quad R_5; \quad c_2 \sigma_2 k_y + c_1 \sigma_0; \]

\[ Z; \quad \{ R_2, R_4 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_6, R_6 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ U; \quad \{ R_2, R_4 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_6, R_6 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ T; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ S; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_3 k_y; \]

\[ R; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ P; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x + c_5 \sigma_3 k_z; \]

\[ B; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x + c_5 \sigma_3 k_z; \]

\[ C; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z; \]

\[ A; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z; \]

\[ H; \quad R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]

\[ Q; \quad R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y; \]
Accidental degeneracies on high symmetry line

$$\Delta: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z;$$

$$D: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z;$$

$$\Sigma: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 \sigma_1 k_y;$$

$$E: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 \sigma_2 k_y;$$

$$\Lambda: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$

$$\{ R_1 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z;$$

$$\{ R_1 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;$$

$$\{ R_2 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;$$

$$\{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z;$$

$$\{ R_3 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$

$$G: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$

$$\{ R_1 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z;$$

$$\{ R_1 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;$$

$$\{ R_2 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;$$

$$\{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z;$$

$$\{ R_3 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\} \rightarrow \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_1\sigma_1k_z; \]

\[ D: \{R_1\}, \{R_2\} \rightarrow \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_1\sigma_1k_z; \]

\[ \Sigma: \{R_1\}, \{R_2\} \rightarrow \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_1\sigma_2k_y; \]

\[ A: \{R_1, R_4\}, \{R_2, R_2\} ; \Gamma_{1,0} (c_1 + c_2k_y) + c_3\Gamma_{3,0}k_x + c_4\Gamma_{2,0}k_y + \sum_{i=1}^3 (c_{i,0}\Gamma_{1,i}k_y + c_{i,2}\Gamma_{0,i}k_z + c_{i,3}\Gamma_{3,i}k_z); \]

\[ \Lambda: \{R_1\}, \{R_2\} \rightarrow \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z; \]

\[ \{R_1\}, \{R_3\} \rightarrow \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_z; \]

\[ \{R_1\}, \{R_4\} \rightarrow \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y; \]

\[ \{R_2\}, \{R_4\} \rightarrow \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y; \]

\[ \{R_2\}, \{R_3\} \rightarrow \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y; \]

\[ \{R_3\}, \{R_4\} \rightarrow \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z; \]
\[ B: \{R_3\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_1 \sigma_1 k_z; \]
\[ \Sigma: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_1 \sigma_2 k_y; \]
\[ A: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 \sigma_2 k_y; \]
\[ \Lambda: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]
\[ \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ Q: \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{R_6\}, \{R_7\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{R_6\}, \{R_7\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_7\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]
\[ \{R_7\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_7\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
SG 33

$\Gamma_0; \{C_2, \frac{1}{2}, \frac{1}{2}\}, \{\sigma_y | 0_{\frac{1}{2}} \frac{1}{2}\}, T; $ Non-Centrosymmetric; without SOC

$Y; \ R_5; \ c_1 \sigma_0 + c_2 \sigma_2 k_y;$
$X; \ R_5; \ c_1 \sigma_0 + c_2 \sigma_2 k_x;$
$Z; \ \{R_2, R_3\}; \ c_1 \sigma_0 + c_2 \sigma_3 k_z;
\ \{R_6, R_8\}; \ c_1 \sigma_0 + c_2 \sigma_3 k_z;$
$U; \ R_5; \ (c_1 + \sum_{i=1}^{4} c_1 k_i^2) \sigma_0 + (c_2 \sigma_3 k_x + c_3 \sigma_1 k_y) k_z;$
$T; \ \{R_5, R_8\}; \ c_1 \Gamma_{0,0} + c_2 \Gamma_{0,1} k_x + c_3 \Gamma_{0,3} k_y + \sum_{i=1}^{3} c_1, i \Gamma_{i,0} k_i;$
$S; \ \{R_2, R_4\}; \ c_1 \sigma_0 + c_2 \sigma_3 k_z;\ 
\ \{R_6, R_8\}; \ c_1 \sigma_0 + c_2 \sigma_3 k_z;$
$R; \ \{R_2, R_4\}; \ c_1 \sigma_0 + c_2 \sigma_3 k_z;$
\ \{R_6, R_8\}; \ c_1 \sigma_0 + c_2 \sigma_3 k_z;$
$D; \ \{R_2, R_4\}; \ (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x + c_5 \sigma_3 k_z;$
$P; \ \{R_1, R_2\}; \ (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_z;$
$B; \ \{R_1, R_2\}; \ (c_1 + c_2 k_y) \sigma_0 + \sum_{i=1}^{3} c_1, i \sigma_1 k_i;\ 
\ \{R_2, R_2\}; \ (c_1 + c_2 k_y) \sigma_0 + \sum_{i=1}^{3} c_1, i \sigma_1 k_i;$
$C; \ \{R_1, R_2\}; \ (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z;$
$E; \ \{R_1, R_1\}; \ (c_1 + c_2 k_x) \sigma_0 + \sum_{i=1}^{3} c_1, i \sigma_1 k_i;\ 
\ \{R_2, R_2\}; \ (c_1 + c_2 k_x) \sigma_0 + \sum_{i=1}^{3} c_1, i \sigma_1 k_i;$
$A; \ \{R_1, R_2\}; \ (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_z;$
$H; \ R_5; \ (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;$
$G; \ R_5; \ (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y;$

Accidental degeneracies on high symmetry line

$\Delta; \ \{R_1\}, \ \{R_2\};\ 
\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z;$
$B; \ \{R_1, R_1\}, \ \{R_2, R_2\}; \ \Gamma_{0,0} (c_1 + c_2 k_y) + c_3 \Gamma_{3,0} k_x + c_4 \Gamma_{1,0} k_x + \sum_{i=1}^{3} (c_1, i \Gamma_{2,0} k_x + c_1, i \Gamma_{0,0} k_x + c_1, i \Gamma_{1,0} k_x);$
$\Sigma; \ \{R_1\}, \ \{R_2\};\ 
\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_3 k_y;$
$E; \ \{R_5, R_3\}, \ \{R_2, R_2\}; \ \Gamma_{0,0} (c_1 + c_2 k_x) + c_3 \Gamma_{3,0} k_x + c_4 \Gamma_{1,0} k_y + \sum_{i=1}^{3} (c_1, i \Gamma_{1,0} k_y + c_1, i \Gamma_{0,0} k_x + c_1, i \Gamma_{3,1} k_x);$
$\Lambda; \ \{R_5\}, \ \{R_3\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$
\ \{R_1\}, \ \{R_3\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z;$
\ \{R_1\}, \ \{R_5\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_2 + c_6 \sigma_1) k_z;$
\ \{R_2\}, \ \{R_5\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;$
\ \{R_2\}, \ \{R_3\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_2 + c_6 \sigma_1) k_y;$
\ \{R_3\}, \ \{R_3\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_2 + c_6 \sigma_1) k_z;$
\ \{R_3\}, \ \{R_5\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;$
$Q; \ \{R_5\}, \ \{R_3\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z;$
\ \{R_3\}, \ \{R_3\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$
\ \{R_5\}, \ \{R_3\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;$
\ \{R_6\}, \ \{R_3\};\ 
\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;
Accidental degeneracies on high symmetry line

\begin{align*}
\Delta: \{R_1\}, \{R_2\} & : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z + c_1 \sigma_1 k_x; \\
P: \{R_1\}, \{R_2\} & : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z; \\
Sigma: \{R_1\}, \{R_2\} & : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_1 \sigma_1 k_y; \\
E: \{R_1\}, \{R_2\} & : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_1 \sigma_1 k_y; \\
\Lambda: \{R_1\}, \{R_2\} & : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \\
\{R_1\}, \{R_2\} & : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \\
\{R_1\}, \{R_2\} & : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \\
\{R_2\}, \{R_3\} & : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \\
\{R_2\}, \{R_3\} & : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \\
\{R_3\}, \{R_4\} & : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \\
Q: \{R_5\}, \{R_6\} & : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \\
\{R_5\}, \{R_7\} & : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \\
\{R_5\}, \{R_8\} & : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \\
\{R_6\}, \{R_7\} & : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \\
\{R_6\}, \{R_8\} & : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \\
\{R_7\}, \{R_8\} & : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z.
\end{align*}
Accidental degeneracies on high symmetry line

\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_y;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_y;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_x;
\{R_2\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_x;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_x;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_y;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_y;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_x;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_y;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_x;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_x;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_x;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_1\sigma_1 + c_2\sigma_2) k_y;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_2\}, \{R_2\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
\{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + \sum_{i=1}^{3} c_{i,1}\sigma_ik_z;
Accidental degeneracies on high symmetry line

\( \Lambda; \{R_1\}, \{R_2\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \)
\( \{R_1\}, \{R_3\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \)
\( \{R_1\}, \{R_3\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \)
\( \{R_2\}, \{R_3\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \)
\( \{R_2\}, \{R_3\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \)
\( \{R_1\}, \{R_2\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \)
\( H; \{R_1\}, \{R_2\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \)
\( \{R_1\}, \{R_3\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \)
\( \{R_1\}, \{R_3\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \)
\( \{R_2\}, \{R_3\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \)
\( \{R_2\}, \{R_3\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \)
\( \{R_3\}, \{R_2\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \)
\( D; \{R_1\}, \{R_2\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \)
\( A; \{R_1, R_1\}, \{R_2, R_2\} \): \( \Gamma_{0,0} (c_1 + c_2 k_x) + c_3 \Gamma_{3,0} k_x + c_4 \Gamma_{2,0} k_y + \sum_{i=1}^{3} (c_{i,1} \Gamma_{1,1} k_y + c_{i,2} \Gamma_{0,1} k_x + c_{i,3} \Gamma_{3,1} k_z); \)
\( \Sigma; \{R_1\}, \{R_2\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_4 \sigma_4 k_y; \)
\( \Delta; \{R_1\}, \{R_2\} \): \( \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_4 k_z; \)
\( F; \{R_1\}, \{R_2\} \): \( \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_4 k_z; \)
\( E; \{R_1, R_1\}, \{R_2, R_2\} \): \( \Gamma_{0,0} (c_1 + c_2 k_x) + c_3 \Gamma_{3,0} k_x + c_4 \Gamma_{2,0} k_y + \sum_{i=1}^{3} (c_{i,1} \Gamma_{1,1} k_y + c_{i,2} \Gamma_{0,1} k_x + c_{i,3} \Gamma_{3,1} k_z); \)
\( C; \{R_1\}, \{R_2\} \): \( \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_4 k_y; \)

SG 37

\( \Gamma_{0}^{0}; \{C_{2z},[000]\}, \{\sigma_{y}[00\frac{1}{2}]\}, T; \) Non-Centrosymmetric; without SOC

\( Z; \{R_2, R_3\} \): \( c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( \{R_6, R_8\} \): \( c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( T; \{R_2, R_3\} \): \( c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( \{R_6, R_8\} \): \( c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( A; \{R_1, R_2\} \): \( (c_1 + c_2 k_x) \sigma_0 + (c_4 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z; \)
\( B; \{R_1, R_2\} \): \( (c_1 + c_2 k_y) \sigma_0 + (c_4 \sigma_1 + c_4 \sigma_2) k_x + c_5 \sigma_3 k_z; \)
\( G; \{R_1, R_2\} \): \( (c_1 + c_2 k_y) \sigma_0 + (c_4 \sigma_1 + c_4 \sigma_2) k_x + c_5 \sigma_3 k_z; \)
\( E; \{R_1, R_2\} \): \( (c_1 + c_2 k_x) \sigma_0 + (c_4 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z; \)
Accidental degeneracies on high symmetry line

\[ \Lambda: \{ \mathbf{R}_1 \}, \{ \mathbf{R}_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ \mathbf{R}_1 \}, \{ \mathbf{R}_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]
\[ \{ \mathbf{R}_1 \}, \{ \mathbf{R}_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{ \mathbf{R}_2 \}, \{ \mathbf{R}_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{ \mathbf{R}_2 \}, \{ \mathbf{R}_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]
\[ \{ \mathbf{R}_4 \}, \{ \mathbf{R}_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ H: \{ \mathbf{R}_1 \}, \{ \mathbf{R}_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ \mathbf{R}_1 \}, \{ \mathbf{R}_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]
\[ \{ \mathbf{R}_1 \}, \{ \mathbf{R}_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{ \mathbf{R}_2 \}, \{ \mathbf{R}_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{ \mathbf{R}_2 \}, \{ \mathbf{R}_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]
\[ \{ \mathbf{R}_4 \}, \{ \mathbf{R}_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ D: \{ \mathbf{R}_1 \}, \{ \mathbf{R}_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \]
\[ \Sigma: \{ \mathbf{R}_1 \}, \{ \mathbf{R}_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 \sigma_2 k_y; \]
\[ \Delta: \{ \mathbf{R}_1 \}, \{ \mathbf{R}_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 \sigma_2 k_x; \]
\[ F: \{ \mathbf{R}_1 \}, \{ \mathbf{R}_2 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + \sigma_1 \sigma_2 k_x; \]
\[ C: \{ \mathbf{R}_1 \}, \{ \mathbf{R}_2 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + \sigma_1 \sigma_2 k_y; \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_5 \sigma_2 k_z; \]
\[ H; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_5 \sigma_2 k_z; \]
\[ A; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ B; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ G; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ F; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ E; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ C; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]

SG 39
\[ \Gamma_{5}^{\sigma}; \{ C_{2y}[000], \{ \sigma_x \{1 \begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix} \} \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ S; \{ R_2, R_3 \}; c_1 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_3; \]
\[ R; \{ R_2, R_4 \}; c_1 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_3; \]
\[ D; \{ R_1, R_1 \}; (c_1 + c_2 k_z) \sigma_0 + \sum_{i=1}^{3} (c_{1i} k_x + c_{2i} k_y) \sigma_i \]
Accidental degeneracies on high symmetry line

$\Delta$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_z$;

$H$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_z$;

$A$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z$;

$\Sigma$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z$;

$\Delta$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_3 k_y) + c_3 \sigma_3 k_y$;

$R_1$, $R_3$ : $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z$;

$R_1$, $R_3$ : $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z$;

$R_2$, $R_3$ : $\sigma_0 (c_1 + c_3 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z$;

$R_2$, $R_3$ : $\sigma_0 (c_1 + c_3 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z$;

$R_1$, $R_3$ : $\sigma_0 (c_1 + c_3 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z$;

$R_1$, $R_3$ : $\sigma_0 (c_1 + c_3 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z$;

$B$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_3 k_y) + c_3 \sigma_3 k_y$;

$C$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_3 k_y) + c_3 \sigma_3 k_y$;

$G$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$F$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$E$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$C$: $\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$T$: \{C_{2v}[000], \{\sigma_z[00\frac{1}{2}]\}, T; Non-Centrosymmetric; without SOC

$Z$: $R_5$: $c_1 \sigma_0 + c_2 \sigma_2 k_z$;

$T$: $R_5$: $c_1 \sigma_0 + c_2 \sigma_2 k_z$;

$A$: $\{R_2, R_4\}: (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z$;

$B$: $R_5$: $(c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z$;

$G$: $R_5$: $(c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z$;

$E$: $\{R_2, R_4\}: (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z$;
Accidental degeneracies on high symmetry line

\[ \Lambda: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_z; \]

\[ H: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_z; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z; \]

\[ \Delta: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ F: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ C: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z; \]
SG 41
\[
\Gamma^0_0; \{C_{2v}|000\}, \{\sigma_x|z\}, \{\sigma_z|x\}; T; \text{Non-Centrosymmetric; without SOC}
\]

\[
Z; R_5: c_1\sigma_0 + c_2\sigma_3k_z;
\]
\[
T; R_5: c_1\sigma_0 + c_2\sigma_2k_z;
\]
\[
S; \{R_2, R_3\}: c_1\sigma_0 + (c_2k_x + c_3k_y)\sigma_3;
\]
\[
R; \{R_2, R_4\}: c_1\sigma_0 + (c_2k_x + c_3k_y)\sigma_3;
\]
\[
D; \{R_1, R_4\}: (c_1 + c_2k_x)\sigma_0 + \sum_{i=1}^{3}(c_{1,i}k_x + c_{1,i}k_y)\sigma_i;
\]
\[
A; \{R_2, R_4\}: (c_1 + c_2k_x)\sigma_0 + c_3\sigma_2k_y + (c_4\sigma_1 + c_5\sigma_3)k_z;
\]
\[
B; R_5: (c_1 + c_2k_y)\sigma_0 + c_3\sigma_2k_x + c_4\sigma_1k_z;
\]
\[
G; R_5: (c_1 + c_2k_y)\sigma_0 + c_3\sigma_2k_x + c_4\sigma_1k_z;
\]
\[
E; \{R_2, R_4\}: (c_1 + c_2k_x)\sigma_0 + c_3\sigma_3k_y + (c_4\sigma_1 + c_5\sigma_2)k_z;
\]

Accidental degeneracies on high symmetry line

\[
\Lambda; \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z + c_5\sigma_2k_z;
\]
\[
H; \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z + c_5\sigma_2k_z;
\]
\[
\Sigma; \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z + c_4\sigma_1k_z;
\]
\[
\Delta; \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_y;
\]
\[
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z + (c_4\sigma_1 + c_5\sigma_2)k_z;
\]
\[
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z + (c_4\sigma_1 + c_5\sigma_2)k_z;
\]
\[
\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z + (c_4\sigma_1 + c_5\sigma_2)k_z;
\]
\[
\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z + (c_4\sigma_1 + c_5\sigma_2)k_z;
\]
\[
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z + (c_4\sigma_1 + c_5\sigma_2)k_z;
\]
\[
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_z + (c_4\sigma_1 + c_5\sigma_2)k_z;
\]
\[
\{R_4\}, \{R_5\}: \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_y;
\]

SG 42
\[
\Gamma^0_0; \{C_{2v}|000\}, \{\sigma_y|000\}, T; \text{Non-Centrosymmetric; without SOC}
\]
Accidental degeneracies on high symmetry line

Λ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;
{R_1}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_z;
{R_1}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y;
{R_2}, \{R_1\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y;
{R_2}, \{R_1\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_z;
{R_3}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;

G: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;
{R_1}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_z;
{R_1}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y;
{R_2}, \{R_1\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y;
{R_2}, \{R_1\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_z;
{R_3}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;

H: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;
{R_1}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_z;
{R_1}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y;
{R_2}, \{R_1\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y;
{R_2}, \{R_1\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_z;
{R_3}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;

Q: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;
{R_1}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_z;
{R_1}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y;
{R_2}, \{R_1\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_y;
{R_2}, \{R_1\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) k_z;
{R_3}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;

Σ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_1\sigma_1k_z;
C: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_1\sigma_1k_z;
A: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_1\sigma_1k_z;
U: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_1\sigma_1k_z;
Δ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_1\sigma_1k_z;
D: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_1\sigma_1k_z;
B: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_1\sigma_1k_z;
R: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_1\sigma_1k_z;
\[ \Gamma^I_v; \{ C_{2v}|00\frac{1}{2}\}, \{ \sigma_y|\frac{1}{2}00\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ Y; \quad R_5; \quad c_1\sigma_0 + c_2\sigma y k_y; \]
\[ X; \quad R_5; \quad c_1\sigma_0 + c_2\sigma y k_x; \]
\[ Z; \quad \{ R_2, R_4 \}; \quad c_1\sigma_0 + c_2\sigma y k_z; \quad \{ R_6, R_8 \}; \quad c_1\sigma_0 + c_2\sigma y k_z; \]
\[ G; \quad R_5; \quad (c_1 + c_2k_x)\sigma_0 + c_3\sigma_3 k_x + c_4\sigma_1 k_y; \]
\[ H; \quad R_5; \quad (c_1 + c_2k_x)\sigma_0 + c_3\sigma_3 k_x + c_4\sigma_1 k_y; \]
\[ C; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y + c_5\sigma_3 k_z; \]
\[ A; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y + c_5\sigma_3 k_z; \]
\[ D; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_x + c_5\sigma_3 k_z; \]
\[ B; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_x + c_5\sigma_3 k_z; \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z + (c_5\sigma_1 + c_6\sigma_2) k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z + (c_5\sigma_1 + c_6\sigma_2) k_y; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z + (c_5\sigma_1 + c_6\sigma_2) k_y; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z + (c_5\sigma_1 + c_6\sigma_2) k_z; \]
\[ \{ R_1 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z; \]
\[ \{ R_5 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z + (c_5\sigma_1 + c_6\sigma_2) k_z; \]
\[ \{ R_6 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z + (c_5\sigma_1 + c_6\sigma_2) k_y; \]
\[ \{ R_7 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z + (c_5\sigma_1 + c_6\sigma_2) k_z; \]
\[ \Sigma; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z + c_1\sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3 k_z + c_1\sigma_3 k_y; \]
\[ \{ R_2 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3 k_y + c_1\sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3 k_y + c_1\sigma_1 k_z; \]
\[ R; \quad \{ R_1 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3 k_y + c_1\sigma_1 k_z; \]

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\[ \Gamma^I_v; \{ C_{2v}|000\}, \{ \sigma_y|000\}, T; \text{Non-Centrosymmetric; without SOC} \]
Accidental degeneracies on high symmetry line

Λ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;

G: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;

P: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^{3} \sigma_i (c_i, 1 k_z + c_i, 2 k_y);
\Sigma: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 \sigma_2 k_y;
\Gamma: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 \sigma_3 k_y;
\Delta: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z;

U: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z;

SG 45
Γ′_0: \{C_{2z}(000), (σ_y [1 1 0])\}, T; Non-Centrosymmetric; without SOC

R: \{R_2, R_4\}; c_1 \sigma_0 + (c_2 k_x + c_3 k_z) \sigma_3;
S: \{R_2, R_4\}; c_1 \sigma_0 + (c_2 k_y + c_3 k_z) \sigma_3;
W: \{R_2, R_4\}; c_1 \sigma_0 + \sum_{i=1}^{3} c_i \sigma_i k_z;
\{R_2, R_2\}; c_1 \sigma_0 + \sum_{i=1}^{3} c_i \sigma_i k_z;
D: \{R_2, R_4\}; (c_1 + c_2 k_x) \sigma_3 + \sum_{i=1}^{3} (c_i, 1 k_y + c_i, 2 k_z) \sigma_i;
Q: \{R_1, R_1\}; (c_1 + c_2 k_y) \sigma_0 + \sum_{i=1}^{3} (c_i, 1 k_x + c_i, 2 k_z) \sigma_i;
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ G; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ P; \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_i k_z + c_i k_y); \]
\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 \sigma_2 k_y; \]
\[ F; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 \sigma_2 k_y; \]
\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_x; \]
\[ U; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_x; \]

SG 46

\[ \Gamma_0^*; \{C_{2z}[000], \{\sigma_y[0\frac{1}{2}^{\pm}]\}, T; Non-Centrosymmetric; without SOC \]

\[ S; \{R_2, R_4\}; c_1 \sigma_0 + (c_2 k_y + c_3 k_z) \sigma_3; \]
\[ W; \{R_1, R_2\}; c_1 \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_y + c_2 \sigma_3 k_z; \]
\[ D; \{R_1, R_2\}; (c_1 + c_2 k_z) \sigma_0 + \sum_{i=1}^{3} (c_i k_y + c_i k_z) \sigma_i; \]
Accidental degeneracies on high symmetry line

Λ: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
   \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;
   \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;
   \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x;
   \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;

G: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
   \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x;
   \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x;
   \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y;
   \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;

P: \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_i, 1 k_z + c_i, 2 k_y);

Σ: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 \sigma_1 k_y;

F: \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 \sigma_1 k_y;

Δ: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z;

U: \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 \sigma_1 k_z;

SG 47

Γ_o: \{C_{2z}|000\}, \{C_{2y}|000\}, \{I|000\}, \mathcal{T}; Centrosymmetric; without SOC
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]

\[ D; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]

\[ P; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]

\[ B; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]

\[ C; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]

\[ E; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
A: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;
\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z + c_5 \sigma_1 k_y;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;

A: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;

H: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;

Q: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;

G: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\( \Gamma_0: \{C_{2z}[000], C_{2y}[000], I[\frac{1}{2} \frac{1}{2} \frac{1}{2}] \}, T; \text{Centrosymmetric; without SOC} \)

\[ \begin{align*}
Y: & \quad R_5: \ c_1\sigma_0 + c_2\sigma_2k_y; \\
& \quad R_{10}: \ c_1\sigma_0 + c_2\sigma_2k_y; \\
X: & \quad R_5: \ c_1\sigma_0 + c_2\sigma_2k_x; \\
& \quad R_{10}: \ c_1\sigma_0 + c_2\sigma_2k_x; \\
Z: & \quad R_5: \ c_1\sigma_0 + c_2\sigma_2k_z; \\
& \quad R_{10}: \ c_1\sigma_0 + c_2\sigma_2k_z; \\
U: & \quad R_5: \ c_1\sigma_0 + c_2\sigma_2k_y; \\
& \quad R_{10}: \ c_1\sigma_0 + c_2\sigma_2k_y; \\
T: & \quad R_5: \ c_1\sigma_0 + c_2\sigma_2k_z; \\
& \quad R_{10}: \ c_1\sigma_0 + c_2\sigma_2k_z; \\
S: & \quad R_5: \ c_1\sigma_0 + c_2\sigma_2k_z; \\
& \quad R_{10}: \ c_1\sigma_0 + c_2\sigma_2k_z; \\
D: & \quad R_5: \ (c_1 + c_2k_y)\sigma_0 + c_3\sigma_1k_x + c_4\sigma_2k_z; \\
& \quad R_{10}: \ (c_1 + c_2k_y)\sigma_0 + c_3\sigma_1k_x + c_4\sigma_2k_z; \\
B: & \quad R_5: \ (c_1 + c_2k_x)\sigma_0 + c_3\sigma_2k_x + c_4\sigma_1k_z; \\
& \quad R_{10}: \ (c_1 + c_2k_x)\sigma_0 + c_3\sigma_2k_x + c_4\sigma_1k_z; \\
C: & \quad R_5: \ (c_1 + c_2k_z)\sigma_0 + c_3\sigma_1k_y + c_4\sigma_2k_z; \\
& \quad R_{10}: \ (c_1 + c_2k_z)\sigma_0 + c_3\sigma_1k_y + c_4\sigma_2k_z; \\
A: & \quad R_5: \ (c_1 + c_2k_x)\sigma_0 + c_3\sigma_2k_y + c_4\sigma_1k_z; \\
& \quad R_{10}: \ (c_1 + c_2k_x)\sigma_0 + c_3\sigma_2k_y + c_4\sigma_1k_z; \\
H: & \quad R_5: \ (c_1 + c_2k_x)\sigma_0 + c_3\sigma_2k_x + c_4\sigma_1k_y; \\
& \quad R_{10}: \ (c_1 + c_2k_x)\sigma_0 + c_3\sigma_2k_x + c_4\sigma_1k_y; \\
G: & \quad R_5: \ (c_1 + c_2k_z)\sigma_0 + c_3\sigma_1k_z + c_4\sigma_2k_y; \\
& \quad R_{10}: \ (c_1 + c_2k_z)\sigma_0 + c_3\sigma_1k_z + c_4\sigma_2k_y; \\
\end{align*} \]
Accidental degeneracies on high symmetry line

$$\Delta; \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$
$$\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$

$$P: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$
$$\{R_2\}, \{R_5\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{R_2\}, \{R_6\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{R_4\}, \{R_6\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{R_4\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{R_6\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$

$$\Sigma: \{R_1\}, \{R_3\}: (c_1 + c_2 k_z) + \sigma_3 (c_3 + c_4 k_z);$$
$$\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_1\}, \{R_5\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_2\}, \{R_5\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_3\}, \{R_4\}: (c_1 + c_2 k_z) + \sigma_3 (c_3 + c_4 k_z);$$

$$E: \{R_2\}, \{R_4\}: (c_1 + c_2 k_z) + \sigma_3 (c_3 + c_4 k_z);$$
$$\{R_2\}, \{R_6\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_2\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_4\}, \{R_6\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_4\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_6\}, \{R_8\}: (c_1 + c_2 k_z) + \sigma_3 (c_3 + c_4 k_z);$$

$$\Lambda: \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_1\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_2\}, \{R_5\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$

$$Q: \{R_2\}, \{R_5\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{R_2\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_2\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_4\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_4\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_3 k_z;$$
$$\{R_8\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
SG 49

Γ₀; \{C_{2z}|000\}, \{C_{2y}|000\}, \{I|001\}; Centrosymmetric; without SOC

Z: \quad R_5: \quad c_1 \sigma_0 + c_2 \sigma_2 k_x;
     \quad R_{10}: \quad c_1 \sigma_0 + c_2 \sigma_2 k_x;
U: \quad R_5: \quad c_1 \sigma_0 + c_2 \sigma_2 k_x;
     \quad R_{10}: \quad c_1 \sigma_0 + c_2 \sigma_2 k_x;
T: \quad R_5: \quad c_1 \sigma_0 + c_2 \sigma_2 k_x;
     \quad R_{10}: \quad c_1 \sigma_0 + c_2 \sigma_2 k_x;
R: \quad R_5: \quad c_1 \sigma_0 + c_2 \sigma_2 k_x;
     \quad R_{10}: \quad c_1 \sigma_0 + c_2 \sigma_2 k_x;
P: \quad R_5: \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_z;
B: \quad R_5: \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_z;
E: \quad R_5: \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_2 k_y + c_4 \sigma_1 k_z;
A: \quad R_5: \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_2 k_y + c_4 \sigma_1 k_z;
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ D: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \Sigma: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ C: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \Lambda: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ H: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ Q: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ G: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
SG 50

Γ₀; \{C₂z|000\}, \{C₂y|000\}, \{I|\frac{1}{2}\frac{1}{2}0\}, \mathcal{T}; \text{Centrosymmetric; without SOC}

\begin{align*}
Y: & \quad R₅: c₁σ₀ + c₂σ₂ky; \\
& \quad R₁₀: c₁σ₀ + c₂σ₂ky; \\
X: & \quad R₅: c₁σ₀ + c₂σ₂kz; \\
& \quad R₁₀: c₁σ₀ + c₂σ₂kz; \\
U: & \quad R₅: c₁σ₀ + c₂σ₂kz; \\
& \quad R₁₀: c₁σ₀ + c₂σ₂kz; \\
T: & \quad R₅: c₁σ₀ + c₂σ₂ky; \\
& \quad R₁₀: c₁σ₀ + c₂σ₂ky; \\
S: & \quad R₅: c₁σ₀ + c₂σ₂kz; \\
& \quad R₁₀: c₁σ₀ + c₂σ₂kz; \\
R: & \quad R₅: c₁σ₀ + c₂σ₂kz; \\
& \quad R₁₀: c₁σ₀ + c₂σ₂kz; \\
D: & \quad R₅: (c₁ + c₂k_y)σ₀ + c₃σ₁k_z + c₄σ₂k_z; \\
& \quad R₁₀: (c₁ + c₂k_y)σ₀ + c₃σ₁k_z + c₄σ₂k_z; \\
P: & \quad R₅: (c₁ + c₂k_y)σ₀ + c₃σ₁k_z + c₄σ₂k_z; \\
& \quad R₁₀: (c₁ + c₂k_y)σ₀ + c₃σ₁k_z + c₄σ₂k_z; \\
C: & \quad R₅: (c₁ + c₂k_z)σ₀ + c₃σ₁k_y + c₄σ₂k_z; \\
& \quad R₁₀: (c₁ + c₂k_z)σ₀ + c₃σ₁k_y + c₄σ₂k_z; \\
E: & \quad R₅: (c₁ + c₂k_z)σ₀ + c₃σ₁k_y + c₄σ₂k_z; \\
& \quad R₁₀: (c₁ + c₂k_z)σ₀ + c₃σ₁k_y + c₄σ₂k_z; \\
H: & \quad R₅: (c₁ + c₂k_z)σ₀ + c₃σ₂k_x + c₄σ₁k_y; \\
& \quad R₁₀: (c₁ + c₂k_z)σ₀ + c₃σ₂k_x + c₄σ₁k_y; \\
G: & \quad R₅: (c₁ + c₂k_z)σ₀ + c₃σ₁k_x + c₄σ₂k_y; \\
& \quad R₁₀: (c₁ + c₂k_z)σ₀ + c₃σ₁k_x + c₄σ₂k_y; 
\end{align*}
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ B: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ A: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Lambda: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ Q: \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_5 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_4 \}, \{ R_5 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_4 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_6 \}, \{ R_5 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
SG 51

Γ₀; \{C_{2z}|00\frac{1}{2}\}, \{C_{2y}|000\}, \{I|000\}, T; Centrosymmetric; without SOC

Z: \(R_5\): \(c_1\sigma_0 + c_2\sigma_2k_z\);
    \(R_{10}\): \(c_1\sigma_0 + c_2\sigma_2k_z\);

U: \(R_5\): \(c_1\sigma_0 + c_2\sigma_2k_z\);
    \(R_{10}\): \(c_1\sigma_0 + c_2\sigma_2k_z\);

T: \(R_5\): \(c_1\sigma_0 + c_2\sigma_2k_z\);
    \(R_{10}\): \(c_1\sigma_0 + c_2\sigma_2k_z\);

R: \(R_5\): \(c_1\sigma_0 + c_2\sigma_2k_z\);
    \(R_{10}\): \(c_1\sigma_0 + c_2\sigma_2k_z\);

P: \(R_5\): \((c_1 + c_2k_y)\sigma_0 + c_3\sigma_1k_z\);

B: \(R_5\): \((c_1 + c_2k_y)\sigma_0 + c_3\sigma_1k_z\);

E: \(R_2, R_4\): \((c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z\);
    \(R_6, R_8\): \((c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z\);

A: \(R_2, R_4\): \((c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z\);
    \(R_6, R_8\): \((c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z\);
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ D: \{R_1\}, \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_y); \]
\[ \Sigma: \{R_1\}, \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_1\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_x); \]
\[ C: \{R_1\}, \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_x); \]
\[ E: \{R_2\}, \{R_4\}, \{R_6\}, \{R_8\} : \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} c_{i1}\Gamma_{1,0}(k_x + k_z (c_{i2}\Gamma_{1,1} + c_{i3}\Gamma_{1,2})) + k_y (c_{21}\Gamma_{1,1} + c_{31}\Gamma_{1,2}); \]
\[ A: \{R_2\}, \{R_4\}, \{R_6\}, \{R_8\} : \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} c_{i1}\Gamma_{1,0}(k_x + k_z (c_{i2}\Gamma_{1,1} + c_{i3}\Gamma_{1,2})) + k_y (c_{21}\Gamma_{1,1} + c_{31}\Gamma_{1,2}); \]
\[ \Lambda: \{R_1\}, \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_z); \]
\[ H: \{R_1\}, \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_z); \]
\[ \Omega: \{R_1\}, \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_z); \]
\[ G; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Gamma_0; \{ C_{2z} | 00 \frac{1}{2} \}, \{ C_{2y} | 000 \}, \{ I | \frac{1}{2} \frac{1}{2} 0 \}, T; \text{Centrosymmetric; without SOC} \]

\[ Y; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ X; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_x; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_x; \]
\[ Z; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ U; \{ R_9, R_{10} \}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_z + c_3 \Gamma_{3,1} k_y + \sum_{i=1}^2 c_i \Gamma_{i,2} k_z; \]
\[ T; \quad R_5; \quad (c_1 + \sum_{i=x}^z c_i k_i^2) \sigma_0 + (c_2 \sigma_3 k_x + c_3 \sigma_1 k_y) k_z; \]
\[ R_{10}; \quad (c_1 + \sum_{i=x}^z c_i k_i^2) \sigma_0 + (c_2 \sigma_3 k_x + c_3 \sigma_1 k_y) k_z; \]
\[ S; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ D; \quad R_5; \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_1 k_x + c_4 \sigma_2 k_z; \]
\[ P; \quad \{ R_2, R_3 \}; (c_1 + c_2 k_y) \sigma_0 + (c_2 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ \{ R_4, R_8 \}; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ B; \quad R_5; \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_1 k_x; \]
\[ C; \quad R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z; \]
\[ E; \quad R_5; \quad (c_2 k_x + c_1) \sigma_0 + c_3 \sigma_2 k_z; \]
\[ A; \quad \{ R_2, R_4 \}; (c_1 + c_2 k_x) \sigma_0 + (c_2 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ \{ R_6, R_8 \}; (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ H; \quad R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_2 k_z + c_4 \sigma_1 k_y; \]
\[ G; \quad R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1 k_z + c_4 \sigma_2 k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_6 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{ R_1 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_5 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ A: \{ R_2 \}, \{ R_3 \}, \{ R_6 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + k_y [c_1 \Gamma_{1,1} + c_3 \Gamma_{1,2}] + k_y (c_2 \Gamma_{1,1} + c_3 \Gamma_{1,2}); \]

\[ \Lambda: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{ R_1 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_5 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ Q: \{ R_2 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{ R_2 \}, \{ R_6 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_4 \}, \{ R_5 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_6 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
Γ₀; \{C_{2x}|00\frac{1}{2}\}, \{C_{2y}|000\}, \{I|\frac{1}{2}00\}, T; Centrosymmetric; without SOC

Y; R₅: c₁σ₀ + c₂σ₂ky;
    R₁₀: c₁σ₀ + c₂σ₂ky;
Z; R₅: c₁σ₀ + c₂σ₂kz;
    R₁₀: c₁σ₀ + c₂σ₂kz;
U; R₅: c₁σ₀ + c₂σ₂kz;
    R₁₀: c₁σ₀ + c₂σ₂kz;
T; R₅: (c₁ + \sum_{i=1}^{x} c_i k_i^2)σ₀ + (c₂σ₂kx + c₃σ₁ky)kz;
    R₁₀: (c₁ + \sum_{i=1}^{x} c_i k_i^2)σ₀ + (c₂σ₂kx + c₃σ₁ky)kz;
S; R₅: c₁σ₀ + c₂σ₂ky;
    R₁₀: c₁σ₀ + c₂σ₂ky;
R; R₅: (c₁ + \sum_{i=1}^{x} c_i k_i^2)σ₀ + (c₂σ₂kx + c₃σ₃ky)kz;
    R₁₀: (c₁ + \sum_{i=1}^{x} c_i k_i^2)σ₀ + (c₂σ₂kx + c₃σ₃ky)kz;
P; R₅: (c₁ + c₂ky)σ₀ + c₃σ₁kz;
B; R₅: (c₁ + c₂ky)σ₀ + c₃σ₁kz;
C; R₅: (c₁ + c₂kx)σ₀ + c₃σ₁ky + c₄σ₂kz;
E; R₅: (c₁ + c₂kx)σ₀ + c₃σ₂kz;
A; \{R₂, R₄\}: (c₁ + c₂kx)σ₀ + (c₃σ₁ - c₄σ₂)kz;
    \{R₆, R₈\}: (c₁ + c₂kx)σ₀ + (c₃σ₁ - c₄σ₂)kz;
H; R₅: (c₁ + c₂kx)σ₀ + c₃σ₂kx + c₄σ₁ky;
Q; R₅: (c₁ + c₂kx)σ₀ + c₃σ₂kx + c₄σ₁ky;
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ D: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ A: \{ R_2 \}, \{ R_4 \}; \quad c_1 \Gamma_{1,0} + \sum_{i=0,3} (c_1 \Gamma_{1,0} k_x + k_y (c_2 \Gamma_i,1 + c_3 \Gamma_i,2)) + k_y (c_2 \Gamma_{1,1} + c_3 \Gamma_{1,2}); \]

\[ \Lambda: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ \Gamma: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
Γ: \{ C_{2v}(00\frac{1}{2}), C_{2v}(000), I(0\frac{1}{2}0) \}, \mathcal{T}; \text{Centrosymmetric; without SOC}

\begin{align*}
X: & R_5: \quad c_1\sigma_0 + c_2\sigma_2k_z; \\
& R_{10}: \quad c_1\sigma_0 + c_2\sigma_2k_x; \\
Z: & R_5: \quad c_1\sigma_0 + c_2\sigma_2k_z; \\
& R_{10}: \quad c_1\sigma_0 + c_2\sigma_2k_z; \\
U: & \{ R_9, R_{10} \}: \quad c_1\Gamma_{0,0} + c_2\Gamma_{0,2}k_x + c_3\Gamma_{3,1}k_y + \sum_{i=1}^{2} c_{i,3}\Gamma_{i,2}k_z; \\
T: & R_5: \quad c_1\sigma_0 + c_2\sigma_2k_z; \\
& R_{10}: \quad c_1\sigma_0 + c_2\sigma_2k_z; \\
S: & R_5: \quad c_1\sigma_0 + c_2\sigma_2k_z; \\
& R_{10}: \quad c_1\sigma_0 + c_2\sigma_2k_z; \\
R: & \{ R_9, R_{10} \}: \quad c_1\Gamma_{0,0} + c_2\Gamma_{0,2}k_x + c_3\Gamma_{3,1}k_y + \sum_{i=1}^{2} c_{i,3}\Gamma_{i,2}k_z; \\
D: & R_5: \quad (c_1 + c_2k_y)\sigma_0 + c_3\sigma_1k_x + c_4\sigma_2k_z; \\
P: & \{ R_2, R_6 \}: \quad (c_1 + c_2k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \\
& \{ R_4, R_6 \}: \quad (c_1 + c_2k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \\
B: & R_5: \quad (c_1 + c_2k_y)\sigma_0 + c_3\sigma_1k_z; \\
E: & \{ R_2, R_4 \}: \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \\
& \{ R_6, R_8 \}: \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \\
A: & \{ R_2, R_4 \}: \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \\
& \{ R_6, R_8 \}: \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \\
Q: & R_5: \quad (c_1 + c_2k_z)\sigma_0 + c_2\sigma_1k_x + c_4\sigma_2k_y; \\
G: & R_5: \quad (c_1 + c_3k_z)\sigma_0 + c_2\sigma_1k_x + c_4\sigma_2k_y; 
\end{align*}
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ P: \{R_2, R_6\}, \{R_4, R_8\}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} c_{i,1 \Gamma_{1,0}} k_y + k_z (c_{i,2 \Gamma_{1,1}} + c_{i,3 \Gamma_{1,2}}) + k_y (c_{i \Gamma_{1,1}} + c_{i \Gamma_{1,2}}); \]

\[ \Sigma: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ C: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]

\[ E: \{R_2, R_6\}, \{R_4, R_8\}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} c_{i,1 \Gamma_{1,0}} k_y + k_z (c_{i,2 \Gamma_{1,1}} + c_{i,3 \Gamma_{1,2}}) + k_y (c_{i \Gamma_{1,1}} + c_{i \Gamma_{1,2}}); \]

\[ A: \{R_2, R_6\}, \{R_4, R_8\}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} c_{i,1 \Gamma_{1,0}} k_y + k_z (c_{i,2 \Gamma_{1,1}} + c_{i,3 \Gamma_{1,2}}) + k_y (c_{i \Gamma_{1,1}} + c_{i \Gamma_{1,2}}); \]

\[ \Lambda: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]

\[ H: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\( Y; R_5; c_1\sigma_0 + c_2\sigma_2k_y; \)
\( R_{10}; c_1\sigma_0 + c_2\sigma_2k_y; \)
\( X; R_5; c_1\sigma_0 + c_2\sigma_2k_z; \)
\( R_{10}; c_1\sigma_0 + c_2\sigma_2k_z; \)
\( U; R_5; c_1\sigma_0 + c_2\sigma_2k_z; \)
\( R_{10}; c_1\sigma_0 + c_2\sigma_2k_z; \)
\( T; R_5; c_1\sigma_0 + c_2\sigma_2k_y; \)
\( R_{10}; c_1\sigma_0 + c_2\sigma_2k_y; \)
\( S; \{R_2, R_4\}; (c_1 + \sum_{i=1}^{z} c_i k_i^2)\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_y; \)
\( \{R_6, R_8\}; (c_1 + \sum_{i=1}^{z} c_i k_i^2)\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_z; \)
\( \{R_{10}, R_{12}\}; (c_1 + \sum_{i=1}^{z} c_i k_i^2)\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_z; \)
\( \{R_{14}, R_{16}\}; (c_1 + \sum_{i=1}^{z} c_i k_i^2)\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_z; \)
\( R; \{R_2, R_4\}; (c_1 + \sum_{i=1}^{z} c_i k_i^2)\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_z; \)
\( \{R_6, R_8\}; (c_1 + \sum_{i=1}^{z} c_i k_i^2)\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_z; \)
\( \{R_{10}, R_{12}\}; (c_1 + \sum_{i=1}^{z} c_i k_i^2)\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_z; \)
\( \{R_{14}, R_{16}\}; (c_1 + \sum_{i=1}^{z} c_i k_i^2)\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_z; \)
\( D; \{R_2, R_4\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \)
\( \{R_6, R_8\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \)
\( P; \{R_2, R_4\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \)
\( \{R_6, R_8\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \)
\( C; \{R_2, R_4\}; (c_2 k_x + c_1)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y; \)
\( \{R_6, R_8\}; (c_2 k_x + c_1)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y; \)
\( E; \{R_2, R_4\}; (c_2 k_x + c_1)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y; \)
\( \{R_6, R_8\}; (c_2 k_x + c_1)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y; \)
\( H; R_5; (c_2 k_z + c_1)\sigma_0 + c_3\sigma_1 k_y; \)
\( Q; \{R_2, R_4\}; (c_1 + c_2 k_z + \sum_{i=1}^{z} c_i k_i^2)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z k_y \)
\( \{R_6, R_8\}; (c_1 + c_2 k_z + \sum_{i=1}^{z} c_i k_i^2)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z k_y \)
\( G; R_5; (c_2 k_z + c_1)\sigma_0 + c_3\sigma_1 k_y; \)
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ D: \{R_2, R_4\}, \{R_6, R_8\}; \quad c_1 \Gamma_0,0 + \sum_{i=0,3} [c_{i,1} \Gamma_{i,0} k_y + k_z (c_{i,2} \Gamma_{i,1,1} + c_{i,3} \Gamma_{i,1,2})] + k_x (c_{i,2} \Gamma_{i,1,1} + c_{i,3} \Gamma_{i,1,2}); \]

\[ P: \{R_2, R_4\}, \{R_6, R_8\}; \quad c_1 \Gamma_0,0 + \sum_{i=0,3} [c_{i,1} \Gamma_{i,0} k_y + k_x (c_{i,2} \Gamma_{i,1,1} + c_{i,3} \Gamma_{i,1,2})] + k_z (c_{i,2} \Gamma_{i,1,1} + c_{i,3} \Gamma_{i,1,2}); \]

\[ B: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ C: \{R_2, R_4\}, \{R_6, R_8\}; \quad c_1 \Gamma_0,0 + \sum_{i=0,3} [c_{i,1} \Gamma_{i,0} k_y + k_y (c_{i,2} \Gamma_{i,1,1} + c_{i,3} \Gamma_{i,1,2})] + k_z (c_{i,2} \Gamma_{i,1,1} + c_{i,3} \Gamma_{i,1,2}); \]

\[ E: \{R_2, R_4\}, \{R_6, R_8\}; \quad c_1 \Gamma_0,0 + \sum_{i=0,3} [c_{i,1} \Gamma_{i,0} k_x + k_y (c_{i,2} \Gamma_{i,1,1} + c_{i,3} \Gamma_{i,1,2})] + k_z (c_{i,2} \Gamma_{i,1,1} + c_{i,3} \Gamma_{i,1,2}); \]

\[ A: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Lambda: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ Q: \{R_2, R_4\}, \{R_6, R_8\}; \quad c_1 \Gamma_0,0 + \sum_{i=0,3} c_{i,1} \Gamma_{i,0} k_x + k_y (c_2 \Gamma_{1,0} + c_3 \Gamma_{2,3}) + k_y (c_4 \Gamma_{1,1} + c_5 \Gamma_{1,2}); \]
Γ₀: \{C_2z\|000\}, \{C_2y\|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}, \{I\|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}; Centrosymmetric; without SOC

Y: \begin{align*}
R₅: & \quad c₁σ₀ + c₂σ₂k_y; \\
R₁₀: & \quad c₁σ₀ + c₂σ₂k_y;
\end{align*}

X: \begin{align*}
R₅: & \quad c₁σ₀ + c₂σ₂k_z; \\
R₁₀: & \quad c₁σ₀ + c₂σ₂k_z;
\end{align*}

Z: \begin{align*}
R₅: & \quad c₁σ₀ + c₂σ₂k_z; \\
R₁₀: & \quad c₁σ₀ + c₂σ₂k_z;
\end{align*}

U: \begin{align*}
\{R₉, R₁₀\}: & \quad c₁Γ₀,0 + \sum_{i=1}² c₁,1Γ₁,2k_x + c₂Γ₀,2k_y + c₃Γ₃,1k_z; \\
T: & \quad \{R₉, R₁₀\}: \quad c₁Γ₀,0 + c₂Γ₀,2k_x + \sum_{i=1}² c₁,1Γ₁,2k_y + c₃Γ₃,1k_z;
\end{align*}

S: \begin{align*}
R₅: & \quad (c₁ + \sum_{i=x}⁰ c₁k_i)σ₀ + c₂σ₂k_y; \\
R₁₀: & \quad (c₁ + \sum_{i=x}⁰ c₁k_i)σ₀ + c₂σ₂k_y;
\end{align*}

R: \begin{align*}
\{R₂, R₄\}: & \quad (c₁ + \sum_{i=x}⁰ c₁k_i)σ₀ + (c₂σ₁ + c₃σ₂)k_yk_y; \\
\{R₆, R₈\}: & \quad (c₁ + \sum_{i=x}⁰ c₁k_i)σ₀ + (c₂σ₁ + c₃σ₂)k_yk_y; \\
\{R₁₀, R₁₂\}: & \quad (c₁ + \sum_{i=x}⁰ c₁k_i)σ₀ + (c₂σ₁ + c₃σ₂)k_yk_y; \\
\{R₁₄, R₁₆\}: & \quad (c₁ + \sum_{i=x}⁰ c₁k_i)σ₀ + (c₂σ₁ + c₃σ₂)k_yk_y;
\end{align*}

D: \begin{align*}
R₅: & \quad (c₁ + c₂k_y)σ₀ + c₃σ₁k_z; \\
P: & \quad \{R₂, R₄\}: \quad (c₁ + c₂k_y)σ₀ + (c₃σ₁ + c₄σ₂)k_z; \\
\{R₄, R₆\}: & \quad (c₁ + c₂k_y)σ₀ + (c₃σ₁ + c₄σ₂)k_z;
\end{align*}

B: \begin{align*}
R₅: & \quad (c₁ + c₂k_y)σ₀ + c₃σ₂k_x + c₄σ₁k_z; \\
C: & \quad \{R₂, R₄\}: \quad (c₁ + c₂k_y)σ₀ + (c₃σ₁ + c₄σ₂)k_y; \\
\{R₄, R₆\}: & \quad (c₁ + c₂k_y)σ₀ + (c₃σ₁ + c₄σ₂)k_y;
\end{align*}

A: \begin{align*}
R₅: & \quad (c₁ + c₂k_y)σ₀ + c₃σ₂k_y + c₄σ₁k_z; \\
H: & \quad \{R₁, R₄\}: \quad (c₁ + c₂k_y)σ₀ + (c₃σ₁ + c₄σ₂)k_y; \\
\{R₂, R₃\}: & \quad (c₁ + c₂k_y)σ₀ + (c₃σ₁ + c₄σ₂)k_y;
\end{align*}

Q: \begin{align*}
\{R₁, R₄\}: & \quad (c₁ + c₂k_z + \sum_{i=x}⁰ c₁k_i)σ₀ + (c₂σ₁ + c₃σ₂)k_yk_y; \\
\{R₃, R₄\}: & \quad (c₁ + c₂k_z + \sum_{i=x}⁰ c₁k_i)σ₀ + (c₂σ₁ + c₃σ₂)k_yk_y;
\end{align*}

G: \begin{align*}
\{R₁, R₃\}: & \quad (c₁ + c₂k_z)σ₀ + (c₃σ₁ + c₄σ₂)k_x; \\
\{R₂, R₄\}: & \quad (c₁ + c₂k_z)σ₀ + (c₃σ₁ + c₄σ₂)k_x;
\end{align*}
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_3 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_3 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ P; \{R_2, R_3\}, \{R_4, R_5\}; c_1 \Gamma_0,0 + \sum_{i=0,3} \left[ \Gamma_{i,0} \sigma_{i,1} k_x + k_y (c_{i,2} \Gamma_{i,1} + c_{i,3} \Gamma_{i,2}) \right] + k_x (c_2 \Gamma_{1,0} + c_3 \Gamma_{2,3}); \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ E; \{R_2, R_3\}, \{R_4, R_5\}; c_1 \Gamma_0,0 + \sum_{i=0,3} \left[ \Gamma_{i,0} \sigma_{i,1} k_x + k_y (c_{i,2} \Gamma_{i,1} + c_{i,3} \Gamma_{i,2}) \right] + k_x (c_2 \Gamma_{1,0} + c_3 \Gamma_{2,3}); \]

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ H; \{R_1, R_2\}, \{R_2, R_3\}; c_1 \Gamma_0,0 + \sum_{i=0,3} \left[ \Gamma_{i,1} \sigma_{i,1} k_x + k_y (c_{i,2} \Gamma_{i,1} + c_{i,3} \Gamma_{i,2}) \right] + k_x (c_2 \Gamma_{1,1} + c_3 \Gamma_{1,2}); \]

\[ Q; \{R_1, R_2\}, \{R_3, R_4\}; c_1 \Gamma_0,0 + \sum_{i=0,3} \left[ \Gamma_{i,1} \sigma_{i,1} k_x + k_y (c_{i,2} \Gamma_{1,0} + c_{i,3} \Gamma_{2,3}) + k_y (c_{i,4} \Gamma_{1,1} + c_{i,5} \Gamma_{1,2}) \right]; \]

\[ G; \{R_1, R_2\}, \{R_2, R_4\}; c_1 \Gamma_0,0 + \sum_{i=0,3} \left[ \Gamma_{i,1} \sigma_{i,1} k_x + k_y (c_{i,2} \Gamma_{1,1} + c_{i,3} \Gamma_{1,2}) \right] + k_y (c_2 \Gamma_{1,1} + c_3 \Gamma_{1,2}); \]
\( \Gamma_0; \{C_2 \{000\}, \{C_2 y\} \frac{1}{2} \frac{1}{2} 0\}, \{I\} \frac{1}{2} \frac{1}{2} 0\}; T; \text{Centrosymmetric; without SOC} \)

Y: \( R_5; \)
\( c_1 \sigma_0 + c_2 \sigma_2 k_y; \)
\( R_{10}; \)
\( c_1 \sigma_0 + c_2 \sigma_2 k_y; \)

X: \( R_5; \)
\( c_1 \sigma_0 + c_2 \sigma_2 k_x; \)
\( R_{10}; \)
\( c_1 \sigma_0 + c_2 \sigma_2 k_x; \)

U: \( R_5; \)
\( c_1 \sigma_0 + c_2 \sigma_2 k_x; \)
\( R_{10}; \)
\( c_1 \sigma_0 + c_2 \sigma_2 k_x; \)

T: \( R_5; \)
\( c_1 \sigma_0 + c_2 \sigma_2 k_y; \)
\( R_{10}; \)
\( c_1 \sigma_0 + c_2 \sigma_2 k_y; \)

S: \( \{R_9, R_{10}\}; \)
\( c_1 \Gamma_{0,0} + c_2 \Gamma_{0,0} k_x + (c_3 \Gamma_{1,2} + c_4 \Gamma_{2,2}) k_y; \)

R: \( \{R_9, R_{10}\}; \)
\( c_1 \Gamma_{0,0} + c_2 \Gamma_{0,0} k_x + (c_3 \Gamma_{1,2} + c_4 \Gamma_{2,2}) k_y; \)

D: \( R_5; \)
\( (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_1 k_x; \)

P: \( R_5; \)
\( (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_1 k_x; \)

C: \( \{R_2, R_4\}; \)
\( (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_2 + c_4 \sigma_1) k_y; \)
\( \{R_6, R_8\}; \)
\( (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_2 + c_4 \sigma_1) k_y; \)

E: \( \{R_2, R_4\}; \)
\( (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_2 + c_4 \sigma_1) k_y; \)
\( \{R_6, R_8\}; \)
\( (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_2 + c_4 \sigma_1) k_y; \)

H: \( R_5; \)
\( (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1 k_y; \)

Q: \( \{R_5, R_3\}; \)
\( (c_1 + c_3 k_x) \Gamma_{0,0} + \sum_{i=1}^{3} (c_{i,1} \Gamma_{i,1} k_x + c_{i,2} \Gamma_{i,1} k_y); \)

G: \( \{R_1, R_4\}; \)
\( (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x; \)
\( \{R_2, R_4\}; \)
\( (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x; \)
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ B; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ C; \{ R_2 \}, \{ R_3 \}, \{ R_6 \}, \{ R_8 \}; c_1 \Gamma_{0,0} + \sum_{i=0,3} [c_{i,0} \Gamma_{1,0} k_x + k_y (c_{i,2} \Gamma_{1,1} + c_{i,3} \Gamma_{1,2}) + k_z (c_{i,2} \Gamma_{1,1} + c_{i,3} \Gamma_{1,2})]; \]
\[ E; \{ R_2 \}, \{ R_4 \}, \{ R_6 \}, \{ R_8 \}; c_1 \Gamma_{0,0} + \sum_{i=0,3} [c_{i,0} \Gamma_{1,0} k_x + k_y (c_{i,2} \Gamma_{1,1} + c_{i,3} \Gamma_{1,2}) + k_z (c_{i,2} \Gamma_{1,1} + c_{i,3} \Gamma_{1,2})]; \]
\[ A; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ G; \{ R_1 \}, \{ R_3 \}, \{ R_2 \}, \{ R_4 \}; c_1 \Gamma_{0,0} + \sum_{i=0,3} [c_{i,0} \Gamma_{1,0} k_x + k_y (c_{i,2} \Gamma_{1,1} + c_{i,3} \Gamma_{1,2}) + k_z (c_{i,2} \Gamma_{1,1} + c_{i,3} \Gamma_{1,2})]; \]
\[ \Gamma_0: \{ C_2 \{000\}, \{ C_2 y \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ I \{00 \frac{1}{2} \} \}, T; Centrosymmetric; without SOC \]

\[ Y: R_5; \quad c_1 \sigma_0 + c_2 \sigma_3 k_y; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_y; \]
\[ X: R_5; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ Z: R_5; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ U: R_5; \quad (c_1 + \sum_{i=x} c_i k_i^2) \sigma_0 + (c_2 \sigma_3 k_y + c_3 \sigma_1 k_z) k_z; \]
\[ R_{10}; \quad (c_1 + \sum_{i=x} c_i k_i^2) \sigma_0 + (c_2 \sigma_3 k_y + c_3 \sigma_1 k_z) k_z; \]
\[ T: R_5; \quad (c_1 + \sum_{i=x} c_i k_i^2) \sigma_0 + (c_2 \sigma_3 k_x + c_3 \sigma_1 k_z) k_y; \]
\[ R_{10}; \quad (c_1 + \sum_{i=x} c_i k_i^2) \sigma_0 + (c_2 \sigma_3 k_x + c_3 \sigma_1 k_z) k_y; \]
\[ S: \{ R_2, R_4 \}; \quad (c_1 + \sum_{i=x} c_i k_i^2) \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z k_y; \]
\[ \{ R_6, R_8 \}; \quad (c_1 + \sum_{i=x} c_i k_i^2) \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z k_y; \]
\[ \{ R_{10}, R_{12} \}; \quad (c_1 + \sum_{i=x} c_i k_i^2) \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z k_y; \]
\[ \{ R_{14}, R_{16} \}; \quad (c_1 + \sum_{i=x} c_i k_i^2) \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z k_y; \]
\[ R: R_5; \quad (c_1 + \sum_{i=x} c_i k_i^2) \sigma_0 + c_3 \sigma_3 k_z k_y \]
\[ R_{10}; \quad (c_1 + \sum_{i=x} c_i k_i^2) \sigma_0 + c_3 \sigma_3 k_z k_y \]
\[ D: \{ R_2, R_4 \}; \quad (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ \{ R_6, R_8 \}; \quad (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ P: R_5; \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_1 k_z; \]
\[ B: R_5; \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_z; \]
\[ C: \{ R_2, R_3 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ \{ R_6, R_8 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ E: R_5; \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_1 k_y; \]
\[ A: R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_2 k_y + c_4 \sigma_1 k_z; \]
\[ H: R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1 k_y; \]
\[ Q: \{ R_2, R_3 \}; \quad (c_1 + c_2 k_z + \sum_{i=x} c_i k_i^2) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x k_y; \]
\[ \{ R_6, R_8 \}; \quad (c_1 + c_2 k_z + \sum_{i=x} c_i k_i^2) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x k_y; \]
\[ G: R_5; \quad (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_1 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]

\[ D: \{R_2, R_4\}, \{R_6, R_8\}; c_1\Gamma_{0,0} + \sum_{i=0,3} [c_{i,1}\Gamma_{i,0}k_y + k_z (c_{i,2}\Gamma_{i,1} + c_{i,3}\Gamma_{i,2})] + k_z (c_2\Gamma_{1,1} + c_3\Gamma_{1,2}); \]

\[ \Sigma: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_1\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]

\[ C: \{R_2, R_4\}, \{R_6, R_8\}; c_1\Gamma_{0,0} + \sum_{i=0,3} [c_{i,1}\Gamma_{i,0}k_z + k_y (c_{i,2}\Gamma_{i,1} + c_{i,3}\Gamma_{i,2})] + k_z (c_2\Gamma_{1,1} + c_3\Gamma_{1,2}); \]

\[ \Lambda: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_1\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]

\[ Q: \{R_2, R_4\}, \{R_6, R_8\}; c_1\Gamma_{0,0} + \sum_{i=0,3} c_{i,1}\Gamma_{i,0}k_z + k_x (c_2\Gamma_{1,0} + c_3\Gamma_{2,3}) + k_y (c_4\Gamma_{1,2} + c_5\Gamma_{2,4}); \]
\[ \Gamma_0; \{C_2\{000\}, \{C_2y\{\frac{1}{2}, \frac{1}{2}, 0\}, \{I\{\frac{1}{2}, \frac{1}{2}, 0\}\}, T; \text{Centrosymmetric; without SOC} \]

\[ Y; \]
\[ R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]

\[ X; \]
\[ R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ U; \]
\[ R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ T; \]
\[ R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]

\[ S; \]
\[ R_5; \quad (c_1 + \sum_{i=x}^z c_i k_i^2) \sigma_0 + c_3 \sigma_3 k_z k_y; \]
\[ R_{10}; \quad (c_1 + \sum_{i=x}^z c_i k_i^2) \sigma_0 + c_3 \sigma_3 k_z k_y; \]

\[ R; \]
\[ R_5; \quad (c_1 + \sum_{i=x}^z c_i k_i^2) \sigma_0 + c_3 \sigma_3 k_z k_y; \]
\[ R_{10}; \quad (c_1 + \sum_{i=x}^z c_i k_i^2) \sigma_0 + c_3 \sigma_3 k_z k_y; \]

\[ D; \]
\[ R_5; \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_1 k_z; \]
\[ P; \]
\[ R_5; \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_1 k_z; \]

\[ C; \]
\[ R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_y; \]
\[ E; \]
\[ R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_y; \]

\[ H; \]
\[ \{R_1, R_4\}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ \{R_2, R_3\}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]

\[ Q; \]
\[ \{R_1, R_4\}; \quad (c_1 + c_2 k_x + \sum_{i=x}^z c_i k_i^2) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z k_y \]
\[ \{R_3, R_4\}; \quad (c_1 + c_2 k_x + \sum_{i=x}^z c_i k_i^2) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z k_y \]

\[ G; \]
\[ \{R_1, R_3\}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ \{R_2, R_4\}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
Accidental degeneracies on high symmetry line

\[\Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;\]

\[B; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;\]

\[\Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]

\[A; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]

\[\Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]

\[H; \{R_1, R_2\}, \{R_2, R_3\}; c_1 \Gamma_{0, 0} + \sum_{i=0,3} [c_{i, 1} \Gamma_{i, 0} k_z + k_y (c_{i, 2} \Gamma_{1, 1} + c_{i, 3} \Gamma_{1, 2})] + k_x (c_2 \Gamma_{1, 1} + c_3 \Gamma_{1, 2});\]
\[Q; \{R_1, R_2\}, \{R_3, R_4\}; c_1 \Gamma_{0, 0} + \sum_{i=0,3} [c_{i, 1} \Gamma_{i, 0} k_z + k_x (c_2 \Gamma_{1, 0} + c_3 \Gamma_{2, 3})] + k_y (c_2 \Gamma_{1, 1} + c_3 \Gamma_{1, 2});\]
\[G; \{R_1, R_3\}, \{R_2, R_4\}; c_1 \Gamma_{0, 0} + \sum_{i=0,3} [c_{i, 1} \Gamma_{i, 0} k_z + k_x (c_{i, 2} \Gamma_{1, 1} + c_{i, 3} \Gamma_{1, 2})] + k_y (c_2 \Gamma_{1, 1} + c_3 \Gamma_{1, 2});\]
\[ \Gamma_0: \{ C_2, [000], \{ C_2^y, 1 \frac{1}{2} 0 \}, \{ I, \frac{1}{2} 0 \} \}, T; \text{Centrosymmetric; without SOC} \]

\[ Y; R_5: c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ R_{10}: c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ X; R_5: c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R_{10}: c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ Z; R_5: c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R_{10}: c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ U; R_5: (c_1 + \sum_{i=1}^3 c_i k_i^2) \sigma_0 + (c_2 \sigma_3 k_y + c_3 \sigma_1 k_z) k_x; \]
\[ R_{10}: (c_1 + \sum_{i=1}^3 c_i k_i^2) \sigma_0 + (c_2 \sigma_3 k_y + c_3 \sigma_1 k_z) k_x; \]
\[ T; \{ R_0, R_{10} \}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^3 c_i \Gamma_{1,2} k_y + c_4 \Gamma_{3,1} k_z; \]
\[ S; \{ R_0, R_{10} \}; c_1 \Gamma_{0,0} + \sum_{i=1}^2 c_i \Gamma_{1,2} k_x + c_2 \Gamma_{0,2} k_y; \]
\[ R; \{ R_0, R_{10} \}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^2 c_i \Gamma_{1,2} k_y; \]
\[ D; \{ R_2, R_4 \}; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ \{ R_6, R_8 \}; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ P; R_5: (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_x; \]
\[ B; R_5: (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ C; R_5: (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_x; \]
\[ E; \{ R_2, R_4 \}; (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ \{ R_4, R_6 \}; (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ A; R_5: (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z; \]
\[ H; \{ R_1, R_4 \}; (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ \{ R_2, R_3 \}; (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ Q; \{ R_3, R_5 \}; (c_1 + c_2 k_x) \Gamma_{0,0} + \sum_{i=1}^3 (c_i \Gamma_{1,1} k_x + c_i \Gamma_{1,2} k_y); \]
\[ G; R_5: (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\} \cup \{R_2\} : \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\} \cup \{R_3\} : \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_1\} \cup \{R_4\} ; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\} \cup \{R_3\} ; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\} \cup \{R_4\} ; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\} \cup \{R_4\} : \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]

\[ D: \{R_2, R_4\} \cup \{R_6, R_8\} ; \quad c_1\Gamma_{0,0} + \sum_{i=0,3} [c_{i,1}\Gamma_{1,0}k_y + k_z (c_{i,2}\Gamma_{1,1} + c_{i,3}\Gamma_{1,2})] + k_x (c_{2}\Gamma_{1,1} + c_{3}\Gamma_{1,2}); \]

\[ \Sigma: \{R_1\} \cup \{R_2\} : \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z; \]
\[ \{R_1\} \cup \{R_3\} : \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_1\} \cup \{R_4\} ; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_4\sigma_1k_z; \]
\[ \{R_2\} \cup \{R_3\} ; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_4\sigma_1k_z; \]
\[ \{R_2\} \cup \{R_4\} ; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_3\} \cup \{R_4\} : \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z; \]

\[ C: \{R_5\} \cup \{R_6\} ; \quad c_1\Gamma_{0,0} + \sum_{i=0,3} c_{i,1}\Gamma_{1,0}k_x + \Gamma_{1,0} (c_2 + c_3k_x) + (c_4\Gamma_{0,3} + c_5\Gamma_{1,3} + c_6\Gamma_{3,3})k_y + c_7\Gamma_{2,1}k_z; \]

\[ E: \{R_2, R_6\} \cup \{R_4, R_8\} ; \quad c_1\Gamma_{0,0} + \sum_{i=0,3} [\Gamma_{1,0}c_{i,1}k_x + k_y (c_{i,2}\Gamma_{1,1} + c_{i,3}\Gamma_{1,2})] + k_x (c_{2}\Gamma_{1,1} + c_{3}\Gamma_{2,3}); \]

\[ \Lambda: \{R_1\} \cup \{R_2\} : \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z; \]
\[ \{R_1\} \cup \{R_3\} : \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_1\} \cup \{R_4\} ; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\} \cup \{R_3\} ; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_2\} \cup \{R_4\} ; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_3\} \cup \{R_4\} : \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z; \]

\[ H: \{R_1, R_3\} \cup \{R_2, R_4\} ; \quad c_1\Gamma_{0,0} + \sum_{i=0,3} [c_{i,1}\Gamma_{1,0}k_z + k_y (c_{i,2}\Gamma_{1,1} + c_{i,3}\Gamma_{1,2})] + k_x (c_{2}\Gamma_{1,1} + c_{3}\Gamma_{1,2}); \]
\[
Y: \Gamma_0; c_1\sigma_0 + c_2\sigma_2k_y; \\
R_{10}; \quad c_1\sigma_0 + c_2\sigma_2k_y; \\
X: \Gamma_0; c_1\sigma_0 + c_2\sigma_2k_z; \\
R_{10}; \quad c_1\sigma_0 + c_2\sigma_2k_z; \\
Z: \Gamma_0; c_1\sigma_0 + c_2\sigma_2k_z; \\
R_{10}; \quad c_1\sigma_0 + c_2\sigma_2k_z; \\
U: \{R_9, R_{10}\}; c_1\Gamma_{0,0} + c_2\Gamma_{0,2k_z} + (c_3\Gamma_{1,2} + c_4\Gamma_{2,2})k_z; \\
T: \{R_9, R_{10}\}; c_1\Gamma_{0,0} + (c_2\Gamma_{1,2} + c_3\Gamma_{2,2})k_y + c_4\Gamma_{0,2k_z}; \\
S: \{R_9, R_{10}\}; c_1\Gamma_{0,0} + (c_2\Gamma_{1,2} + c_3\Gamma_{2,2})k_y + c_4\Gamma_{0,2k_z}; \\
R: \{R_5, R_3\}; (c_1 + \sum_{i=1}^{3} c_i k_i^2)\Gamma_{0,0} + \sum_{i=1}^{3} c_i \Gamma_{1,3k_z} \Gamma_{0,0} + \sum_{i=1}^{3} G_{i} c_{i,2} k_z + c_{i,3}\Gamma_{1,2k_y} k_z; \\
\{R_0, R_{10}\}; (c_1 + \sum_{i=1}^{3} c_i k_i^2)\Gamma_{0,0} + \sum_{i=1}^{3} c_i \Gamma_{1,3k_z} \Gamma_{0,0} + \sum_{i=1}^{3} G_{i} c_{i,2} k_z + c_{i,3}\Gamma_{1,2k_y} k_z; \\
D: \{R_2, R_4\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \\
\{R_6, R_8\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \\
P: \{R_5, R_3\}; (c_1 + c_2 k_y)\Gamma_{0,0} + \sum_{i=1}^{3} c_i \Gamma_{1,3} k_z + c_{i,2}\Gamma_{1,1} k_z; \\
B: R_5; (c_1 + c_2 k_y)\sigma_0 + c_3\sigma_1 k_z; \\
C: R_5; (c_1 + c_2 k_y)\sigma_0 + c_3\sigma_1 k_y; \\
E: \{R_5, R_3\}; (c_1 + c_2 k_y)\Gamma_{0,0} + \sum_{i=1}^{3} c_i \Gamma_{1,3} k_y + c_{i,2}\Gamma_{1,1} k_z; \\
A: \{R_2, R_4\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \\
\{R_6, R_8\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \\
H: \{R_2, R_4\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y; \\
\{R_6, R_8\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y; \\
Q: \{R_5, R_3\}; (c_1 + c_2 k_y)\Gamma_{0,0} + \sum_{i=1}^{3} c_i \Gamma_{1,1} k_z + c_{i,2}\Gamma_{1,3} k_y; \\
G: R_5; (c_1 + c_2 k_y)\sigma_0 + c_2\sigma_1 k_z;
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ D; \{R_2, R_4\}, \{R_6, R_8\} : c_1 \Gamma_{0,0} + \sum_{i=0,3} \left[ c_{i,1} \Gamma_{i,0} k_y + k_z (c_{i,2} \Gamma_{i,1} + c_{i,3} \Gamma_{i,2}) \right] + k_x (c_{2} \Gamma_{1,1} + c_{3} \Gamma_{1,2}); \]

\[ \Sigma; \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{R_1\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ A; \{R_2, R_4\}, \{R_6, R_8\} : c_1 \Gamma_{0,0} + \sum_{i=0,3} \left[ c_{i,1} \Gamma_{i,0} k_x + k_z (c_{i,2} \Gamma_{i,1} + c_{i,3} \Gamma_{i,2}) \right] + k_y (c_{2} \Gamma_{1,1} + c_{3} \Gamma_{1,2}); \]

\[ \Lambda; \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ H; \{R_2, R_4\}, \{R_6, R_8\} : c_1 \Gamma_{0,0} + \sum_{i=0,3} \left[ c_{i,1} \Gamma_{i,0} k_z + k_y (c_{i,2} \Gamma_{i,1} + c_{i,3} \Gamma_{i,2}) \right] + k_x (c_{2} \Gamma_{1,1} + c_{3} \Gamma_{1,2}); \]
$\Gamma_0$: \{ $C_{2v}$, $C_{2z}$, $C_{2y}$, $C_{2x}$, $I$ \}; Centrosymmetric; without SOC

$Y$: $R_5$: $c_1\sigma_0 + c_2\sigma_2k_y$

$R_{10}$: $c_1\sigma_0 + c_2\sigma_2k_y$

$X$: $R_5$: $c_1\sigma_0 + c_2\sigma_2k_z$

$R_{10}$: $c_1\sigma_0 + c_2\sigma_2k_z$

$Z$: $R_5$: $c_1\sigma_0 + c_2\sigma_2k_z$

$R_{10}$: $c_1\sigma_0 + c_2\sigma_2k_z$

$U$: \{ $R_2$, $R_4$ \};

\{ $R_6$, $R_8$ \};

\{ $R_{10}$, $R_{12}$ \};

\{ $R_{14}$, $R_{16}$ \};

$T$: $R_5$: $c_1\Gamma_0, 0 + c_2\Gamma_{3,1}k_x + \sum_{i=1}^2 (c_3\Gamma_{1,2} + c_4\Gamma_{2,2})k_y$

$R$: \{ $R_9$, $R_{10}$ \};

$c_1\Gamma_{0,0} + c_2\Gamma_{3,1}k_x + c_3\Gamma_{0,2}k_y$

$D$: $R_5$: $c_1\Gamma_{0,0} + c_2\Gamma_{3,1}k_x + c_3\Gamma_{0,2}k_y$

$P$: \{ $R_2$, $R_3$ \};

\{ $R_4$, $R_8$ \};

\{ $R_{10}$, $R_{12}$ \};

\{ $R_{14}$, $R_{16}$ \};

$B$: $R_5$: $c_1\Gamma_{0,0} + c_2\Gamma_{3,1}k_x + c_3\Gamma_{0,2}k_y$

$C$: \{ $R_1$, $R_3$ \};

\{ $R_2$, $R_4$ \};

\{ $R_5$, $R_3$ \};

\{ $R_6$, $R_4$ \};

\{ $R_7$, $R_2$ \};

\{ $R_8$, $R_1$ \};

\{ $R_9$, $R_0$ \};

$E$: \{ $R_2$, $R_3$ \};

\{ $R_4$, $R_8$ \};

\{ $R_{10}$, $R_{12}$ \};

\{ $R_{14}$, $R_{16}$ \};

$A$: \{ $R_2$, $R_4$ \};

\{ $R_6$, $R_4$ \};

\{ $R_7$, $R_2$ \};

\{ $R_8$, $R_1$ \};

\{ $R_9$, $R_0$ \};

$H$: $R_5$: $c_1\Gamma_{0,0} + c_2\Gamma_{3,1}k_x + c_3\Gamma_{0,2}k_y$

$Q$: \{ $R_5$, $R_3$ \};

\{ $R_6$, $R_4$ \};

\{ $R_7$, $R_2$ \};

\{ $R_8$, $R_1$ \};

\{ $R_9$, $R_0$ \};

$G$: \{ $R_5$, $R_3$ \};

\{ $R_6$, $R_4$ \};

\{ $R_7$, $R_2$ \};

\{ $R_8$, $R_1$ \};

\{ $R_9$, $R_0$ \};
\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ P; \{ R_2 \}, \{ R_4 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + k_z (c_2 \Gamma_{1.1} + c_3 \Gamma_{1.2}) + k_x (c_4 \Gamma_{1.0} + c_5 \Gamma_{2.3}); \]
\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ C; \{ R_1 \}, \{ R_3 \}, \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + k_y \Gamma_{1.0} + \sum_{i=0,3} [c_{i,1} \Gamma_{1.0} k_y + k_z (c_{i,2} \Gamma_{1.1} + c_{i,3} \Gamma_{1.2})] + k_x (c_{2,1} \Gamma_{1.1} + c_{3,2} \Gamma_{1.2}); \]
\[ E; \{ R_2 \}, \{ R_4 \}, \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + k_y \Gamma_{1.0} + \sum_{i=0,3} [c_{i,1} \Gamma_{1.0} k_y + k_z (c_{i,2} \Gamma_{1.1} + c_{i,3} \Gamma_{1.2})] + k_x (c_{2,1} \Gamma_{1.1} + c_{3,2} \Gamma_{1.2}); \]
\[ A; \{ R_2 \}, \{ R_4 \}, \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + k_y \Gamma_{1.0} + \sum_{i=0,3} [c_{i,1} \Gamma_{1.0} k_y + k_z (c_{i,2} \Gamma_{1.1} + c_{i,3} \Gamma_{1.2})] + k_x (c_{2,1} \Gamma_{1.1} + c_{3,2} \Gamma_{1.2}); \]
\[ \Lambda; \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z; \]
\[ G; \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + k_y \Gamma_{1.0} + \sum_{i=0,3} [c_{i,1} \Gamma_{1.0} k_y + k_z (c_{i,2} \Gamma_{1.1} + c_{i,3} \Gamma_{1.2})] + k_x (c_{2,1} \Gamma_{1.1} + c_{3,2} \Gamma_{1.2}); \]

SG 63

\[ \Gamma_0^0; \{ C_{2x}[00\frac{1}{2}] \}, \{ C_{2y}[00\frac{1}{2}] \}, \{ I[000] \}, T; \] Centrosymmetric; without SOC

\[ Z; \{ R_5 \}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ \{ R_{10} \}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ T; \{ R_5 \}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ \{ R_{10} \}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R; \{ R_5 \}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ A; \{ R_5 \}; (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1 k_z; \]
\[ B; \{ R_2 \}, \{ R_3 \}; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ G; \{ R_2 \}, \{ R_3 \}; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ E; \{ R_5 \}; (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_4\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]

\[ B; \{R_2\}, \{R_3\}, \{R_6\}, \{R_8\}; c_1\Gamma_{0,0} + \sum_{i=0,3} [c_i\Gamma_{i,0}k_y + k_z (c_{i,2}\Gamma_{i,1} + c_{i,3}\Gamma_{i,2})] + k_\Delta (c_2\Gamma_{1,1} + c_3\Gamma_{1,2}); \]
\[ G; \{R_2\}, \{R_3\}, \{R_6\}, \{R_8\}; c_1\Gamma_{0,0} + \sum_{i=0,3} [c_i\Gamma_{i,0}k_y + k_z (c_{i,2}\Gamma_{i,1} + c_{i,3}\Gamma_{i,2})] + k_\Delta (c_2\Gamma_{1,1} + c_3\Gamma_{1,2}); \]

\[ F; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]

\[ C; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
SG 64

Γb: \{C_2z|00\frac{1}{2}\}, \{C_2y|00\frac{1}{2}\}, \{I|\frac{1}{2}\frac{1}{2}0\}, T; Centrosymmetric; without SOC

Z: R_5; \quad c_1\sigma_0 + c_2\sigma_2 k_z;
R_{10}; \quad c_1\sigma_0 + c_2\sigma_2 k_z;
T: R_5; \quad c_1\sigma_0 + c_2\sigma_2 k_z;
R_{10}; \quad c_1\sigma_0 + c_2\sigma_2 k_z;
S: R_5; \quad c_1\sigma_0 + (c_2 k_x + c_3 k_y)\sigma_2;
R: \{R_2, R_4\}; (c_1 + c_2 k_x k_y + \sum_{i=x}^z c_i k_i^2)\sigma_0 + \sum_{i=1}^2 c_i (c_{i,1} k_x + c_{i,2} k_y) k_z;
R_6, R_8; \quad (c_1 + c_2 k_x k_y + \sum_{i=x}^z c_i k_i^2)\sigma_0 + \sum_{i=1}^2 c_i (c_{i,1} k_x + c_{i,2} k_y) k_z;
D: \{R_1, R_2\}; (c_1 + c_4 k_z)\sigma_0 + \sum_{i=1}^2 (c_{i,1} k_x + c_{i,2} k_y)\sigma_i;
A: R_5; \quad (c_1 + c_4 k_z)\sigma_0 + c_3\sigma_1 k_z;
B: \{R_2, R_4\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_z;
R_6, R_8; \quad (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_z;
G: \{R_2, R_4\}; (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_z;
R_6, R_8; \quad (c_1 + c_2 k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_z;
E: R_5; \quad (c_1 + c_2 k_x)\sigma_0 + c_3\sigma_1 k_z;
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ H: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ B: \{ R_2 , R_4 \}, \{ R_6 , R_8 \} : \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} [c_3 \Gamma_{i,0} k_y + k_z (c_1 \Gamma_{i,1} + c_3 \Gamma_{i,3})] + k_z (c_2 \Gamma_{1,1} + c_3 \Gamma_{3,1}); \]
\[ G: \{ R_2 , R_4 \}, \{ R_6 , R_8 \} : \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} [c_3 \Gamma_{i,0} k_y + k_z (c_1 \Gamma_{i,1} + c_3 \Gamma_{i,3})] + k_z (c_2 \Gamma_{1,1} + c_3 \Gamma_{3,1}); \]
\[ F: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ C: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

SG 65

\[ \Gamma_{0}^{c} : \{ C_{2z}|000 \}, \{ C_{2y}|000 \}, \{ J|000 \}, T \]; Centrosymmetric; without SOC
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[ H; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[ D; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_x + \sigma_1 (c_4k_x + c_5k_y); \]

\[ A; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]

\[ B; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]

\[ G; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y; \]
\[
\begin{align*}
F; \{R_1\}, \{R_2\}: & \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \\
\{R_1\}, \{R_3\}: & \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \\
\{R_1\}, \{R_4\}: & \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \\
\{R_2\}, \{R_4\}: & \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \\
\{R_3\}, \{R_4\}: & \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
\end{align*}
\]

\[
\begin{align*}
G; \{R_5\}: & (c_1 + c_2 k_y) \sigma_0 + c_4 \sigma_2 k_x + c_3 \sigma_1 k_z; \\
E; \{R_5\}: & c_1 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_2 + c_4 \sigma_3 k_z;
\end{align*}
\]

\[
\begin{align*}
C; \{R_1\}, \{R_2\}: & \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \\
\{R_1\}, \{R_3\}: & \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \\
\{R_1\}, \{R_4\}: & \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \\
\{R_2\}, \{R_4\}: & \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \\
\{R_3\}, \{R_4\}: & \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\end{align*}
\]

\[
\begin{align*}
Z; \{R_5\}: & c_1 \sigma_0 + c_2 \sigma_2 k_z; \\
\{R_{10}\}: & c_1 \sigma_0 + c_2 \sigma_2 k_z;
\end{align*}
\]

\[
\begin{align*}
T; \{R_5\}: & c_1 \sigma_0 + c_2 \sigma_2 k_z; \\
\{R_{10}\}: & c_1 \sigma_0 + c_2 \sigma_2 k_z;
\end{align*}
\]

\[
\begin{align*}
A; \{R_5\}: & (c_1 + c_2 k_x) \sigma_0 + c_4 \sigma_2 k_y + c_3 \sigma_1 k_z; \\
B; \{R_5\}: & (c_1 + c_2 k_y) \sigma_0 + c_4 \sigma_2 k_x + c_3 \sigma_1 k_z; \\
G; \{R_5\}: & (c_1 + c_2 k_y) \sigma_0 + c_4 \sigma_2 k_x + c_3 \sigma_1 k_z; \\
E; \{R_5\}: & c_1 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_2 + c_4 \sigma_3 k_z;
\end{align*}
\]

\[
\begin{align*}
\Gamma_0^\ast; \{C_{2y}\} [000], \{C_{2y}\} [000], \{J\} [00\overline{1}]; \\
T; \text{Centrosymmetric; without SOC}
\end{align*}
\]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
SG 67

Γb; \{C_{2z}[000]\}, \{C_{2y}[000]\}, \{I|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}\}; T; Centrosymmetric; without SOC

\begin{align*}
S: & \quad R_5; \quad c_1 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_2; \\
R: & \quad R_5; \quad c_1 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_2; \\
D: & \quad \{R_1, R_2\}; \quad (c_1 + c_2 k_z) \sigma_0 + \sum_{i=1}^{2} (c_{i,1} k_x + c_{i,2} k_y) \sigma_i;
\end{align*}
Accidental degeneracies on high symmetry line

Λ: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;

H: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;

A: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;

Σ: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;

Δ: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_y;
\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;

B: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;

G: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;

F: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
E; \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;
{R_1}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;
{R_1}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;
{R_2}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;
\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;
\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;

C; \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;
{R_1}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;
{R_1}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;
{R_2}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;
{R_2}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;
{R_3}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;

\Gamma_0; \{C_{2z}|000\}, \{C_{2y}|000\}, \{I\frac{1}{2}\frac{1}{2}\frac{1}{2}\}; T; \text{Centrosymmetric; without SOC}

Z; R_5: \ c_1 \sigma_0 + c_2 \sigma_2 k_z;
R_{10}: \ c_1 \sigma_0 + c_2 \sigma_2 k_z;

T; R_5: \ c_1 \sigma_0 + c_2 \sigma_2 k_z;
R_{10}: \ c_1 \sigma_0 + c_2 \sigma_2 k_z;

S; R_5: \ c_1 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_2;
R_5: \ c_1 \sigma_0 + (c_2 k_x + c_3 k_y) \sigma_2;

D; \{R_1, R_2\}; \ (c_1 + c_2 k_x) \sigma_0 + \sum_{i=1}^{2} (c_{i,1} k_x + c_{i,2} k_y) \sigma_i;

A; R_5: \ (c_1 + c_2 k_x) \sigma_0 + c_4 \sigma_2 k_y + c_3 \sigma_1 k_z;
B; R_5: \ (c_1 + c_2 k_y) \sigma_0 + c_4 \sigma_2 k_x + c_3 \sigma_1 k_z;
G; R_5: \ (c_1 + c_2 k_y) \sigma_0 + c_4 \sigma_2 k_x + c_3 \sigma_1 k_z;
E; R_5: \ (c_1 + c_2 k_x) \sigma_0 + c_4 \sigma_2 k_y + c_3 \sigma_1 k_z;
Accidental degeneracies on high symmetry line

\[ \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_1\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_z; \]
\[ \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_y; \]
\[ \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_y; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_z; \]
\[ \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ H: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_z; \]
\[ \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_y; \]
\[ \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_y; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_z; \]
\[ \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Sigma: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_z; \]
\[ \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_y; \]
\[ \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_y; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_z; \]
\[ \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Delta: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_5 k_z; \]
\[ \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_5 k_y; \]
\[ \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_5 k_z; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_5 k_y; \]
\[ \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ F: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_5 k_z; \]
\[ \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_5 k_y; \]
\[ \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_5 k_z; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_5 k_y; \]
\[ \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ C: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_y; \]
\[ \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_z; \]
\[ \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_y; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_z; \]
\[ \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Gamma_0^f; \{C_{2z}\}[000], \{C_{2y}\}[000], \{T\}[000], T; \text{Centrosymmetric; without SOC}\]
Accidental degeneracies on high symmetry line

\[ \Lambda: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_4\}, \{R_1\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ G: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_4\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ H: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ Q: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \Sigma: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ C: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ A: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ U: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
$\Delta$: \{R_1\}, \{R_2\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

\{R_1\}, \{R_3\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_1\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_2\}, \{R_3\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_2\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_3\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$D$: \{R_1\}, \{R_2\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

\{R_1\}, \{R_3\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_1\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_2\}, \{R_3\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_2\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_3\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$B$: \{R_1\}, \{R_2\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

\{R_1\}, \{R_3\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_1\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_2\}, \{R_3\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_2\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_3\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$R$: \{R_1\}, \{R_2\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

\{R_1\}, \{R_3\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_1\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_2\}, \{R_3\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_2\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;

\{R_3\}, \{R_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$Y$: \{R_5\}; $c_1 \sigma_0 + c_2 \sigma_2 k_y$;

\{R_{10}\}; $c_1 \sigma_0 + c_2 \sigma_2 k_y$;

$X$: \{R_5\}; $c_1 \sigma_0 + c_2 \sigma_2 k_z$;

\{R_{10}\}; $c_1 \sigma_0 + c_2 \sigma_2 k_z$;

$Z$: \{R_5\}; $c_1 \sigma_0 + c_2 \sigma_2 k_z$;

\{R_{10}\}; $c_1 \sigma_0 + c_2 \sigma_2 k_z$;

$G$: \{R_5\}; $(c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y$;

$H$: \{R_5\}; $(c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y$;

$C$: \{R_5\}; $(c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y$;

$A$: \{R_5\}; $(c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y$;

$D$: \{R_5\}; $(c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y$;

$B$: \{R_5\}; $(c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y$;

\hline
$\Gamma^{\nu}_{6}: \{C_{2v}|000\}, \{C_{2v}|000\}$, \{I|$\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$\}, $T$: Centrosymmetric; without SOC.

\begin{align*}
Y: & \{R_5\}; c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
& \{R_{10}\}; c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
X: & \{R_5\}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \\
& \{R_{10}\}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \\
Z: & \{R_5\}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \\
& \{R_{10}\}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \\
G: & \{R_5\}; (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y; \\
H: & \{R_5\}; (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y; \\
C: & \{R_5\}; (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y; \\
A: & \{R_5\}; (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y; \\
D: & \{R_5\}; (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y; \\
B: & \{R_5\}; (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_2 k_y; \\
\end{align*}
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_5\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ Q; \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_6\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_1\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ U; \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z; \]
\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z; \]
\[ \{R_6\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ R; \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_6\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
9. SG 71-80

SG 71

$\Gamma^\prime_0; \{C_{2z}|000\}, \{C_{2y}|000\}, \{I|000\}, T$; Centrosymmetric; without SOC
Accidental degeneracies on high symmetry line

Λ: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;  \\  \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;  \\  \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;  \\  \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;  \\  \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;  \\  \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;  \\  

G: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;  \\  \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;  \\  \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;  \\  \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;  \\  \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;  \\  \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;  \\  

P: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_4 k_x + c_5 k_y);  \\  \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;  \\  \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;  \\  \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;  \\  \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;  \\  \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;  \\  

F: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;  \\  \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;  \\  \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;  \\  \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;  \\  \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;  \\  \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;  \\  

D: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;  \\  \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;  \\  

Δ: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;  \\  \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;  \\  

U: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;  \\  \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\  \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;  \\  

Q: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + \sigma_1 (c_5 k_z + c_6 k_z);
SG 72

Γν: \(\{C_{2v}|000\}, \{C_{2v}y|000\}, \{I|\frac{1}{2}\frac{1}{2}0\}\), \(T\); Centrosymmetric; without SOC

\[\begin{align*}
R: \quad R_5; & \quad c_1\sigma_0 + (c_2 k_x + c_3 k_z)\sigma_2; \\
S: \quad R_5; & \quad c_1\sigma_0 + (c_2 k_y + c_3 k_z)\sigma_2; \\
W; \quad \{R_1, R_2\}; & \quad c_1\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_z; \\
\quad \{R_3, R_4\}; & \quad c_1\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_z; \\
D; \quad \{R_1, R_2\}; & \quad (c_1 + c_2 k_x)\sigma_0 + \sum_{i=1}^{2} (c_{i,1} k_y + c_{i,2} k_z)\sigma_i; \\
Q; \quad \{R_1, R_2\}; & \quad (c_1 + c_2 k_y)\sigma_0 + \sum_{i=1}^{2} (c_{i,1} k_x + c_{i,2} k_z)\sigma_i; \\
\end{align*}\]
Accidental degeneracies on high symmetry line

$\Lambda$: \{R_1\}, \{R_2\}: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y$;
$\{R_2\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y$;

$G$: \{R_1\}, \{R_2\}: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y$;
$\{R_2\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$P$: \{R_1\}, \{R_2\}: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\Sigma$: \{R_1\}, \{R_2\}: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y$;
$\{R_2\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$F$: \{R_1\}, \{R_2\}: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y$;
$\{R_2\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\Delta$: \{R_1\}, \{R_2\}: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
$\{R_1\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;
$\{R_2\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$U$: \{R_1\}, \{R_2\}: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
$\{R_1\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;
$\{R_2\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
SG 73

Γ\textsuperscript{v}; \{C\textsubscript{2z}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}, \{C\textsubscript{2y}|\frac{1}{2}\frac{1}{2}0\}, \{I|000\}, T; Centrosymmetric; without SOC

R: \quad R\textsubscript{5}; \quad c\textsubscript{1}\sigma\textsubscript{0} + (c\textsubscript{2}k\textsubscript{x} + c\textsubscript{3}k\textsubscript{z})\sigma\textsubscript{2};

S: \quad R\textsubscript{5}; \quad c\textsubscript{1}\sigma\textsubscript{0} + (c\textsubscript{2}k\textsubscript{y} + c\textsubscript{3}k\textsubscript{z})\sigma\textsubscript{2};

T: \quad R\textsubscript{5}; \quad c\textsubscript{1}\sigma\textsubscript{0} + (c\textsubscript{2}k\textsubscript{x} + c\textsubscript{3}k\textsubscript{y})\sigma\textsubscript{2};

W: \quad \{R\textsubscript{0}, R\textsubscript{9}\}; \quad 2c\textsubscript{1}\Gamma\textsubscript{0,0} + \sum_{i=1}^{3}(c\textsubscript{i,1}\Gamma\textsubscript{1,2}k\textsubscript{x} + c\textsubscript{i,2}\Gamma\textsubscript{1,3}k\textsubscript{y} + c\textsubscript{i,3}\Gamma\textsubscript{1,1}k\textsubscript{z});

P: \quad \{R\textsubscript{2}, R\textsubscript{4}\}; \quad (c\textsubscript{1} + c\textsubscript{2}k\textsubscript{y})\sigma\textsubscript{0} + \sum_{i=1}^{2}(c\textsubscript{i,1}k\textsubscript{x} + c\textsubscript{i,2}k\textsubscript{z})\sigma\textsubscript{i};

D: \quad \{R\textsubscript{2}, R\textsubscript{4}\}; \quad (c\textsubscript{1} + c\textsubscript{2}k\textsubscript{x})\sigma\textsubscript{0} + \sum_{i=1}^{2}(c\textsubscript{i,1}k\textsubscript{y} + c\textsubscript{i,2}k\textsubscript{z})\sigma\textsubscript{i};

Q: \quad \{R\textsubscript{2}, R\textsubscript{4}\}; \quad (c\textsubscript{1} + c\textsubscript{2}k\textsubscript{y})\sigma\textsubscript{0} + \sum_{i=1}^{2}(c\textsubscript{i,1}k\textsubscript{x} + c\textsubscript{i,2}k\textsubscript{z})\sigma\textsubscript{i};
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Gamma_5; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_3 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_3 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_3 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_3 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

SG 74

\[ \Gamma_{50}; \{C_{2v}, \frac{1}{2}, \frac{1}{2}\}; \{C_{2v}, \frac{1}{2}, 0\}; \{I, \frac{1}{2}, \frac{1}{2}\}; T; \text{Centrosymmetric}; \text{without SOC} \]

\[ T; \{R_5\}; \sigma_0 + (c_2 k_z + c_3 k_y) \sigma_2; \]
\[ W; \{R_6\}; \sigma_0 + c_2 \sigma_2 k_x + c_3 \sigma_3 k_y; \]
\[ P; \{R_2, R_4\}; (c_1 + c_2 k_z) \sigma_0 + \sum_{i=1}^{2}(c_{i,1} k_x + c_{i,2} k_y) \sigma_i; \]
Accidental degeneracies on high symmetry line

Λ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
G: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
Σ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
F: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
D: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_1 (c_5 k_y + c_6 k_z);
Δ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
U: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
Q: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_1 (c_5 k_z + c_6 k_z);
\[\Gamma_{\eta}; \{C^+_4\}, T; \text{Non-Centrosymmetric; without SOC}\]

\[\Gamma; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2) \right] \sigma_i + c_4 \sigma_3 k_z;\]

\[M; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2) \right] \sigma_i + c_4 \sigma_3 k_z;\]

\[Z; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2) \right] \sigma_i + c_4 \sigma_3 k_z;\]

\[A; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2) \right] \sigma_i + c_4 \sigma_3 k_z;\]

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**Accidental degeneracies on high symmetry line**

\[\Lambda; \{R_1\} \cdot \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_- + h.c.);\]

\[R_1, \{R_1\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_- + h.c.);\]

\[R_4, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_- + h.c.);\]

\[R_2, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_- + h.c.);\]

\[R_3, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_- + h.c.);\]

\[V; \{R_1\} \cdot \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_- + h.c.);\]

\[R_1, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_- + h.c.);\]

\[R_4, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_- + h.c.);\]

\[R_2, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_- + h.c.);\]

\[R_3, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_- + h.c.);\]

\[W; \{R_1\} \cdot \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y);\]

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SG 76

\[\Gamma_{\eta}; \{C^+_4\}, T; \text{Non-Centrosymmetric; without SOC}\]

\[\Gamma; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2) \right] \sigma_i + c_4 \sigma_3 k_z;\]

\[M; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2) \right] \sigma_i + c_4 \sigma_3 k_z;\]

\[Z; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2) \right] \sigma_i + c_4 \sigma_3 k_z;\]

\[A; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2) \right] \sigma_i + c_4 \sigma_3 k_z;\]

\[R; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2) \right] \sigma_i + c_4 \sigma_3 k_z;\]

\[U; \{R_1, R_1\}; (c_1 + c_2 k_x + c_3 k_y)\sigma_0 + \sum_{i=1}^{3} c_{i,1} \sigma_i k_z;\]

\[S; \{R_1, R_1\}; (c_1 + c_2 k_x + c_3 k_y)\sigma_0 + \sum_{i=1}^{3} c_{i,1} \sigma_i k_z;\]

\[T; \{R_1, R_1\}; (c_1 + c_2 k_x + c_3 k_y)\sigma_0 + \sum_{i=1}^{3} c_{i,1} \sigma_i k_z;\]
Accidental degeneracies on high symmetry line

Λ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.);
 {R_1}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_7 k^2_z) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^2_+ + \alpha_2 k^2_+) + h.c.];
 {R_1}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.);
 {R_2}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.);
 {R_2}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_7 k^2_z) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^2_+ + \alpha_2 k^2_+) + h.c.];
 \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.);

V: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.);
 {R_1}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_7 k^2_z) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^2_+ + \alpha_2 k^2_+) + h.c.];
 {R_1}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.);
 {R_2}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.);
 {R_2}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_7 k^2_z) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^2_+ + \alpha_2 k^2_+) + h.c.];
 \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.);

W: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^2 \sigma_i (c_i k_x + c_i k_y);
\( \Gamma; \{ C_{4h}^{+} | 00\frac{1}{2} \}; T; \) Non-Centrosymmetric; without SOC

\[ \Gamma; \{ R_2, R_4 \}; (c_1 + c_2 k^2 + c_3 k^2) \sigma_0 + \sum_{i=1}^{2} [c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2)] \sigma_i + c_4 \sigma_3 k_z; \]

\[ M; \{ R_2, R_4 \}; (c_1 + c_2 k^2 + c_3 k^2) \sigma_0 + \sum_{i=1}^{2} [c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2)] \sigma_i + c_4 \sigma_3 k_z; \]

\[ Z; \{ R_2, R_6 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ A; \{ R_2, R_6 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ R; \{ R_2, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ U; \{ R_1, R_1 \}; (c_1 + c_2 k_x + c_3 k_y) \sigma_0 + \sum_{i=1}^{3} c_{i,1} \sigma_i k_z; \]

\[ S; \{ R_1, R_1 \}; (c_1 + c_2 k_x + c_3 k_y) \sigma_0 + \sum_{i=1}^{3} c_{i,1} \sigma_i k_z; \]

\[ T; \{ R_1, R_1 \}; (c_1 + c_2 k_x + c_3 k_y) \sigma_0 + \sum_{i=1}^{3} c_{i,1} \sigma_i k_z; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_x + h.c.); \]

\[ \{ R_1 \}, \{ R_1 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k^2) + [\sigma_1 (\alpha_1 k_x^2 + \alpha_2 k^2) + h.c.]; \]

\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_x + h.c.); \]

\[ \{ R_2 \}, \{ R_1 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_x + h.c.); \]

\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_x + h.c.); \]

\[ \{ R_2 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_x + h.c.); \]

\[ V; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_x + h.c.); \]

\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k^2) + [\sigma_1 (\alpha_1 k_x^2 + \alpha_2 k^2) + h.c.]; \]

\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_x + h.c.); \]

\[ \{ R_2 \}, \{ R_1 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k^2) + [\sigma_1 (\alpha_1 k_x^2 + \alpha_2 k^2) + h.c.]; \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_4 k_x + h.c.); \]

\[ W; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \]
Accidental degeneracies on high symmetry line

Λ; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_x + h.c.);
\{R_3\}, \{R_1\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_x^2) + c_3 (c_5 k_z + c_6 k^2 + c_7 k_x^2) + [\sigma_+ (\alpha_1 k^2_x + \alpha_2 k^2_2) + h.c.];
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_+ + h.c.);
\{R_2,2\}; \sigma_0 (c_1 + c_2 k_z + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_x^2) + c_3 (c_5 k_z + c_6 k^2 + c_7 k_x^2) + [\sigma_+ (\alpha_1 k^2_z + \alpha_2 k^2_x) + h.c.];
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
V; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
\{R_3\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_x^2) + c_3 (c_5 k_z + c_6 k^2 + c_7 k_x^2) + [\sigma_+ (\alpha_1 k^2_x + \alpha_2 k^2_z) + h.c.];
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
\{R_2\}, \{R_1\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_x^2) + c_3 (c_5 k_z + c_6 k^2 + c_7 k_x^2) + [\sigma_+ (\alpha_1 k^2_x + \alpha_2 k^2_z) + h.c.];
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
W; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_x + c_{2,i} k_y);

SG 80
\Gamma^0_v; \{C_{4v}^{1+} \mid \frac{\pi}{2} \}, T; Non-Centrosymmetric; without SOC

Γ; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_x^2) \sigma_0 + \sum_{i=1}^2 [c_{1,i} k_x k_y + c_{1,2} (k_x^2 - k_y^2)] \sigma_i + c_4 \sigma_3 k_z;
Z; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_x^2) \sigma_0 + \sum_{i=1}^2 [c_{1,i} k_x k_y + c_{1,2} (k_x^2 - k_y^2)] \sigma_i + c_4 \sigma_3 k_z;
P; \{R_1, R_2\}; c_1 \sigma_0 + c_3 (\sigma_2 k_x + \sigma_1 k_y) + c_4 (\sigma_1 k_x - \sigma_2 k_y) + c_2 \sigma_3 k_z;

Accidental degeneracies on high symmetry line

Λ; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_+ + h.c.);
\{R_3\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + c_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k^2_z + \alpha_2 k^2_z) + h.c.];
\{R_4\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_+ + h.c.);
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + c_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k^2_z + \alpha_2 k^2_z) + h.c.];
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + c_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k^2_z + \alpha_2 k^2_z) + h.c.];
\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
\{R_2\}, \{R_1\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 \sigma_3 k_- + h.c.);
W; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_x + c_{2,i} k_y);
SG 81
\[ \Gamma_q; \{S^+_4, [000]\}, \Gamma; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^2 \left[c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2)\right] \sigma_i; \]

\[ M; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^2 \left[c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2)\right] \sigma_i; \]

\[ Z; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^2 \left[c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2)\right] \sigma_i; \]

\[ A; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^2 \left[c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2)\right] \sigma_i; \]

\[ N; \{R_2, R_3\}; (c_1 + c_2 k_z + c_3 k^2 + c_4 k_y^2)\sigma_0 + \sum_{i=1}^3 \left[c_{i,1} k_z k_y + c_{i,2} (k_z^2 - k_y^2)\right] \sigma_i; \]

\[ V; \{R_2, R_3\}; (c_1 + c_2 k_z + c_3 k^2 + c_4 k_y^2)\sigma_0 + \sum_{i=1}^3 \left[c_{i,1} k_z k_y + c_{i,2} (k_z^2 - k_y^2)\right] \sigma_i; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_2, R_3\}; A_0 (c_1 + c_2 k_z) + \sqrt{3} A_5 + A_8 c_5 k_z + (A_4 c_3 + A_6 c_4 - A_1 c_6 - A_2 c_7) k_z + \left(-A_6 c_3 + A_4 c_4 - A_2 c_6 + A_1 c_7\right) k_y; \]

\[ V; \{R_1, R_2\}; A_0 (c_1 + c_2 k_z) + \sqrt{3} A_5 + A_8 c_5 k_z + (A_4 c_3 + A_6 c_4 - A_1 c_6 - A_2 c_7) k_z + \left(-A_6 c_3 + A_4 c_4 - A_2 c_6 + A_1 c_7\right) k_y; \]

\[ W; \{R_1, R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^2 \sigma_1 (c_{i,1} k_z + c_{i,2} k_y); \]

SG 82
\[ \Gamma_q; \{S^+_4, [000]\}, \Gamma; \text{Non-Centrosymmetric; without SOC} \]

\[ \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^2 \left[c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2)\right] \sigma_i; \]

\[ Z; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + \sum_{i=1}^2 \left[c_{i,1} k_x k_y + c_{i,2} (k_x^2 - k_y^2)\right] \sigma_i; \]

\[ A; \{R_2, R_4\}; (c_1 + c_2 k_z + c_3 k^2 + c_4 k_y^2)\sigma_0 + \sum_{i=1}^3 \left[c_{i,1} k_z k_y + c_{i,2} (k_z^2 - k_y^2)\right] \sigma_i; \]

\[ V; \{R_2, R_3\}; (c_1 + c_2 k_z + c_3 k^2 + c_4 k_y^2)\sigma_0 + \sum_{i=1}^3 \left[c_{i,1} k_z k_y + c_{i,2} (k_z^2 - k_y^2)\right] \sigma_i; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_1, R_2\}; A_0 (c_1 + c_2 k_z) + \sqrt{3} A_5 + A_8 c_5 k_z + (A_4 c_3 + A_6 c_4 - A_1 c_6 - A_2 c_7) k_z + \left(-A_6 c_3 + A_4 c_4 - A_2 c_6 + A_1 c_7\right) k_y; \]

\[ V; \{R_1, R_2\}; A_0 (c_1 + c_2 k_z) + \sqrt{3} A_5 + A_8 c_5 k_z + (A_4 c_3 + A_6 c_4 - A_1 c_6 - A_2 c_7) k_z + \left(-A_6 c_3 + A_4 c_4 - A_2 c_6 + A_1 c_7\right) k_y; \]

\[ W; \{R_1, R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^2 \sigma_1 (c_{i,1} k_z + c_{i,2} k_y); \]
SG 83

Γ: \{R_2, R_4\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
\{R_6, R_8\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
M: \{R_2, R_4\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
\{R_6, R_8\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
Z: \{R_2, R_4\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
\{R_6, R_8\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
A: \{R_2, R_4\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
\{R_6, R_8\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
V: \{R_2, R_4\}; \{c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;

Accidental degeneracies on high symmetry line

Δ: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x + c_3k_y) + \sigma_3 (c_4k_x + c_5k_y) + c_6 \sigma_1k_z;
U: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x + c_3k_y) + \sigma_3 (c_4k_x + c_5k_y) + c_6 \sigma_1k_z;
L: \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x + c_3k_y) + \sigma_3 (c_4k_x + c_5k_y) + c_6 \sigma_1k_z;
\{R_1\}, \{R_2, R_4\}; \{(A_4 + A_6) c_3 + (A_2 - A_1) c_4\} k_x + [(A_1 - A_2) c_3 + (A_4 + A_6) c_4] k_y + A_0 \sigma_0 (c_1 + c_2k_x) + \sqrt{3} A_5 + A_8 \sigma_1k_z;
\{R_2, R_6\}, \{R_3\}; \{(A_6 + A_7) c_3 + (A_2 - A_1) c_4\} k_x + [(A_2 - A_3) c_3 + (A_6 + A_7) c_4] k_y + A_0 \sigma_0 (c_1 + c_2k_x) + \sqrt{3} A_5 + A_8 \sigma_1k_z;
\{R_2, R_6\}, \{R_5\}; \sigma_0 (c_1 + c_2k_x + c_3k_y) + \sigma_3 (c_4k_x + c_5k_y) + c_6 \sigma_1k_z;
\{R_1\}, \{R_2, R_4\}; \{(A_4 + A_6) c_3 + (A_2 - A_1) c_4\} k_x + [(A_1 - A_2) c_3 + (A_4 + A_6) c_4] k_y + A_0 \sigma_0 (c_1 + c_2k_x) + \sqrt{3} A_5 + A_8 \sigma_1k_z;
\{R_2, R_6\}, \{R_5\}; \{(A_6 + A_7) c_3 + (A_2 - A_1) c_4\} k_x + [(A_2 - A_3) c_3 + (A_6 + A_7) c_4] k_y + A_0 \sigma_0 (c_1 + c_2k_x) + \sqrt{3} A_5 + A_8 \sigma_1k_z;
\{R_2, R_4\}, \{R_5\}; \sigma_0 (c_1 + c_2k_x + c_3k_y) + \sigma_3 (c_4k_x + c_5k_y) + c_6 \sigma_1k_z;
\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x + c_3k_y) + \sigma_3 (c_4k_x + c_5k_y) + c_6 \sigma_1k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x + c_3k_y) + \sigma_3 (c_4k_x + c_5k_y) + c_6 \sigma_1k_z;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x + c_3k_y) + \sigma_3 (c_4k_x + c_5k_y) + c_6 \sigma_1k_z;

SG 84

Γ: \{R_2, R_4\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
\{R_6, R_8\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
M: \{R_2, R_4\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
\{R_6, R_8\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
Z: \{R_2, R_4\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
\{R_6, R_8\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
A: \{R_2, R_4\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
\{R_6, R_8\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
V: \{R_2, R_4\}; \{c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2\} \sigma_0 + \sum_{i=1}^{2} \left[ c_{i,1}k_xk_y + c_{i,2}(k_x^2 - k_y^2) \right] \sigma_i;
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

\[ \Upsilon: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

\[ \Lambda: \{ R_1 \}, \{ R_3 \} ; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ \{ R_2 \}, \{ R_3 \} ; \quad [(A_4 + A_6) c_3 + (A_2 - A_1) c_4] k_x + [(A_1 - A_2) c_3 + (A_4 + A_6) c_4] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_2 + A_6) c_5 k_z; \]

\[ \{ R_2, R_4 \}, \{ R_3 \} ; \quad [(A_6 + A_7) c_3 + (A_2 - A_4) c_4] k_x + [(A_2 - A_3) c_3 + (A_6 + A_7) c_4] k_y + A_0 (c_1 + c_2 k_z) + A_3 c_5 k_z; \]

\[ \nu: \{ R_1 \}, \{ R_3 \} ; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ \{ R_2 \}, \{ R_3 \} ; \quad [(A_4 + A_6) c_3 + (A_2 - A_1) c_4] k_x + [(A_1 - A_2) c_3 + (A_4 + A_6) c_4] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_2 + A_6) c_5 k_z; \]

\[ \{ R_2, R_4 \}, \{ R_3 \} ; \quad [(A_6 + A_7) c_3 + (A_2 - A_4) c_4] k_x + [(A_2 - A_3) c_3 + (A_6 + A_7) c_4] k_y + A_0 (c_1 + c_2 k_z) + A_3 c_5 k_z; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

\[ \Sigma: \{ R_2 \}, \{ R_4 \} ; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

\[ \tau: \{ R_2 \}, \{ R_4 \} ; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

\[ \gamma: \{ R_1 \}, \{ R_2 \} ; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sigma_1 (c_4 k_x + c_5 k_y); \]

\[ \Gamma: \{ C_{4v} \}, \{ \frac{1}{2} \frac{1}{2} 0 \}, \{ I \}, \{ \frac{1}{2} \frac{1}{2} 0 \}, \tau; \text{ Centrosymmetric; without SOC} \]

\[ \gamma: \{ R_2, R_4 \} ; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sum_{i=1}^{1} [c_{i\,1} k_x k_y + c_{i\,2} (k_x^2 - k_y^2)] \sigma_i; \]

\[ \{ R_2, R_4 \}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sum_{i=1}^{1} [c_{i\,1} k_x k_y + c_{i\,2} (k_x^2 - k_y^2)] \sigma_i; \]

\[ M: \{ R_2, R_4 \}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sum_{i=1}^{1} [c_{i\,1} k_x k_y + c_{i\,2} (k_x^2 - k_y^2)] \sigma_i; \]

\[ R_{10}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sum_{i=1}^{1} [c_{i\,1} k_x k_y + c_{i\,2} (k_x^2 - k_y^2)] \sigma_i; \]

\[ Z: \{ R_4 \}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sum_{i=1}^{1} [c_{i\,1} k_x k_y + c_{i\,2} (k_x^2 - k_y^2)] \sigma_i; \]

\[ \{ R_6 \}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sum_{i=1}^{1} [c_{i\,1} k_x k_y + c_{i\,2} (k_x^2 - k_y^2)] \sigma_i; \]

\[ A: \{ R_6 \}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sum_{i=1}^{1} [c_{i\,1} k_x k_y + c_{i\,2} (k_x^2 - k_y^2)] \sigma_i; \]

\[ R_{10}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sum_{i=1}^{1} [c_{i\,1} k_x k_y + c_{i\,2} (k_x^2 - k_y^2)] \sigma_i; \]

\[ R_{10}; \quad c_1 \sigma_0 + \sigma_2 (c_2 k_x + c_3 k_y); \]

\[ R_{10}; \quad c_1 \sigma_0 + \sigma_2 (c_2 k_x + c_3 k_y); \]

\[ \Lambda: \{ R_2, R_4 \}; \quad [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + \sum_{i=1}^{1} [c_{i\,1} k_x k_y + c_{i\,2} (k_x^2 - k_y^2)] \sigma_i; \]

\[ V: \{ R_6 \}; \quad [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + \sum_{i=1}^{1} [c_{i\,1} k_x k_y + c_{i\,2} (k_x^2 - k_y^2)] \sigma_i; \]

\[ W: \{ R_6 \}; \quad (c_1 + c_2 k_x) \sigma_0 + \sum_{i=1}^{1} (c_{i\,1} k_x + c_{i\,2} k_y) \sigma_i; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

\[ U; \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

\[ \Lambda; \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_2, R_4 \}; \quad [(A_4 + A_6) c_3 + (A_2 - A_1) c_4] k_x + [(A_1 - A_2) c_3 + (A_4 + A_6) c_4] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_5 k_z; \]

\[ \{ R_2, R_4 \}, \{ R_3 \}; \quad [(A_4 + A_7) c_3 + (A_3 - A_2) c_4] k_x + [(A_2 - A_1) c_3 + (A_6 + A_8) c_4] k_y + A_0 (c_1 + c_2 k_z) + A_5 c_5 k_z; \]

\[ V; \{ R_5, R_7 \}, \{ R_6 \}; \quad [(A_6 + A_8) c_3 + (A_2 - A_1) c_4] k_x + [(A_2 - A_1) c_3 + (A_6 + A_8) c_4] k_y + A_0 (c_1 + c_2 k_z) + A_5 c_5 k_z; \]

\[ \{ R_5, R_7 \}, \{ R_8 \}; \quad [(A_6 + A_8) c_3 + (A_2 - A_1) c_4] k_x + [(A_3 - A_2) c_3 + (A_6 + A_8) c_4] k_y + A_0 (c_1 + c_2 k_z) + A_5 c_5 k_z; \]

\[ \{ R_6 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

\[ S; \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

\[ Y; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

\[ T; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

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SG 86

\[ \Gamma_q; \{ C_{4v}^+ \} \{ \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ I \} \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; \{ R_2, R_4 \}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sum_{i=1}^{2} \left[ c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2) \right] \sigma_i; \]

\[ \{ R_6, R_8 \}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sum_{i=1}^{2} \left[ c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2) \right] \sigma_i; \]

\[ M; \quad R_0; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sum_{i=1}^{2} \left[ c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2) \right] \sigma_i; \]

\[ R_{10}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sum_{i=1}^{2} \left[ c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2) \right] \sigma_i; \]

\[ Z; \quad R_0; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sum_{i=1}^{2} \left[ c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2) \right] \sigma_i; \]

\[ R_{10}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sum_{i=1}^{2} \left[ c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2) \right] \sigma_i; \]

\[ A; \quad \{ R_2, R_4 \}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sum_{i=1}^{2} \left[ c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2) \right] \sigma_i; \]

\[ \{ R_6, R_8 \}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sum_{i=1}^{2} \left[ c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2) \right] \sigma_i; \]

\[ R; \quad R_5; \quad c_1 \sigma_0 + c_2 (c_2 k_x + c_3 k_y); \]

\[ X; \quad R_5; \quad c_1 \sigma_0 + c_2 (c_2 k_x + c_3 k_y); \]

\[ \Lambda; \{ R_2, R_4 \}; \quad \left[ c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sum_{i=1}^{2} \left[ c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2) \right] \sigma_i; \]

\[ V; \{ R_6, R_8 \}; \quad \left[ c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sum_{i=1}^{2} \left[ c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2) \right] \sigma_i; \]

\[ W; \{ R_1, R_2 \}; \quad (c_1 + c_2 k_z) \sigma_0 + \sum_{i=1}^{2} (c_{1,1} k_x + c_{1,2} k_y) \sigma_i; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ U; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ \Lambda; \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_6 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_2, R_4 \}; [(A_1 - A_2) c_x + (A_2 - A_1) k_x] k_y + \sigma_3 (c_4 k_x + c_5 k_y) + \sigma_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_8) c_5 k_z; \]
\[ \{ R_2, R_4 \}, \{ R_3 \}; [(A_1 - A_2) c_x + (A_2 - A_1) k_x] k_y + \sigma_3 (c_4 k_x + c_5 k_y) + \sigma_0 (c_1 + c_2 k_x) + A_8 c_3 k_z; \]
\[ V; \{ R_5, R_7 \}, \{ R_6 \}; [(A_6 + A_7) c_x + (A_2 - A_1) k_x] k_y + \sigma_3 (c_4 k_x + c_5 k_y) + \sigma_0 (c_1 + c_2 k_x) + A_8 c_3 k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + c_6 \sigma_3 k_z; \]
\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ S; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ Y; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ T; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

SG 87
\[ \Gamma^G_{\gamma}; \{ C_{4v}^+ \}, \{ I \}, T; \] Centrosymmetric; without SOC

\[ \Gamma; \{ R_2, R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ \{ R_6, R_8 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ Z; \{ R_2, R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ \{ R_6, R_8 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ P; \{ R_2, R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ \Lambda; \{ R_2, R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ V; \{ R_2, R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + c_6 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_2, R_4 \}; [(A_4 + A_6) c_x + (A_2 - A_1) c_4] k_x + [(A_1 - A_2) c_3 + (A_4 + A_6) c_4] k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_8) c_5 k_z; \]
\[ \{ R_2, R_4 \}, \{ R_3 \}; [(A_6 + A_7) c_x + (A_2 - A_1) c_4] k_x + [(A_1 - A_2) c_3 + (A_6 + A_7) c_4] k_y + A_0 (c_1 + c_2 k_x) + A_8 c_3 k_z; \]
\[ V; \{ R_5, R_7 \}, \{ R_6 \}; [(A_6 + A_7) c_x + (A_2 - A_1) c_4] k_x + [(A_1 - A_2) c_3 + (A_6 + A_7) c_4] k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_8) c_5 k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ \{ R_7 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ W; \{ R_5, R_7 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
\[ \{ R_5 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Gamma \] set: \{C_{4v}^+, \{\frac{1}{2}, \frac{3}{2}, \frac{7}{2}\}\}; \{I\{\frac{3}{2}, \frac{1}{2}\}\}; T; Centrosymmetric; without SOC

\[ \Gamma \] set: \{R_2, R_4\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^2 \{c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2)\} \sigma_i; \\
\{R_6, R_8\}; \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \sum_{i=1}^2 \{c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2)\} \sigma_i; \\
X \ set: \{R_5, R_7\}; \quad c_1 \sigma_0 + \sigma_2 (c_2k_x + c_3k_y); \\
Z \ set: \{R_9\}; \quad \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \{c_4k_xk_y + c_5(k_x^2 - k_y^2)\} \sigma_3; \\
\{R_{10}\}; \quad \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \{c_4k_xk_y + c_5(k_x^2 - k_y^2)\} \sigma_3 + c_2\sigma_2k_z; \\
P \ set: \{R_1, R_2\}; \quad \{c_1 + c_2k_x\} \sigma_0 + \{c_4k_x + c_5k_y\} \sigma_1 + \{c_6k_x + c_5k_y\} \sigma_2; \\
\{R_3, R_4\}; \quad \{c_2\sigma_2k_z + \sigma_1k_y\} + \{c_3(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
\Lambda \ set: \{R_2, R_4\}; \quad \{c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2\} \sigma_0 + \sum_{i=1}^2 \{c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2)\} \sigma_i; \\
V \ set: \{R_5, R_7\}; \quad \{c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2\} \sigma_0 + \sum_{i=1}^2 \{c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2)\} \sigma_i; \\
W \ set: \{R_1, R_2\}; \quad \{c_1 + c_2k_x\} \sigma_0 + \{c_4k_x + c_5k_y\} \sigma_1 + \{c_6k_x + c_5k_y\} \sigma_2; \\
\Lambda \ set: \{R_2, R_4\}; \quad \{c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2\} \sigma_0 + \sum_{i=1}^2 \{c_{1,1} k_x k_y + c_{1,2} (k_x^2 - k_y^2)\} \sigma_i; \\
F \ set: \{R_2, R_4\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
\Delta \ set: \{R_1, R_4\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
U \ set: \{R_2, R_4\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
Y \ set: \{R_1, R_2\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
\Sigma \ set: \{R_1, R_2\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
F \ set: \{R_2, R_4\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
\Delta \ set: \{R_1, R_4\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
U \ set: \{R_2, R_4\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
Y \ set: \{R_1, R_2\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
\Sigma \ set: \{R_1, R_2\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
F \ set: \{R_2, R_4\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
\Delta \ set: \{R_1, R_4\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
U \ set: \{R_2, R_4\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; \\
Y \ set: \{R_1, R_2\}; \quad \{c_1 + c_2k_x + c_3k_y\} + \{c_5(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0; 

SG 89

\[ \Gamma \] set: \{C_{4v}^+, \{000\}, \{C_{2v}\} \}; \{000\}; \text{Non-Centrosymmetric; without SOC}

\[ \Gamma \] set: \{R_5\}; \quad \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \{c_4\sigma_1k_xk_y + c_5(k_x^2 - k_y^2)\} \sigma_3 + c_2\sigma_2k_z; \\
M \ set: \{R_3\}; \quad \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \{c_4\sigma_1k_xk_y + c_5(k_x^2 - k_y^2)\} \sigma_3 + c_2\sigma_2k_z; \\
Z \ set: \{R_5\}; \quad \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \{c_4\sigma_1k_xk_y + c_5(k_x^2 - k_y^2)\} \sigma_3 + c_2\sigma_2k_z; \\
A \ set: \{R_3\}; \quad \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + \{c_4\sigma_1k_xk_y + c_5(k_x^2 - k_y^2)\} \sigma_3 + c_2\sigma_2k_z; 

597
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x + c_6 \sigma_2 k_z; \]

\[ U; \{ R_3 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x + c_6 \sigma_2 k_z; \]

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 + i) c_5 \sigma_4 k_y - h.c.]; \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 - i) c_5 \sigma_4 k_y + h.c.]; \]

\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z + [\sigma_0 (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]

\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [\sigma_0 (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [\sigma_0 (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [\sigma_0 (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [\sigma_0 (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]

\[ V; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 + i) c_5 \sigma_4 k_y + h.c.]; \]

\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 - i) c_5 \sigma_4 k_y - h.c.]; \]

\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z + [\sigma_0 (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]

\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [\sigma_0 (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]

\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [\sigma_0 (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]

\[ \Sigma; \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z); \]

\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z); \]

\[ S; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z); \]

\[ Y; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x + c_6 \sigma_2 k_y; \]

\[ T; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x + c_6 \sigma_2 k_y; \]

\[ W; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x + c_6 \sigma_2 k_y; \]

\[ \Gamma; \{ C_{4v}^+ \}, \{ \Gamma \}; \quad T; \quad \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \begin{aligned} \{ R_5 \}; & \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5 (k_x^2 - k_y^2) \sigma_3 + c_2 \sigma_2 k_z; \\
M; \{ R_6, R_8 \}; & \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \\
\{ R_7, R_9 \}; & \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \\
R_5; & \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_2 k_y; \end{aligned} \]

\[ Z; \{ R_5 \}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5 (k_x^2 - k_y^2) \sigma_3 + c_2 \sigma_2 k_z; \]

\[ A; \{ R_6, R_8 \}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \\
\{ R_7, R_9 \}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \\
R_9; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_y; \]

\[ R; \begin{aligned} \{ R_5 \}; & \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
X; \{ R_5 \}; & \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \end{aligned} \]

\[ V; \{ R_1, R_3 \}; \quad [c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \\
\{ R_2, R_4 \}; \quad [c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ Y; \{ R_2, R_4 \}; \quad (c_1 + c_2 k_z) \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ T; \{ R_2, R_4 \}; \quad (c_1 + c_2 k_z) \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ W; \{ R_1, R_2 \}; \quad (c_1 + c_2 k_z) \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x + c_6 \sigma_2 k_z; \]

\[ U: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x + c_6 \sigma_2 k_z; \]

\[ \Lambda: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 + i) c_5 \sigma_+ k_- + h.c.]; \]

\[ \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (a_1 k^2 + a_2 k^2) + h.c.]; \]

\[ \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 - i) c_5 \sigma_+ k_- + h.c.]; \]

\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 + i) c_5 \sigma_+ k_- + h.c.]; \]

\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (a_1 k^2 + a_2 k^2) + h.c.]; \]

\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 + i) c_5 \sigma_+ k_- + h.c.]; \]

\[ V: \{R_1, R_3\}, \{R_2, R_4\}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + c_3 \Gamma_{3,0} k_z + \{(1 + i) [(c_4 \Gamma_{+,0} + i c_5 \Gamma_{+,3}) k_- + i k_z (c_6 \Gamma_{+,1} + c_7 \Gamma_{+,2})] + h.c. \}; \]

\[ \Sigma: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 (c_3 k_x + c_5 k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z); \]

\[ S: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 (c_3 k_x + c_5 k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z); \]
\[ \Gamma; \{ C_4^+ \} | 00 \}, \{ C_2 \} | 00 \}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; R_5; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3k_y^2 \right] \sigma_0 + c_4\sigma_3k_xk_y + c_5(k_x^2 - k_y^2)\sigma_3 + c_6\sigma_2k_z; \]

\[ M; R_5; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3k_y^2 \right] \sigma_0 + c_4\sigma_3k_xk_y + c_5(k_x^2 - k_y^2)\sigma_3 + c_6\sigma_2k_z; \]

\[ Z; R_6; \quad c_1\sigma_0 + c_2\sigma_3k_z; \]

\[ R_7; \quad c_1\sigma_0 + c_2\sigma_3k_z; \]

\[ A; R_6; \quad c_1\sigma_0 + c_2\sigma_3k_z; \]

\[ R_7; \quad c_1\sigma_0 + c_2\sigma_3k_z; \]

\[ R; R_5; \quad c_1\sigma_0 + c_2\sigma_3k_z; \]

\[ U; \{ R_2, R_4 \}; \quad (c_1 + c_2k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \]

\[ S; \{ R_2, R_6 \}; \quad (c_1 + c_2k_x + c_2k_y)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \]

\[ T; \{ R_1, R_2 \}; \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z; \]

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**Accidental degeneracies on high symmetry line**

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_x + c_6\sigma_2k_z; \]

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + [(1 + i)c_4\sigma_1k_+ + h.c.]; \]

\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2k_x + c_3k^2 + c_4k_x^2) + \sigma_3 (c_3k_z + c_6k^2 + c_7k_x^2) + [\sigma_+ (\alpha_1k_x^2 + \alpha_2k_x^2) + h.c.]; \]

\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + [(1 - i)c_4\sigma_1k_+ + h.c.]; \]

\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2k_x + c_3k^2 + c_4k_x^2) + \sigma_3 (c_3k_z + c_6k^2 + c_7k_x^2) + [\sigma_+ (\alpha_1k_x^2 + \alpha_2k_x^2) + h.c.]; \]

\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2k_x + c_3k^2 + c_4k_x^2) + \sigma_3 (c_3k_z + c_6k^2 + c_7k_x^2) + [\sigma_+ (\alpha_1k_x^2 + \alpha_2k_x^2) + h.c.]; \]

\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + [(1 + i)c_4\sigma_1k_- + h.c.]; \]

\[ \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + [(1 + i)c_5\sigma_4k_- + h.c.]; \]

\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2k_x + c_3k^2 + c_4k_x^2) + \sigma_3 (c_3k_z + c_6k^2 + c_7k_x^2) + [\sigma_+ (\alpha_1k_x^2 + \alpha_2k_x^2) + h.c.]; \]

\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2k_x + c_3k^2 + c_4k_x^2) + \sigma_3 (c_3k_z + c_6k^2 + c_7k_x^2) + [\sigma_+ (\alpha_1k_x^2 + \alpha_2k_x^2) + h.c.]; \]

\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + [(1 + i)c_4\sigma_1k_- + h.c.]; \]

\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2k_x + c_3k^2 + c_4k_x^2) + \sigma_3 (c_3k_z + c_6k^2 + c_7k_x^2) + [\sigma_+ (\alpha_1k_x^2 + \alpha_2k_x^2) + h.c.]; \]

\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + [(1 + i)c_5\sigma_4k_- + h.c.]; \]

\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x + c_2k_y) + \sigma_3 (c_3k_z + c_4k_y) + c_4\sigma_1k_z + c_5\sigma_2(k_y - k_x); \]

\[ Y; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_6\sigma_2k_y + c_5\sigma_1k_z; \]

\[ W; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_5\sigma_1k_x + c_6\sigma_2k_y; \]
\[ \Gamma_2: \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + c_4\sigma_3k_xk_y + c_5(k_x^2 - k_y^2)\sigma_3 + c_6\sigma_2k_z; \]

\[ M: \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_xk_y; \]

\[ R: \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_xk_y; \]

\[ 0: \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + c_4\sigma_3k_xk_y; \]

\[ Z: \{c_1\sigma_0 + c_2\sigma_2k_z; \]

\[ 7: \{c_1\sigma_0 + c_2\sigma_2k_z; \]

\[ A: \{c_1\Gamma_{0,0} + c_2[\Gamma_{0,2}(k_x - k_y) + \Gamma_{3,3}(k_x + k_y)] + c_3\Gamma_{3,1}k_z; \]

\[ R: \{c_1 + \sum_{i=x} c_i\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_yk_z; \]

\[ \{c_1 + \sum_{i=x} c_i\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_yk_z; \]

\[ X: \{c_1\sigma_0 + c_2\sigma_2k_y; \]

\[ U: \{c_1 + c_3k_z)\sigma_0 + (c_2\sigma_1 + c_4\sigma_2)k_z; \]

\[ V: \{c_1 + c_3k_z + c_3(k_x^2 + k_y^2) + c_4\sigma_3\} \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_xk_y; \]

\[ \{c_1 + c_3k_z + c_3(k_x^2 + k_y^2) + c_4\sigma_3\} \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_xk_y; \]

\[ S: \{c_1 + c_3k_z + c_4k_y)\sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_z; \]

\[ Y: \{c_1 + c_3k_z)\sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_y; \]

\[ T: \{c_1 + c_3k_z + \sum_{i=x} c_i\sigma_0 + \sum_{i=x} c_i\sigma_0 + \sum_{i=x} c_i\sigma_0 + \sum_{i=x} c_i\sigma_0 + \sum_{i=x} c_i\sigma_0; \]

\[ \{c_1 + c_3k_z; \]

\[ W: \{c_1 + c_3k_z)\sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_y; \]

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Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1, R_2\}; \]

\[ A: \{R_1, R_2\}; \]

\[ V: \{R_1, R_2, R_4\}; \]

\[ \Sigma: \{R_1, R_2\}; \]

\[ T: \{R_2, R_4\}; \]

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\[ \Gamma_2: \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + c_4\sigma_3k_xk_y + c_5(k_x^2 - k_y^2)\sigma_3 + c_6\sigma_2k_z; \]

\[ M: \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + c_4\sigma_3k_xk_y + c_5(k_x^2 - k_y^2)\sigma_3 + c_6\sigma_2k_z; \]

\[ Z: \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + c_4\sigma_3k_xk_y + c_5(k_x^2 - k_y^2)\sigma_3 + c_6\sigma_2k_z; \]

\[ A: \{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + c_4\sigma_3k_xk_y + c_5(k_x^2 - k_y^2)\sigma_3 + c_6\sigma_2k_z; \]
Accidental degeneracies on high symmetry line

$\Delta$: \{R_1\}, \{R_2\}; $\sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_x + c_5\sigma_1k_x + c_6\sigma_2k_z$;
$U$: \{R_3\}, \{R_4\}; $\sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_x + c_5\sigma_1k_x + c_6\sigma_2k_z$;
$\Lambda$: \{R_1\}, \{R_2\}; $\sigma_0 (c_1 + c_2k_z) + c_0\sigma_3k_z + [(1 + i)c_0\sigma_zk_z + h.c.]$;
\quad \{R_0\}, \{R_3\}; $\sigma_0 (c_1 + c_2k_z + c_4k_z^2 + c_5k_z^2) + \sigma_3 (c_0k_z + c_3k_z^2 + c_7k_z^2) + \sigma_3 (\alpha_1k_z^2 + \alpha_2k_z^2) + h.c.$;
\quad \{R_4\}, \{R_5\}; $\sigma_0 (c_1 + c_2k_z + c_4k_z^2 + c_5k_z^2) + \sigma_3 (c_0k_z + c_3k_z^2 + c_7k_z^2) + \sigma_3 (\alpha_1k_z^2 + \alpha_2k_z^2) + h.c.$;
\quad \{R_6\}, \{R_7\}; $\sigma_0 (c_1 + c_2k_z + c_4k_z^2 + c_5k_z^2) + \sigma_3 (c_0k_z + c_3k_z^2 + c_7k_z^2) + \sigma_3 (\alpha_1k_z^2 + \alpha_2k_z^2) + h.c.$;
\quad \{R_5\}, \{R_8\}; $\sigma_0 (c_1 + c_2k_z + c_4k_z^2 + c_5k_z^2) + \sigma_3 (c_0k_z + c_3k_z^2 + c_7k_z^2) + \sigma_3 (\alpha_1k_z^2 + \alpha_2k_z^2) + h.c.$;
$V$: \{R_1\}, \{R_2\}; $\sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_x + [(1 + i)c_0\sigma_zk_z + h.c.]$;
\quad \{R_0\}, \{R_3\}; $\sigma_0 (c_1 + c_2k_z + c_4k_z^2 + c_5k_z^2) + \sigma_3 (c_0k_z + c_3k_z^2 + c_7k_z^2) + \sigma_3 (\alpha_1k_z^2 + \alpha_2k_z^2) + h.c.$;
\quad \{R_4\}, \{R_5\}; $\sigma_0 (c_1 + c_2k_z + c_4k_z^2 + c_5k_z^2) + \sigma_3 (c_0k_z + c_3k_z^2 + c_7k_z^2) + \sigma_3 (\alpha_1k_z^2 + \alpha_2k_z^2) + h.c.$;
\quad \{R_6\}, \{R_7\}; $\sigma_0 (c_1 + c_2k_z + c_4k_z^2 + c_5k_z^2) + \sigma_3 (c_0k_z + c_3k_z^2 + c_7k_z^2) + \sigma_3 (\alpha_1k_z^2 + \alpha_2k_z^2) + h.c.$;
\quad \{R_8\}, \{R_9\}; $\sigma_0 (c_1 + c_2k_z + c_4k_z^2 + c_5k_z^2) + \sigma_3 (c_0k_z + c_3k_z^2 + c_7k_z^2) + \sigma_3 (\alpha_1k_z^2 + \alpha_2k_z^2) + h.c.$;
$\Sigma$: \{R_1\}, \{R_2\}; $\sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_x + [(1 + i)c_0\sigma_zk_z + h.c.]$;
$S$: \{R_3\}, \{R_4\}; $\sigma_0 (c_1 + c_2k_z + c_2k_y) + \sigma_3 (c_3k_z + c_5k_y) + c_4\sigma_1k_z + c_5\sigma_2(k_y - k_z)$;
$S\Sigma$: \{R_5\}, \{R_6\}; $\sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_x + c_4\sigma_1k_z + c_5\sigma_2k_y + c_6\sigma_1k_z$;
$T$: \{R_0\}, \{R_3\}; $\sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_x + c_4\sigma_1k_z + c_5\sigma_2k_y + c_6\sigma_1k_z$;
$W$: \{R_1\}, \{R_2\}; $\sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_x + c_5\sigma_1k_x + c_6\sigma_2k_y$;

SG 94
$\Gamma$: \{C_{4z}^{+}[00\frac{3}{2}]\}, \{C_{2z}[\frac{1}{2}\frac{1}{2}0]\}, T; Non-Centrosymmetric; without SOC

$\Gamma$: \{R_5\}; $[c_1 + c_2k_z^2 + k_y^2] + c_3k_x^2] \sigma_0 + c_0\sigma_3k_y + c_2(k_y^2 - k_z^2)\sigma_3 + c_6\sigma_2k_z$;
$M$: \{R_0, R_6\}; $[c_1 + c_2k_z^2 + k_y^2] + c_3k_x^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y$;
\quad \{R_7, R_8\}; $[c_1 + c_2k_z^2 + k_y^2] + c_3k_x^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y$;
\quad \{R_9\}; $[c_1 + c_2k_z^2 + k_y^2] + c_3k_x^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y$;

$Z$: \{R_5\}; $[c_1 + c_2k_z^2 + k_y^2] + c_3k_x^2] \sigma_0 + c_0c_1k_zk_y + c_2(k_y^2 - k_z^2)\sigma_3 + c_6\sigma_2k_z$;
$A$: \{R_0, R_6\}; $[c_1 + c_2k_z^2 + k_y^2] + c_3k_x^2] \sigma_0 + (c_0\sigma_1 + c_5\sigma_2)k_zk_y$;
\quad \{R_7, R_8\}; $[c_1 + c_2k_z^2 + k_y^2] + c_3k_x^2] \sigma_0 + (c_0\sigma_1 + c_5\sigma_2)k_zk_y$;
\quad \{R_9\}; $[c_1 + c_2k_z^2 + k_y^2] + c_3k_x^2] \sigma_0 + (c_0\sigma_1 + c_5\sigma_2)k_zk_y$;

$R$: \{R_5\}; $c_1\sigma_0 + c_2\sigma_2k_y$;
$X$: \{R_5\}; $c_1\sigma_0 + c_2\sigma_2k_y$;
$V$: \{R_1, R_3\}; $[c_1 + c_2k_z + c_3k_x^2 + k_y^2] + c_4k_z^2] \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_zk_y$;
\quad \{R_2, R_4\}; $[c_1 + c_2k_z + c_3k_x^2 + k_y^2] + c_4k_z^2] \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_zk_y$;
$Y$: \{R_2, R_4\}; $(c_1 + c_2k_z)\sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_y$;
$T$: \{R_2, R_4\}; $(c_1 + c_2k_z)\sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_y$;
$W$: \{R_1, R_2\}; $(c_1 + c_2k_z)\sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_y$;
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \]

\[ U; \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \]

\[ \Lambda; \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 + i)c_5 \sigma_+ k_- + h.c.]; \]

\[ \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k^2 + \alpha_2 k^2) + h.c.]; \]

\[ \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 - i)c_5 \sigma_+ k_- + h.c.]; \]

\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 + i)c_5 \sigma_+ k_- + h.c.]; \]

\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k^2 + \alpha_2 k^2) + h.c.]; \]

\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1 + i)c_5 \sigma_+ k_- + h.c.]; \]

\[ V; \{R_1, R_3\}, \{R_2, R_4\}; \quad \Gamma_0, 0 (c_1 + c_2 k_z) + c_3 \Gamma_{3,0} k_z + \{1 + i\} [(c_4 \Gamma_{+0} + c_5 \Gamma_{+,3}) k_- + i k_z (c_6 \Gamma_{+,1} + c_7 \Gamma_{+,2}) + h.c.]; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k_y) + \sigma_3 (c_5 k_z + c_6 k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 (k_y - k_z); \]

\[ S; \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_z + c_2 k_y) + \sigma_3 (c_3 k_z + c_5 k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 (k_y - k_z); \]

SG 95

\[ \Gamma_4; \{C_{4v}^\dagger, 000\}, \{C_{2v}, 000\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \quad R_5; \quad [c_1 + c_2 (k_2^2 + k_y^2) + c_3 k_2^2] \sigma_0 + c_4 \sigma_1 k_z k_y + c_5 (k_2^2 - k_y^2) \sigma_3 + c_6 \sigma_2 k_z; \]

\[ M; \quad R_5; \quad [c_1 + c_2 (k_2^2 + k_y^2) + c_3 k_2^2] \sigma_0 + c_4 \sigma_1 k_z k_y + c_5 (k_2^2 - k_y^2) \sigma_3 + c_6 \sigma_2 k_z; \]

\[ Z; \quad R_6; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ \quad R_7; \quad c_3 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ A; \quad R_6; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ \quad R_7; \quad c_3 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ R; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ U; \quad \{R_2, R_4\}; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]

\[ S; \quad \{R_4, R_6\}; (c_1 + c_2 k_z) \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ T; \quad \{R_1, R_2\}; (c_1 + c_2 k_2) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_1 k_x + c_5\sigma_1 k_z + c_6\sigma_2 k_z; \]

\[ \Lambda: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_3k_z) + c_4\sigma_2 k_x + [ (1 + i)c_3\sigma_1 k_x + h.c. ] \]

\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z + c_3k^2 + c_4k^2_y) + c_5\sigma_3 k_y + c_6\sigma_2 k_z + [ c_7k^2_x + [ \sigma_+ (\alpha_1 k^2_x + \alpha_2 k^2_z) + h.c. ]; \]

\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_3k_z) + c_4\sigma_2 k_x + [ (1 + i)c_3\sigma_1 k_x + h.c. ]; \]

\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z + c_3k^2 + c_4k^2_y) + c_5\sigma_3 k_y + c_6\sigma_2 k_z + [ c_7k^2_x + [ \sigma_+ (\alpha_1 k^2_x + \alpha_2 k^2_z) + h.c. ]; \]

\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_3k_z) + c_4\sigma_2 k_x + [ (1 + i)c_3\sigma_1 k_x + h.c. ]; \]

\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z + c_3k^2 + c_4k^2_y) + c_5\sigma_3 k_y + c_6\sigma_2 k_z + [ c_7k^2_x + [ \sigma_+ (\alpha_1 k^2_x + \alpha_2 k^2_z) + h.c. ]; \]

\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z + c_3k^2 + c_4k^2_y) + c_5\sigma_3 k_y + c_6\sigma_2 k_z + [ c_7k^2_x + [ \sigma_+ (\alpha_1 k^2_x + \alpha_2 k^2_z) + h.c. ]; \]

\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_3k_z) + c_4\sigma_2 k_x + [ (1 + i)c_3\sigma_1 k_x + h.c. ]; \]

\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z + c_3k^2 + c_4k^2_y) + c_5\sigma_3 k_y + c_6\sigma_2 k_z + [ c_7k^2_x + [ \sigma_+ (\alpha_1 k^2_x + \alpha_2 k^2_z) + h.c. ]; \]

\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z + c_3k^2 + c_4k^2_y) + c_5\sigma_3 k_y + c_6\sigma_2 k_z + [ c_7k^2_x + [ \sigma_+ (\alpha_1 k^2_x + \alpha_2 k^2_z) + h.c. ]; \]

\[ \Sigma: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z + c_2k_y) + c_3(c_3k_z + c_4k_y) + c_4\sigma_1 k_x + c_5\sigma_1 k_z + c_6\sigma_2 k_y; \]

\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z + c_3k^2 + c_4k^2_y) + c_5\sigma_3 k_y + c_6\sigma_2 k_z; \]

\[ W: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_2 k_z + c_5\sigma_1 k_z + c_6\sigma_2 k_y; \]

\[ \text{SG 96} \]

\[ \Gamma_4: \{C_{4z}^+|00\}^2, \{C_{2z}|\frac{1}{2} \frac{1}{2}\}^2, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \{R_5\}; \text{ } [c_1 + c_2(k^2_x + k^2_z) + c_3k^2_y] \sigma_0 + c_4\sigma_1 k_z k_y + c_5(k^2_x - k^2_y)\sigma_3 + c_6\sigma_2 k_z; \]

\[ M: \{R_0, R_6\}; \text{ } [c_1 + c_2(k^2_x + k^2_z) + c_3k^2_y] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2) k_z k_y; \]

\[ \{R_2, R_6\}; \text{ } [c_1 + c_2(k^2_x + k^2_z) + c_3k^2_y] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2) k_z k_y; \]

\[ R_0; \text{ } [c_1 + c_2(k^2_x + k^2_z) + c_3k^2_y] \sigma_0 + c_4\sigma_3 k_z k_y; \]

\[ Z; \{R_6\}; \text{ } c_1\sigma_0 + c_2\sigma_2 k_z; \]

\[ \{R_7\}; \text{ } c_1\sigma_0 + c_2\sigma_2 k_z; \]

\[ A: \{R_0, R_7\}; \text{ } [c_1 + c_2(k^2_x - k^2_y)] \sigma_0 + [c_4\sigma_1 - c_3\sigma_2] k_z k_y + c_4\Gamma_3 k_z; \]

\[ R; \{R_2, R_4\}; \text{ } [c_1 + \sum_{i=x} c_i k^2_i] \sigma_0 + (c_2\sigma_1 + c_3\sigma_2) k_y k_z; \]

\[ \{R_0, R_9\}; \text{ } [c_1 + \sum_{i=x} c_i k^2_i] \sigma_0 + (c_2\sigma_1 + c_3\sigma_2) k_y k_z; \]

\[ X; \{R_5\}; \text{ } c_1\sigma_0 + c_2\sigma_2 k_y; \]

\[ U; \{R_2, R_4\}; \text{ } [c_1 + c_2k_y] \sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_z; \]

\[ V; \{R_2, R_3\}; \text{ } [c_1 + c_2k_z + c_3(k^2_x + k^2_y) + c_4k^2_x] \sigma_0 + (c_2\sigma_1 + c_3\sigma_2) k_z k_y; \]

\[ \{R_2, R_4\}; \text{ } [c_1 + c_2k_z + c_3(k^2_x + k^2_y) + c_4k^2_x] \sigma_0 + (c_2\sigma_1 + c_3\sigma_2) k_z k_y; \]

\[ S; \{R_4, R_6\}; \text{ } [c_1 + c_2k_z + c_2k_y] \sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_z; \]

\[ Y; \{R_2, R_4\}; \text{ } c_1\sigma_0 + c_2\sigma_2 k_y; \]

\[ T; \{R_2, R_2\}; \text{ } (c_1 + c_2k_z + \sum_{i=x} c_i k^2_i) \sigma_0 + \sum_{i=x} c_i \sigma_i k_y k_z; \]

\[ \{R_4, R_6\}; \text{ } (c_1 + c_2k_z + \sum_{i=x} c_i k^2_i) \sigma_0 + \sum_{i=x} c_i \sigma_i k_y k_z; \]

\[ W; \{R_1, R_2\}; \text{ } (c_1 + c_2k_z) \sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_x + c_6 \sigma_2 k_z ; \]
\[ \Lambda: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + [(1 + i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_1 \}, \{ R_3 \} ; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_y^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_y^2) + [\sigma_+ (a_1 k^2_x + a_2 k^2_y) + h.c.]; \]
\[ \{ R_1 \}, \{ R_4 \} ; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + [(1 - i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_2 \}, \{ R_3 \} ; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + [(1 + i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_2 \}, \{ R_4 \} ; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 (c_3 k_x + c_4 k_y) + c_5 \sigma_1 k_z + c_6 \sigma_2 (k_y - k_z); \]
\[ Y: \{ R_3 \}, \{ R_4 \} ; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 (c_3 k_x + c_4 k_y) + c_5 \sigma_1 (k_x + k_y) + c_6 \sigma_2 k_z; \]

\[ V: \{ R_1 \}, \{ R_2 \}, \{ R_3 \}, \{ R_4 \} ; \Gamma_{0,0} (c_1 + c_2 k_z) + c_5 \Gamma_{3,0} k_x + [(1 + i) [(c_4 \Gamma_{+1} + c_5 \Gamma_{-1}) k_+ + i k_+ (c_6 \Gamma_{+2} + c_7 \Gamma_{-2})] + h.c.]; \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 (c_3 k_x + c_4 k_y) + c_5 \sigma_1 k_x + c_6 \sigma_2 (k_y - k_z); \]

\[ T: \{ R_2 \}, \{ R_3 \}, \{ R_4 \} ; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_6 \Gamma_{2,0} k_y + \sum_{i=1}^{3} (c_1 \Gamma_{1,0} k_y + c_2 \Gamma_{1,0} k_z); \]

\[ SG 97 \]

\[ \Gamma^0; \{ C^+_{4h}[000], \{ C_{2v}[000], \} T; \text{Non-Centrosymmetric; without SOC} \]

\[ \begin{align*}
\Gamma; \{ R_2 \} & : \ [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k^2_z + c_4 (k^2_y - k^2_x)] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5 (k^2_x - k^2_y) \sigma_3 + c_6 \sigma_2 k_z; \\
Z; \{ R_5 \} & : \ [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k^2_z + c_4 (k^2_y - k^2_x)] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5 (k^2_x - k^2_y) \sigma_3 + c_6 \sigma_2 k_z; \\
P; \{ R_3 \}, \{ R_4 \} & : \ [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k^2_z + c_4^2] \sigma_0 + \sum_{i=1}^{2} (c_{1,2} k_x k_y + c_{1,2} k_z) \sigma_i + c_4 (k^2_x - k^2_y) \sigma_3; \\
\end{align*} \]

Accidental degeneracies on high symmetry line

\[ \Lambda: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + [(1 + i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_1 \}, \{ R_3 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + [(1 - i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_1 \}, \{ R_4 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + [(1 + i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_2 \}, \{ R_3 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + [(1 - i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_2 \}, \{ R_4 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + [(1 + i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_3 \}, \{ R_4 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + [(1 + i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ V: \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + [(1 + i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_1 \}, \{ R_3 \} ; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + [(1 - i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_1 \}, \{ R_4 \} ; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + [(1 + i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_2 \}, \{ R_3 \} ; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + [(1 - i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ \{ R_2 \}, \{ R_4 \} ; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + [(1 + i) c_5 \sigma_4 k_+ + h.c.]; \]
\[ W; \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_5 \sigma_1 (k_y + k_z) + c_6 \sigma_2 (k_y - k_z); \]
\[ \Sigma; \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_y + c_6 \sigma_1 k_z; \]
\[ F; \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_y + c_6 \sigma_1 k_z; \]
\[ Q; \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} I_i (c_{1,2} k_x + c_{1,2} k_z); \]
\[ \Delta; \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 (c_3 k_x + c_4 k_y) + c_5 \sigma_1 k_z + c_6 \sigma_2 (k_y - k_z); \]
\[ U; \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 (c_3 k_x + c_4 k_y) + c_5 \sigma_1 k_z + c_6 \sigma_2 (k_y - k_z); \]
\[ Y; \{ R_1 \}, \{ R_2 \} ; \sigma_0 (c_1 + c_2 k_x - c_2 k_y) + \sigma_3 (c_3 k_x - c_4 k_y) + c_5 \sigma_1 (k_x + k_y) + c_6 \sigma_2 k_z; \]
\[ \Gamma_v: \{C_{4v}^{+}, \frac{1}{4} \tilde{P} \}, \{C_{2v}|0\tilde{2}^{+} \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma_v: \]

\[ R_5: \quad \left[ c_1 + c_2(k_x^2 + k_y^2) \right] \sigma_0 + c_3 \sigma_1 k_x k_y + c_5(k_x^2 - k_y^2)\sigma_3 + c_6 \sigma_2 k_z; \]

\[ Z: R_5; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5(k_x^2 - k_y^2)\sigma_3 + c_6 \sigma_2 k_z; \]

\[ P: R_{10}; \; c_1 \sigma_0 + c_2(\sigma_2 k_x - \sigma_3 k_y) + c_3 \sigma_1 k_z; \]

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**Accidental degeneracies on high symmetry line**

\[ \Lambda: \{ R_1 \}, \{ R_2 \}: \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1+i)c_5 \sigma_+ k_- + h.c.]; \]

\[ \{ R_3 \}, \{ R_4 \}: \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1-i)c_5 \sigma_+ k_- + h.c.]; \]

\[ \{ R_5 \}, \{ R_6 \}: \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1+i)c_5 \sigma_+ k_- + h.c.]; \]

\[ \{ R_7 \}, \{ R_8 \}: \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1-i)c_5 \sigma_+ k_- + h.c.]; \]

\[ \{ R_9 \}, \{ R_{10} \}: \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + [(1+i)c_5 \sigma_+ k_- + h.c.]; \]

\[ \{ R_{11} \}, \{ R_{12} \}: \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 (k_x + k_y) + c_6 \sigma_2 (k_y - k_x); \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \}: \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x + c_6 \sigma_2 k_y + c_5 \sigma_1 k_z; \]

\[ \Phi: \{ R_3 \}, \{ R_4 \}: \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x + c_6 \sigma_2 k_y + c_5 \sigma_1 k_z; \]

\[ \Omega: \{ R_5 \}, \{ R_6 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + \sum_{i=1}^{2} \sigma_i (c_1 k_x + c_2 k_z); \]

\[ \Delta: \{ R_7 \}, \{ R_8 \}: \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + c_3 (c_3 k_z + c_3 k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 (k_y - k_x); \]

\[ \Upsilon: \{ R_9 \}, \{ R_{10} \}: \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + c_3 (c_3 k_z + c_3 k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 (k_y - k_x); \]

\[ \Psi: \{ R_1 \}, \{ R_2 \}: \quad \sigma_0 (c_1 + c_2 k_z - c_2 k_y) + c_3 (c_3 k_z - c_3 k_y) + c_4 \sigma_1 (k_x + k_y) + c_5 \sigma_2 k_z; \]

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\[ \Gamma_y: \{C_{4v}^{+}, [000] \}, \{\sigma_y|000 \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma_y: \]

\[ R_5; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5(k_x^2 - k_y^2)\sigma_3; \]

\[ M: R_5; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5(k_x^2 - k_y^2)\sigma_3; \]

\[ Z: R_5; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5(k_x^2 - k_y^2)\sigma_3; \]

\[ A: R_5; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5(k_x^2 - k_y^2)\sigma_3; \]

\[ N: R_5; \quad \left[ c_1 + c_2 k_x + c_2 k_y + c_2 k_z \right] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5(k_x^2 - k_y^2)\sigma_3; \]

\[ V: R_5; \quad \left[ c_1 + c_2 k_x + c_2 k_y + c_2 k_z \right] \sigma_0 + c_4 \sigma_1 k_x k_y + c_5(k_x^2 - k_y^2)\sigma_3; \]
Accidental degeneracies on high symmetry line

Δ: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x$;

U: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x$;

Λ: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x$;

$\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x$;

$\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

V: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\{R_1\}, \{R_5\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x$;

$\{R_1\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x$;

$\{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x$;

$\{R_3\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x$;

$\{R_1\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$\{R_2\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$\{R_3\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$\{R_1\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$\{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$\{R_3\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

W: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x$;

$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y$;

$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y$;

$\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x$;

$\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
\[ \Gamma; \{ \text{Non-Centrosymmetric; without SOC} \} \]

\[ \Gamma; \{ C_4^+ \{000\}, \{\sigma_y \{1 0 0\}, \} \} \]

\[ \Gamma; \{ R_5, R_6 \} ; c_2 \sigma_1 k_x + c_1 \sigma_0 \]

\[ \{ R_7, R_8 \}; \]

\[ \Gamma; \{ R_5 \}; c_2 \sigma_3 k_z + c_1 \sigma_0 \]

\[ \{ R_7, R_8 \}; \]

\[ \Gamma; \{ R_5 \}; c_1 \sigma_0 + c_2 \sigma_2 k_y \]

\[ \{ R_7, R_8 \}; \]

\[ \Lambda; \{ R_5 \}; (c_1 + c_2 k_z) \sigma_0 + (c_3 \sigma_1 + c_3 \sigma_2) k_y + c_4 \sigma_3 k_x \]

\[ \{ R_7, R_8 \}; \]

\[ \Gamma; \{ R_5 \}; (c_1 + c_2 k_z) \sigma_0 + c_4 \sigma_1 k_x k_y + c_5 (k_x^2 - k_y^2) \sigma_3 \]

\[ \{ R_7, R_8 \}; \]

\[ \{ R_5 \}; (c_1 + c_2 k_z) \sigma_0 + c_4 k_x k_y \sigma_3 \]

\[ \{ R_7, R_8 \}; \]

\[ \{ R_5 \}; c_1 \sigma_0 + c_2 \sigma_2 k_y \]

\[ \{ R_7, R_8 \}; \]

\[ \Lambda; \{ R_5 \}; (A_4 c_3 - A_1 c_3) k_x + (A_2 c_5 - A_6 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z \]

\[ \{ R_7, R_8 \}; \]

\[ \{ R_5 \}; (c_5 (A_1 k_x + A_2 k_y) + c_5 (A_4 k_x + A_5 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z \]

\[ \{ R_7, R_8 \}; \]

\[ \{ R_5 \}; (A_6 c_1 - A_2 c_3) k_x + (A_1 c_5 - A_4 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z \]

\[ \{ R_7, R_8 \}; \]

\[ \{ R_5 \}; (A_2 c_3 - A_3 c_5) k_x + (A_6 c_3 - A_3 c_5) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z \]

\[ \{ R_7, R_8 \}; \]

\[ \{ R_5 \}; (c_5 (A_1 k_x + A_2 k_y) + c_5 (A_4 k_x + A_5 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z \]

\[ \{ R_7, R_8 \}; \]

\[ \{ R_5 \}; (c_5 (A_1 k_x + A_2 k_y) + c_5 (A_4 k_x + A_5 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z \]

\[ \{ R_7, R_8 \}; \]

\[ \{ R_5 \}; (c_5 (A_1 k_x + A_2 k_y) + c_5 (A_4 k_x + A_5 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z \]

\[ \{ \Sigma \}; \]

\[ \{ R_5 \}; \]

\[ \{ R_5 \}; (c_5 (A_1 k_x + A_2 k_y) + c_5 (A_4 k_x + A_5 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z \]

\[ \{ \Sigma \}; \]

\[ \{ R_5 \}; \]

\[ \{ S \}; \]

\[ \{ R_5 \}; \]

\[ \{ R_5 \}; (c_5 (A_1 k_x + A_2 k_y) + c_5 (A_4 k_x + A_5 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z \]
\( \Gamma_q; \{ C_{4v}^{\pm}, |00\frac{1}{2} \}; \{ \sigma_y |00\frac{1}{2} \}; T; \) Non-Centrosymmetric; without SOC

\[ R_5, R_6; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ R_7, R_8; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ R_9; \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]

\[ Z; \{ R_5, R_6 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ \{ R_7, R_8 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ R_9; \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]

\[ A; \{ R_5, R_6 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ \{ R_7, R_8 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ R_9; \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]

\[ R; \{ R_2, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ \{ R_6, R_8 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ U; \{ R_1, R_2 \}; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x + c_5 \sigma_3 k_z; \]

\[ \Lambda; \{ R_5 \}; \begin{bmatrix} c_1 + c_3 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \end{bmatrix} \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 (k_x^2 - k_y^2) \sigma_3; \]

\[ V; \{ R_5 \}; \begin{bmatrix} c_1 + c_3 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \end{bmatrix} \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 (k_x^2 - k_y^2) \sigma_3; \]

\[ T; \{ R_1, R_2 \}; (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z; \]
Accidental degeneracies on high symmetry line

\[\Delta: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_5 \sigma_3 k_y + c_5 \sigma_1 k_x;\]

\[\Lambda: \{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_z;\]
\[\{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_1\}, \{R_3\}: (A_4 c_3 - A_1 c_5) k_x + (A_2 c_5 - A_6 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_x;\]
\[\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_2\}, \{R_5\}: c_5 (A_2 k_z + A_1 k_y) + c_3 (A_6 k_x + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;\]
\[\{R_1\}, \{R_6\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_2\}, \{R_6\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_3\}, \{R_6\}: c_5 (A_2 k_z + A_1 k_y) + c_3 (A_6 k_x + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;\]
\[\{R_4\}, \{R_6\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_5\}, \{R_6\}: c_5 (A_2 k_z + A_1 k_y) + c_3 (A_6 k_x + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;\]
\[\{R_1\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_2\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_3\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_4\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_5\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_6\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_1\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_2\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_3\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_4\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_5\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_6\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
\[\{R_7\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_2 k_y;\]
Γ: \[ \{R_5, R_6\} : c_1 \sigma_0 + c_2 \sigma_3 k_z ; \]
\[ \{R_7, R_8\} : c_1 \sigma_0 + c_2 \sigma_3 k_z ; \]
\[ \{R_9\} : c_1 \sigma_0 + c_2 \sigma_3 k_z ; \]
\[ \{R_{10}\} : \quad \frac{c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2}{\sqrt{2}} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3 ; \]

M: \[ \{R_5, R_6\} : c_1 \sigma_0 + c_2 \sigma_3 k_z ; \]
\[ \{R_7, R_8\} : c_1 \sigma_0 + c_2 \sigma_3 k_z ; \]
\[ \{R_9\} : c_1 \sigma_0 + c_2 \sigma_3 k_z ; \]
\[ \{R_{10}\} : \quad \frac{c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2}{\sqrt{2}} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3 ; \]

Z: \[ \{R_5, R_6\} : c_1 \sigma_0 + c_2 \sigma_3 k_z ; \]
\[ \{R_7, R_8\} : c_1 \sigma_0 + c_2 \sigma_3 k_z ; \]
\[ \{R_{10}\} : \quad \frac{c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2}{\sqrt{2}} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3 ; \]

A: \[ \{R_5\} : \quad \frac{c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2}{\sqrt{2}} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3 ; \]
\[ \{R_6\} : \quad \frac{c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2}{\sqrt{2}} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3 ; \]
\[ \{R_7\} : \quad \frac{c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2}{\sqrt{2}} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3 ; \]
\[ \{R_{10}\} : \quad \frac{c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2}{\sqrt{2}} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3 ; \]
\[ \{R_{11}\} : \quad \frac{c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2}{\sqrt{2}} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3 ; \]
\[ \{R_{12}\} : \quad \frac{c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2}{\sqrt{2}} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3 ; \]

X: \[ \{R_5, R_6\} : \quad \frac{c_1 + c_2 k_x^2}{\sqrt{2}} \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_y ; \]

U: \[ \{R_5, R_6\} : \quad \frac{c_1 + c_2 k_x^2}{\sqrt{2}} \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_y ; \]
\[ \{R_7\} : \quad \frac{c_1 + c_2 k_x^2}{\sqrt{2}} \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_y ; \]
\[ \{R_{10}\} : \quad \frac{c_1 + c_2 k_x^2}{\sqrt{2}} \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_y ; \]
\[ \{R_{11}\} : \quad \frac{c_1 + c_2 k_x^2}{\sqrt{2}} \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_y ; \]
\[ \{R_{12}\} : \quad \frac{c_1 + c_2 k_x^2}{\sqrt{2}} \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_y ; \]

Accidental degeneracies on high symmetry line

\[ \Delta: \quad \{R_3\} \times \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \Lambda: \quad \{R_3\} \times \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_3\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_5\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_6\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_7\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_8\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_9\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_{10}\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_{11}\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_1\} \times \{R_{12}\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]

\[ \Sigma: \quad \{R_1\} \times \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_3\} \times \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \{R_4\} \times \{R_2\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]

T: \[ \{R_2\} \times \{R_4\} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \]
\[ \Gamma; \quad R_\delta: \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \]

\[ M; \quad R_\delta: \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \]

\[ Z; \quad \{ R_5, R_6 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_7, R_8 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_{10}, R_{10} \}; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \Gamma_{0,0} + \sum_{i=1}^{3} \left[ c_{i,1} \Gamma_{i,0} k_z + c_{i,2} \Gamma_{i,1} (k_x^2 - k_y^2) + c_{i,3} \Gamma_{i,2} k_x k_y \right]; \]

\[ A; \quad \{ R_5, R_6 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_7, R_8 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_{10}, R_{10} \}; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \Gamma_{0,0} + \sum_{i=1}^{3} \left[ c_{i,1} \Gamma_{i,0} k_z + c_{i,2} \Gamma_{i,1} (k_x^2 - k_y^2) + c_{i,3} \Gamma_{i,2} k_x k_y \right]; \]

\[ R; \quad \{ R_2, R_4 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_6, R_8 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ U; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z + c_5 \sigma_3 k_z; \]

\[ N; \quad R_\delta: \quad \left[ c_1 + c_2 k_x + c_3(k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 k_x k_y \sigma_1 + c_6(k_x^2 - k_y^2) \sigma_3; \]

\[ V; \quad R_\delta: \quad \left[ c_1 + c_2 k_x + c_3(k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 k_x k_y \sigma_1 + c_6(k_x^2 - k_y^2) \sigma_3; \]

\[ S; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2(k_x + k_y)) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2)(k_x - k_y) + c_5 \sigma_3 k_z; \]

\[ T; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_5 \sigma_1 k_z; \]

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_5 \}; (A_1 c_3 - A_1 c_5) k_x + (A_2 c_1 - A_2 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{ R_3 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_5 \}; c_5 (A_2 k_x + A_1 k_y) + c_3 (A_6 k_x + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_5 \}; c_5 (A_1 k_x + A_2 k_y) + c_3 (A_1 k_x + A_6 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{ R_4 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_4 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_4 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_4 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_4 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
Γ: \( R_\Gamma: \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2)\sigma_3; \)

\(
M: \{ R_5, R_6 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z;
\)
\( \{ R_7, R_8 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( \{ R_9 \}; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 k_x k_y \sigma_3; \)

\( Z: \{ R_6, R_8 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( \{ R_7, R_8 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( \{ R_{10}, R_{110} \}; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \Gamma_{0,0} + \sum_{i=1}^{3} \left[ c_{i,1} \Gamma_{i,0} k_z + c_{i,2} \Gamma_{i,1} k_x^2 - k_y^2 \right] + c_{i,3} \Gamma_{i,2} k_z k_9 \right); \)

\( A: \{ R_6, R_8 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( \{ R_7, R_8 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( R: \quad \{ R_5 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( X: \quad \{ R_5 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \)

\( U: \{ R_1, R_2 \}; \quad (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z + c_5 \sigma_3 k_9; \)

\( \Lambda: \quad \{ R_5 \}; \quad \left[ c_1 + c_2 k_z + c_3(k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 k_x k_y \sigma_1 + c_6(k_x^2 - k_y^2)\sigma_3; \)

\( V: \quad \{ R_9 \}; \quad \left[ c_1 + c_2 k_z + c_3(k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 k_x k_y \sigma_3 + c_6(k_x^2 - k_y^2)\sigma_2; \)

\( S: \{ R_1, R_2 \}; \quad [c_1 + c_2(k_x + k_y)] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2)(k_x - k_y) + c_5 \sigma_3 k_z; \)

\( Y: \{ R_7, R_4 \}; \quad (c_1 + c_2 k_x)\sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2)k_y + c_5 \sigma_3 k_z; \)

\( W: \quad \{ R_5 \}; \quad (c_1 + c_2 k_x)\sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_y; \)
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_1\}, \{R_2\}; (A_1 c_3 - A_1 c_5) k_z + (A_2 c_5 - A_0 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_1\}, \{R_2\}; c_5 (A_2 k_x + A_1 k_y) + c_3 (A_6 k_x + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_3\}, \{R_4\}; c_5 (A_1 k_x + A_2 k_y) + c_3 (A_4 k_x + A_6 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{R_4\}, \{R_5\}; (A_0 c_3 - A_2 c_5) k_x + (A_1 c_5 - A_4 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ V; \{R_3\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_5\}, \{R_6\}; [(A_2 - A_4) c_4 + (A_1 + A_6) c_4] k_z - [(A_2 - A_4) c_4 + (A_1 + A_6) c_4] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_5 k_z; \]

\[ \{R_6\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_6\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_6\}, \{R_7\}; [(A_2 - A_4) c_4 + (A_1 - A_6) c_4] k_z + [(A_2 - A_4) c_4 + (A_1 - A_6) c_4] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_5 k_z; \]

\[ \{R_7\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_7\}, \{R_8\}; [(A_2 - A_4) c_4 + (A_1 - A_6) c_4] k_z - [(A_2 - A_4) c_4 + (A_1 - A_6) c_4] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_5 k_z; \]

\[ \{R_8\}, \{R_9\}; [(A_2 - A_4) c_4 + (A_6 - A_1) c_4] k_z + [(A_2 - A_4) c_4 + (A_6 - A_1) c_4] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_5 k_z; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z + c_2 k_y) + \sigma_3 (c_3 k_z + c_3 k_y) + c_4 \sigma_2 (k_y - k_z); \]

\[ T; \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_5 \sigma_3 k_y; \]

\[ \Gamma; \{R_5\}; (c_1 + c_2 (k_x^2 + k_y^2) + c_2 k_x^2) \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]

\[ M; \{R_5\}; (c_1 + c_2 (k_x^2 + k_y^2) + c_2 k_x^2) \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]

\[ Z; \{R_5, R_6\}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ \{R_7, R_8\}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ R_9; \sigma_0 + c_4 (k_x^2 - k_y^2) \sigma_3; \]

\[ A; \{R_5, R_6\}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{R_7, R_8\}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ R_9; \sigma_0 + c_4 (k_x^2 - k_y^2) \sigma_3; \]

\[ \Lambda; \{R_5\}; (c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_x^2) \sigma_0 + c_5 k_x k_y \sigma_1 + c_6 (k_x^2 - k_y^2) \sigma_3; \]

\[ V; \{R_5\}; (c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_x^2) \sigma_0 + c_5 k_x k_y \sigma_1 + c_6 (k_x^2 - k_y^2) \sigma_3; \]

\[ S; \{R_1, R_2\}; (c_1 + c_2 (k_x + k_y)) \sigma_0 + (c_1 \sigma_1 + c_2 \sigma_2)(k_x - k_y) + c_5 \sigma_3 k_z; \]
Accidental degeneracies on high symmetry line

$$\Delta: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_5 \sigma_3 k_y + c_5 \sigma_1 k_x;$$

$$U: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_5 \sigma_3 k_y + c_5 \sigma_1 k_x;$$

$$\Lambda: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$

$$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_3 k_z;$$

$$\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$

$$\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_3 k_z;$$

$$\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_3 k_z;$$

$$V: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$

$$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_3 k_z;$$

$$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_3 k_z;$$

$$\{R_3\}, \{R_5\}; (A_4 c_3 - A_1 c_5) k_z + (A_2 c_5 - A_6 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;$$

$$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_3 k_z;$$

$$\{R_2\}, \{R_4\}; c_5 (A_2 k_z + A_1 k_y) + c_3 (A_6 k_z + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;$$

$$\{R_3\}, \{R_5\}; c_5 (A_1 k_z + A_2 k_y) + c_3 (A_6 k_z + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;$$

$$\{R_3\}, \{R_5\}; (A_6 c_3 - A_2 c_5) k_z + (A_1 c_5 - A_4 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;$$

$$\{R_4\}, \{R_5\}; (A_6 c_3 - A_2 c_5) k_z + (A_1 c_5 - A_4 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;$$

$$\Sigma: \{R_2\}, \{R_3\}; c_5 (A_2 k_z + A_1 k_y) + c_3 (A_6 k_z + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;$$

$$\{R_2\}, \{R_4\}; c_5 (A_1 k_z + A_2 k_y) + c_3 (A_6 k_z + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;$$

$$\{R_3\}, \{R_4\}; (A_6 c_3 - A_2 c_5) k_z + (A_1 c_5 - A_4 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;$$

$$\{R_2\}, \{R_3\}; c_5 (A_2 k_z + A_1 k_y) + c_3 (A_6 k_z + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;$$

$$\{R_2\}, \{R_4\}; c_5 (A_1 k_z + A_2 k_y) + c_3 (A_6 k_z + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;$$

$$Y: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_2 k_y;$$

$$T: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_2 k_y;$$

$$W: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;$$
Γ; \( \{C_4^+|00\frac{1}{2}\}, \{\sigma_y|\frac{1}{2}0\} \); Non-Centrosymmetric; without SOC

\[ \begin{align*}
\Gamma: & \quad \{\sigma_0\}; \quad \{\Gamma_0\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4k_xk_y\sigma_1 + c_5(k_x^2 - k_y^2)\sigma_3; \\
M: & \quad \{\Gamma_0, \Gamma_6\}; \quad \{\Gamma_0, \Gamma_6\}; \quad \{\Gamma_0, \Gamma_6\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4k_xk_y\sigma_3; \\
Z: & \quad \{\Gamma_0, \Gamma_6\}; \quad \{\Gamma_0, \Gamma_6\}; \quad \{\Gamma_0, \Gamma_6\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4(k_x^2 - k_y^2)\sigma_3; \\
A: & \quad \{\Gamma_0, \Gamma_6\}; \quad \{\Gamma_0, \Gamma_6\}; \quad \{\Gamma_0, \Gamma_6\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \Gamma_{0,0} + \sum_{i=1}^3 [c_{i,1}\Gamma_{1,0}k_z + c_{i,2}\Gamma_{1,1}(k_x^2 - k_y^2) + c_{i,3}\Gamma_{1,2}k_xk_y]; \\
R: & \quad \{\Gamma_0\}; \quad \{\Gamma_0\}; \quad \{\Gamma_0\}; \quad c_1\sigma_0 + c_2\sigma_3k_z; \\
X: & \quad \{\Gamma_0\}; \quad \{\Gamma_0\}; \quad \{\Gamma_0\}; \quad c_1\sigma_0 + c_2\sigma_3k_y; \\
\Lambda: & \quad \{\Gamma_0\}; \quad \{\Gamma_0\}; \quad \{\Gamma_0\}; \quad [c_1 + c_2k_z + c_3(k_x^2 + k_y^2)] \sigma_0 + c_4k_xk_y\sigma_1 + c_6(k_x^2 - k_y^2)\sigma_3; \\
V: & \quad \{\Gamma_0\}; \quad \{\Gamma_0\}; \quad \{\Gamma_0\}; \quad [c_1 + c_2k_z + c_3(k_x^2 + k_y^2)] \sigma_0 + c_4k_xk_y\sigma_2 + c_6(k_x^2 - k_y^2)\sigma_3; \\
S: & \quad \{\Gamma_0, \Gamma_2\}; \quad [c_1 + c_2(k_x + k_y)]\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)(k_x - k_y) + c_5\sigma_3k_z; \\
Y: & \quad \{\Gamma_0, \Gamma_4\}; \quad [c_1 + c_2k_z]\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y + c_5\sigma_3k_z; \\
T: & \quad \{\Gamma_0, \Gamma_4\}; \quad [c_1 + c_2k_z]\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y + c_5\sigma_3k_z; \\
W: & \quad \{\Gamma_0, \Gamma_4\}; \quad [c_1 + c_2k_z]\sigma_0 + c_4\sigma_2k_x + c_2\sigma_1k_y; \\
\end{align*} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ U; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; (A_4 c_1 - A_1 c_3) k_x + (A_2 c_5 - A_6 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; c_5 (A_3 k_x + A_1 k_y) + c_3 (A_0 k_x + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; c_5 (A_1 k_x + A_2 k_y) + c_3 (A_4 k_x + A_6 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{ R_4 \}, \{ R_5 \}; (A_6 c_1 - A_2 c_3) k_x + (A_1 c_5 - A_4 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ V; \{ R_5 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_5 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_5 \}, \{ R_6 \}; (A_4 - A_2) c_4 + (A_0 - A_1) c_4 k_y + [(A_2 + A_4) c_3 + (A_1 - A_6) c_4 k_x + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_6 \}, \{ R_7 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_6 \}, \{ R_7 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_6 \}, \{ R_7 \}; [(A_2 + A_4) c_3 + (A_0 - A_1) c_4 k_x + [(A_2 - A_4) c_3 + (A_1 + A_6) c_4 k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_7 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_7 \}, \{ R_8 \}; [(A_2 - A_4) c_3 + (A_1 + A_6) c_4 k_x + [(A_2 + A_4) c_3 + (A_1 - A_6) c_4 k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_8 \}, \{ R_9 \}; [(A_2 + A_4) c_3 + (A_0 - A_1) c_4 k_x + [(A_2 - A_4) c_3 + (A_1 + A_6) c_4 k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \Sigma; \{ R_9 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z + c_2 k_y) + c_3 (c_5 k_x + c_3 k_y) + c_4 k_z (k_y - k_z); \]

SG 107

\[ \Gamma_{\nu}^0; \{ C_{4z}^+ | 000 \}, \{ \sigma_y | 000 \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \{ R_5 \}; \quad \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} \sigma_0 + c_4 k_z k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]
\[ \{ R_5 \}; \quad \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} \sigma_0 + c_4 k_z k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]
\[ P; \{ R_3, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ \Lambda; \{ R_5 \}; \quad \begin{bmatrix} c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \end{bmatrix} \sigma_0 + c_5 k_z k_y \sigma_1 + c_6 (k_x^2 - k_y^2) \sigma_3; \]
\[ P; \{ R_3, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ \{ R_5 \}; \quad \begin{bmatrix} c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \end{bmatrix} \sigma_0 + c_5 k_z k_y \sigma_1 + c_6 (k_x^2 - k_y^2) \sigma_3; \]
\[ V; \{ R_5 \}; \quad \begin{bmatrix} c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \end{bmatrix} \sigma_0 + c_5 k_z k_y \sigma_1 + c_6 (k_x^2 - k_y^2) \sigma_3; \]
Accidental degeneracies on high symmetry line

$\Lambda$: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_3\}, \{R_1\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_3\}, \{R_5\}; A c_3 (A_5 - A_6 c_3) k_x + (A_2 c_5 - A_6 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_4\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_2\}, \{R_5\}; c_5 (A_2 k_x + A_1 k_y) + c_3 (A_6 k_x + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_3\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_3\}, \{R_5\}; c_5 (A_1 k_x + A_2 k_y) + c_3 (A_4 k_x + A_6 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_4\}, \{R_5\}; (A_6 c_3 - A_2 c_5) k_z + (A_1 c_5 - A_4 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$

$V$: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_3\}, \{R_1\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_2\}, \{R_5\}; (A_4 c_3 - A_1 c_5) k_x + (A_2 c_5 - A_6 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_2\}, \{R_7\}; c_5 (A_2 k_x + A_1 k_y) + c_3 (A_6 k_x + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_3\}, \{R_5\}; c_5 (A_1 k_x + A_2 k_y) + c_3 (A_4 k_x + A_6 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_4\}, \{R_6\}; (A_6 c_3 - A_2 c_5) k_z + (A_1 c_5 - A_4 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$

$W$: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) (k_x + k_y)$;
$\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) (k_x + k_y)$;
$\{R_3\}, \{R_5\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) (k_x - k_y)$;
$\{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) (k_x + k_y)$;
$\{R_5\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$\Sigma$: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_y$;

$\Phi$: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_y$;

$\Delta$: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_3 k_z + c_2 k_y) + \sigma_3 (c_5 k_x + c_3 k_y) + c_4 \sigma_2 (k_y - k_x)$;

$U$: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z + c_2 k_y) + \sigma_3 (c_5 k_x + c_3 k_y) + c_4 \sigma_2 (k_y - k_x)$;

$Y$: $\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_3 k_z - c_2 k_y) + \sigma_3 (c_5 k_x - c_3 k_y) + c_4 \sigma_1 (k_x + k_y)$;
\[ \Gamma_0; \{ C_{4z}^+ \{000\}, \{ \sigma_y \{1 \bar{2} \bar{1} \} \}, T; \text{Non-Centrosymmetric; without SOC} \]

\( \Gamma; \quad R_5: \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \)

\( N; \quad \{ R_2, R_3 \}; \quad c_1 \sigma_0 + (c_2 k_x + c_3 k_z) \sigma_3; \)

\( Z; \quad R_5: \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \)

\( P; \quad \{ R_1, R_3 \}; \quad c_1 \sigma_0 + c_2 \sigma_y k_z; \)

\( \quad \{ R_2, R_2 \}; \quad c_1 \sigma_0 + \sum_{i=1}^3 c_i \sigma_i k_z; \)

\( \{ R_4, R_4 \}; \quad c_1 \sigma_0 + \sum_{i=1}^3 c_i \sigma_i k_z; \)

\( \Lambda; \quad R_5: \quad [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_5 k_x k_y \sigma_1 + c_6 (k_x^2 - k_y^2) \sigma_3; \)

\( V; \quad R_5: \quad [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_5 k_x k_y \sigma_1 + c_6 (k_x^2 - k_y^2) \sigma_3; \)

\( Q; \quad \{ R_1, R_1 \}; \quad (c_1 + c_2 k_y) \sigma_0 + \sum_{i=1}^3 (c_{i,1} k_x + c_{i,2} k_z) \sigma_i; \)
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_3\}, \{R_5\}; (A_1c_3 - A_1c_5) k_x + (A_2c_5 - A_6c_3) k_y + A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_4k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_2\}, \{R_3\}; c_5 (A_2k_x + A_1k_y) + c_3 (A_6k_x + A_4k_y) + A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_4k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_3\}, \{R_5\}; c_5 (A_1k_x + A_2k_y) + c_3 (A_4k_x + A_6k_y) + A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_4k_z; \]
\[ \{R_4\}, \{R_5\}; (A_6c_3 - A_2c_5) k_x + (A_1c_5 - A_4c_3) k_y + A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_4k_z; \]

\[ V; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_2\}, \{R_3\}; (A_4c_3 - A_1c_5) k_x + (A_2c_5 - A_6c_3) k_y + A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_4k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_2\}, \{R_5\}; c_5 (A_2k_x + A_1k_y) + c_3 (A_6k_x + A_4k_y) + A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_4k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_3\}, \{R_5\}; c_5 (A_1k_x + A_2k_y) + c_3 (A_4k_x + A_6k_y) + A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_4k_z; \]
\[ \{R_4\}, \{R_5\}; (A_6c_3 - A_2c_5) k_x + (A_1c_5 - A_4c_3) k_y + A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_4k_z; \]

\[ W; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) (k_x + k_y); \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) (k_x + k_y); \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) (k_x - k_y); \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + (c_5\sigma_1 + c_6\sigma_2) (k_x + k_y); \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_2k_y; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_2k_y; \]
\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z + c_2k_y) + \sigma_3 (c_5k_x + c_3k_y) + c_4\sigma_2 (k_y - k_x); \]
\[ U; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z + c_2k_y) + \sigma_3 (c_5k_x + c_3k_y) + c_4\sigma_2 (k_y - k_x); \]
\[ Y; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z - c_2k_y) + \sigma_3 (c_5k_x - c_3k_y) + c_4\sigma_1 (k_x + k_y); \]
Accidental degeneracies on high symmetry line

\[ \Lambda: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) - c_3 \sigma_3 k_z; \]
\[ \{R_5\}, \{R_6\} : \sigma_0 (c_1 - c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_7\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_9\}, \{R_{10}\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_{11}\}, \{R_{12}\} : \sigma_0 (c_1 - c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_{13}\}, \{R_{14}\} : \sigma_0 (c_1 - c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_{15}\}, \{R_{16}\} : \sigma_0 (c_1 + c_2 k_z) - c_3 \sigma_3 k_z; \]
\[ \{R_{17}\}, \{R_{18}\} : \sigma_0 (c_1 + c_2 k_z) - c_3 \sigma_3 k_z; \]
\[ V: \{R_5\}, \{R_6\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_7\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_9\}, \{R_{10}\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_{11}\}, \{R_{12}\} : \sigma_0 (c_1 - c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_{13}\}, \{R_{14}\} : \sigma_0 (c_1 - c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_{15}\}, \{R_{16}\} : \sigma_0 (c_1 - c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_{17}\}, \{R_{18}\} : \sigma_0 (c_1 - c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \Sigma: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_y; \]
\[ F: \{R_5\}, \{R_6\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_5 k_y; \]
\[ \Delta: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5\sigma_5 + c_6 k_y); \]
\[ \Gamma_{\nu}; \{ C_{4v}^1, C_{4v}^2, C_{4v}^3, \sigma_v \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[
\Gamma; \quad R_3; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3;
\]

\[
N; \{ R_2, R_4 \}; \quad c_1 \sigma_0 + (c_2 k_x + c_3 k_z) \sigma_3;
\]

\[
X; \quad R_5; \quad c_1 \sigma_0 + c_2 (k_x + k_y) \sigma_2;
\]

\[
Z; \quad \{ R_5, R_6 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z;
\]

\[
\{ R_7, R_8 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z;
\]

\[
R_9; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2] \sigma_0 + c_4 (k_x^2 - k_y^2) \sigma_3;
\]

\[
P; \quad \{ R_{10}, R_{10} \}; \quad c_1 \Gamma_{0,0} + c_2 [(k_x + k_y) \Gamma_{0,1} + (k_x - k_y) \Gamma_{0,3}] + \sum_{i=1}^{3} c_{1, i} [k_x + k_y(\Gamma_{1,1} - (k_x - k_y)\Gamma_{1,3} + k_z \Gamma_{1,0})];
\]

\[
\Lambda; \quad R_5; \quad [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_x^2] \sigma_0 + c_5 k_x k_y \sigma_1 + c_6 (k_x^2 - k_y^2) \sigma_3;
\]

\[
V; \quad R_9; \quad [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_x^2] \sigma_0 + c_5 k_x k_y \sigma_2 + c_6 (k_x^2 - k_y^2) \sigma_3;
\]

\[
W; \quad R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 (k_x + k_y) \sigma_1 + c_4 (k_x - k_y) \sigma_2;
\]

\[
Q; \quad \{ R_7, R_8 \}; \quad (c_1 + c_2 k_x) \sigma_0 + \sum_{i=1}^{3} (c_{i,1} k_x + c_{i,2} k_z) \sigma_i;
\]

\[
U; \quad \{ R_7, R_8 \}; \quad [c_1 + c_2 (k_x + k_y)] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) (k_x - k_y) + c_5 \sigma_3 k_z;
\]

\[
Y; \quad \{ R_2, R_4 \}; \quad [c_1 + c_2 (k_x - k_y)] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) (k_x + k_y) + c_5 \sigma_3 k_z;
\]

Accidental degeneracies on high symmetry line

\[
\Lambda; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_1 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_1 \}, \{ R_6 \}; \quad (A_1 c_3 - A_1 c_5) k_x + (A_2 c_5 - A_6 c_3) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z;
\]

\[
\{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_2 \}, \{ R_5 \}; \quad c_5 (A_2 k_x + A_1 k_y) + c_3 (A_6 k_x + A_4 k_y) + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z;
\]

\[
\{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_3 \}, \{ R_6 \}; \quad (A_2 k_x + A_1 k_y) + c_3 k_x k_y \sigma_1 + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z;
\]

\[
\{ R_4 \}, \{ R_5 \}; \quad (A_6 c_3 - A_2 c_5) k_x + (A_1 c_3 - A_4 c_5) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z;
\]

\[
V; \quad \{ R_3 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_5 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_5 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_6 \}, \{ R_8 \}; \quad (A_2 c_3 - A_1 c_4) k_x + (A_4 c_3 - A_6 c_4) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_5 k_z;
\]

\[
\{ R_7 \}, \{ R_9 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
\]

\[
\{ R_7 \}, \{ R_10 \}; \quad (A_6 c_1 - A_2 c_4) k_x + (A_1 c_3 + A_4 c_4) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_5 k_z;
\]

\[
\{ R_8 \}, \{ R_9 \}; \quad (A_6 c_1 - A_2 c_4) k_x + (A_1 c_3 + A_4 c_4) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_5 k_z;
\]

\[
\Sigma; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_y;
\]

\[
F; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_y;
\]

\[
\Delta; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 (c_3 k_x + c_3 k_y) + c_2 \sigma_2 (k_y - k_x);
\]
Accidental degeneracies on high symmetry line

\begin{align*}
\Delta: & \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \\
U: & \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x + c_6 \sigma_2 k_z; \\
\Lambda: & \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \\
& \{R_1\}, \{R_3, R_4\}; \quad [(A_4 + A_6) c_3 + (A_2 - A_1) c_0] k_x - [(A_6 - A_4) c_3 + (A_1 + A_2) c_0] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_3 + A_5) c_4 k_z; \\
& \{R_2\}, \{R_3, R_4\}; \quad [(A_6 - A_4) c_3 + (A_1 + A_2) c_0] k_x + [(A_4 + A_6) c_3 + (A_2 - A_1) c_0] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_3 + A_5) c_4 k_z; \\
V: & \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \\
& \{R_1\}, \{R_3, R_4\}; \quad [(A_4 + A_6) c_3 + (A_2 - A_1) c_0] k_x - [(A_6 - A_4) c_3 + (A_1 + A_2) c_0] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_3 + A_5) c_4 k_z; \\
& \{R_2\}, \{R_3, R_4\}; \quad [(A_6 - A_4) c_3 + (A_1 + A_2) c_0] k_x + [(A_4 + A_6) c_3 + (A_2 - A_1) c_0] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_3 + A_5) c_4 k_z; \\
\Sigma: & \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + c_3 (c_3 k_x + c_3 k_y) + c_4 \sigma_2 (k_y - k_x); \\
S: & \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + c_3 (c_3 k_x + c_3 k_y) + c_4 \sigma_2 (k_y - k_x); \\
Y: & \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_2 k_y + c_6 \sigma_1 k_z; \\
T: & \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_2 k_y + c_6 \sigma_1 k_z; \\
W: & \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_x + c_6 \sigma_2 k_y; 
\end{align*}
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x + c_6 \sigma_2 k_z; \]

\[ U: \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x + c_6 \sigma_2 k_z; \]

\[ A: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ \{R_2\}, \{R_3, R_4\}; \quad [(A_4 + A_6) c_3 + (A_2 - A_1) c_4] k_x - [(A_6 - A_4) c_3 + (A_1 + A_2) c_4] k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_2 + A_8) c_4 k_z; \]

\[ \{R_2\}, \{R_3, R_4\}; \quad [(A_6 - A_4) c_3 + (A_1 + A_2) c_4] k_x + [(A_1 + A_2) c_3 + (A_2 - A_1) c_4] k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_8) c_4 k_z; \]

\[ V: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ \{R_2\}, \{R_3, R_4\}; \quad [(A_4 + A_6) c_3 + (A_2 - A_1) c_4] k_x - [(A_6 - A_4) c_3 + (A_1 + A_2) c_4] k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_8) c_4 k_z; \]

\[ \{R_2\}, \{R_3, R_4\}; \quad [(A_6 - A_4) c_3 + (A_1 + A_2) c_4] k_x + [(A_1 + A_2) c_3 + (A_2 - A_1) c_4] k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_8) c_4 k_z; \]

\[ \Sigma: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_6 \sigma_2 k_y + c_5 \sigma_1 k_z; \]

\[ Y: \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_6 \sigma_2 k_y + c_5 \sigma_1 k_z; \]

\[ T: \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_6 \sigma_2 k_y + c_5 \sigma_1 k_z; \]

\[ W: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_6 \sigma_2 k_y; \]

SG 113

\[ \Gamma_\eta; \{S^+_i, |000\}, \{C_2z, |\frac{1}{2} \pm 0\}; T; \text{Non-Centrosymmetric; without SOC} \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x + c_6 \sigma_2 k_z; \]

\[ U: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x + c_6 \sigma_2 k_z; \]

\[ \Lambda: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ \{R_3\}, \{R_4\}; \quad [(A_4 + A_6) c_3 + (A_2 - A_1) c_6] k_y - [(A_6 - A_4) c_3 + (A_1 + A_2) c_6] k_x + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{R_2\}, \{R_3\}; \quad [(A_4 - A_6) c_3 + (A_1 + A_2) c_6] k_x + [(A_4 + A_6) c_3 + (A_2 - A_1) c_6] k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ V: \{R_1, R_2\}, \{R_3, R_5\}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0\Gamma_{1,1} k_x} + k_z (c_2 \Gamma_{2,1} + c_3 \Gamma_{2,2}) + c_4 (\Gamma_{1,0} k_x + \Gamma_{1,3} k_y) + c_5 (\Gamma_{2,3} k_x + \Gamma_{2,0} k_y) - k_y (c_6 \Gamma_{1,1} - c_7 \Gamma_{1,2}); \]

\[ \{R_1, R_2\}, \{R_4, R_4\}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0\Gamma_{1,1} k_x} + k_z (c_2 \Gamma_{1,1} - c_3 \Gamma_{1,2}) + c_4 (\Gamma_{1,3} k_z + \Gamma_{1,0} k_y) + c_5 (\Gamma_{2,3} k_y - \Gamma_{2,0} k_x) + k_y (c_6 \Gamma_{1,1} + c_7 \Gamma_{1,2}); \]

\[ \{R_3, R_5\}, \{R_4, R_4\}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0\Gamma_{1,1} k_x} + k_z (c_2 \Gamma_{1,1} - c_3 \Gamma_{1,2}) + c_4 (\Gamma_{1,3} k_z + \Gamma_{1,0} k_y) + c_5 (\Gamma_{2,3} k_y - \Gamma_{2,0} k_x) + k_y (c_6 \Gamma_{1,1} + c_7 \Gamma_{1,2}); \]

\[ \Sigma: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_1 (c_3 k_x + c_3 k_y) + c_4 \sigma_2 (k_y - k_x); \]

\[ S: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 (c_3 k_x + c_3 k_y) + c_4 \sigma_2 (k_y - k_x); \]

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SG 114

\[ \Gamma_\nu: \{S_{1,1}^+ | 000 \}, \{C_{2z} | \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \quad R_5; \quad [c_1 + c_2 (k_y^2 + k_x^2) + c_3 k_y^2] \sigma_0 + c_4 k_x k_y \sigma_3 + c_5 (k_x^2 - k_z^2) \sigma_3; \]

\[ M: \quad \{R_5, R_6\}; \quad [c_1 + c_2 (k_y^2 + k_x^2) + c_3 k_y^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \]

\[ \{R_7, R_8\}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \]

\[ R_9; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_x k_y; \]

\[ Z: \quad \{R_5, R_6\}; \quad [c_1 + c_2 (k_y^2 + k_x^2) + c_3 k_y^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2)(k_x^2 - k_z^2); \]

\[ \{R_7, R_8\}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2)(k_x^2 - k_z^2); \]

\[ R_9; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ A: \quad \{R_5, R_6\}; \quad [c_1 + c_2 (k_y^2 + k_x^2) + c_3 k_y^2] \sigma_0 + c_4 \sigma_3 k_x k_y k_z; \]

\[ \{R_7, R_8\}; \quad [c_1 + c_2 (k_y^2 + k_x^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_x k_y k_z; \]

\[ \{R_{10}, R_{10}\}; \quad [c_1 + c_2 (k_y^2 + k_x^2) + c_3 k_y^2] \Gamma_{0,0} + c_4 \Gamma_{0,2} k_z + \sum_{i=1}^2 [c_1 \Gamma_{1,1} (k_y^2 - k_x^2) + c_2 \Gamma_{1,2} k_z k_y]; \]

\[ R: \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ X: \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]

\[ \Lambda: \quad \{R_5, R_6\}; \quad [c_1 + c_2 k_x + c_3 (k_z^2 + k_y^2) + c_4 k_x k_y] \sigma_0 + c_5 \sigma_3 k_x k_y + (c_6 \sigma_1 + c_7 \sigma_2)(k_x^2 - k_y^2); \]

\[ V: \quad \{R_5, R_6\}; \quad [c_1 + c_2 k_x + c_3 (k_z^2 + k_y^2) + c_4 k_x k_y] \sigma_0 + c_5 \sigma_3 k_x k_y; \]

\[ \{R_7, R_8\}; \quad [c_1 + c_2 k_x + c_3 (k_z^2 + k_y^2) + c_4 k_x k_y] \sigma_0 + \sum_{i=1}^2 c_1 \sigma_1 k_z k_y; \]

\[ \{R_9, R_4\}; \quad [c_1 + c_2 k_x + c_3 (k_z^2 + k_y^2) + c_4 k_x k_y] \sigma_0 + \sum_{i=1}^2 c_1 \sigma_1 k_z k_y; \]

\[ S: \quad \{R_5, R_6\}; \quad [c_1 + c_2 (k_x + k_y)] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2)(k_x - k_y) + c_5 \sigma_3 k_z; \]

\[ Y: \quad \{R_7, R_8\}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]

\[ T: \quad \{R_5, R_6\}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]

\[ W: \quad \{R_1, R_2\}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \]

\[ U: \{ R_2 \}, \{ R_1 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \]

\[ \Lambda: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_2, R_4 \} : \quad [(A_4 + A_6) c_1 + (A_2 - A_1) c_0] k_x - [(A_6 - A_4) c_3 + (A_1 + A_2) c_0] k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_6) c_4 k_z; \]

\[ \{ R_2 \}, \{ R_3, R_4 \} : \quad [(A_6 - A_4) c_3 + (A_1 + A_2) c_0] k_x + [(A_4 + A_6) c_1 + (A_2 - A_1) c_0] k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_6) c_4 k_z; \]

\[ V: \{ R_1, R_2 \}, \{ R_3, R_5 \} : \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0} c_i k_x + k_y (c_2 \Gamma_{2,1} + c_1 \Gamma_{2,2}) + c_4 (\Gamma_{1,0} k_x + \Gamma_{1,3} k_y) + c_5 (\Gamma_{2,3} k_x + \Gamma_{2,0} k_y) - k_y (\alpha_1 \Gamma_{1,1} - \Gamma_1 2); \]

\[ \{ R_1, R_2 \}, \{ R_4, R_4 \} : \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0} c_i k_x + k_y (c_2 \Gamma_{1,1} - c_1 \Gamma_{1,2}) + c_4 (\Gamma_{1,3} k_x - \Gamma_{1,0} k_y) + c_5 (\Gamma_{2,3} k_y - \Gamma_{2,0} k_x) + k_y (\alpha_1 \Gamma_{2,1} + \Gamma_2 2); \]

\[ \{ R_3, R_5 \}, \{ R_4, R_4 \} : \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0} c_i k_x + k_y (c_2 \Gamma_{1,1} - c_1 \Gamma_{1,2}) + c_4 (\Gamma_{1,3} k_x - \Gamma_{1,0} k_y) + c_5 (\Gamma_{2,3} k_y - \Gamma_{2,0} k_x) + k_y (\alpha_1 \Gamma_{2,1} + \Gamma_2 2); \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_1 (c_3 k_x + c_3 k_y) + c_4 \sigma_2 (k_y - k_x); \]

SG 115

\[ \Gamma_4: \{ S_{4,0} \}, \{ C_{2,0} \}, \{ T \}: \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \quad \{ R_5 \} : \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2 \right] \sigma_0 + c_4 k_x k_y \sigma_3 + c_5 (k_x^2 - k_y^2) \sigma_1; \]

\[ M: \quad \{ R_5 \} : \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2 \right] \sigma_0 + c_4 k_x k_y \sigma_3 + c_5 (k_x^2 - k_y^2) \sigma_1; \]

\[ Z: \quad \{ R_5 \} : \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2 \right] \sigma_0 + c_4 k_x k_y \sigma_3 + c_5 (k_x^2 - k_y^2) \sigma_1; \]

\[ A: \quad \{ R_5 \} : \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2 \right] \sigma_0 + c_4 k_x k_y \sigma_3 + c_5 (k_x^2 - k_y^2) \sigma_1; \]

\[ \{ R_3, R_4 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + c_4 \sigma_3 (k_x^2 - k_y^2) + (c_6 \sigma_1 + c_7 \sigma_2) k_x k_y; \]

\[ V: \quad \{ R_3, R_4 \} : \quad \left[ c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_x^2 \right] \sigma_0 + c_5 \sigma_3 (k_x^2 - k_y^2) + (c_6 \sigma_1 + c_7 \sigma_2) k_x; \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \]

\[ U: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \]

\[ \Lambda: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_3, R_4 \} : \quad (A_4 c_1 - A_1 c_0) k_x - (A_6 c_1 + A_2 c_0) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_6) c_4 k_z; \]

\[ \{ R_2 \}, \{ R_3, R_4 \} : \quad (A_6 c_1 - A_2 c_0) k_x + (A_1 c_1 + A_3 c_0) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_6) c_4 k_z; \]

\[ \{ R_1 \}, \{ R_3, R_4 \} : \quad (A_4 c_1 - A_1 c_0) k_x - (A_6 c_1 + A_2 c_0) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_6) c_4 k_z; \]

\[ \{ R_2 \}, \{ R_3, R_4 \} : \quad (A_6 c_1 - A_2 c_0) k_x + (A_1 c_1 + A_3 c_0) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_6) c_4 k_z; \]

\[ \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + c_4 (c_3 k_x + c_3 k_y) + c_5 \sigma_1 k_z + c_6 \sigma_2 (k_y - k_x); \]

\[ \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + c_4 (c_3 k_x + c_3 k_y) + c_5 \sigma_1 k_z + c_6 \sigma_2 (k_y - k_x); \]

\[ \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + c_4 (c_3 k_x + c_3 k_y) + c_5 \sigma_1 k_z + c_6 \sigma_2 (k_y - k_x); \]

\[ \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + c_4 (c_3 k_x + c_3 k_y) + c_5 \sigma_1 k_z + c_6 \sigma_2 (k_y - k_x); \]

\[ \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + c_4 (c_3 k_x + c_3 k_y) + c_5 \sigma_1 k_z + c_6 \sigma_2 (k_y - k_x); \]

\[ \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + c_4 (c_3 k_x + c_3 k_y) + c_5 \sigma_1 k_z + c_6 \sigma_2 (k_y - k_x); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1, R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_2 k_z; \]

\[ \Lambda: \{R_1, R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_1, R_3, R_4\}; \quad (A_4 c_3 - A_1 c_3) k_x - (A_6 c_3 + A_2 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{R_2, R_3, R_4\}; \quad (A_6 c_3 - A_2 c_3) k_x + (A_4 c_3 + A_1 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{R_1, R_3, R_4\}; \quad (A_4 c_3 - A_1 c_3) k_x - (A_6 c_3 + A_2 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{R_2, R_3, R_4\}; \quad (A_6 c_3 - A_2 c_3) k_x + (A_4 c_3 + A_1 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \Sigma: \{R_1, R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_2 (k_y - k_x); \]

\[ \Theta: \{R_2, R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ W: \{R_1, R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_1, R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{R_1, R_3\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]

\[ \{R_1, R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{R_2, R_3\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{R_2, R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]

\[ \{R_3, R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \Gamma: \quad R_{\text{c}}; \quad \begin{bmatrix} c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \end{bmatrix} \sigma_0 + c_4k_xk_y\sigma_3 + c_5(k_x^2 - k_y^2)\sigma_5; \]

\[ M: \quad \{R_5, R_6\}; \quad \begin{bmatrix} c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \end{bmatrix} \sigma_0 + \left[ (c_4\sigma_1 + c_5\sigma_2)k_xk_y \right]; \]

\[ \{R_7, R_8\}; \quad \begin{bmatrix} c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \end{bmatrix} \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_xk_y; \]

\[ R_9; \quad c_1\sigma_0 + c_2\sigma_2k_z; \]

\[ Z: \quad R_{\text{c}}; \quad \begin{bmatrix} c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \end{bmatrix} \sigma_0 + c_4k_xk_y\sigma_3 + c_5(k_x^2 - k_y^2)\sigma_5; \]

\[ A: \quad \{R_5, R_6\}; \quad \begin{bmatrix} c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \end{bmatrix} \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_xk_y; \]

\[ \{R_7, R_8\}; \quad \begin{bmatrix} c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \end{bmatrix} \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_xk_y; \]

\[ R_9; \quad c_1\sigma_0 + c_2\sigma_2k_z; \]

\[ X: \quad R_{\text{c}}; \quad c_1\sigma_0 + c_2\sigma_2k_x; \]

\[ \Lambda: \quad \{R_5, R_6\}; \quad \begin{bmatrix} c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2 \end{bmatrix} \sigma_0 + c_5\sigma_3(k_x^2 - k_y^2) + (c_6\sigma_1 + c_7\sigma_2)k_xk_y; \]

\[ V: \quad \{R_5, R_6\}; \quad \begin{bmatrix} c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2 \end{bmatrix} \sigma_0 + c_5\sigma_3(k_x^2 - k_y^2) + (c_6\sigma_1 + c_7\sigma_2)k_xk_y; \]

\[ Y: \quad \{R_5, R_6\}; \quad (c_1 + c_2k_z)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_x + c_5\sigma_3k_z; \]

\[ T: \quad \{R_5, R_6\}; \quad (c_1 + c_2k_z)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_x + c_5\sigma_3k_z; \]

\[ W: \quad R_{\text{c}}; \quad (c_1 + c_2k_x)\sigma_0 + c_3\sigma_2k_x + c_4\sigma_1k_y; \]

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**Accidental degeneracies on high symmetry line**

\[ \Delta: \quad \{R_1, R_2\}; \quad \sigma_0(c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_2k_z; \]

\[ U: \quad \{R_1, R_2\}; \quad \sigma_0(c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_2k_z; \]

\[ \Lambda: \quad \{R_1\}; \quad \sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[ \{R_1\}; \quad \{R_3, R_4\}; \quad (A_1c_3 - A_1c_5)k_x - (A_6c_3 + A_2c_5)k_y + A_0(c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8)c_4k_z; \]

\[ \{R_2\}; \quad \{R_3, R_4\}; \quad (A_1c_3 - A_1c_5)k_x - (A_6c_3 + A_2c_5)k_y + A_0(c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8)c_4k_z; \]

\[ V: \quad \{R_2\}; \quad \sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[ \{R_2\}; \quad \{R_6, R_8\}; \quad (A_1c_3 - A_5c_5)k_x + (A_1c_3 + A_1c_5)k_y + A_0(c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8)c_4k_z; \]

\[ \{R_4\}; \quad \{R_6, R_8\}; \quad (A_1c_3 - A_5c_5)k_x - (A_6c_3 + A_2c_5)k_y + A_0(c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8)c_4k_z; \]

\[ \Sigma: \quad \{R_1\}; \quad \sigma_0(c_1 + c_2k_x + c_2k_y) + \sigma_3(c_1k_z + c_3k_y) + c_4\sigma_1k_x + c_5\sigma_2(k_y - k_z); \]

\[ S: \quad \{R_1\}; \quad \sigma_0(c_1 + c_2k_x + c_2k_y) + \sigma_3(c_1k_z + c_3k_y) + c_4\sigma_1k_x + c_5\sigma_2(k_y - k_z); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_5 \sigma_3 k_x + c_5 \sigma_2 k_z; \]

\[ \Lambda: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_5 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_1, R_4 \}; \quad (A_0 c_3 - A_1 c_5) k_x - (A_0 c_3 + A_2 c_5) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{ R_2 \}, \{ R_2, R_4 \}; \quad (A_0 c_3 - A_2 c_5) k_x + (A_1 c_3 + A_2 c_5) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ V: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_5 \sigma_3 k_z; \]

\[ \{ R_2 \}, \{ R_2, R_4 \}; \quad (A_0 c_3 - A_2 c_5) k_x + (A_1 c_3 + A_2 c_5) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{ R_2 \}, \{ R_2, R_4 \}; \quad (A_0 c_3 - A_1 c_5) k_x - (A_0 c_3 + A_2 c_5) k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_4 k_y) + \sigma_3 (c_5 k_x + c_5 k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z); \]

\[ S: \{ R_2 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_4 k_y) + \sigma_3 (c_5 k_x + c_5 k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z); \]

\[ T: \{ R_2 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_4 k_y) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]

\[ \Gamma^\prime; \{ S_4^\prime \}, \{ C_2 \}, \{ 1 \}; \quad \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \quad \begin{cases} \Gamma^\prime; & \{ S_4^\prime \}, \{ C_2 \}, \{ 1 \}; \quad \text{Non-Centrosymmetric; without SOC} \\ R_1; \quad c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_y^2 \sigma_0 + c_4 k_x k_y \sigma_3 + c_5 (k_x^2 - k_y^2) \sigma_1 \end{cases} \]

\[ Z; \quad R_2; \quad c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_y^2 \sigma_0 + c_4 k_x k_y \sigma_3 + c_5 (k_x^2 - k_y^2) \sigma_1 \]

\[ \Lambda: \quad \begin{cases} \{ R_3 \}, \{ R_4 \}; \quad c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_y^2 \sigma_0 + c_5 \sigma_3 (k_x^2 - k_y^2) + (c_6 \sigma_1 + c_7 \sigma_2) k_x k_y \\ V; \quad \{ R_3 \}, \{ R_4 \}; \quad c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_y^2 \sigma_0 + c_5 \sigma_3 (k_x^2 - k_y^2) + (c_6 \sigma_1 + c_7 \sigma_2) k_x k_y \end{cases} \]
Accidental degeneracies on high symmetry line

\(\Lambda\): \(\{R_1\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\)

\(\{R_3\}, \{R_4\}\); \((A_1 c_3 - A_1 c_3) k_z - (A_6 c_3 + A_2 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_9) c_4 k_z;\)

\(\{R_2\}, \{R_3, R_4\}\); \((A_1 c_3 - A_2 c_3) k_z + (A_4 + A_1 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_9) c_4 k_z;\)

\(V\): \(\{R_1\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\)

\(\{R_3, R_4\}\); \((A_3 c_3 - A_1 c_3) k_z - (A_6 c_3 + A_2 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_9) c_4 k_z;\)

\(\{R_2\}, \{R_3, R_4\}\); \((A_1 c_3 - A_2 c_3) k_z + (A_4 + A_1 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_9) c_4 k_z;\)

\(W\): \(\{R_1\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_3 \sigma_1 (k_x + k_y) + c_0 \sigma_2 (k_y - k_x);\)

\(\Sigma\): \(\{R_3\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_3 \sigma_1 k_y;\)

\(F\): \(\{R_3\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_3 \sigma_1 k_y;\)

\(\Delta\): \(\{R_3\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_3 \sigma_1 k_z + c_3 \sigma_2 (k_y - k_x);\)

\(U\): \(\{R_3\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z + c_2 k_y) + \sigma_3 (c_3 k_x + c_3 k_y) + c_4 \sigma_1 k_z + c_3 \sigma_2 (k_y - k_x);\)

\(Y\): \(\{R_3\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z - c_2 k_y) + \sigma_3 (c_3 k_x - c_3 k_y) + c_4 \sigma_1 (k_x + k_y) + c_0 \sigma_2 k_z;\)

SG 120

\(\Gamma\): \(\{S_{\nu}^{+} \mid 000\}, \{E_{2\nu} \mid \frac{1}{2} \pm 0\}\); Non-Centrosymmetric; without SOC

\(\Gamma\): \(\{R_5\}\); \(\{R_2\}, \{R_4\}\); \(\sigma_0 (c_1 + c_2 k_z + c_3 k_z^2) + c_5 (k_z^2 - k_y^2);\)

\(N\): \(\{R_2\}, \{R_4\}\); \(\sigma_0 (c_1 + c_2 k_z + c_3 k_z^2) \); \(\sigma_3;\)

\(Z\): \(\{R_5\}\); \(\sigma_0 (c_1 + c_2 k_z + c_3 k_z^2) + c_5 (k_z^2 - k_x^2);\)

\(P\): \(\{R_1\}, \{R_3\}\); \(\{R_2\}, \{R_4\}\); \(\sigma_0 (c_1 + c_2 k_z + c_3 k_z^2) \); \(\sigma_3;\)

\(N\): \(\{R_3, R_4\}\); \(\{R_2\}, \{R_4\}\); \(\sigma_0 (c_1 + c_2 k_z + c_3 k_z^2) + c_5 (k_z^2 - k_x^2);\)

\(V\): \(\{R_3, R_4\}\); \(\{R_2\}, \{R_4\}\); \(\sigma_0 (c_1 + c_2 k_z + c_3 k_z^2) + c_5 (k_z^2 - k_x^2);\)

\(Q\): \(\{R_1\}, \{R_1\}\); \(\{R_2\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_y) + \sigma_0 (c_1 + c_2 k_z + c_3 k_z^2) \); \(\sigma_3;\)

Accidental degeneracies on high symmetry line

\(\Lambda\): \(\{R_1\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\)

\(\{R_3, R_4\}\); \((A_1 c_3 - A_3 c_3) k_z - (A_6 c_3 + A_2 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_9) c_4 k_z;\)

\(\{R_2\}, \{R_3, R_4\}\); \((A_1 c_3 - A_2 c_3) k_z + (A_4 + A_1 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_9) c_4 k_z;\)

\(V\): \(\{R_1\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\)

\(\{R_3, R_4\}\); \((A_1 c_3 - A_1 c_3) k_z - (A_6 c_3 + A_2 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_9) c_4 k_z;\)

\(\{R_2\}, \{R_3, R_4\}\); \((A_1 c_3 - A_2 c_3) k_z + (A_4 + A_1 c_3) k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_9) c_4 k_z;\)

\(W\): \(\{R_1\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_3 \sigma_1 (k_x + k_y) + c_0 \sigma_2 (k_y - k_x);\)

\(\Sigma\): \(\{R_3\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_3 \sigma_1 k_y;\)

\(F\): \(\{R_3\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_3 \sigma_1 k_y;\)

\(\Delta\): \(\{R_3\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_3 \sigma_1 k_z + c_3 \sigma_2 (k_y - k_x);\)

\(U\): \(\{R_3\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_3 \sigma_1 k_z + c_3 \sigma_2 (k_y - k_x);\)

\(Y\): \(\{R_3\}, \{R_2\}\); \(\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_3 \sigma_1 k_z + c_3 \sigma_2 (k_y - k_x);\)
Accidental degeneracies on high symmetry line

\( \Gamma' \); \( \{S_4^+|000\}, \{C_2z|000\}, T \); Non-Centrosymmetric; without SOC

\( \Gamma; \ R_5; \ [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_y^2] \sigma_0 + c_4 k_z k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \)

\( Z; \ R_5; \ [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_y^2] \sigma_0 + c_4 k_z k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \)

\( P; \ R_5; \ [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_y^2] \sigma_0 + (c_4 k_z + c_6 k_x k_y) \sigma_1 + c_6(k_x^2 - k_y^2) \sigma_3; \)

\( \Lambda; \ {R_3, R_4}; \ [c_1 + c_2 k_z + c_3(k_x^2 + k_y^2) + c_4 k_y^2] \sigma_0 + c_5 \sigma_3 k_z k_y + (c_6 \sigma_1 + c_7 \sigma_2)(k_x^2 - k_y^2); \)

\( V; \ {R_3, R_4}; \ [c_1 + c_2 k_z + c_3(k_x^2 + k_y^2) + c_4 k_y^2] \sigma_0 + c_5 \sigma_3 k_z k_y + (c_6 \sigma_1 + c_7 \sigma_2)(k_x^2 - k_y^2); \)

\( W; \ {R_3, R_2}; \ [c_1 + c_2 k_z] + c_3 \sigma_3 k_z; \)

\( \Sigma; \ {R_1}, \ {R_2}; \ [c_1 + c_2 k_z] + c_3 \sigma_3 k_z; \)

\( F; \ {R_1}, \ {R_2}; \ [c_1 + c_2 k_z] + c_3 \sigma_3 k_z + c_6 \sigma_2 k_y + c_5 \sigma_1 k_z; \)

\( Q; \ {R_1}, \ {R_2}; \ [c_1 + c_2 k_y] + c_3 \sigma_3 k_y + \sum_{\ell=1}^2 \sigma_1 (c_{1, \ell} k_x + c_{2, \ell} k_z); \)

\( \Delta; \ {R_1}, \ {R_2}; \ [c_1 + c_2 k_z + c_3 k_y)] + c_3 \sigma_3 k_x + c_4 \sigma_2 (k_y - k_z); \)

\( U; \ {R_1}, \ {R_2}; \ [c_1 + c_2 k_z + c_3 k_y)] + c_3 \sigma_3 k_x + c_4 \sigma_2 (k_y - k_z); \)

\( Y; \ {R_1}, \ {R_2}; \ [c_1 + c_2 k_z - c_3 k_y)] + c_3 \sigma_3 (k_x - c_3 k_y) + c_4 \sigma_1 (k_x + k_y); \)
Accidental degeneracies on high symmetry line

\[ \Gamma: \{R_5\}, \{R_3\}: \quad \sigma_0 (c_1 + c_2 k_x) + c_5 \sigma_3 k_i; \]
\[ \{R_1\}, \{R_3\}, \{R_4\}: \quad [(A_0 + A_6) c_3 + (A_2 - A_1) c_6] k_x - [(A_0 - A_4) c_3 + (A_1 + A_2) c_6] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]
\[ \{R_2\}, \{R_4, R_8\}: \quad [(A_0 - A_4) c_3 + (A_1 + A_2) c_6] k_x + [(A_4 + A_6) c_3 + (A_2 - A_1) c_6] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]
\[ \{R_2, R_6\}, \{R_5, R_7\}: \quad \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_3 k_z; \]
\[ \{R_3, R_4\}, \{R_6, R_8\}: \quad [(A_0 - A_4) c_3 + (A_1 + A_2) c_6] k_x + [(A_4 + A_6) c_3 + (A_2 - A_1) c_6] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]
\[ \{R_4, R_8\}, \{R_4, R_8\}: \quad [(A_0 + A_6) c_3 + (A_2 - A_1) c_6] k_x - [(A_0 - A_4) c_3 + (A_1 + A_2) c_6] k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]
\[ \Sigma: \{R_1\}, \{R_2\}: \quad \sigma_0 (c_1 + c_2 k_x) + c_5 \sigma_3 k_x + c_6 \sigma_2 k_y + c_6 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}: \quad \sigma_0 (c_1 + c_2 k_z) + c_5 \sigma_3 k_z + c_6 \sigma_2 k_y + c_6 \sigma_1 k_z; \]
\[ \{R_4\}, \{R_6\}: \quad \sigma_0 (c_1 + c_2 k_y) + c_5 \sigma_3 k_y + \sum_{i=1}^{2} \sigma_i (c_{i,k_x} + c_{i,k_z}); \]
\[ \Delta: \{R_1\}, \{R_2\}: \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 (c_3 k_x + c_3 k_y) + c_4 \sigma_2 (k_y - k_x); \]
\[\Delta; \{R_1\}, \{R_2\}; 0 \left( c_1 + c_2 k_y \right) + c_3 \sigma_3 k_y;\]
\[\{R_1\}, \{R_3\}; 0 \left( c_1 + c_2 k_y \right) + c_2 \sigma_3 k_y + c_3 \sigma_1 k_z;\]
\[\{R_2\}, \{R_3\}; 0 \left( c_1 + c_2 k_y \right) + c_2 \sigma_3 k_y + c_3 \sigma_1 k_z;\]
\[\{R_1\}, \{R_4\}; 0 \left( c_1 + c_2 k_y \right) + c_2 \sigma_3 k_y + c_3 \sigma_1 k_z;\]
\[\{R_2\}, \{R_4\}; 0 \left( c_1 + c_2 k_y \right) + c_2 \sigma_3 k_y + c_3 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}; 0 \left( c_1 + c_2 k_y \right) + c_2 \sigma_3 k_y + c_3 \sigma_1 k_z;\]
\[\Lambda; \{R_1\}, \{R_2\}; 0 \left( c_1 + c_2 k_z \right) + c_2 \sigma_3 k_z;\]
\[\{R_1\}, \{R_3\}; 0 \left( c_1 + c_2 k_z \right) + c_2 \sigma_3 k_z;\]
\[\{R_2\}, \{R_3\}; 0 \left( c_1 + c_2 k_z \right) + c_2 \sigma_3 k_z;\]
\[\{R_1\}, \{R_4\}; 0 \left( c_1 + c_2 k_z \right) + c_2 \sigma_3 k_z;\]
\[\{R_2\}, \{R_4\}; 0 \left( c_1 + c_2 k_z \right) + c_2 \sigma_3 k_z;\]
\[\{R_3\}, \{R_4\}; 0 \left( c_1 + c_2 k_z \right) + c_2 \sigma_3 k_z;\]
\[\Sigma; \{R_1\}, \{R_2\}; 0 \left[ c_1 + c_2 k_x \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_1\}, \{R_3\}; 0 \left[ c_1 + c_2 k_x \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_1\}, \{R_4\}; 0 \left[ c_1 + c_2 k_x \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_2\}, \{R_4\}; 0 \left[ c_1 + c_2 k_x \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_3\}, \{R_4\}; 0 \left[ c_1 + c_2 k_x \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_1\}, \{R_2\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_1\}, \{R_3\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_2\}, \{R_3\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_1\}, \{R_4\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_2\}, \{R_4\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_3\}, \{R_4\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_1\}, \{R_2\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_1\}, \{R_3\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_2\}, \{R_3\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_1\}, \{R_4\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_2\}, \{R_4\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\[\{R_3\}, \{R_4\}; 0 \left[ c_1 + c_2 k_x + k_y \right] + c_2 \sigma_3 (k_x + k_y);\]
\( \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \)
\( \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \)
\( \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \)
\( \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \)
\( \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \)

\( \{R_1, R_2, R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \)
\( \{R_1, R_3, R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_1, R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_3, R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \)
\( \{R_1, R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \)
\( \{R_1, R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_1, R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \)
\( \{R_3, R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \)

SG 124

\( \Gamma_\eta; \{C_{4s}^+|000\}, \{C_{2s}|000\}, \{T|000\}; T; \) Centrosymmetric; without SOC

\( \Gamma; \)
\( R_5; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \)
\( R_{10}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \)
\( M; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \)
\( R_{10}; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \)
\( Z; \quad R_{10}; \quad \sigma_0 + c_2 \sigma_3 k_x; \)
\( R_{11}; \quad \sigma_0 + c_2 \sigma_3 k_x; \)
\( [R_{12, R_{13}}]; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2] \Gamma_{0,0} + \sum_{i=1}^2 \left[c_i \Gamma_{i,2} k_x + c_{i,2} \Gamma_{i,0} k_x k_y + c_4 \Gamma_{i,3} (k_x^2 - k_y^2)\right]; \)
\( A; \quad R_{10}; \quad \sigma_0 + c_2 \sigma_3 k_x; \)
\( R_{11}; \quad \sigma_0 + c_2 \sigma_3 k_x; \)
\( [R_{12, R_{13}}]; \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_x^2] \Gamma_{0,0} + \sum_{i=1}^2 \left[c_i \Gamma_{i,2} k_x + c_{i,2} \Gamma_{i,0} k_x k_y + c_4 \Gamma_{i,3} (k_x^2 - k_y^2)\right]; \)
\( R; \quad R_{5}; \quad \sigma_0 + c_2 \sigma_3 k_x; \)
\( R_{10}; \quad \sigma_0 + c_2 \sigma_3 k_x; \)
\( U; \quad R_{5}; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_2 k_x + c_5 \sigma_1 k_z; \)
\( \Lambda; \quad R_{5}; \quad [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_x^2] \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \)
\( V; \quad R_{5}; \quad [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_x^2] \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \)
\( S; \quad R_{5}; \quad [c_1 + c_2 (k_x + k_y)] \sigma_0 + c_3 \sigma_2 (k_x - k_y) + c_4 \sigma_1 k_z; \)
\( T; \quad R_{5}; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_2 k_y + c_4 \sigma_1 k_z; \)
Accidental degeneracies on high symmetry line

$$\Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$
$$\{ R_3 \}, \{ R_1 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$

$$\Lambda: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_3 \}, \{ R_1 \}; c_3 (A_2 k_y - A_1 k_z) + A_0 (c_1 + c_2 k_z) + \left( \sqrt{3} A_5 + A_8 \right) c_4 k_z;$$
$$\{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_4 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_2 \}, \{ R_5 \}; c_3 (A_2 k_z + A_1 k_y) + A_0 (c_1 + c_2 k_z) + \left( \sqrt{3} A_5 + A_8 \right) c_4 k_z;$$
$$\{ R_4 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_4 \}, \{ R_3 \}; c_3 (A_1 k_y - A_2 k_z) + A_0 (c_1 + c_2 k_z) + \left( \sqrt{3} A_5 + A_8 \right) c_4 k_z;$$
$$\{ R_4 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$

$$V: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_3 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_3 \}, \{ R_6 \}; c_3 (A_2 k_z + A_1 k_y) + A_0 (c_1 + c_2 k_z) + \left( \sqrt{3} A_5 + A_8 \right) c_4 k_z;$$
$$\{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_2 \}, \{ R_5 \}; c_3 (A_2 k_z + A_1 k_y) + A_0 (c_1 + c_2 k_z) + \left( \sqrt{3} A_5 + A_8 \right) c_4 k_z;$$
$$\{ R_2 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_1 \}, \{ R_5 \}; c_3 (A_1 k_y - A_2 k_z) + A_0 (c_1 + c_2 k_z) + \left( \sqrt{3} A_5 + A_8 \right) c_4 k_z;$$
$$\{ R_1 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$

$$\Sigma: \{ R_1 \}, \{ R_2 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_z + k_y);$$
$$\{ R_1 \}, \{ R_3 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);$$
$$\{ R_1 \}, \{ R_4 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);$$
$$\{ R_2 \}, \{ R_3 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);$$
$$\{ R_2 \}, \{ R_4 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);$$
$$\{ R_3 \}, \{ R_4 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_z + k_y);$$

$$Y: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;$$
$$\{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;$$
$$\{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;$$
$$\{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;$$
$$\{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y;$$
$$\{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;$$

$$W: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
$$\{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x;$$
$$\{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x;$$
$$\{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x;$$
$$\{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x;$$
$$\{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;$$
\( \Gamma_q \): \{C_{4z}^4[\frac{1}{2} \frac{1}{2} 0], \{C_{2z}[000], \{I\frac{1}{2} \frac{1}{2} 0\}, T\}; \) Centrosymmetric, without SOC

\( \Gamma; R_5; \) \[\begin{align*}
&c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4k_xk_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \\
&R_{10}; [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4k_xk_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \\
&\end{align*}\]

\( M; R_5; \) \[\begin{align*}
&c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4 \sigma_3 k_x k_y; \\
&R_{11}; c_1 \sigma_0 + c_2 \sigma_2 k_x; \\
&R_{12}; [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4 \sigma_3 k_x k_y; \\
&R_{14}; c_1 \sigma_0 + c_2 \sigma_2 k_x; \\
&\end{align*}\]

\( Z; R_5; \) \[\begin{align*}
&c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4k_xk_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \\
&R_{10}; [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4k_xk_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \\
&\end{align*}\]

\( A; R_5; \) \[\begin{align*}
&c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4 \sigma_3 k_x k_y; \\
&R_{11}; c_1 \sigma_0 + c_2 \sigma_2 k_x; \\
&R_{12}; [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4 \sigma_3 k_x k_y; \\
&R_{14}; c_1 \sigma_0 + c_2 \sigma_2 k_x; \\
&\end{align*}\]

\( R; R_5; \) \[\begin{align*}
&c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
&R_{10}; c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
&\end{align*}\]

\( X; R_5; \) \[\begin{align*}
&c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
&R_{10}; c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
&\end{align*}\]

\( A; R_5; \) \[\begin{align*}
&c_1 + c_2 k_z + c_3(k_x^2 + k_y^2) + c_4 k_z^2 \sigma_0 + c_5 \sigma_3 k_x k_y + c_6 \sigma_3(k_x^2 - k_y^2); \\
&\end{align*}\]

\( V; R_5; \) \[\begin{align*}
&c_1 + c_2 k_z + c_3(k_x^2 + k_y^2) + c_4 k_z^2 \sigma_0 + c_5 \sigma_3(k_x^2 - k_y^2) + c_6 \sigma_3 k_x k_y; \\
&\end{align*}\]

\( Y; R_5; \) \[\begin{align*}
&(c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z; \\
&T; R_5; (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z; \\
&\end{align*}\]

\( W; R_5; (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z; \\
\]
Accidental degeneracies on high symmetry line

\[\Delta: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;\]
\[\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;\]

\[U: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;\]
\[\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;\]

\[\Lambda: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_1\}, \{R_4\}: c_3 (A_2 k_y - A_2 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;\]
\[\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_2\}, \{R_5\}: c_3 (A_2 k_x + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;\]
\[\{R_3\}, \{R_5\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_4\}, \{R_5\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_5\}, \{R_6\}: c_3 [(A_1 - A_2 - A_4 + A_6) k_y - (A_1 + A_2 - A_4 + A_6) k_x] + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;\]
\[\{R_6\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_6\}, \{R_7\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_7\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_7\}, \{R_8\}: c_3 [(A_1 + A_2 - A_4 + A_6) k_x - (A_1 + A_2 - A_4 + A_6) k_y] + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;\]
\[\{R_8\}, \{R_9\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]
\[\{R_8\}, \{R_9\}: c_3 [(A_1 + A_2 - A_4 + A_6) k_x - (A_1 + A_2 - A_4 + A_6) k_y] + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;\]

\[\Sigma: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y);\]
\[\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y);\]

\[S: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y);\]
\[\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y);\]
\[ \Gamma; \quad R_5; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \]

\[ R_{10}; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \]

\[ M; \quad R_5; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_3 k_x k_y; \]

\[ R_{11}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ R_{12}; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_3 k_x k_y; \]

\[ R_{14}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ Z; \quad R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ R_{11}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_{12}, R_{13} \}; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \Gamma_{0,0} + \sum_{i=1}^{2} \left[ c_{i,1} \Gamma_{i,2} k_z + c_{i,2} \Gamma_{i,0} k_x k_y + c_{i,4} \Gamma_{i,3} (k_x^2 - k_y^2) \right]; \]

\[ A; \quad R_5; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_3 (k_x^2 - k_y^2); \]

\[ R_{11}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ R_{12}; \quad \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_3 (k_x^2 - k_y^2); \]

\[ R_{14}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ R; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ X; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_3 k_y; \]

\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_y; \]

\[ U; \quad R_5; \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_z; \]

\[ U; \quad R_5; \quad \left[ c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \]

\[ V; \quad R_5; \quad \left[ c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 \sigma_2 (k_x^2 - k_y^2) + c_6 \sigma_3 k_x k_y; \]

\[ S; \quad R_5; \quad \left[ c_1 + c_2 (k_x + k_y) \right] \sigma_0 + c_4 \sigma_2 (k_x - k_y) + c_3 \sigma_1 k_z; \]

\[ Y; \quad R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z; \]

\[ W; \quad R_5; \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ V; \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_5\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_5\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_6\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_7\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y); \]
\[ T; \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_5\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_4 k_z; \]
\[ \{R_5\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_4 k_z; \]
\[ \{R_6\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_4 k_z; \]
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[\Gamma; \{R_5, R_10\}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_z^2 - k_y^2) \sigma_3; \]
\[R_{10}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_z^2 - k_y^2) \sigma_3; \]

\[M; \{R_5, R_6\}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \]
\[\{R_7, R_8\}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \]
\[R_{10}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + c_4 \sigma_3 k_x k_y; \]
\[\{R_{15}, R_{16}\}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \]
\[\{R_{17}, R_{18}\}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \]

\[R_{20}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + c_4 \sigma_3 k_x k_y; \]

\[Z; \{R_5, R_10\}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_z^2 - k_y^2) \sigma_3; \]
\[R_{10}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_z^2 - k_y^2) \sigma_3; \]

\[A; \{R_5, R_6\}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \]
\[\{R_7, R_8\}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \]
\[R_{10}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + c_4 \sigma_3 k_x k_y; \]
\[\{R_{15}, R_{16}\}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \]
\[\{R_{17}, R_{18}\}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_x k_y; \]
\[R_{20}; \{c_1 + c_2(k_z^2 + k_y^2) + c_3 k_z^2\} \sigma_0 + c_4 \sigma_3 k_x k_y; \]

\[R; \{c_1 \sigma_0 + c_2 \sigma_3 k_y; \]
\[R_{10}; \{c_1 \sigma_0 + c_2 \sigma_3 k_y; \]

\[X; \{R_5, R_6\}; \{c_1 \sigma_0 + c_2 \sigma_3 k_y; \]
\[R_{10}; \{c_1 \sigma_0 + c_2 \sigma_3 k_y; \]

\[A; \{R_5, R_6\}; \{c_1 + c_2 k_x + c_3 (k_z^2 + k_y^2) + c_4 k_x^2\} \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3 (k_z^2 - k_y^2); \]

\[V; \{R_7, R_8\}; \{c_1 + c_2 k_x + c_3 (k_z^2 + k_y^2) + c_4 k_x^2\} \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_x k_y; \]
\[\{R_{15}, R_{16}\}; \{c_1 + c_2 k_x + c_3 (k_z^2 + k_y^2) + c_4 k_x^2\} \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_x k_y; \]
\[\{R_{17}, R_{18}\}; \{c_1 + c_2 k_x + c_3 (k_z^2 + k_y^2) + c_4 k_x^2\} \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_x k_y; \]
\[Y; \{R_2, R_4\}; \{c_1 + c_2 k_x \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[\{R_5, R_6\}; \{c_1 + c_2 k_x \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[T; \{R_2, R_4\}; \{c_1 + c_2 k_x \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[\{R_5, R_6\}; \{c_1 + c_2 k_x \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[W; \{c_1 + c_2 k_x \sigma_0 + c_5 \sigma_1 k_y; \]
Accidental degeneracies on high symmetry line

$\Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_4 \sigma_1 k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_5 \sigma_5 k_y + c_6 \sigma_1 k_z;
\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_7 \sigma_1 k_z;
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_5 k_y + c_8 \sigma_1 k_z;
\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_5 k_y$;

$U; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_5 k_y$;
$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_6 \sigma_1 k_z;
\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_4 \sigma_1 k_z$;
$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_7 \sigma_1 k_z$;
$\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_5 k_y + c_8 \sigma_1 k_z$;
$\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_5 k_y$;

$\Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_5 k_y$;
$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_5 k_y$;
$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_6 \sigma_1 k_z$;
$\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_5 k_y + c_7 \sigma_1 k_z$;
$\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_5 k_y$;

$V; \{R_5\}, \{R_6\}, \{R_{10}\}; c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_i c_i k_x + (c_2 \Gamma_{1,0} + c_3 \Gamma_{2,0} + c_4 \Gamma_{3,0}) (k_z - k_y) - (c_5 \Gamma_{0,0} - c_6 \Gamma_{1,0} + c_7 \Gamma_{2,0} - c_8 \Gamma_{3,0}) (k_z + k_y) + [(1 + i) (c_1 + c_6) (\Gamma_{4,0} + \Gamma_{1,0}) + h.c.]$;
$\{R_7\}, \{R_8\}, \{R_{10}\}; c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_i c_i k_x + (c_2 \Gamma_{1,0} + c_3 \Gamma_{2,0} + c_4 \Gamma_{3,0}) (k_z - k_y) - (c_5 \Gamma_{0,0} - c_6 \Gamma_{1,0} + c_7 \Gamma_{2,0} - c_8 \Gamma_{3,0}) (k_z + k_y) + [(1 + i) (c_1 + c_6) (\Gamma_{4,0} + \Gamma_{1,0}) + h.c.]$;

$\Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y)$;
$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_4 \sigma_1 (k_z - k_y)$;
$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_5 (k_z) + c_6 \sigma_1 (k_z - k_y)$;
$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_7 \sigma_1 (k_z - k_y)$;
$\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_8 \sigma_1 (k_z - k_y)$;
$\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y)$;

$S; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y)$;
$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_4 \sigma_1 (k_z - k_y)$;
$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_5 (k_z) + c_6 \sigma_1 (k_z - k_y)$;
$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_7 \sigma_1 (k_z - k_y)$;
$\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_8 \sigma_1 (k_z - k_y)$;
$\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y)$;

$Y; \{R_5\}, \{R_6\}, \{R_{10}\}; c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_i c_i k_x + k_y (c_2 \Gamma_{0,1} + c_3 \Gamma_{0,2} + c_4 \Gamma_{0,3} + c_5 \Gamma_{0,4}) + k_z (c_6 \Gamma_{1,0} + c_7 \Gamma_{1,1})$;
$T; \{R_5\}, \{R_6\}, \{R_{10}\}; c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_i c_i k_x + k_y (c_2 \Gamma_{0,1} + c_3 \Gamma_{0,2} + c_4 \Gamma_{0,3} + c_5 \Gamma_{0,4}) + k_z (c_6 \Gamma_{1,0} + c_7 \Gamma_{1,1})$;
\[ \Gamma_q; \{ C_{4v}^+ | \frac{1}{2} \pm 0 \}, \{ C_{2x} | \frac{1}{2} \pm 0 \}, \{ I | 00 \frac{1}{2} \}; T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; \quad R_5; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 k_z k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \]
\[ R_{10}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 k_z k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \]

\[ M; \{ R_5, R_6 \}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_z k_y; \]
\[ \{ R_7, R_8 \}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_z k_y; \]
\[ R_{10}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_z k_y; \]
\[ \{ R_{15}, R_{16} \}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_z k_y; \]
\[ \{ R_{17}, R_{18} \}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_z k_y; \]
\[ R_{20}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_z k_y; \]

\[ Z; \quad R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R_{11}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ \{ R_{12}, R_{13} \}; \quad (c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2) \Gamma_{0,0} + \sum_{i=1}^{3} \left[ c_{i,1} \Gamma_{1,2} k_z + c_{i,2} \Gamma_{1,0} k_x k_y + c_{i,3} \Gamma_{1,3} (k_x^2 - k_y^2) \right] \]

\[ A; \quad R_{10}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_2 k_z k_y; \]
\[ R_{11}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_2 k_z k_y; \]
\[ \{ R_{12}, R_{13} \}; \quad (c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2) \Gamma_{0,0} + c_4 \Gamma_{0,2} k_z + \sum_{i=1}^{3} \left[ c_{i,1} \Gamma_{i,0} k_x k_y + c_{i,2} \Gamma_{i,3} (k_x^2 - k_y^2) \right]; \]
\[ R; \quad R_{5}; \quad (c_1 + \sum_{i=x}^{3} c_i k_i^2) \sigma_0 + (c_2 \sigma_3 k_z + c_3 \sigma_1 k_z) k_y; \]
\[ R_{10}; \quad (c_1 + \sum_{i=x}^{3} c_i k_i^2) \sigma_0 + (c_2 \sigma_3 k_z + c_3 \sigma_1 k_z) k_y; \]

\[ X; \quad R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ U; \quad R_5; \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_z; \]
\[ \Lambda; \quad R_5; \quad [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \]
\[ V; \{ R_5, R_6 \}; \quad [c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_z k_y; \]
\[ \{ R_7, R_8 \}; \quad [c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_z k_y; \]
\[ R_{10}; \quad [c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_z k_y; \]

\[ S; \quad R_5; \quad [c_1 + c_2 (k_x + k_y)] \sigma_0 + c_4 \sigma_2 (k_x - k_y) + c_3 \sigma_1 k_z; \]
\[ Y; \{ R_2, R_4 \}; \quad [c_1 + c_2 k_z] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ \{ R_6, R_8 \}; \quad (c_1 + c_2 k_z) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]

\[ T; \quad R_5; \quad (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_y; \]
\[ W; \quad R_5; \quad (c_1 + c_2 k_z) \sigma_0 + c_2 \sigma_1 k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \Lambda: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_6 \Gamma_0, 0; \]
\[ \{ R_2 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_6 \Gamma_0, 0 + \sum_{i=0}^{3} \Gamma_i, 0 c_i k_x + c_i k_y (c_2 \Gamma_0, 1 + c_3 \Gamma_0, 2 + c_4 \Gamma_3, 1 + c_5 \Gamma_3, 2) + c_i k_z (c_6 \Gamma_1, 0 + c_7 \Gamma_2, 3); \]
\[ \{ R_4 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_4 \} : \quad c_3 (A_2 k_y - A_1 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_2 + A_3) c_z k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \quad c_3 (A_2 k_y - A_1 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_2 + A_3) c_z k_z; \]
\[ \{ R_4 \}, \{ R_3 \} : \quad c_3 (A_2 k_y - A_1 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_2 + A_3) c_z k_z; \]
\[ V: \{ R_5 \}, \{ R_6 \}, \{ R_{10} \} : \quad c_1 \Gamma_{1, 0} + \sum_{i=0}^{3} \Gamma_{i, 0} c_i k_x + (c_2 \Gamma_{1, 0} + c_2 \Gamma_{1, 3} + c_3 \Gamma_{2, 0} + c_4 \Gamma_{2, 3}) (k_x - k_y) - (c_5 \Gamma_{1, 0} - c_6 \Gamma_{1, 3} + c_7 \Gamma_{2, 0} - c_8 \Gamma_{2, 3}) (k_x + k_y) + [(1 + i) (c_3 + i c_6) (\Gamma_{2, 3} k_z + \Gamma_{2, 3} k_z) + h.c.]; \]
\[ \{ R_5 \}, \{ R_6 \}, \{ R_7 \}, \{ R_8 \} : \quad c_1 \Gamma_{1, 0} + \sum_{i=0}^{3} \Gamma_{i, 0} c_i k_x + (c_2 \Gamma_{1, 0} + c_2 \Gamma_{1, 3} + c_3 \Gamma_{2, 0} + c_4 \Gamma_{2, 3}) (k_x - k_y) + (c_5 \Gamma_{1, 0} + c_6 \Gamma_{1, 3} + c_7 \Gamma_{2, 0} + c_8 \Gamma_{2, 3}) (k_x + k_y) + [(1 + i) (c_3 + i c_6) (\Gamma_{2, 3} k_z + \Gamma_{2, 3} k_z) + h.c.]; \]
\[ \{ R_7 \}, \{ R_8 \}, \{ R_{10} \} : \quad c_1 \Gamma_{1, 0} + \sum_{i=0}^{3} \Gamma_{i, 0} c_i k_x + [c_2 (\Gamma_{1, 0} + \Gamma_{1, 3}) - c_3 (\Gamma_{2, 0} + \Gamma_{2, 3})] (k_x + k_y) + [c_2 (\Gamma_{2, 0} - \Gamma_{2, 3}) - c_3 (\Gamma_{1, 0} - \Gamma_{1, 3})] (k_x - k_y) + [(1 + i) (c_3 + i c_6) (\Gamma_{2, 3} k_z + \Gamma_{2, 3} k_z) + h.c.]; \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{ R_1 \}, \{ R_3 \} : \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_1 \}, \{ R_4 \} : \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \} : \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_3 \}, \{ R_4 \} : \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ Y: \{ R_5 \}, \{ R_6 \}, \{ R_8 \} : \quad c_1 \Gamma_{0, 0} + \sum_{i=0}^{3} \Gamma_{i, 0} c_i k_x + k_y (c_2 \Gamma_{0, 1} + c_2 \Gamma_{0, 3} + c_4 \Gamma_{3, 1} + c_5 \Gamma_{3, 2}) + k_z (c_5 \Gamma_{1, 0} + c_7 \Gamma_{2, 3}); \]
\[ \Gamma_q; \{ C_4^1\{000\}, \{ C_2, \frac{1}{4} \pm \frac{1}{4} 0 \}, \{ I, \frac{1}{2} \frac{1}{2} 0 \}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; \quad R_5; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4k_xk_y\sigma_1 + c_5(k_y^2 - k_x^2)\sigma_3; \]
\[ R_{10}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4k_xk_y\sigma_1 + c_5(k_y^2 - k_x^2)\sigma_3; \]
\[ M; \quad R_5; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_xk_y; \]
\[ R_{11}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_xk_y; \]
\[ R_{12}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_xk_y; \]
\[ R_{14}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_xk_y; \]
\[ Z; \quad R_5; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4k_xk_y\sigma_1 + c_5(k_y^2 - k_x^2)\sigma_3; \]
\[ R_{10}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4k_xk_y\sigma_1 + c_5(k_y^2 - k_x^2)\sigma_3; \]
\[ A; \quad R_5; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_xk_y; \]
\[ R_{11}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_xk_y; \]
\[ R_{12}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_xk_y; \]
\[ R_{14}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_xk_y; \]
\[ R; \quad R_5; \quad c_1\sigma_0 + c_2\sigma_2k_y; \]
\[ R_{10}; \quad c_1\sigma_0 + c_2\sigma_2k_y; \]
\[ X; \quad R_5; \quad c_1\sigma_0 + c_2\sigma_2k_y; \]
\[ R_{10}; \quad c_1\sigma_0 + c_2\sigma_2k_y; \]
\[ A; \quad R_5; \quad [c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + c_5\sigma_3k_xk_y + c_6\sigma_4(k_x^2 - k_y^2); \]
\[ V; \quad \{ R_1, R_4 \}; \quad [c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_xk_y; \]
\[ \{ R_2, R_3 \}; \quad [c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_xk_y; \]
\[ R_5; \quad [c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + c_5\sigma_3k_xk_y; \]
\[ Y; \quad R_5; \quad (c_1 + c_2k_z)\sigma_0 + c_3\sigma_1k_y; \]
\[ T; \quad R_5; \quad (c_1 + c_2k_z)\sigma_0 + c_3\sigma_1k_y; \]
\[ W; \quad \{ R_1, R_4 \}; \quad (c_1 + c_2k_z)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y; \]
\[ \{ R_2, R_3 \}; \quad (c_1 + c_2k_z)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_6 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_7 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_8 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ U; \{ R_3 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_6 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_7 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_8 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ A; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ V; \{ R_2 \}, \{ R_3 \}, \{ R_4 \}; \quad \gamma_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_1 k_z + c_2 (\Gamma_{1,0} - \Gamma_{1,1} - \Gamma_{2,0} - \Gamma_{2,1}) k_y + (\Gamma_{1,1} - \Gamma_{1,2} + \Gamma_{1,2} - \Gamma_{2,2}) k_y + c_3 (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_z + (\Gamma_{1,1} + \Gamma_{1,2} + \Gamma_{2,1} + \Gamma_{2,2}) k_z; \]
\[ \{ R_2 \}, \{ R_3 \}, \{ R_4 \}; \quad \gamma_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_1 k_z + c_2 (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} - \Gamma_{2,2}) k_y + (\Gamma_{1,1} - \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_y + c_3 (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} - \Gamma_{2,2}) k_z + (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_z; \]
\[ \{ R_3 \}, \{ R_2 \}, \{ R_4 \}; \quad \gamma_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_1 k_z + c_2 (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} - \Gamma_{2,2}) k_y + (\Gamma_{1,1} - \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_y + c_3 (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} - \Gamma_{2,2}) k_z + (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_z; \]
\[ \{ R_3 \}, \{ R_2 \}, \{ R_4 \}; \quad \gamma_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_1 k_z + c_2 (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} - \Gamma_{2,2}) k_y + (\Gamma_{1,1} - \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_y + c_3 (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} - \Gamma_{2,2}) k_z + (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_z; \]
\[ \{ R_3 \}, \{ R_2 \}, \{ R_4 \}; \quad \gamma_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_1 k_z + c_2 (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} - \Gamma_{2,2}) k_y + (\Gamma_{1,1} - \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_y + c_3 (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} - \Gamma_{2,2}) k_z + (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_z; \]
\[ \{ R_3 \}, \{ R_2 \}, \{ R_4 \}; \quad \gamma_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_1 k_z + c_2 (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} - \Gamma_{2,2}) k_y + (\Gamma_{1,1} - \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_y + c_3 (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} - \Gamma_{2,2}) k_z + (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_z; \]
\[ \Gamma; \{ C_2 \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \} \] 
\[ \{ C_2 \uparrow \uparrow \uparrow \uparrow \uparrow \uparrow \uparrow \} \], \[ \{ I \uparrow \uparrow \uparrow \uparrow \} \] 
\[ T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; \quad R_\Gamma; \quad \{ c_1 + c_2 (k_x^2 + k_y^2) \} \sigma_0 \]
\[ \{ c_1 + c_2 (k_x^2 + k_y^2) \} \sigma_0 + c_4 k_x k_y \sigma_4 + c_5 (k_x^2 - k_y^2) \sigma_3; \]
\[ R_{10}; \quad \{ c_1 + c_2 (k_x^2 + k_y^2) \} \sigma_0 + c_4 k_x k_y \sigma_4 + c_5 (k_x^2 - k_y^2) \sigma_3; \]
\[ M; \quad R_0; \quad \{ c_1 + c_2 (k_x^2 + k_y^2) \} \sigma_0 + c_4 k_x k_y \sigma_4; \]
\[ R_{11}; \quad \{ c_1 + c_2 (k_x^2 + k_y^2) \} \sigma_0 + c_4 k_x k_y \sigma_4; \]
\[ R_{12}; \quad \{ c_1 + c_2 (k_x^2 + k_y^2) \} \sigma_0 + c_4 k_x k_y \sigma_4; \]
\[ R_{14}; \quad \{ c_1 + c_2 (k_x^2 + k_y^2) \} \sigma_0 + c_4 k_x k_y \sigma_4; \]
\[ Z; \quad R_\Gamma; \quad \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R_{11}; \quad \sigma_0 + c_2 \sigma_2 k_z; \]
\[ \{ R_{12}, R_{13} \}; \quad \sigma_0 + c_2 \sigma_2 k_z + \sum_{i=1}^{2} \{ c_{i1} \Gamma_{i,2} k_x + c_{i2} \Gamma_{i,0} k_y + c_{i3} \Gamma_{i,1} (k_x^2 - k_y^2) \}; \]
\[ \{ R_0, R_{10} \}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ \{ R_{13}, R_{14} \}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R; \quad \{ R_0, R_{10} \}; \quad \{ R_{13}, R_{14} \}; \quad \{ R_0, R_{10} \}; \quad \sigma_0 + c_2 \sigma_2 k_z; \]
\[ \{ R_{13}, R_{14} \}; \quad \sigma_0 + c_2 \sigma_2 k_z; \]
\[ X; \quad R_\Gamma; \quad \sigma_0 + c_2 \sigma_2 k_y; \]
\[ R_{10}; \quad \sigma_0 + c_2 \sigma_2 k_y; \]
\[ U; \quad R_\Gamma; \quad (c_1 + c_2 k_y) \sigma_0 + c_4 \sigma_2 k_x + c_4 \sigma_1 k_z; \]
\[ V; \quad \{ R_1, R_4 \}; \quad \sigma_0 + c_5 \sigma_1 k_z; \]
\[ \{ R_{2}, R_3 \}; \quad \sigma_0 + c_5 \sigma_1 k_z; \]
\[ S; \quad R_\Gamma; \quad \sigma_0 + c_2 \sigma_2 (k_x - k_y) + c_3 \sigma_1 k_z; \]
\[ Y; \quad \{ R_2, R_3 \}; \quad \sigma_0 + c_2 \sigma_2 k_x \sigma_0 + c_3 \sigma_1 k_z; \]
\[ \{ R_4, R_6 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ W; \quad \{ R_1, R_4 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ \{ R_2, R_3 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_3\}, \{R_1\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \Lambda: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_2\}, \{R_3\}; \quad c_3 (A_2 k_y - A_1 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_5\}; \quad c_3 (A_2 k_y + A_1 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{R_4\}, \{R_5\}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ V: \{R_1\}, \{R_4\}, \{R_3\}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3}^4 \Gamma_{i,0} c_{i,1} k_z + c_2 (\Gamma_{1,0} - \Gamma_{1,3} - \Gamma_{2,0} - \Gamma_{2,3}) k_x + (\Gamma_{1,1} + \Gamma_{1,2} + \Gamma_{2,1} - \Gamma_{2,2}) k_y + c_3 (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_x - (\Gamma_{1,1} + \Gamma_{1,2} + \Gamma_{2,1} + \Gamma_{2,2}) k_y; \]
\[ \{R_2\}, \{R_4\}, \{R_5\}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_1\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x + k_z); \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x + k_z); \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_4\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_4\}, \{R_5\}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_5\}, \{R_3\}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_5\}, \{R_4\}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ T: \{R_2\}, \{R_3\}, \{R_4\}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3}^4 \Gamma_{i,0} c_{i,1} k_z + k_x (c_2 \Gamma_{1,0} + c_3 \Gamma_{2,3}) + k_y (c_4 \Gamma_{0,1} + c_5 \Gamma_{0,2} + c_6 \Gamma_{3,1} + c_7 \Gamma_{3,2}); \]
\[ W: \{R_1\}, \{R_2\}, \{R_3\}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3}^4 \Gamma_{i,0} c_{i,1} k_z + k_x (c_2 \Gamma_{1,1} + c_3 \Gamma_{1,2}) + k_y (c_4 \Gamma_{0,1} + c_5 \Gamma_{0,2} + c_6 \Gamma_{3,1} + c_7 \Gamma_{3,2}); \]
15. SG 131-140

SG 131

Γ; \{C_{4v}^+|00\frac{1}{2}\}, \{C_{2v}|000\}, \{I|000\}, T; Centrosymmetric; without SOC

\[
\Gamma:
\begin{align*}
R_5: & \quad \left[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2\right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \\
R_{10}: & \quad \left[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2\right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3;
\end{align*}
\]

\[
M:
\begin{align*}
R_5: & \quad \left[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2\right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \\
R_{10}: & \quad \left[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2\right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3;
\end{align*}
\]

\[
Z:\n\begin{align*}
R_5: & \quad \left[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2\right] \sigma_0 + c_4 \sigma_3(k_x^2 - k_y^2); \\
R_{11}: & \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \\
R_{12}: & \quad \left[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2\right] \sigma_0 + c_4 \sigma_3(k_x^2 - k_y^2); \\
R_{14}: & \quad c_1 \sigma_0 + c_2 \sigma_2 k_z;
\end{align*}
\]

\[
A:\n\begin{align*}
R_5: & \quad \left[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2\right] \sigma_0 + c_4 \sigma_3(k_x^2 - k_y^2); \\
R_{11}: & \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \\
R_{12}: & \quad \left[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2\right] \sigma_0 + c_4 \sigma_3(k_x^2 - k_y^2); \\
R_{14}: & \quad c_1 \sigma_0 + c_2 \sigma_2 k_z;
\end{align*}
\]

\[
\Lambda:\n\begin{align*}
R_5: & \quad \left[c_1 + c_2(k_x + k_y) + c_3(k_x^2 + k_y^2) + c_4 k_z^2\right] \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3(k_x^2 - k_y^2); \\
V: & \quad \left[c_1 + c_2(k_x + k_y) + c_3(k_x^2 + k_y^2) + c_4 k_z^2\right] \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3(k_x^2 - k_y^2);
\end{align*}
\]

\[
S:\n\begin{align*}
R_5: & \quad \left[c_1 + c_2(k_x + k_y)\right] \sigma_0 + c_4 \sigma_3(k_x - k_y) + c_5 \sigma_1 k_z;
\end{align*}
\]
Accidental degeneracies on high symmetry line

\[ \Delta : \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_5 \sigma_1 k_z; \]

\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y); \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y); \]

\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ U : \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]

\[ \Lambda : \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_y - A_1 k_x) + \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z); \]

\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_y - A_1 k_x); \]

\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z); \]

\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z); \]

\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z); \]

\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z); \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_y - A_1 k_x) + \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y); \]

\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]

\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]

\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]

\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y); \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]

\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]

\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]

\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y; \]
Accidental degeneracies on high symmetry line

\[\Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y;\]
\[\Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;\]
\[V; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y);\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y);\]
\[S; \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 c_0 \sigma_1 k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 c_0 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 c_0 \sigma_1 k_z;\]
\[\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y);\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 \sigma_1 (k_x - k_y);\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y);\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_z + k_y)) + c_3 \sigma_3 (k_z + k_y) + c_5 c_0 \sigma_1 k_z;\]
\[Y; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 c_0 \sigma_1 k_y;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 c_0 \sigma_1 k_y;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 c_0 \sigma_1 k_y;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 c_0 \sigma_1 k_y;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z;\]
\[ W; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_x; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_x + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_x; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ U; \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Lambda; \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ V; \{R_5\}, \{R_6\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_5\}, \{R_7\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_5\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_6\}, \{R_7\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_6\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_7\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \Sigma; \{R_1\}, \{R_2\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_3\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_1\}, \{R_4\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_2\}, \{R_3\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_2\}, \{R_4\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_3\}, \{R_4\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
$\Gamma_{q}$: {$C_4^{\ast} | \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}$}, {$C_2^z | 000$}, {$I | \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}$}, $\mathcal{T}$; Centrosymmetric; without SOC

$\Gamma$:

| $R_5$ | $[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_y^2] \sigma_0 + c_4 k_z k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3$; |
|-------|---------------------------------------------------------------------------------------------------------------|
| $R_{10}$ | $[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_x^2] \sigma_0 + c_4 k_z k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3$; |

$M$:

| $R_5$ | $[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_y^2] \sigma_0 + c_4 \sigma_3 k_z k_y$; |
|-------|---------------------------------------------------------------------------------------------------------------|
| $R_{11}$ | $c_1 \sigma_0 + c_2 \sigma_3 k_z$; |
| $R_{12}$ | $[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_y^2] \sigma_0 + c_4 \sigma_3 k_z k_y$; |
| $R_{14}$ | $c_1 \sigma_0 + c_2 \sigma_3 k_z$; |

$Z$:

| $R_5$ | $[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_z k_y$; |
|-------|---------------------------------------------------------------------------------------------------------------|
| $R_{11}$ | $c_1 \sigma_0 + c_2 \sigma_3 k_z$; |
| $R_{12}$ | $[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_z k_y$; |
| $R_{14}$ | $c_1 \sigma_0 + c_2 \sigma_3 k_z$; |

$A$:

| $R_5$ | $[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 k_z k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3$; |
|-------|---------------------------------------------------------------------------------------------------------------|
| $R_{10}$ | $[c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 k_z k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3$; |

$R$:

| $R_5$ | $c_1 \sigma_0 + c_2 \sigma_3 k_z$; |
|-------|---------------------------------------------------------------------------------------------------------------|
| $R_{10}$ | $c_1 \sigma_0 + c_2 \sigma_3 k_z$; |

$X$:

| $R_5$ | $c_1 \sigma_0 + c_2 \sigma_3 k_y$; |
|-------|---------------------------------------------------------------------------------------------------------------|
| $R_{10}$ | $c_1 \sigma_0 + c_2 \sigma_3 k_y$; |

$U$:

| $R_5$ | $(c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_2 k_x + c_4 \sigma_1 k_z$; |

$N$:

| $R_5$ | $[c_1 + c_2 k_z + c_3(k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_5 \sigma_1 k_z k_y + c_6 \sigma_3(k_x^2 - k_y^2)$; |

$V$:

| $R_5$ | $[c_1 + c_2 k_z + c_3(k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_5 \sigma_2(k_x^2 - k_y^2) + c_6 \sigma_3 k_z k_y$; |

$Y$:

| $R_5$ | $(c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z$; |

$W$:

| $R_5$ | $(c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z$; |
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Lambda: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; c_0 (A_2 k_y - A_1 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; c_0 (A_2 k_y - A_1 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_4 \}, \{ R_8 \}; c_3 (A_1 k_y - A_2 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]

\[ V: \{ R_2 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_4 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_5 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; c_0 [(A_1 - A_2 - A_4 - A_6) k_y - (A_1 + A_2 - A_4 + A_6) k_x] + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; c_0 [(A_1 - A_2 - A_4 - A_6) k_y - (A_1 + A_2 - A_4 + A_6) k_x] + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]
\[ \{ R_7 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_7 \}, \{ R_8 \}; c_0 [(A_1 - A_2 - A_4 + A_6) k_y - (A_1 + A_2 - A_4 + A_6) k_x] + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]
\[ \{ R_8 \}, \{ R_8 \}; c_0 [(A_1 - A_2 + A_4 + A_6) k_y - (A_1 + A_2 - A_4 - A_6) k_x] + A_0 (c_1 + c_2 k_z) + (\sqrt{3}A_5 + A_8) c_4 k_z; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]

\[ S: \{ R_2 \}, \{ R_3 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 c_0 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{ R_2 \}, \{ R_8 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_4 \}, \{ R_8 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_4 \}, \{ R_8 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 c_0 \sigma_1 k_z; \]

\[ T: \{ R_2 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z; \]
\[ \{ R_4 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z; \]
\[ \{ R_4 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[\Gamma; R_5: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3;\]
\[R_{10}: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3;\]
\[M; \{R_5, R_6\}: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_x k_y;\]
\[\{R_7, R_8\}: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_x k_y;\]
\[R_{10}: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4\sigma_3 k_x k_y;\]
\[\{R_{15}, R_{16}\}: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_x k_y;\]
\[\{R_{17}, R_{18}\}: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_x k_y;\]
\[R_{20}: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4\sigma_3 k_x k_y;\]
\[Z; R_0: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4\sigma_3(k_x^2 - k_y^2);\]
\[R_{11}: c_1\sigma_0 + c_2\sigma_2 k_x;\]
\[R_{12}: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4\sigma_3(k_x^2 - k_y^2);\]
\[R_{14}: c_1\sigma_0 + c_2\sigma_2 k_x;\]
\[A; \{R_0, R_{10}\}: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \Gamma_{0,0} + c_4\Gamma_{3,1} k_x + c_5\Gamma_{0,3}(k_x^2 - k_y^2) + \sum_{i=1}^{2} c_i \Gamma_{i,3} k_x k_y;\]
\[\{R_{13}, R_{14}\}: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \Gamma_{0,0} + c_4\Gamma_{0,3}(k_x^2 - k_y^2) + \sum_{i=1}^{2} [c_i \Gamma_{i,2} k_x + c_{i,2} \Gamma_{i,3} k_x k_y];\]
\[R; R_5: c_1\sigma_0 + c_2\sigma_2 k_x;\]
\[R_{10}: c_1\sigma_0 + c_2\sigma_2 k_y;\]
\[X; R_5: c_1\sigma_0 + c_2\sigma_2 k_y;\]
\[R_{10}: c_1\sigma_0 + c_2\sigma_2 k_y;\]
\[N; R_5: [c_1 + c_2 k_x + c_3(k_x^2 + k_y^2) + c_4 k_x^2] \sigma_0 + c_5\sigma_1 k_x k_y + c_6\sigma_3(k_x^2 - k_y^2);\]
\[V; \{R_5, R_6\}: [c_1 + c_2 k_x + c_3(k_x^2 + k_y^2) + c_4 k_x^2] \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_x k_y;\]
\[\{R_7, R_8\}: [c_1 + c_2 k_x + c_3(k_x^2 + k_y^2) + c_4 k_x^2] \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_x k_y;\]
\[R_{10}: [c_1 + c_2 k_x + c_3(k_x^2 + k_y^2) + c_4 k_x^2] \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_x k_y;\]
\[S; R_5: [c_1 + c_2(k_x + k_y)] \sigma_0 + c_5\sigma_3(k_x - k_y) + c_3\sigma_1 k_x;\]
\[Y; \{R_2, R_4\}: (c_1 + c_2 k_x) \sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_y;\]
\[\{R_5, R_6\}: (c_1 + c_2 k_x) \sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_y;\]
\[T; \{R_2, R_4\}: (c_1 + c_2 k_x) \sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_y;\]
\[\{R_5, R_6\}: (c_1 + c_2 k_x) \sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_y;\]
\[W; R_5: (c_1 + c_2 k_x) \sigma_0 + c_2\sigma_1 k_y;\]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_4\}, \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_4 k_x; \]
\[ T; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_4\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_2\}, \{R_4\}, \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_4 k_x; \]
\[ V; \{R_5\}, \{R_6\}, \{R_{10}\}; c_1 \Gamma_0,0 + \sum_{i=0,3} \Gamma_i,2 \sigma_3 k_z + c_3 \Gamma_2,0 + c_3 \Gamma_2,3 (k_z - k_y) - (c_1 \Gamma_{1,0} + c_2 \Gamma_{1,3} + c_2 \Gamma_{2,0} - c_2 \Gamma_{2,3} (k_x + k_y) + (1 + i) (c_1 + i c_2) (\Gamma_{2,0} + \Gamma_{1,0}) + h.c.); \]
\[ \{R_5\}, \{R_6\}, \{R_7\}, \{R_8\}; c_1 \Gamma_0,0 + \sum_{i=0,3} \Gamma_i,2 \sigma_3 k_z + c_3 \Gamma_2,0 + c_3 \Gamma_2,3 (k_z - k_y) - (c_1 \Gamma_{1,0} + c_2 \Gamma_{1,3} + c_2 \Gamma_{2,0} - c_2 \Gamma_{2,3} (k_x + k_y) + (1 + i) (c_1 + i c_2) (\Gamma_{2,0} + \Gamma_{1,0} + \Gamma_{1,0} - \Gamma_{1,0}) + h.c.); \]
\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_2\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_2\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_2\}, \{R_3\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_3\}, \{R_4\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_2\}, \{R_3\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_3\}, \{R_4\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_2\}, \{R_3\}, \{R_6\}, \{R_8\}; c_1 \Gamma_0,0 + \sum_{i=0,3} \Gamma_i,2 \sigma_3 k_z + c_3 \Gamma_2,0 + c_3 \Gamma_2,3 (k_z - k_y) - (c_1 \Gamma_{1,0} + c_2 \Gamma_{1,3} + c_2 \Gamma_{2,0} + c_2 \Gamma_{2,3} (k_x + k_y) + (1 + i) (c_1 + i c_2) (\Gamma_{2,0} + \Gamma_{1,0}) + h.c.); \]
\[ T; \{R_2\}, \{R_3\}, \{R_6\}, \{R_8\}; c_1 \Gamma_0,0 + \sum_{i=0,3} \Gamma_i,2 \sigma_3 k_z + c_3 \Gamma_2,0 + c_3 \Gamma_2,3 (k_z - k_y) - (c_1 \Gamma_{1,0} + c_2 \Gamma_{1,3} + c_2 \Gamma_{2,0} + c_2 \Gamma_{2,3} (k_x + k_y) + (1 + i) (c_1 + i c_2) (\Gamma_{2,0} + \Gamma_{1,0}) + h.c.); \]
\(\Gamma_q; \{C_{4v}^{\{1,1,1\}}, \{C_{2v}^{\{1,1,1\}}, \{T^{\{0,0,1\}}\}\}; T; \text{Centrosymmetric; without SOC}\)

\(\Gamma; \quad R_5; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4k_zk_y\sigma_1 + c_6(k_x^2 - k_y^2)\sigma_3;
R_{10}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4k_zk_y\sigma_1 + c_5(k_x^2 - k_y^2)\sigma_3;
M; \quad \{R_5, R_6\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y;
\{R_7, R_8\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y;
R_{10}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_zk_y;
\{R_{15}, R_{16}\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y;
\{R_{17}, R_{18}\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y;
R_{20}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_zk_y;
Z; \quad \{R_0\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_zk_y;
R_{11}; \quad c_1\sigma_0 + c_2\sigma_2k_z;
R_{12}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_zk_y;
R_{14}; \quad c_1\sigma_0 + c_2\sigma_2k_z;
A; \quad \{R_0\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_zk_y;
R_{11}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_zk_y;
R_{12}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_zk_y;
R_{14}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_zk_y;
R; \quad \{R_5\}; \quad (c_1 + \sum_{i=x} z c_i k_i^2) \sigma_0 + (c_2\sigma_3k_z + c_3\sigma_1k_z)k_y;
R_{10}; \quad (c_1 + \sum_{i=x} z c_i k_i^2) \sigma_0 + (c_2\sigma_3k_z + c_3\sigma_1k_z)k_y;
X; \quad \{R_5\}; \quad c_1\sigma_0 + c_2\sigma_2k_y;
R_{10}; \quad c_1\sigma_0 + c_2\sigma_2k_y;
U; \quad \{R_5\}; \quad (c_1 + c_2k_y)\sigma_0 + c_3\sigma_2k_x + c_4\sigma_1k_z;
A; \quad \{R_5\}; \quad [c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + c_5\sigma_1k_zk_y + c_6\sigma_3(k_x^2 - k_y^2);
V; \quad \{R_5, R_6\}; \quad [c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_zk_y;
\{R_7, R_8\}; \quad [c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_zk_y;
R_{10}; \quad [c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_zk_y;
Y; \quad \{R_2, R_4\}; \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y;
\{R_6, R_8\}; \quad (c_1 + c_2k_x)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_y;
T; \quad \{R_5\}; \quad (c_1 + c_2k_z)\sigma_0 + c_3\sigma_1k_y;
W; \quad \{R_5\}; \quad (c_1 + c_2k_z)\sigma_0 + c_3\sigma_1k_y;
Δ: \{R_1\}, \{R_2\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;  \\ \{R_1\}, \{R_3\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\ \{R_1\}, \{R_4\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\ \{R_2\}, \{R_3\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\ \{R_2\}, \{R_4\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;  \\ \{R_3\}, \{R_4\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;  \\ Λ: \{R_1\}, \{R_2\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z;  \\ \{R_1\}, \{R_3\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z;  \\ \{R_1\}, \{R_4\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z;  \\ \{R_2\}, \{R_3\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z;  \\ \{R_2\}, \{R_4\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z;  \\ \{R_3\}, \{R_4\}; \; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z;  \\ V: \{R_5\}, \{R_6\}, \{R_{10}\}; \; c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0} c_1 k_x + (c_2 \Gamma_{1,0} + c_2 \Gamma_{1,3} + c_3 \Gamma_{2,0} + c_3 \Gamma_{2,3}) (k_x - k_y) - \frac{1}{2} (c_3 \Gamma_{1,1} - c_3 \Gamma_{1,2} + c_2 \Gamma_{2,0} - c_2 \Gamma_{2,3}) (k_y + k_y) + \frac{1}{2} (1 + i) (c_2 + i c_3) (\Gamma_{2,4} k_x + \Gamma_{1,4} k_y) + h.c.;  \\ \{R_5\}, \{R_7\}, \{R_8\}; \; c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0} (c_1 k_x + c_2 k_y^2 + c_3 k_y^3) + (c_2 \Gamma_{1,1} + c_3 \Gamma_{1,2}) (k_x^2 - k_y^2) + \frac{1}{2} (c_3 \Gamma_{0,2} - c_3 \Gamma_{0,3} + c_2 \Gamma_{1,1} - c_1 \Gamma_{1,2}) k_x k_y;  \\ Σ: \{R_9\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y);  \\ \{R_1\}, \{R_9\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);  \\ \{R_1\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;  \\ \{R_2\}, \{R_9\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;  \\ \{R_2\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;  \\ \{R_3\}, \{R_9\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);  \\ \{R_3\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;  \\ S: \{R_4\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;  \\ \{R_2\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;  \\ \{R_2\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;  \\ \{R_4\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);  \\ \{R_4\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;  \\ \{R_5\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;  \\ \{R_5\}, \{R_{10}\}; \; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;  \\ Y: \{R_2\}, \{R_{6}\}, \{R_8\}; \; c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0} c_i k_x + k_x (c_2 \Gamma_{1,1} + c_3 \Gamma_{1,2}) + k_y (c_4 \Gamma_{0,1} + c_5 \Gamma_{0,2} + c_6 \Gamma_{3,1} + c_7 \Gamma_{3,2}) ;
\[ \Gamma; R_5; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 k_z k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]
\[ R_{10}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 k_z k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]
\[ M; R_5; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_z k_y; \]
\[ R_{11}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_z k_y; \]
\[ R_{12}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_z k_y; \]
\[ R_{14}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 k_z k_y; \]
\[ Z; R_5; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 (k_x^2 - k_y^2); \]
\[ R_{11}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ R_{12}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_3 (k_x^2 - k_y^2); \]
\[ R_{14}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_z; \]
\[ A; R_{10}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_2 k_z k_y k_z; \]
\[ R_{11}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \sigma_2 k_z k_y k_z; \]
\[ \{ R_{12}, R_{13} \}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2] \Gamma_{00} + c_4 \Gamma_{02} k_z + \sum_{i=1}^2 [c_{i,2} \Gamma_{0i} k_z k_y + c_4 \Gamma_{13} (k_x^2 - k_y^2)]; \]
\[ R; R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ X; R_5; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ \Lambda; R_5; \quad [c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_5 \sigma_1 k_z k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \]
\[ V; \{ R_1, R_4 \}; \quad [c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_z k_y; \]
\[ \{ R_2, R_3 \}; \quad [c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_z k_y; \]
\[ S; R_5; \quad [c_1 + c_2 (k_x + k_y)] \sigma_0 + c_4 \sigma_3 (k_x - k_y) + c_5 \sigma_1 k_z; \]
\[ Y; R_5; \quad (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_y; \]
\[ T; R_5; \quad (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_y; \]
\[ W; \{ R_1, R_4 \}; \quad (c_1 + c_2 k_z) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
\[ \{ R_2, R_3 \}; \quad (c_1 + c_2 k_z) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ U; \{R_3\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Lambda; \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]

\[ V; \{R_1\}, \{R_4\}, \{R_5\}; \quad c_1 \Gamma_0,0 + \sum_{i=0,3} \Gamma_{i,0} \alpha_i k_x + c_2 \left[ (\Gamma_{1,0} - \Gamma_{1,1} - \Gamma_{2,0} - \Gamma_{2,1}) k_x + \Gamma_{1,1} + \Gamma_{2,1} - \Gamma_{2,2} \right] k_y + c_3 \left[ (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_x + \Gamma_{1,1} + \Gamma_{2,1} - \Gamma_{2,2} \right] k_y + c_5 \left[ (\Gamma_{1,0} + \Gamma_{1,2} - \Gamma_{2,1} + \Gamma_{2,2}) k_x + (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_y \right]; \]
\[ \{R_1\}, \{R_4\}, \{R_3\}; \quad c_1 \Gamma_0,0 + \sum_{i=0,3} \Gamma_{i,0} \alpha_i k_x + c_2 \left[ (\Gamma_{1,1} - \Gamma_{1,2} - \Gamma_{1,2} + \Gamma_{2,2}) k_x + (\Gamma_{1,1} - \Gamma_{1,3} - \Gamma_{2,0} - \Gamma_{2,3}) k_y \right] + c_3 \left[ (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} + \Gamma_{2,2}) k_x + (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_y \right]; \]
\[ \{R_1\}, \{R_3\}, \{R_2\}; \quad c_1 \Gamma_0,0 + \sum_{i=0,3} \Gamma_{i,0} \alpha_i k_x + c_2 \left[ (\Gamma_{1,1} - \Gamma_{1,2} - \Gamma_{1,2} + \Gamma_{2,2}) k_x + (\Gamma_{1,1} - \Gamma_{1,3} - \Gamma_{2,0} - \Gamma_{2,3}) k_y \right] + c_3 \left[ (\Gamma_{1,1} + \Gamma_{1,2} - \Gamma_{2,1} + \Gamma_{2,2}) k_x + (\Gamma_{1,0} + \Gamma_{1,3} - \Gamma_{2,0} + \Gamma_{2,3}) k_y \right] + h.c.; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_3\}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_1\}, \{R_4\}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x + k_y); \]
\[ \{R_2\}, \{R_3\}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x + k_y); \]
\[ \{R_2\}, \{R_4\}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_3\}, \{R_4\}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]

\[ W; \{R_1\}, \{R_2\}, \{R_3\}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} \alpha_i k_x + k_x (c_2 \Gamma_{1,1} + c_3 \Gamma_{1,2}) + k_y (c_4 \Gamma_{0,1} + c_5 \Gamma_{0,2} + c_6 \Gamma_{3,1} + c_7 \Gamma_{3,2}); \]
\[ \Gamma; \{ R_5 \}; \begin{array}{llll}
R_5; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4k_zk_y \sigma_3 + c_5(k_x^2 - k_y^2) \sigma_3; \\
R_{10}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4k_zk_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \\
M; \{ R_5 \}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4\sigma_3k_zk_y; \\
R_{11}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4\sigma_3k_zk_y; \\
R_{12}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4\sigma_3k_zk_y; \\
R_{14}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4\sigma_3k_zk_y; \\
Z; \{ R_5 \}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4\sigma_3k_zk_y; \\
R_{11}; & c_1\sigma_0 + c_2\sigma_2k_z; \\
R_{12}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4\sigma_3k_zk_y; \\
R_{14}; & c_1\sigma_0 + c_2\sigma_2k_z; \\
A; \{ R_5, R_{10} \}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y; \\
\{ R_7, R_8 \}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y; \\
R_{10}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4\sigma_3k_zk_y; \\
\{ R_{15}, R_{16} \}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y; \\
\{ R_{17}, R_{18} \}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + (c_4\sigma_1 + c_5\sigma_2)k_zk_y; \\
R_{20}; & c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \sigma_0 + c_4\sigma_3k_zk_y; \\
X; \{ R_5 \}; & c_1\sigma_0 + c_2\sigma_2k_y; \\
R_{10}; & c_1\sigma_0 + c_2\sigma_2k_y; \\
U; \{ R_5 \}; & c_1 + c_2k_y \sigma_0 + c_3\sigma_3k_x + c_4\sigma_1k_x; \\
A; \{ R_5 \}; & c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2 \sigma_0 + c_5\sigma_1k_zk_y + c_6\sigma_3(k_x^2 - k_y^2); \\
V; \{ R_5, R_4 \}; & c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2 \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_zk_y; \\
\{ R_2, R_3 \}; & c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2 \sigma_0 + (c_5\sigma_1 + c_6\sigma_2)k_zk_y; \\
R_5; & c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2 \sigma_0 + c_5\sigma_1k_zk_y; \\
Y; \{ R_5 \}; & c_1 + c_2k_z \sigma_0 + c_3\sigma_3k_y; \\
T; \{ R_2, R_5 \}; & (c_1 + c_2k_z)\sigma_0 + (c_5\sigma_1 + c_4\sigma_2)k_y; \\
\{ R_4, R_5 \}; & (c_1 + c_2k_z)\sigma_0 + (c_5\sigma_1 + c_4\sigma_2)k_y; \\
W; \{ R_3, R_4 \}; & (c_1 + c_2k_z)\sigma_0 + (c_5\sigma_1 + c_4\sigma_2)k_y; \\
\{ R_2, R_3 \}; & (c_1 + c_2k_z)\sigma_0 + (c_5\sigma_1 + c_4\sigma_2)k_y; \end{array} \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_3 \}, \{ R_1 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_1 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \Lambda: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_1 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_4 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ \{ R_4 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z; \]
\[ W: \{ R_1, R_4 \}, \{ R_2, R_3 \}; \quad c_{1 \Gamma_0,0}^0 + \sum_{i=0,3} \Gamma_i,0 c_i k_z + k_x (c_2 \Gamma_1,1 + c_3 \Gamma_1,2) + k_y (c_4 \Gamma_0,1 + c_5 \Gamma_0,2 + c_6 \Gamma_3,1 + c_7 \Gamma_3,2); \]
\[ S: \{ R_5 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y + k_y) + c_3 \sigma_3 (k_x + k_y); \]
\[ \{ R_5 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_5 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{ R_5 \}, \{ R_1 \}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{ R_5 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_5 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y); \]
\[ \{ R_5 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ T: \{ R_6 \}, \{ R_4 \}; \quad c_1 \Gamma_0,0 + \sum_{i=0,3} \Gamma_i,0 c_i k_z + k_x (c_2 \Gamma_1,1 + c_3 \Gamma_2,3) + k_y (c_4 \Gamma_0,1 + c_5 \Gamma_0,2 + c_6 \Gamma_3,1 + c_7 \Gamma_3,2); \]
\[ W: \{ R_1, R_4 \}, \{ R_2, R_3 \}; \quad c_1 \Gamma_0,0 + \sum_{i=0,3} \Gamma_i,0 c_i k_z + k_x (c_2 \Gamma_1,1 + c_3 \Gamma_1,2) + k_y (c_4 \Gamma_0,1 + c_5 \Gamma_0,2 + c_6 \Gamma_4,1 + c_7 \Gamma_3,2); \]
\[ \Gamma; \ R_5; \ \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]

\[ \text{R}_{10}; \ \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]

\[ \text{Z}; \ R_5; \ \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]

\[ \text{R}_{10}; \ \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} \sigma_0 + c_4 k_x k_y \sigma_1 + c_5 (k_x^2 - k_y^2) \sigma_3; \]

\[ \text{P}; \ R_5; \ \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} \sigma_0 + (c_4 k_x k_y + c_5 k_z) \sigma_1 + c_6 (k_x^2 - k_y^2) \sigma_3; \]

\[ \Lambda; \ R_5; \ \begin{bmatrix} c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \end{bmatrix} \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \]

\[ \text{V}; \ R_5; \ \begin{bmatrix} c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \end{bmatrix} \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \]
Accidental degeneracies on high symmetry line

Λ: \{R_1\}, \{R_2\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_1\}, \{R_3\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_1\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_2\}, \{R_3\}: \frac{c_1}{\sqrt{3}} A_5 (A_k + A_8) + c_4 k_z;
\{R_2\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_2\}, \{R_5\}: \frac{c_1}{\sqrt{3}} A_5 (A_k + A_8) + c_4 k_z;
\{R_2\}, \{R_6\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_3\}, \{R_5\}: \frac{c_1}{\sqrt{3}} A_5 (A_k + A_8) + c_4 k_z;
\{R_3\}, \{R_6\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_4\}, \{R_5\}: \frac{c_1}{\sqrt{3}} A_5 (A_k + A_8) + c_4 k_z;
\{R_4\}, \{R_6\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
V: \{R_1\}, \{R_2\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_1\}, \{R_3\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_1\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_2\}, \{R_3\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_2\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_2\}, \{R_5\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_2\}, \{R_6\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_3\}, \{R_5\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_3\}, \{R_6\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_4\}, \{R_5\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_4\}, \{R_6\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
W: \{R_1\}, \{R_2\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_1\}, \{R_3\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 (k_x + k_y);
\{R_1\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 (k_x - k_y);
\{R_2\}, \{R_3\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 (k_x - k_y);
\{R_2\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 (k_x + k_y);
\{R_3\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
Σ: \{R_1\}, \{R_2\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_1\}, \{R_3\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 k_y;
\{R_1\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 k_z;
\{R_2\}, \{R_3\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 k_z;
\{R_2\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 k_y;
\{R_3\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
F: \{R_1\}, \{R_2\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
\{R_1\}, \{R_3\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 k_y;
\{R_1\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 k_z;
\{R_2\}, \{R_3\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 k_z;
\{R_2\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + c_5 σ_1 k_y;
\{R_3\}, \{R_4\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z;
Q: \{R_1\}, \{R_2\}: σ_0 (c_1 + c_2 k_z) + c_3 σ_3 k_z + σ_1 (c_5 k_x + c_6 k_y);
Δ: \{R_1\}, \{R_2\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_1 σ_1 (k_x + k_y);
\{R_1\}, \{R_3\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_1 σ_3 (k_x + k_y) + c_5 σ_1 (k_x - k_y);
\{R_1\}, \{R_4\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_1 σ_3 (k_x + k_y) + c_5 σ_1 k_z;
\{R_2\}, \{R_3\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 k_z;
\{R_2\}, \{R_4\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 (k_x - k_y);
\{R_3\}, \{R_4\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y);
U: \{R_1\}, \{R_2\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y);
\{R_1\}, \{R_3\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 (k_x - k_y);
\{R_1\}, \{R_4\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 k_z;
\{R_2\}, \{R_3\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 k_z;
\{R_2\}, \{R_4\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 (k_x - k_y);
\{R_3\}, \{R_4\}: σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y);

Y: \{R_1\}, \{R_2\}: σ_0 [c_1 + c_2 (k_x - k_y)] + σ_3 σ_1 (k_x - k_y);
\{R_1\}, \{R_3\}: σ_0 [c_1 + c_2 (k_x - k_y)] + σ_3 σ_1 (k_x - k_y) + c_5 σ_1 k_z;
\{R_1\}, \{R_4\}: σ_0 [c_1 + c_2 (k_x - k_y)] + σ_3 σ_1 (k_x - k_y) + c_5 σ_1 k_z;
\{R_2\}, \{R_3\}: σ_0 [c_1 + c_2 (k_x - k_y)] + σ_3 σ_1 (k_x - k_y) + c_5 σ_1 (k_x + k_y);
\{R_2\}, \{R_4\}: σ_0 [c_1 + c_2 (k_x - k_y)] + σ_3 σ_1 (k_x - k_y) + c_5 σ_1 k_z;
\{R_3\}, \{R_4\}: σ_0 [c_1 + c_2 (k_x - k_y)] + σ_3 σ_1 (k_x - k_y);

Γ: \{C_4^1, \frac{1}{2} \frac{1}{2} 0\}, \{C_2^1, 000\}, \{I|\frac{1}{2} \frac{1}{2} 0\}, T; Centrosymmetric; without SOC

Γ; R_5: \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} σ_0 + c_4 k_x k_y σ_1 + c_5 (k_x^2 - k_y^2) σ_3;
R_{10}: \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} σ_0 + c_4 k_x k_y σ_1 + c_5 (k_x^2 - k_y^2) σ_3;
N; R_5: \begin{bmatrix} c_1 σ_0 + (c_2 k_x + c_3 k_z) σ_2 \end{bmatrix};
Z; R_5: \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} σ_0 + c_4 k_x k_y σ_1 + c_5 (k_x^2 - k_y^2) σ_3;
R_{10}: \begin{bmatrix} c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \end{bmatrix} σ_0 + c_4 k_x k_y σ_1 + c_5 (k_x^2 - k_y^2) σ_3;

P; \{R_1, R_2\}: c_1 σ_0 + (c_2 σ_1 + c_3 σ_2) k_z;
\{R_2, R_3\}: c_1 σ_0 + (c_2 σ_1 + c_3 σ_2) k_z;
R_5: c_1 σ_0 + c_2 σ_1 k_z;

Λ; R_5: \begin{bmatrix} c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \end{bmatrix} σ_0 + c_5 σ_1 k_x k_y + c_6 σ_3 (k_x^2 - k_y^2);
V; R_5: \begin{bmatrix} c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \end{bmatrix} σ_0 + c_5 σ_1 k_x k_y + c_6 σ_3 (k_x^2 - k_y^2);

Q; \{R_1, R_2\}; (c_1 + c_2 k_y) σ_0 + \sum_{i=1}^{2} (c_{1,i} k_x + c_{2,i} k_x) σ_i;
Accidental degeneracies on high symmetry line

\[ \Lambda: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_3 \}, \{ R_5 \} : c_5 (A_2 k_y - A_1 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z ; \]
\[ \{ R_2 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_2 \}, \{ R_7 \} : c_5 (A_2 k_x + A_1 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z ; \]
\[ \{ R_3 \}, \{ R_8 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_3 \}, \{ R_9 \} : c_5 (A_1 k_x + A_2 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z ; \]
\[ \{ R_4 \}, \{ R_10 \} : c_5 (A_1 k_y - A_2 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z ; \]

\[ V: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_3 \}, \{ R_11 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_3 \}, \{ R_12 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_2 \}, \{ R_13 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_2 \}, \{ R_14 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_2 \}, \{ R_5 \} : c_5 (A_2 k_x + A_1 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z ; \]
\[ \{ R_1 \}, \{ R_15 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_1 \}, \{ R_16 \} : c_5 (A_1 k_y - A_2 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z ; \]

\[ W: \{ R_1 \}, \{ R_17 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_3 \}, \{ R_18 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 (k_x + k_y) ; \]
\[ \{ R_3 \}, \{ R_19 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 (k_x - k_y) ; \]
\[ \{ R_2 \}, \{ R_20 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 (k_x - k_y) ; \]
\[ \{ R_2 \}, \{ R_21 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 (k_x + k_y) ; \]
\[ \{ R_1 \}, \{ R_22 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]

\[ \Sigma: \{ R_1 \}, \{ R_23 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_3 \}, \{ R_24 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y ; \]
\[ \{ R_3 \}, \{ R_25 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x ; \]
\[ \{ R_2 \}, \{ R_26 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x ; \]
\[ \{ R_2 \}, \{ R_27 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y ; \]
\[ \{ R_1 \}, \{ R_28 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_1 \}, \{ R_29 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]

\[ F: \{ R_1 \}, \{ R_30 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z ; \]
\[ \{ R_3 \}, \{ R_31 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y ; \]
\[ \{ R_3 \}, \{ R_32 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_x ; \]
\[ \{ R_2 \}, \{ R_33 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_x ; \]
\[ \{ R_2 \}, \{ R_34 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y ; \]
\[ \{ R_1 \}, \{ R_35 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_x ; \]
\[ \{ R_1 \}, \{ R_36 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) ; \]
\[ \{ R_3 \}, \{ R_37 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y) ; \]
\[ \{ R_3 \}, \{ R_38 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y) ; \]
\[ \{ R_4 \}, \{ R_39 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) ; \]

\[ \Delta: \{ R_1 \}, \{ R_40 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) ; \]
\[ \{ R_3 \}, \{ R_41 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y) ; \]
\[ \{ R_2 \}, \{ R_42 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y) ; \]
\[ \{ R_4 \}, \{ R_43 \} : \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) ; \]
U: \{R_1\}, \{R_2\}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y);
\{R_1\}, \{R_3\}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);
\{R_1\}, \{R_4\}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;
\{R_2\}, \{R_3\}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z;
\{R_2\}, \{R_4\}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);
\{R_3\}, \{R_4\}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y);

Y: \{R_1\}, \{R_2\}: \sigma_0 [c_1 + c_2 (k_x - k_y)] + \sigma_3 c_3 (k_x - k_y);
\{R_1\}, \{R_3\}: \sigma_0 [c_1 + c_2 (k_x - k_y)] + \sigma_3 c_3 (k_x - k_y) + c_5 \sigma_1 k_z;
\{R_1\}, \{R_4\}: \sigma_0 [c_1 + c_2 (k_x - k_y)] + \sigma_3 c_3 (k_x - k_y) + c_5 \sigma_1 (k_x + k_y);
\{R_2\}, \{R_3\}: \sigma_0 [c_1 + c_2 (k_x - k_y)] + \sigma_3 c_3 (k_x - k_y) + c_5 \sigma_1 (k_x + k_y);
\{R_2\}, \{R_4\}: \sigma_0 [c_1 + c_2 (k_x - k_y)] + \sigma_3 c_3 (k_x - k_y) + c_5 \sigma_1 k_z;
\{R_3\}, \{R_4\}: \sigma_0 [c_1 + c_2 (k_x - k_y)] + \sigma_3 c_3 (k_x - k_y);
\[ T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma^0; \{ C_4^+|0\frac{1}{2}0 \}, \{ C_2^+|\frac{1}{2}\frac{1}{2}0 \}, \{ I|\frac{1}{2}\frac{1}{2}0 \}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; \]
- \( R_5; \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \)
- \( R_{10}; \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 k_x k_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \)

\[ X; \]
- \( R_5; c_1 \sigma_0 + c_2 \sigma_2(k_x + k_y); \)
- \( R_{10}; c_1 \sigma_0 + c_2 \sigma_2(k_x + k_y); \)

\[ Z; \]
- \( R_5; \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_3(k_x^2 - k_y^2); \)
- \( R_{11}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \)
- \( R_{12}; \left[ c_1 + c_2(k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_3(k_x^2 - k_y^2); \)
- \( R_{14}; c_1 \sigma_0 + c_2 \sigma_2 k_z; \)

\[ P; \]
- \( R_{13}; c_1 \sigma_0 + c_2(\sigma_2 k_x + \sigma_1 k_y); \)
- \( R_{14}; c_1 \sigma_0 + c_2(\sigma_2 k_x + \sigma_1 k_y); \)

\[ \Lambda; \]
- \( R_5; \left[ c_1 + c_2 k_x + c_3(k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3(k_x^2 - k_y^2); \)
- \( R_{10}; \left[ c_1 + c_2 k_x + c_3(k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_3(k_x^2 - k_y^2); \)

\[ W; \]
- \( R_5; (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1(k_x - k_y) + c_4 \sigma_3(k_x + k_y); \)

\[ U; \]
- \( R_5; [c_1 + c_2(k_x + k_y)] \sigma_0 + c_3 \sigma_3(k_x - k_y) + c_4 \sigma_1 k_z; \)

\[ Y; \]
- \( R_5; [c_1 + c_2(k_x - k_y)] \sigma_0 + c_3 \sigma_1(k_x + k_y) + c_4 \sigma_3 k_z; \)
Accidental degeneracies on high symmetry line

$\Lambda$: $\{R_1\}, \{R_2\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_5\}, \{R_6\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_7\}, \{R_6\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_8\}, \{R_7\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_8\}, \{R_8\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_9\}, \{R_9\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_9\}, \{R_10\}$: $c_5 (A_2 k_y + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_6\}, \{R_10\}$: $c_5 (A_2 k_y + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_6\}, \{R_6\}$: $c_5 (A_2 k_y + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_7\}, \{R_7\}$: $c_5 (A_2 k_y + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_8\}, \{R_8\}$: $c_5 (A_2 k_y + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_9\}, \{R_9\}$: $c_5 (A_2 k_y + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_9\}, \{R_10\}$: $c_5 (A_2 k_y + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;
$\{R_10\}, \{R_10\}$: $c_5 (A_2 k_y + A_4 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z$;

$\Sigma$: $\{R_1\}, \{R_2\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_2\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_2\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_3\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$F$: $\{R_1\}, \{R_2\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_1\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_2\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_2\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_3\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z$;

$Q$: $\{R_2\}, \{R_1\}$: $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_5 k_z + c_6 k_z)$;

$\Delta$: $\{R_1\}, \{R_2\}$: $\sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y)$;
$\{R_1\}, \{R_3\}$: $\sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y)$;
$\{R_1\}, \{R_4\}$: $\sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y)$;
$\{R_2\}, \{R_3\}$: $\sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y)$;
$\{R_2\}, \{R_4\}$: $\sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y)$;
$\{R_3\}, \{R_4\}$: $\sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y)$;
\[ \begin{align*}
\Gamma: & \quad R_5: \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4k_xk_y \sigma_3 + c_5(k_x^2 - k_y^2) \sigma_3; \\
& \quad R_{10}: \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4k_xk_y \sigma_1 + c_5(k_x^2 - k_y^2) \sigma_3; \\
N: & \quad R_5: \quad c_1 \sigma_0 + \sigma_2(c_2k_x + c_3k_y); \\
X: & \quad R_5: \quad c_1 \sigma_0 + c_2 \sigma_2(k_x + k_y); \\
& \quad R_{10}: \quad c_1 \sigma_0 + c_2 \sigma_2(k_x + k_y); \\
Z: & \quad R_5: \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4 \sigma_3(k_x^2 - k_y^2); \\
& \quad R_{11}: \quad c_1 \sigma_0 + c_2 \sigma_2k_x; \\
& \quad R_{12}: \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4 \sigma_3(k_x^2 - k_y^2); \\
& \quad R_{14}: \quad c_1 \sigma_0 + c_2 \sigma_3k_z; \\
P: & \quad \{R_{13}, R_{14}\}: \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,2}k_x + \Gamma_{0,1}k_y) + c_3 (\Gamma_{2,0}k_x - \Gamma_{1,3}k_y) + c_4 (\Gamma_{1,0}k_x + \Gamma_{2,3}k_y) + k_z (c_4 \Gamma_{1,1} - c_6 \Gamma_{2,1}); \\
N: & \quad R_5: \quad [c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_x^2] \sigma_0 + c_5 \sigma_1k_xk_y + c_6 \sigma_3(k_x^2 - k_y^2); \\
V: & \quad R_{10}: \quad h_0 + c_5 \sigma_1k_xk_y + c_6 \sigma_3(k_x^2 - k_y^2); \\
W: & \quad R_5: \quad (c_1 + c_2k_x) \sigma_0 + c_3 \sigma_1(k_x + k_y) + c_4 \sigma_3(k_x - k_y); \\
Q: & \quad \{R_{1}, R_{2}\}: \quad (c_1 + c_2k_y) \sigma_0 + \sum_{i=1}^2 (c_{i,1}k_x + c_{i,2}k_y) \sigma_i; \\
U: & \quad R_5: \quad [c_1 + c_2(k_x + k_y)] \sigma_0 + c_3 \sigma_3(k_x - k_y) + c_4 \sigma_1k_z; \\
Y: & \quad R_5: \quad [c_1 + c_2(k_x - k_y)] \sigma_0 + c_3 \sigma_3(k_x + k_y) + c_4 \sigma_3k_z; 
\end{align*} \]
Accidental degeneracies on high symmetry line

Λ: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;
  \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_3\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;
  \{R_4\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;

V: \{R_6\}, \{R_{10}\} : c_5 (A_2 k_x + A_1 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z;
  \{R_6\}, \{R_{10}\} : c_5 (A_2 k_x + A_1 k_y) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z;
  \{R_6\}, \{R_9\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_6\}, \{R_9\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_{10}\}, \{R_9\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;
  \{R_{10}\}, \{R_9\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_4 k_z;
  \{R_7\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_7\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_8\}, \{R_{10}\} : c_5 (A_1 k_y - A_2 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z;
  \{R_8\}, \{R_{10}\} : c_5 (A_1 k_y - A_2 k_x) + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z;
  \{R_6\}, \{R_9\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_6\}, \{R_9\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;

Σ: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
  \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
  \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
  \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;

F: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
  \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
  \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
  \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;
  \{R_2\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_y;

Δ: \{R_1\}, \{R_2\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y);
  \{R_1\}, \{R_3\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_4 \sigma_1 (k_x - k_y);
  \{R_1\}, \{R_3\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_4 \sigma_1 (k_x - k_y);
  \{R_2\}, \{R_3\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_4 \sigma_1 (k_x - k_y);
  \{R_2\}, \{R_3\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_4 \sigma_1 (k_x - k_y);
  \{R_3\}, \{R_4\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y);
Accidental degeneracies on high symmetry line

$\Gamma$: \{R_2, R_3\}; $[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_z + \sigma_z(\alpha_1k_zk_+ + \alpha_2k_z^2) + h.c.$

$\Delta$: \{R_1\}; \{R_2\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

$\Delta$: \{R_1\}; \{R_3\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

$\Delta$: \{R_2\}; \{R_3\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

$P$: \{R_1\}; \{R_2\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

$P$: \{R_1\}; \{R_3\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

Accidental degeneracies on high symmetry line

$\Gamma$: \{R_2, R_3\}; $[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_z + \sigma_z(\alpha_1k_zk_+ + \alpha_2k_z^2) + h.c.$

$\Delta$: \{R_1\}; \{R_2\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

$\Delta$: \{R_1\}; \{R_3\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

$\Delta$: \{R_2\}; \{R_3\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

$P$: \{R_1\}; \{R_2\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

$P$: \{R_1\}; \{R_3\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

Accidental degeneracies on high symmetry line

$\Gamma$: \{R_2, R_3\}; $[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4\sigma_3k_z + \sigma_z(\alpha_1k_zk_+ + \alpha_2k_z^2) + h.c.$

$\Delta$: \{R_1\}; \{R_2\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

$\Delta$: \{R_1\}; \{R_3\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$

$\Delta$: \{R_2\}; \{R_3\}; $\sigma_0(c_1 + c_2k_z) + c_3\sigma_3k_z + c_5(\sigma_1k_y - \sigma_2k_x) + c_6(\sigma_1k_x + \sigma_2k_y)$
Accidental degeneracies on high symmetry line

\[
\Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_6 \left( \sigma_1 k_x + \sigma_2 k_y \right);
\]
\[
\{ R_1 \}, \{ R_2 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_2 k_x + \sigma_1 k_y \right) + c_6 \left( \sigma_1 k_x - \sigma_2 k_y \right);
\]
\[
\{ R_2 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_6 \left( \sigma_1 k_x + \sigma_2 k_y \right);
\]
\[
P: \{ R_1 \}, \{ R_2 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_6 \left( \sigma_1 k_x + \sigma_2 k_y \right);
\]
\[
\{ R_1 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_2 k_x + \sigma_1 k_y \right) + c_6 \left( \sigma_1 k_x - \sigma_2 k_y \right);
\]
\[
\{ R_2 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_6 \left( \sigma_1 k_x + \sigma_2 k_y \right);
\]

SG 146
\[ \Gamma_{\pm}; \{ C^3_4 \} \{ 000 \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[
\Gamma: \{ R_2 \}, \{ R_3 \}; \left[ c_1 + c_2 k_x^2 + k_y^2 \right] + c_3 k_z^2 \sigma_0 + c_4 \sigma_3 k_z + \left[ \sigma_+ \left( \alpha_1 k_z k_- + \alpha_2 k_z^2 \right) \right] + h.c. \]
\[
Z: \{ R_2 \}, \{ R_3 \}; \left[ c_1 + c_2 k_x^2 + k_y^2 \right] + c_3 k_z^2 \sigma_0 + c_4 \sigma_3 k_z + \left[ \sigma_- \left( \alpha_1 k_z k_- + \alpha_2 k_z^2 \right) \right] + h.c. \]

Accidental degeneracies on high symmetry line

\[
\Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_6 \left( \sigma_1 k_x + \sigma_2 k_y \right);
\]
\[
\{ R_1 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_2 k_x + \sigma_1 k_y \right) + c_6 \left( \sigma_1 k_x - \sigma_2 k_y \right);
\]
\[
\{ R_2 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_6 \left( \sigma_1 k_x + \sigma_2 k_y \right);
\]
\[
P: \{ R_1 \}, \{ R_2 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_6 \left( \sigma_1 k_x + \sigma_2 k_y \right);
\]
\[
\{ R_1 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_2 k_x + \sigma_1 k_y \right) + c_6 \left( \sigma_1 k_x - \sigma_2 k_y \right);
\]
\[
\{ R_2 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_6 \left( \sigma_1 k_x + \sigma_2 k_y \right);
\]

SG 147
\[ \Gamma_{\pm}; \{ S^0_6 \} \{ 000 \}, T; \text{Centrosymmetric; without SOC} \]

\[
\Gamma: \{ R_2 \}, \{ R_3 \}; \left[ c_1 + c_2(k_x^2 + k_y^2) + c_4 k_z^2 \right] + c_0 \sigma_0 + \left[ \sigma_+ \left( \alpha_1 k_z k_- + \alpha_2 k_z^2 \right) \right] + h.c.;
\]
\[
\{ R_3 \}, \{ R_4 \}; \left[ c_1 + c_2(k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + \left[ \sigma_- \left( \alpha_1 k_z k_- + \alpha_2 k_z^2 \right) \right] + h.c.;
\]
\[
A: \{ R_2 \}, \{ R_3 \}; \left[ c_1 + c_2(k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + \left[ \sigma_+ \left( \alpha_1 k_z k_- + \alpha_2 k_z^2 \right) \right] + h.c.;
\]
\[
\{ R_3 \}, \{ R_4 \}; \left[ c_1 + c_2(k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + \left[ \sigma_- \left( \alpha_1 k_z k_- + \alpha_2 k_z^2 \right) \right] + h.c.;
\]
\[
K: \{ R_2 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + \left[ a_1 \sigma_+ k_- \right] + h.c.;
\]
\[
H: \{ R_2 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + \left[ a_1 \sigma_- k_- \right] + h.c.;
\]
\[
\Delta: \{ R_2 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + \left[ a_1 \sigma_+ k_- \right] + h.c.;
\]
\[
P: \{ R_2 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_z \right) + \left[ a_1 \sigma_- k_- \right] + h.c.;
\]

Accidental degeneracies on high symmetry line

\[
\Delta: \{ R_1 \}, \{ R_2 \}, \{ R_3 \}; \left[ (A_4 + A_6) c_3 + A_7 c_4 + (A_2 - A_1) c_5 - A_3 c_6 \right] k_x + \left[ (A_1 - A_2) c_3 + A_3 c_4 + (A_4 + A_6) c_5 + A_7 c_6 \right] k_y + \left[ A_0 \left( c_1 + c_2 k_z \right) + (\sqrt{3} A_5 + A_8) \right] c_7 k_z;
\]
\[
P: \{ R_1 \}, \{ R_2 \}, \{ R_3 \}; \left[ (A_4 + A_6) c_3 + A_7 c_4 + (A_2 - A_1) c_5 - A_3 c_6 \right] k_x + \left[ (A_1 - A_2) c_3 + A_3 c_4 + (A_4 + A_6) c_5 + A_7 c_6 \right] k_y + \left[ A_0 \left( c_1 + c_2 k_z \right) + (\sqrt{3} A_5 + A_8) \right] c_7 k_z;
\]
\[ \{ R_2, R_3 \} : \{ c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \} \sigma_0 + \{ \sigma_x (\alpha_1 k_x k_+ + \alpha_2 k_z^2) + \text{h.c.} \}; \]

\[ \{ R_3, R_5 \} : \{ c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2 \} \sigma_0 + \{ \sigma_x (\alpha_1 k_x k_+ + \alpha_2 k_z^2) + \text{h.c.} \}; \]

\[ \{ R_2, R_3 \} : \{ c_1 + c_2k_x^2 + c_3k_y^2 \} \sigma_0 + \{ \sigma_x (\alpha_1 k_x k_+ + \alpha_2 k_z^2) + \text{h.c.} \}; \]

Accidental degeneracies on high symmetry line

\[ \{ R_1 \}, \{ R_2, R_3 \} : \{ (A_4 + A_6) c_3 + A_2 c_4 + (A_2 - A_1) c_5 - A_3 c_6 \} k_x + \{ (A_1 - A_2) c_3 + A_3 c_4 + (A_4 + A_6) c_5 + A_7 c_6 \} k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_2 k_z; \]

\[ \{ R_1 \}, \{ R_2, R_3 \} : \{ (A_4 + A_6) c_3 + A_2 c_4 + (A_2 - A_1) c_5 - A_3 c_6 \} k_x + \{ (A_1 - A_2) c_3 + A_3 c_4 + (A_4 + A_6) c_5 + A_7 c_6 \} k_y + A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_2 k_z; \]

Accidental degeneracies on high symmetry line

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left[ \sigma_1 \left( k_x + \frac{\sqrt{3} \sigma_2}{2} \right) + \sigma_2 \left( k_y - \frac{\sqrt{3} \sigma_2}{2} \right) \right]; \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left[ 3 \sigma_1 + \sqrt{3} \sigma_2 \right] k_x + \left( \sqrt{3} \sigma_1 - 3 \sigma_2 \right) k_y; \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left[ \sigma_1 \left( k_x + \frac{\sqrt{3} \sigma_2}{2} \right) + \sigma_2 \left( k_y - \frac{\sqrt{3} \sigma_2}{2} \right) \right]; \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left[ 3 \sigma_1 + \sqrt{3} \sigma_2 \right] k_x + \left( \sqrt{3} \sigma_1 - 3 \sigma_2 \right) k_y; \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left[ \sigma_1 \left( k_x + \frac{\sqrt{3} \sigma_2}{2} \right) + \sigma_2 \left( k_y - \frac{\sqrt{3} \sigma_2}{2} \right) \right]; \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

Accidental degeneracies on high symmetry line

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \left[ (\sigma_1 + \sqrt{3} \sigma_2) k_x + (\sigma_2 - \sqrt{3} \sigma_1) k_y \right]; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \left[ (\sigma_1 - \sqrt{3} \sigma_2) k_x - (\sqrt{3} \sigma_1 + \sigma_2) k_y \right]; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \left[ (\sigma_1 + \sqrt{3} \sigma_2) k_x + (\sigma_2 - \sqrt{3} \sigma_1) k_y \right]; \]

\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 (\sigma_1 k_y - \sigma_3 k_z) + c_6 (\sigma_1 k_x + \sigma_2 k_y); \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 (\sigma_2 k_x + \sigma_4 k_y) + c_6 (\sigma_1 k_x - \sigma_2 k_y); \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 (\sigma_1 k_y - \sigma_2 k_z) + c_6 (\sigma_1 k_x + \sigma_2 k_y); \]

\[ \{R_1\}, \{R_2\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + \sum_{i=1}^2 \sigma_i \left[ c_{i,1} \left( k_x - \sqrt{3} k_y \right) + c_{i,2} k_z \right]; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + \sum_{i=1}^2 \sigma_i \left[ c_{i,1} \left( k_x - \sqrt{3} k_y \right) + c_{i,2} k_z \right]; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + \sum_{i=1}^2 \sigma_i \left[ c_{i,1} \left( k_x - \sqrt{3} k_y \right) + c_{i,2} k_z \right]; \]

\[ \{R_1\}, \{R_2\}; \sigma_0 \left( c_1 + c_2 k_y \right) + c_3 \sigma_3 k_y + \sum_{i=1}^2 \sigma_i \left( c_{i,1} k_x + c_{i,2} k_z \right); \]
\[ \{R_1\}, \{R_2\}; \sigma_0 \left( c_1 + c_2 k_y \right) + c_3 \sigma_3 k_y + \sum_{i=1}^2 \sigma_i \left( c_{i,1} k_x + c_{i,2} k_z \right); \]
\[ \{R_1\}, \{R_2\}; \sigma_0 \left( c_1 + c_2 k_y \right) + c_3 \sigma_3 k_y + \sum_{i=1}^2 \sigma_i \left( c_{i,1} k_x + c_{i,2} k_z \right); \]
\[ \{R_1\}, \{R_2\}; \sigma_0 \left( c_1 + c_2 k_y \right) + c_3 \sigma_3 k_y + \sum_{i=1}^2 \sigma_i \left( c_{i,1} k_x + c_{i,2} k_z \right); \]
SG 151

\[ \Gamma_h; \{ C_{3h}^\infty \{001\}, C_{3v}^\infty \{00\frac{1}{3}\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; R_3; [c_1 + c_2(k_x^2 + k_y^2) + c_5k_z^2] \sigma_0 + \sigma_1 k_x(2c_4k_y + c_5k_z) + \sigma_3 [c_4(k_x^2 - k_y^2) + c_5k_yk_z] + c_6 \sigma_2 k_z; \]

\[ A; R_3; [c_1 + c_2(k_x^2 + k_y^2) + c_5k_z^2] \sigma_0 + \sigma_1 k_x(2c_4k_y + c_5k_z) + \sigma_3 [c_4(k_x^2 - k_y^2) + c_5k_yk_z] + c_6 \sigma_2 k_z; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 [\sigma_1 (k_x + \frac{k_y}{\sqrt{3}}) + \sigma_2 (k_y - \frac{k_x}{\sqrt{3}})]; \]

\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 [(3\sigma_1 + 3\sigma_2) k_x + (\sqrt{3} \sigma_1 - 3\sigma_2) k_y] ; \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 (k_x + \frac{k_y}{\sqrt{3}}) + \sigma_2 (k_y - \frac{k_x}{\sqrt{3}}); \]

\[ P; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 (k_x + \frac{k_y}{\sqrt{3}}) + \sigma_2 (k_y - \frac{k_x}{\sqrt{3}}); \]

\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 [(3\sigma_1 + 3\sigma_2) k_x + (\sqrt{3} \sigma_1 - 3\sigma_2) k_y] ; \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 (k_x + \frac{k_y}{\sqrt{3}}) + \sigma_2 (k_y - \frac{k_x}{\sqrt{3}}); \]

\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^2 \sigma_i (c_{i,1}k_y + c_{i,2}k_z) ; \]

\[ R; \{ R_3 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^2 \sigma_i (c_{i,1}k_y + c_{i,2}k_z) ; \]

SG 152

\[ \Gamma_h; \{ C_{3h}^\infty \{001\}, C_{3v}^\infty \{00\frac{1}{3}\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; R_3; [c_1 + c_2(k_x^2 + k_y^2) + c_5k_z^2] \sigma_0 + \sigma_1 k_y(2c_4k_x - c_5k_z) + \sigma_3 [c_4(k_x^2 - k_y^2) + c_5k_yk_x] + c_6 \sigma_2 k_z; \]

\[ A; R_3; [c_1 + c_2(k_x^2 + k_y^2) + c_5k_z^2] \sigma_0 + \sigma_1 k_y(2c_4k_x - c_5k_z) + \sigma_3 [c_4(k_x^2 - k_y^2) + c_5k_yk_x] + c_6 \sigma_2 k_z; \]

\[ K; R_3; c_1 \sigma_0 + c_2(\sigma_1 k_x + \sigma_3 k_y) + c_3 \sigma_2 k_z; \]

\[ H; R_3; c_1 \sigma_0 + c_2(\sigma_1 k_x + \sigma_3 k_y) + c_3 \sigma_2 k_z; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 [(\sigma_1 + \sqrt{3} \sigma_2) k_x + (\sigma_2 - \sqrt{3} \sigma_1) k_y]; \]

\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 [(\sigma_1 - \sqrt{3} \sigma_2) k_x - (\sqrt{3} \sigma_1 + \sigma_2) k_y]; \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 [(\sigma_1 + \sqrt{3} \sigma_2) k_x + (\sigma_2 - \sqrt{3} \sigma_1) k_y]; \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 [(\sigma_1 - \sqrt{3} \sigma_2) k_x - (\sqrt{3} \sigma_1 + \sigma_2) k_y]; \]

\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 (\sigma_1 k_y - \sigma_2 k_x) + c_6 (\sigma_1 k_x + \sigma_2 k_y); \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3 k_z + c_5 (\sigma_1 k_y - \sigma_2 k_x) + c_6 (\sigma_1 k_x + \sigma_2 k_y); \]

\[ T; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2(\sqrt{3} k_x + k_y)) + c_3 \sigma_3 (\sqrt{3} k_z + k_y) + \sum_{i=1}^2 \sigma_i [c_{i,1} (k_x - \sqrt{3} k_y) + c_{i,2} k_z]; \]

\[ S; \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2(\sqrt{3} k_x + k_y)) + c_3 \sigma_3 (\sqrt{3} k_z + k_y) + \sum_{i=1}^2 \sigma_i [c_{i,1} (k_x - \sqrt{3} k_y) + c_{i,2} k_z]; \]

\[ T'; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + \sum_{i=1}^2 \sigma_i (c_{i,1} k_x + c_{i,2} k_z); \]

\[ S'; \{ R_3 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2k_y) + c_3 \sigma_3 k_y + \sum_{i=1}^2 \sigma_i (c_{i,1} k_x + c_{i,2} k_z); \]
SG 153
\[\Gamma_h; \{C_3^2\left[00\frac{2}{3}\right], C_3^2\left[00\frac{1}{3}\right]\}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC}\]

\[\Gamma: R_3; \left[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\right] \sigma_0 + \sigma_1k_x(2c_4k_y + c_5k_z) + \sigma_3 \left[c_4(k_x^2 - k_y^2) + c_5k_yk_z\right] + c_6\sigma_2k_z;\]

\[A: R_3; \left[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\right] \sigma_0 + \sigma_1k_x(2c_4k_y + c_5k_z) + \sigma_3 \left[c_4(k_x^2 - k_y^2) + c_5k_yk_z\right] + c_6\sigma_2k_z;\]

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Accidental degeneracies on high symmetry line

\[\Delta: \{R_3\}, \{R_3\}; \quad \sigma_0 \left(\sigma_1 + c_2k_x + c_3k_z\right) + c_5 \left[\sigma_1 \left(k_x + \frac{k_y}{\sqrt{3}}\right) + \sigma_2 \left(k_y - \frac{k_x}{\sqrt{3}}\right)\right];\]
\[\{R_3\}, \{R_3\}; \quad \sigma_0 \left(\sigma_1 + c_2k_x + c_3k_z\right) + c_5 \left[\left(3\sigma_1 + \sqrt{3}\sigma_2\right) k_x + \left(\sqrt{3}\sigma_1 - 3\sigma_2\right) k_y\right];\]
\[\{R_3\}, \{R_3\}; \quad \sigma_0 \left(\sigma_1 + c_2k_x + c_3k_z\right) + c_5 \left[\sigma_1 \left(k_x + \frac{k_y}{\sqrt{3}}\right) + \sigma_2 \left(k_y - \frac{k_x}{\sqrt{3}}\right)\right];\]

\[P: \{R_3\}, \{R_3\}; \quad \sigma_0 \left(\sigma_1 + c_2k_x + c_3k_z\right) + c_5 \left[\left(3\sigma_1 + \sqrt{3}\sigma_2\right) k_x + \left(\sqrt{3}\sigma_1 - 3\sigma_2\right) k_y\right];\]
\[\{R_3\}, \{R_3\}; \quad \sigma_0 \left(\sigma_1 + c_2k_x + c_3k_z\right) + c_5 \left[\sigma_1 \left(k_x + \frac{k_y}{\sqrt{3}}\right) + \sigma_2 \left(k_y - \frac{k_x}{\sqrt{3}}\right)\right];\]

\[\Sigma: \{R_3\}, \{R_3\}; \quad \sigma_0 \left(c_1 + c_2k_x + c_3k_z\right) + \sum_{i=1}^2 \sigma_i \left(c_1k_y + c_2k_z\right);\]

\[R: \{R_3\}, \{R_3\}; \quad \sigma_0 \left(c_1 + c_2k_x + c_3k_z\right) + \sum_{i=1}^2 \sigma_i \left(c_1k_y + c_2k_z\right);\]

SG 154
\[\Gamma_h; \{C_3^2\left[00\frac{2}{3}\right], C_3^2\left[00\frac{1}{3}\right]\}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC}\]

\[\Gamma: R_3; \left[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\right] \sigma_0 + \sigma_1k_y(2c_4k_y + c_5k_z) + \sigma_3 \left[c_4(k_x^2 - k_y^2) + c_5k_yk_z\right] + c_6\sigma_2k_z;\]

\[A: R_3; \left[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\right] \sigma_0 + \sigma_1k_y(2c_4k_y + c_5k_z) + \sigma_3 \left[c_4(k_x^2 - k_y^2) + c_5k_yk_z\right] + c_6\sigma_2k_z;\]

\[K: R_3; c_1\sigma_0 + c_2\sigma_1k_x + c_3\sigma_2k_z;\]

\[H: R_3; c_1\sigma_0 + c_2\sigma_1k_x + c_3\sigma_2k_z;\]

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Accidental degeneracies on high symmetry line

\[\Delta: \{R_3\}, \{R_3\}; \quad \sigma_0 \left(\sigma_1 + c_2k_x + c_3k_z\right) + c_5 \left[\left(\sigma_1 + \sqrt{3}\sigma_2\right) k_x + \left(\sigma_2 - \sqrt{3}\sigma_1\right) k_y\right];\]
\[\{R_3\}, \{R_3\}; \quad \sigma_0 \left(\sigma_1 + c_2k_x + c_3k_z\right) + c_5 \left[\left(\sigma_1 - \sqrt{3}\sigma_2\right) k_x + \left(\sqrt{3}\sigma_1 + \sigma_2\right) k_y\right];\]
\[\{R_3\}, \{R_3\}; \quad \sigma_0 \left(\sigma_1 + c_2k_x + c_3k_z\right) + c_5 \left[\left(\sigma_1 + \sqrt{3}\sigma_2\right) k_x + \left(\sigma_2 - \sqrt{3}\sigma_1\right) k_y\right];\]

\[P: \{R_3\}, \{R_3\}; \quad \sigma_0 \left(\sigma_1 + c_2k_x + c_3k_z\right) + c_5 \left[\left(\sigma_1 + \sqrt{3}\sigma_2\right) k_x + \left(\sigma_2 - \sqrt{3}\sigma_1\right) k_y\right];\]
\[\{R_3\}, \{R_3\}; \quad \sigma_0 \left(\sigma_1 + c_2k_x + c_3k_z\right) + c_5 \left[\left(\sigma_1 - \sqrt{3}\sigma_2\right) k_x + \left(\sqrt{3}\sigma_1 + \sigma_2\right) k_y\right];\]

\[T: \{R_3\}, \{R_3\}; \quad \sigma_0 \left[c_1 + c_2(\sqrt{3}k_x + k_y)\right] + \sigma_3 \left(\sqrt{3}k_x + k_y\right) + \sum_{i=1}^2 \sigma_i \left[c_1(k_x - \sqrt{3}k_y) + c_3k_z\right];\]

\[S: \{R_3\}, \{R_3\}; \quad \sigma_0 \left[c_1 + c_2(\sqrt{3}k_x + k_y)\right] + \sigma_3 \left(\sqrt{3}k_x + k_y\right) + \sum_{i=1}^2 \sigma_i \left[c_1(k_x - \sqrt{3}k_y) + c_3k_z\right];\]

\[T': \{R_3\}, \{R_3\}; \quad \sigma_0 \left[c_1 + c_2k_y\right] + \sigma_3 \left(c_3k_y\right) + \sum_{i=1}^2 \sigma_i \left(c_1k_x + c_2k_z\right);\]

\[S': \{R_3\}, \{R_3\}; \quad \sigma_0 \left[c_1 + c_2k_y\right] + \sigma_3 \left(c_3k_y\right) + \sum_{i=1}^2 \sigma_i \left(c_1k_x + c_2k_z\right);\]

SG 155
\[\Gamma_h; \{C_3^2\left[00\right], C_3^2\left[00\right]\}, \mathcal{T}; \text{Non-Centrosymmetric; without SOC}\]

\[\Gamma: R_3; \left[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\right] \sigma_0 + \sigma_1k_x(2c_4k_y + c_5k_z) + \sigma_3 \left[c_4(k_x^2 - k_y^2) + c_5k_yk_z\right] + c_6\sigma_2k_z;\]

\[Z: R_3; \left[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\right] \sigma_0 + \sigma_1k_x(2c_4k_y + c_5k_z) + \sigma_3 \left[c_4(k_x^2 - k_y^2) + c_5k_yk_z\right] + c_6\sigma_2k_z;\]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left[ \sigma_1 \left( k_x + \frac{k_y}{\sqrt{2}} \right) + \sigma_2 \left( k_y - \frac{k_x}{\sqrt{2}} \right) \right]; \]
\[ \{ R_1 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left( 3 \sigma_1 + \sqrt{3} \sigma_2 \right) k_x + \left( \sqrt{3} \sigma_1 - 3 \sigma_2 \right) k_y; \]
\[ \{ R_2 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 \left( k_x + \frac{k_y}{\sqrt{2}} \right) + \sigma_2 \left( k_y - \frac{k_x}{\sqrt{2}} \right) \right); \]
\[ P: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left[ \sigma_1 \left( k_x + \frac{k_y}{\sqrt{2}} \right) + \sigma_2 \left( k_y - \frac{k_x}{\sqrt{2}} \right) \right]; \]
\[ \{ R_1 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left[ 3 \sigma_1 + \sqrt{3} \sigma_2 \right] k_x + \left( \sqrt{3} \sigma_1 - 3 \sigma_2 \right) k_y; \]
\[ \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left[ \sigma_1 \left( k_x + \frac{k_y}{\sqrt{2}} \right) + \sigma_2 \left( k_y - \frac{k_x}{\sqrt{2}} \right) \right]; \]
\[ B: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i1} k_y + c_{i2} k_z); \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i1} k_y + c_{i2} k_z); \]
\[ Q: \{ R_1 \}, \{ R_2 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i1} (k_x + \sqrt{3} k_y) + \sigma_1 \left[ c_2 \left( k_x - \frac{k_y}{\sqrt{2}} \right) + c_3 k_z \right] + \sigma_2 \left[ c_4 \left( \frac{k_y}{\sqrt{2}} - k_x \right) - c_5 k_z \right]; \]
\[ Y: \{ R_1 \}, \{ R_2 \}: \sum_{i=0,3} \sigma_i c_{i2} (k_x - \sqrt{3} k_y) + \sigma_1 \left[ c_2 \left( k_x + \frac{k_y}{\sqrt{2}} \right) + c_3 k_z \right] + \sigma_2 \left[ c_4 \left( k_x + \sqrt{3} k_y \right) + 3 c_5 k_z \right]; \]

\[ \text{SG 156} \]
\[ \Gamma_h: \{ C_3^+ [000], \sigma_3 [000], T \}; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \ R_3: \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_6 k_z^2 \right] \sigma_0 + \sigma_1 k_y (2 c_4 k_x - c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) + c_5 k_z k_x \right]; \]
\[ A: \ R_3: \left[ c_1 + c_2 (k_y^2 + k_z^2) + c_6 k_z^2 \right] \sigma_0 + \sigma_1 k_y (2 c_4 k_x - c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) + c_5 k_z k_x \right]; \]
\[ \Delta: \ R_3: \left( c_1 + c_3 k_x \right) \sigma_0 + c_2 (\sigma_3 k_x - \sigma_1 k_y); \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}: A_0 (c_1 + c_2 k_x) + \left( \sqrt{3} A_5 + A_8 \right) c_3 k_z + \left[ 2 A_4 c_3 + \left( \sqrt{3} A_8 - A_5 \right) \right] c_4 - 2 A_1 c_6 \left[ k_x + 2 \left( A_6 c_3 - A_7 c_4 - A_2 c_6 \right) \right] k_y; \]
\[ \{ R_2 \}, \{ R_3 \}: A_0 (c_1 + c_2 k_x) + \left( \sqrt{3} A_5 + A_8 \right) c_3 k_z + \left[ 2 A_4 c_3 + \left( \sqrt{3} A_8 - A_5 \right) \right] c_4 - 2 A_2 c_6 \left[ k_x + 2 \left( A_6 c_3 - A_7 c_4 - A_1 c_6 \right) \right] k_y; \]
\[ U: \{ R_1 \}, \{ R_2 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i1} k_x + c_{i2} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_y; \]
\[ P: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_3 k_x) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_6 \left( \sigma_1 k_x + \sigma_2 k_y \right); \]
\[ \{ R_1 \}, \{ R_4 \}: \sigma_0 (c_1 + c_3 k_x) + c_3 \sigma_3 k_z + c_5 \left( \sigma_2 k_x + \sigma_1 k_y \right) + c_6 \left( \sigma_1 k_x - \sigma_2 k_y \right); \]
\[ \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_3 k_x) + c_3 \sigma_3 k_z + c_5 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_6 \left( \sigma_1 k_x + \sigma_2 k_y \right); \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i1} k_x + c_{i2} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_y; \]
\[ R: \{ R_1 \}, \{ R_2 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i1} k_x + c_{i2} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_y; \]

\[ \text{SG 157} \]
\[ \Gamma_h: \{ C_3^+ [000], \sigma_3 [000], T \}; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \ R_3: \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_6 k_z^2 \right] \sigma_0 + \sigma_1 k_y (2 c_4 k_x - c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) + c_5 k_z k_x \right]; \]
\[ A: \ R_3: \left[ c_1 + c_2 (k_y^2 + k_z^2) + c_6 k_z^2 \right] \sigma_0 + \sigma_1 k_y (2 c_4 k_x - c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) + c_5 k_z k_x \right]; \]
\[ K: \ R_3: \left( c_1 + c_3 k_z \right) \sigma_0 + c_2 (\sigma_3 k_z - \sigma_1 k_y); \]
\[ H: \ R_3: \left( c_1 + c_3 k_x \right) \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y); \]
\[ \Delta: \ R_3: \left( c_1 + c_3 k_x \right) \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y); \]
\[ P: \ R_3: \left( c_1 + c_3 k_z \right) \sigma_0 + c_2 (\sigma_1 k_z + \sigma_3 k_y); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 k_x + c_2 k_z) + c_3 \sigma_2 k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; A_0 (c_1 + c_2 k_x) + \sqrt{3} A_8 A_9 B_5 k_x + 2 (A_6 c_3 + A_7 c_4 - A_2 c_6) k_x + \left( \sqrt{3} A_8 - A_2 \right) c_4 + 2 (A_1 c_6 - A_4 c_3) k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_x) + \sqrt{3} A_8 A_9 B_5 k_x + 2 (A_4 c_3 + A_7 c_4 - A_1 c_6) k_x + \left( \sqrt{3} A_8 - A_2 \right) c_4 + 2 (A_6 c_3 - A_2 c_6) k_y; \]
\[ U: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{1,i} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_z; \]
\[ P: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_2 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_x) + \sqrt{3} A_8 A_9 B_5 k_x + 2 (A_6 c_3 + A_7 c_4 - A_1 c_6) k_x + \left( \sqrt{3} A_8 - A_2 \right) c_4 + 2 (A_6 c_3 - A_2 c_6) k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_x) + \sqrt{3} A_8 A_9 B_5 k_x + 2 (A_4 c_3 + A_7 c_4 - A_1 c_6) k_x + \left( \sqrt{3} A_8 - A_2 \right) c_4 + 2 (A_6 c_3 - A_2 c_6) k_y; \]
\[ T: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_i [c_{1,i} (\sqrt{3} k_x + k_y) + c_{1,i} k_z] + (c_2 \sigma_1 + c_3 \sigma_2) (k_x - \sqrt{3} k_y); \]
\[ S: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_i [c_{1,i} (\sqrt{3} k_x + k_y) + c_{1,i} k_z] + (c_2 \sigma_1 + c_3 \sigma_2) (k_x - \sqrt{3} k_y); \]
\[ T': \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{1,i} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_z; \]
\[ S': \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{1,i} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_z; \]

\[ \Gamma_h; \{ C_{3z}^+ [000], \{ \sigma_{1x}[00\frac{1}{2}] \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \{ R_3 \}; [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sigma_1 k_y (2 c_4 k_x - c_5 k_x) + \sigma_3 [c_4 (k_x^2 - k_y^2) + c_5 k_x k_z]; \]
\[ A: \{ R_3, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]
\[ \{ R_6, R_6 \}; c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,3 k_z} + \Gamma_{0,1 k_y}) + \sum_{i=1}^{3} \Gamma_{i,0} k_x; \]
\[ L: \{ R_2, R_4 \}; c_1 \sigma_0 + \sigma_3 (c_2 k_x + c_3 k_z); \]
\[ H: \{ R_1, R_1 \}; c_1 \sigma_0 + \sum_{i=1}^{3} c_{1,i} k_x \sigma_i; \]
\[ \{ R_2, R_2 \}; c_1 \sigma_0 + \sum_{i=1}^{3} c_{1,i} k_x \sigma_i; \]
\[ \{ R_3, R_3 \}; c_1 \sigma_0 + \sum_{i=1}^{3} c_{1,i} k_x \sigma_i; \]
\[ \Delta: \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{1,i} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_x; \]
\[ S: \{ R_1, R_1 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{1,i} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_x; \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; A_0 (c_1 + c_2 k_x) + \sqrt{3} A_8 A_9 B_5 k_x + 2 (A_6 c_3 + A_7 c_4 - A_2 c_6) k_x + \left( \sqrt{3} A_8 - A_2 \right) c_4 + 2 (A_1 c_6 - A_4 c_3) k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_x) + \sqrt{3} A_8 A_9 B_5 k_x + 2 (A_4 c_3 + A_7 c_4 - A_1 c_6) k_x + \left( \sqrt{3} A_8 - A_2 \right) c_4 + 2 (A_6 c_3 - A_2 c_6) k_y; \]
\[ U: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{1,i} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_y; \]
\[ P: \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 (\sigma_1 k_y - \sigma_2 k_x) + c_6 (\sigma_1 k_x + \sigma_2 k_y); \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 (\sigma_1 k_y - \sigma_2 k_x) + c_6 (\sigma_1 k_x + \sigma_2 k_y); \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{1,i} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_y; \]
\[ R: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{1,i} k_z) + (c_2 \sigma_1 + c_3 \sigma_2) k_y; \]
\[\Gamma_h; \{C_3^+|000\}, \{\sigma_{d1}|00\frac{1}{3}\}, T; \text{Non-Centrosymmetric; without SOC}\]

\[\Gamma: \{R_5\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + \sigma_1k_x(2c_4k_y + c_5k_z) + \sigma_3(c_4k_x^2 - k_y^2) + c_6k_yk_z; \]

\[A: \{R_3, R_4\}; \quad c_1\sigma_0 + c_2\sigma_3k_z; \]

\[\{R_6, R_8\}; \quad c_1\Gamma_{0,0} + c_2(\Gamma_{0,1}k_x - \Gamma_{0,3}k_y) + \sum_{i=1}^3 c_{i,1}\Gamma_{i,0}k_z; \]

\[L: \{R_2, R_4\}; \quad c_1\sigma_0 + \sigma_3(c_2k_y + c_3k_z); \]

\[K: \{R_3\}; \quad (c_1 + c_2k_z)\sigma_0 + c_3(\sigma_1k_x + \sigma_3k_y); \]

\[H: \{R_6\}; \quad (c_1 + c_2k_z)\sigma_0 + c_3(\sigma_1k_x - \sigma_3k_y); \]

\[\Delta: \{R_3\}; \quad (c_1 + c_2k_z)\sigma_0 + c_3(\sigma_1k_x + c_3k_y); \]

\[P: \{R_3\}; \quad (c_1 + c_2k_z)\sigma_0 + c_3(\sigma_1k_x + c_3k_y); \]

\[R: \{R_1, R_2\}; \quad (c_1 + c_2k_z)\sigma_0 + \sum_{i=1}^3 (c_{i,1}k_y + c_{i,2}k_z)\sigma_i; \]

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Accidental degeneracies on high symmetry line

\[\Delta: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[\{R_1\}, \{R_3\}; \quad A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + 2 (A_6c_3 + A_7c_4 - A_2c_6) k_x + \left((\sqrt{3}A_8 - A_5) c_4 + 2 (A_1c_6 - A_4c_3)\right) k_y; \]

\[\{R_2\}, \{R_3\}; \quad A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + 2 (A_6c_3 + A_7c_4 - A_2c_6) k_x + \left((\sqrt{3}A_8 - A_5) c_4 + 2 (A_1c_6 - A_4c_3)\right) k_y; \]

\[\{R_1\}, \{R_2\}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1}k_y + c_{i,2}k_z) + (c_2\sigma_1 + c_3\sigma_2) k_z; \]

\[P: \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[\{R_1\}, \{R_3\}; \quad A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + 2 (A_6c_3 + A_7c_4 - A_2c_6) k_x + \left((\sqrt{3}A_8 - A_5) c_4 + 2 (A_1c_6 - A_4c_3)\right) k_y; \]

\[\{R_2\}, \{R_3\}; \quad A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + 2 (A_6c_3 + A_7c_4 - A_2c_6) k_x + \left((\sqrt{3}A_8 - A_5) c_4 + 2 (A_1c_6 - A_4c_3)\right) k_y; \]

\[T: \Gamma, \{R_2\}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1}(\sqrt{3}k_x + k_y) + c_{i,2}k_z) + (c_2\sigma_1 + c_3\sigma_2) (k_x - \sqrt{3}k_y); \]

\[S: \{R_1\}, \{R_2\}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1}(\sqrt{3}k_x + k_y) + c_{i,2}k_z) + (c_2\sigma_1 + c_3\sigma_2) (k_x - \sqrt{3}k_y); \]

\[T': \{R_1\}, \{R_2\}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1}k_y + c_{i,2}k_z) + (c_2\sigma_1 + c_3\sigma_2) k_z; \]

\[S': \{R_1\}, \{R_2\}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1}k_y + c_{i,2}k_z) + (c_2\sigma_1 + c_3\sigma_2) k_z; \]

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\[\Gamma_{r\alpha}; \{C_3^+|000\}, \{\sigma_{d1}|00\frac{1}{3}\}, T; \text{Non-Centrosymmetric; without SOC}\]

\[\Gamma: \{R_3\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + \sigma_1k_x(2c_4k_y + c_5k_z) + \sigma_3(c_4k_x^2 - k_y^2) + c_6k_yk_z; \]

\[Z: \{R_3\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + \sigma_1k_x(2c_4k_y + c_5k_z) + \sigma_3(c_4k_x^2 - k_y^2) + c_6k_yk_z; \]

\[\Lambda: \{R_3\}; \quad (c_1 + c_2k_z)\sigma_0 + c_3(\sigma_1k_x + c_3k_y); \]

\[P: \{R_3\}; \quad (c_1 + c_2k_z)\sigma_0 + c_3(\sigma_1k_x + c_3k_y); \]

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Accidental degeneracies on high symmetry line

\[\Lambda: \{R_1\}, \{R_2\}; \quad \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[\{R_1\}, \{R_3\}; \quad A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + 2 (A_6c_3 + A_7c_4 - A_2c_6) k_x + \left((\sqrt{3}A_8 - A_5) c_4 + 2 (A_1c_6 - A_4c_3)\right) k_y; \]

\[\{R_2\}, \{R_3\}; \quad A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + 2 (A_6c_3 + A_7c_4 - A_2c_6) k_x + \left((\sqrt{3}A_8 - A_5) c_4 + 2 (A_1c_6 - A_4c_3)\right) k_y; \]

\[P: \{R_1\}, \{R_3\}; \quad \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z; \]

\[\{R_1\}, \{R_3\}; \quad A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + 2 (A_6c_3 + A_7c_4 - A_2c_6) k_x + \left((\sqrt{3}A_8 - A_5) c_4 + 2 (A_1c_6 - A_4c_3)\right) k_y; \]

\[\{R_2\}, \{R_3\}; \quad A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + 2 (A_6c_3 + A_7c_4 - A_2c_6) k_x + \left((\sqrt{3}A_8 - A_5) c_4 + 2 (A_1c_6 - A_4c_3)\right) k_y; \]
SG 161
\[ \Gamma_{rh} \{ C_4^+ \} \{ 000 \}, \{ \sigma_{d1}, \frac{1}{2}, \frac{1}{2} \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; R_3; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sigma_1 k_x (2c_4 k_y + c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) + c_5 k_y k_z \right] \; ; \]
\[ Z; \{ R_3, R_4 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_z ; \]
\[ \{ R_6, R_9 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,1} k_z - \Gamma_{0,3} k_y) + \sum_{i=1}^{3} c_{i,1} \Gamma_{i,0} k_z ; \]
\[ L; \{ R_2, R_4 \}; \quad c_1 \sigma_0 + \left[ c_2 \left( \sqrt{3} k_x + k_y \right) + c_5 k_z \right] \sigma_3 ; \]
\[ A; \{ R_3 \}; \quad \left( c_1 + c_3 k_z \right) \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_3 k_y \right) ; \]
\[ P; \{ R_3 \}; \quad \left( c_1 + c_3 k_z \right) \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_3 k_y \right) ; \]
\[ B; \{ R_1, R_3 \}; \quad \left( c_1 + c_2 k_z \right) \sigma_0 + \sum_{i=1}^{3} \left( c_{i,1} k_y + c_{i,2} k_z \right) \sigma_i ; \]
\[ Y; \{ R_1, R_3 \}; \quad \left( c_1 + \sqrt{3} c_2 k_x - c_2 k_y \right) \sigma_0 + \sum_{i=1}^{3} \left[ c_{i,1} (\sqrt{3} k_x + k_y) + c_{i,2} k_z \right] \sigma_i ; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z ; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad A_0 \left( c_1 + c_2 k_z \right) + \left( \sqrt{3} A_5 + A_8 \right) c_2 k_z + 2 \left( A_0 c_3 + A_7 c_4 - A_2 c_6 \right) k_x + \left( \sqrt{3} A_8 - A_5 \right) \quad \sigma_1 + 2 \left( A_1 c_6 - A_4 c_3 \right) \right] k_y ; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad A_0 \left( c_1 + c_2 k_z \right) + \left( \sqrt{3} A_5 + A_8 \right) c_2 k_z + 2 \left( A_4 c_3 + A_7 c_4 - A_1 c_6 \right) k_x + \left( \sqrt{3} A_8 - A_5 \right) \quad \sigma_1 + 2 \left( A_1 c_6 - A_4 c_3 \right) \right] k_y ; \]
\[ P; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z ; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad A_0 \left( c_1 + c_2 k_z \right) + \left( \sqrt{3} A_5 + A_8 \right) c_2 k_z + 2 \left( A_0 c_3 + A_7 c_4 - A_2 c_6 \right) k_x + \left( \sqrt{3} A_8 - A_5 \right) \quad \sigma_1 + 2 \left( A_1 c_6 - A_4 c_3 \right) \right] k_y ; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad A_0 \left( c_1 + c_2 k_z \right) + \left( \sqrt{3} A_5 + A_8 \right) c_2 k_z + 2 \left( A_4 c_3 + A_7 c_4 - A_1 c_6 \right) k_x + \left( \sqrt{3} A_8 - A_5 \right) \quad \sigma_1 + 2 \left( A_1 c_6 - A_4 c_3 \right) \right] k_y ; \]

SG 162
\[ \Gamma_h; \{ S_6^+ \} \{ 000 \}, \{ C_{2d} \} \{ 000 \}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; R_5; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sigma_1 k_x (2c_4 k_y + c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) - c_5 k_y k_z \right] ; \]
\[ R_6; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sigma_1 k_x (2c_4 k_y + c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) - c_5 k_y k_z \right] ; \]
\[ A; \{ R_5 \}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sigma_1 k_x (2c_4 k_y + c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) - c_5 k_y k_z \right] ; \]
\[ R_6; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sigma_1 k_x (2c_4 k_y + c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) - c_5 k_y k_z \right] ; \]
\[ K; \{ R_5 \}; \quad \left( c_1 + c_3 k_z \right) \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_3 k_y \right) ; \]
\[ H; \{ R_3 \}; \quad \left( c_1 + c_3 k_z \right) \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_3 k_y \right) ; \]
\[ \Delta; \{ R_3 \}; \quad \left( c_1 + c_3 k_z \right) \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_3 k_y \right) ; \]
\[ P; \{ R_5 \}; \quad \left( c_1 + c_3 k_z \right) \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_3 k_y \right) ; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; A_0 (c_1 + c_2 k_z + \sqrt{3} A_2 + A_3) c_2 k_z + (2A_2 c_4 - A_2 c_5) k_x + [c_5 A_1 - c_4 (A_5 - \sqrt{3} A_8)] k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_z + \sqrt{3} A_2 + A_3) c_3 k_z + (2A_2 c_4 - A_1 c_5) k_x - [c_5 A_2 + c_4 (A_5 - \sqrt{3} A_8)] k_y; \]

\[ U: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_1 k_y + c_2 k_z) + c_3 \sigma_1 k_x; \]
\[ P: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; A_0 (c_1 + c_2 k_z + \sqrt{3} A_2 + A_3) c_2 k_z + (2A_2 c_4 - A_2 c_5) k_x + [c_5 A_1 - c_4 (A_5 - \sqrt{3} A_8)] k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_z + \sqrt{3} A_2 + A_3) c_3 k_z + (2A_2 c_4 - A_1 c_5) k_x - [c_5 A_2 + c_4 (A_5 - \sqrt{3} A_8)] k_y; \]

\[ T: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_1 k_y + c_2 k_z) + c_3 \sigma_1 k_x; \]
\[ S: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_1 k_y + c_2 k_z) + c_3 \sigma_1 k_x; \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i, c_1 k_x + \sigma_1 (c_2 k_y + c_3 k_z); \]

SG 163

\[ \Gamma_h: \{ S_0^+ |000\}, \{ C_{2z}^+ |001\}; T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma: \{ R_5 \}; \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sigma_1 k_x (2c_4 k_y + c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) - c_5 k_y k_z \right]; \]
\[ \{ R_6 \}; \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sigma_1 k_x (2c_4 k_y + c_5 k_z) + \sigma_3 \left[ c_4 (k_x^2 - k_y^2) + c_5 k_y k_z \right]; \]

\[ A: \{ R_1, R_8 \}; c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2k_y} + \Gamma_{3,1k_y}) + k_x (c_4 \Gamma_{1,2} + c_5 \Gamma_{2,2}); \]
\[ \{ R_9 \}; \sigma_0 c_1 + c_2 \sigma_1 k_x; \]

\[ L: \{ R_5 \}; c_1 \sigma_0 + \sigma_2 (c_2 k_y + c_3 k_z); \]
\[ K: \{ R_3 \}; (c_1 + c_3 k_x) \sigma_0 + c_2 (\sigma_1 k_z + c_3 k_y); \]
\[ H: \{ R_6 \}; (c_1 + c_3 k_x) \sigma_0 + c_2 (\sigma_1 k_z - c_3 k_y); \]

\[ \Delta: \{ R_3 \}; (c_1 + c_2 k_z) \sigma_0 + c_2 (\sigma_1 k_x + c_3 k_y); \]
\[ P: \{ R_5 \}; (c_1 + c_3 k_x) \sigma_0 + c_2 (\sigma_1 k_z + c_3 k_y); \]
\[ R: \{ R_2, R_4 \}; (c_1 + c_3 k_x) \sigma_0 + \sum_{i=1}^2 (c_1 k_y + c_2 k_z) \sigma_i; \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; A_0 (c_1 + c_2 k_z + \sqrt{3} A_2 + A_3) c_2 k_z + (2A_2 c_4 - A_2 c_5) k_x + [c_5 A_1 - c_4 (A_5 - \sqrt{3} A_8)] k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_z + \sqrt{3} A_2 + A_3) c_3 k_z + (2A_2 c_4 - A_1 c_5) k_x - [c_5 A_2 + c_4 (A_5 - \sqrt{3} A_8)] k_y; \]

\[ U: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_1 k_y + c_2 k_z) + c_3 \sigma_1 k_x; \]
\[ P: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_2 \}; A_0 (c_1 + c_2 k_z + \sqrt{3} A_2 + A_3) c_2 k_z + (2A_2 c_4 - A_2 c_5) k_x + [c_5 A_1 - c_4 (A_5 - \sqrt{3} A_8)] k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_z + \sqrt{3} A_2 + A_3) c_3 k_z + (2A_2 c_4 - A_1 c_5) k_x - [c_5 A_2 + c_4 (A_5 - \sqrt{3} A_8)] k_y; \]

\[ T: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_1 k_y + c_2 k_z) + c_3 \sigma_1 k_x; \]
\[ S: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_1 k_y + c_2 k_z) + c_3 \sigma_1 k_x; \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i, c_1 k_x + \sigma_1 (c_2 k_y + c_3 k_z); \]
\[ \Gamma_h; \{ S_6^+ \{000\}, C_4'' \{001\}\}; T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; R_5; \quad \sigma_0 \left( c_1 + c_3 (k_x^2 + k_y^2) + c_5 k_x^2 \right) \sigma_0 + \sigma_1 k_y \left( 2c_4 k_x + c_5 k_x \right) + \sigma_3 \left( c_4 (k_x^2 - k_y^2) + c_5 k_x k_z \right) ; \]

\[ R_6; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sigma_1 k_y \left( 2c_4 k_x - c_5 k_z \right) + \sigma_3 \left( c_4 (k_x^2 - k_y^2) + c_5 k_x k_z \right) ; \]

\[ A; R_5; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sigma_1 k_y \left( 2c_4 k_x + c_5 k_z \right) + \sigma_3 \left( c_4 (k_x^2 - k_y^2) + c_5 k_x k_z \right) ; \]

\[ R_6; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sigma_1 k_y \left( 2c_4 k_x - c_5 k_z \right) + \sigma_3 \left( c_4 (k_x^2 - k_y^2) + c_5 k_x k_z \right) ; \]

\[ K; R_3; \quad c_1 \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_3 k_y \right) ; \]

\[ H; R_3; \quad c_1 \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_3 k_y \right) ; \]

\[ \Delta; R_3; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \left( \sigma_3 k_z - \sigma_1 k_y \right) ; \]

\[ P; \quad \{ R_2, R_3 \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_1 \left( c_4 k_x + c_5 k_y \right) + \sigma_2 \left( c_2 k_y - c_3 k_z \right) ; \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 \left( c_1 + c_4 k_x \right) + c_1 + \sigma_4 \left( c_5 - c_4 \right) k_z ; \]

\[ \{ R_1 \}, \{ R_3 \}; \quad A_0 \left( c_1 + c_2 k_z \right) + \left( \sqrt{3} A_4 + A_8 \right) c_4 k_x - 2 \left( A_2 c_3 + A_2 c_5 \right) k_y + \left[ \left( \sqrt{3} A_8 - A_3 \right) c_3 - 2A_1 c_5 \right] k_z ; \]

\[ \{ R_2 \}, \{ R_3 \}; \quad A_0 \left( c_1 + c_3 k_z \right) + \left( \sqrt{3} A_4 + A_8 \right) c_4 k_x - 2 \left( A_7 c_3 - A_4 c_5 \right) k_y + \left[ \left( \sqrt{3} A_8 - A_3 \right) c_3 - 2A_2 c_6 \right] k_z ; \]

\[ U; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left( c_{1,1} k_y + c_{2,2} k_z \right) + c_2 \sigma_1 k_y ; \]

\[ P; \quad \{ R_1 \}, \{ R_2, R_3 \}; \quad A_0 \left( c_1 + c_2 k_z \right) + \left( \sqrt{3} A_4 + A_8 \right) c_4 k_x + \left[ \left( A_4 + A_6 \right) c_3 + A_2 c_4 + \left( A_2 - A_4 \right) c_5 - A_3 c_6 \right] k_x + \left( A_1 - A_2 \right) c_3 + A_2 c_4 + \left( A_4 + A_6 \right) c_3 + \left( A_2 - A_4 \right) c_5 - A_3 c_6 \right] k_y ; \]

\[ T; \quad \{ R_1 \}, \{ R_2 \}; \quad \sum_{i=0,3} \sigma_i \left( c_{1,1} + c_{2,2} \left( \sqrt{3} k_x + k_y \right) \right) + \sigma_1 \left( k_x - \sqrt{3} k_y \right) + c_2 k_x ; \]

\[ S; \quad \{ R_1 \}, \{ R_2 \}; \quad \sum_{i=0,3} \sigma_i \left( c_{1,1} + c_{2,2} \left( \sqrt{3} k_x + k_y \right) \right) + \sigma_1 \left( k_y - \sqrt{3} k_x \right) + c_2 k_y ; \]

\[ T'; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left( c_{1,1} k_y + c_{2,2} k_z \right) + c_2 \sigma_1 k_y \; ; \]

\[ S'; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left( c_{1,1} k_y + c_{2,2} k_z \right) + c_2 \sigma_1 k_y \; ; \]

\[ \Sigma; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left( c_{1,1} k_y + c_{2,2} k_z \right) + c_2 \sigma_1 k_y \; ; \]

\[ R; \quad \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left( c_{1,1} k_y + c_{2,2} k_z \right) + c_2 \sigma_1 k_y \; ; \]

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\[ \Gamma_h; \{ S_6^+ \{000\}, C_4'' \{001\}\}; T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; R_5; \quad \left[ c_1 + c_3 (k_x^2 + k_y^2) + c_5 k_x^2 \right] \sigma_0 + \sigma_1 k_y \left( 2c_4 k_x + c_5 k_x \right) + \sigma_3 \left( c_4 (k_x^2 - k_y^2) + c_5 k_x k_z \right) ; \]

\[ R_6; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_5 k_z^2 \right] \sigma_0 + \sigma_1 k_y \left( 2c_4 k_x - c_5 k_z \right) + \sigma_3 \left( c_4 (k_x^2 - k_y^2) + c_5 k_x k_z \right) ; \]

\[ A; \quad \{ R_1, R_2 \}; \quad c_1 \Gamma_{0,0} + c_2 \left( \Gamma_{3,1} k_x - \Gamma_{0,2} k_y \right) + k_x \left( c_4 \Gamma_{1,2} + c_5 \Gamma_{2,2} \right) ; \]

\[ R_9; \quad c_2 \sigma_0 + c_2 \sigma_1 k_z ; \]

\[ L; \quad R_5; \quad c_1 \sigma_0 + c_2 \left( c_4 k_x + c_5 k_z \right) ; \]

\[ K; \quad R_3; \quad c_1 \sigma_0 + c_2 \left( c_1 k_x + c_3 k_y \right) ; \]

\[ H; \quad \{ R_3, R_4 \}; \quad c_1 \sigma_0 + c_2 \sigma_1 + c_3 \sigma_2 \; k_z \; ; \]

\[ \{ R_9, R_6 \}; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^{c_1} \left[ c_{1,1} \left( \Gamma_{1,1} k_x - \Gamma_{1,2} k_y \right) + c_{2,2} k_z \Gamma_{1,2} \right] ; \]

\[ \Delta; \quad R_3; \quad \left[ c_1 + c_2 k_x \right] \sigma_0 + c_3 \left( \sigma_3 k_x - \sigma_1 k_y \right) ; \]

\[ P; \quad \{ R_2, R_3 \}; \quad \left( c_1 + c_2 k_z \right) \sigma_0 + \sigma_1 \left( c_3 k_x + c_4 k_y \right) - \sigma_2 \left( c_4 k_x - c_5 k_y \right) ; \]

\[ S; \quad \{ R_2, R_3 \}; \quad \left( c_1 + \sqrt{3} k_x + k_y \right) \sigma_0 + \sum_{i=1}^{c_2} \left[ c_{1,1} \left( k_x - \sqrt{3} k_y \right) + c_{2,2} k_z \right] \sigma_i ; \]

\[ S'; \quad \{ R_2, R_4 \}; \quad \left( c_1 + c_2 k_y \right) \sigma_0 + \sum_{i=1}^{c_2} \left[ c_{1,1} k_z + c_{2,2} k_x \right] ; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 \left( (c_3 + c_4) k_z + c_1 \right) + \sigma_3 \left( (c_3 - c_4) k_z \right); \]
\[ \{R_2\}, \{R_3\}; A_0 \left( c_1 + c_2 k_z \right) + (\sqrt{3} A_5 + A_8) c_4 k_z - 2 (A_7 c_3 + A_2 c_5) k_y + \left[ (\sqrt{3} A_5 - A_8) c_3 - 2 A_1 c_5 \right] k_z; \]
\[ \{R_2\}, \{R_3\}; A_0 \left( c_1 + c_2 k_z \right) + (\sqrt{3} A_5 + A_8) (c_4 + c_5 k_z) - 2 (A_7 c_3 - A_1 c_6) k_y + \left[ (\sqrt{3} A_5 - A_8) c_3 - 2 A_2 c_6 \right] k_z; \]

\[ U; \{R_1\}, \{R_2\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{1,1} k_y + c_{2,2} k_z) + c_2 \sigma_1 k_y; \]
\[ P; \{R_1\}, \{R_2, R_3\}; A_0 \left( c_1 + c_2 k_z \right) + (\sqrt{3} A_5 + A_8) c_7 k_z + [(A_4 + A_6) c_3 + A_5 c_4 + (A_2 - A_1) c_3 - A_5 c_6] k_z + [(A_1 - A_2) c_3 + A_5 c_4 + (A_4 + A_6) c_5 + A_7 c_6] k_y; \]
\[ T; \{R_1\}, \{R_2\}; \sum_{i=0,3} \sigma_i \left[ (c_{1,1} + c_{1,2} (\sqrt{3} k_x + k_y)) \right] + \sigma_1 \left[ c_1 (k_y - \sqrt{3} k_y) + c_2 k_z \right]; \]
\[ T'; \{R_1\}, \{R_2\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{1,1} k_y + c_{1,2} k_z) + c_2 \sigma_1 k_y; \]
\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{1,1} k_y + c_{1,2} k_z) + c_2 \sigma_1 k_y; \]
\[ R; \{R_1\}, \{R_2\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{1,1} k_y + c_{1,2} k_z) + c_2 \sigma_1 k_y; \]

SG 166

\[ \Gamma_{14}; \{S^x_{\uparrow}\} \{000\}, \{C^z_{2h}\} \{000\}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; \{R_5\}; [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sigma_1 k_x (2 c_1 k_y + c_3 k_z) + \sigma_2 \left[ c_4 \left( k_x^2 - k_y^2 \right) - c_5 k_y k_z \right]; \]
\[ \{R_6\}; [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sigma_1 k_x (2 c_1 k_y + c_3 k_z) + \sigma_2 \left[ c_4 \left( k_x^2 - k_y^2 \right) - c_5 k_y k_z \right]; \]
\[ \{R_7\}; [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sigma_1 k_x (2 c_1 k_y + c_3 k_z) + \sigma_2 \left[ c_4 \left( k_x^2 - k_y^2 \right) - c_5 k_y k_z \right]; \]
\[ \{R_8\}; [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + \sigma_1 k_x (2 c_1 k_y + c_3 k_z) + \sigma_2 \left[ c_4 \left( k_x^2 - k_y^2 \right) - c_5 k_y k_z \right]; \]
\[ \Lambda; \{R_5\}; (c_1 + c_3 k_z) \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y); \]
\[ \{R_6\}; (c_1 + c_3 k_z) \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y); \]
\[ \{R_7\}; (c_1 + c_3 k_z) \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y); \]
\[ \{R_8\}; (c_1 + c_3 k_z) \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y); \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 \left( c_1 + c_2 k_z \right) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_2\}; A_0 \left( c_1 + c_2 k_z \right) + (\sqrt{3} A_5 + A_8) c_3 k_z + \left( 2 A_7 c_3 - A_2 c_5 \right) k_x + [c_5 A_1 - c_4 \left( A_5 - \sqrt{3} A_8 \right)] k_y; \]
\[ \{R_2\}, \{R_3\}; A_0 \left( c_1 + c_2 k_z \right) + (\sqrt{3} A_5 + A_8) c_3 k_z + \left( 2 A_7 c_3 - A_2 c_5 \right) k_x + [c_5 A_2 + c_4 \left( A_5 - \sqrt{3} A_8 \right)] k_y; \]
\[ P; \{R_1\}, \{R_2\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{1,1} k_x + \sigma_1 (c_2 k_y + c_3 k_z)); \]
\[ \{R_1\}, \{R_2\}; A_0 \left( c_1 + c_2 k_z \right) + (\sqrt{3} A_5 + A_8) c_3 k_z + \left( 2 A_7 c_3 - A_2 c_5 \right) k_x + [c_5 A_1 - c_4 \left( A_5 - \sqrt{3} A_8 \right)] k_y; \]
\[ \{R_2\}, \{R_3\}; A_0 \left( c_1 + c_2 k_z \right) + (\sqrt{3} A_5 + A_8) c_3 k_z + \left( 2 A_7 c_3 - A_2 c_5 \right) k_x + [c_5 A_2 + c_4 \left( A_5 - \sqrt{3} A_8 \right)] k_y; \]
\[ B; \{R_1\}, \{R_2\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{1,1} k_x + \sigma_1 (c_2 k_y + c_3 k_z)); \]
\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{1,1} k_x + \sigma_1 (c_2 k_y + c_3 k_z)); \]
\[ Q; \{R_1\}, \{R_2\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{1,1} (k_x + \sqrt{3} k_y) + \sigma_1 [c_2 \left( \sqrt{3} k_x - k_y \right) + c_3 k_z]); \]
\[ Y; \{R_1\}, \{R_2\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{1,1} (k_x - \sqrt{3} k_y) + \sigma_1 [c_2 \left( \sqrt{3} k_x + k_y \right) + c_3 k_z]); \]
\[ \Gamma; R_5; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sigma_1 k_x (2c_4 k_y + c_5 k_z) + \sigma_2 \left( c_4 (k_x^2 - k_y^2) - c_5 k_y k_z \right); \]
\[ R_6; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + \sigma_1 k_x (2c_4 k_y + c_5 k_z) + \sigma_2 \left( c_4 (k_x^2 - k_y^2) + c_5 k_y k_z \right); \]
\[ Z; \{ R_5, R_6 \}; \quad c_1 \Gamma_0 + c_2 (\Gamma_0, 2k_x + \Gamma_3, k_y) + k_z (c_4 \Gamma_1, 2 + c_3 \Gamma_2); \]
\[ R_9; \quad c_1 \sigma_0 + c_2 \sigma_1 k_z; \]
\[ L; R_5; \quad c_1 \sigma_0 + c_2 \left[ c_2 (\sqrt{3}k_y + k_y) + c_3 k_z \right]; \]
\[ A; R_3; \quad (c_1 + c_3 k_x) \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_3 k_y \right); \]
\[ P; R_3; \quad (c_1 + c_3 k_x) \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_3 k_y \right); \]
\[ B; \{ R_2, R_4 \}; \quad (c_1 + c_2 k_x) \sigma_0 + \sum_{i=1}^2 \sigma_i (c_1 k_y + c_i k_z); \]
\[ Y; \{ R_2, R_4 \}; \quad (c_1 + c_2 k_x - c_2 \sqrt{3} k_y) \sigma_0 + \sum_{i=1}^2 \left[ c_1 (\sqrt{3} k_x + k_y) + c_i k_z \right] \sigma_i; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 \left( c_1 + c_2 k_x \right) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad A_0 \left( c_1 + c_2 k_x \right) + \left( \sqrt{3} A_5 + A_8 \right) c_3 k_z + (2A_7 c_4 - A_2 c_3) k_x + \left[ c_5 A_1 - c_4 \left( A_5 - \sqrt{3} A_8 \right) \right] k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad A_0 \left( c_1 + c_2 k_x \right) + \left( \sqrt{3} A_5 + A_8 \right) c_3 k_z + (2A_7 c_4 - A_2 c_3) k_x - \left[ c_5 A_2 + c_4 \left( A_5 - \sqrt{3} A_8 \right) \right] k_y; \]
\[ P; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 \left( c_1 + c_2 k_x \right) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad A_0 \left( c_1 + c_2 k_x \right) + \left( \sqrt{3} A_5 + A_8 \right) c_3 k_z + (2A_7 c_4 - A_2 c_3) k_x + \left[ c_5 A_1 - c_4 \left( A_5 - \sqrt{3} A_8 \right) \right] k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad A_0 \left( c_1 + c_2 k_x \right) + \left( \sqrt{3} A_5 + A_8 \right) c_3 k_z + (2A_7 c_4 - A_2 c_3) k_x - \left[ c_5 A_2 + c_4 \left( A_5 - \sqrt{3} A_8 \right) \right] k_y; \]
\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 \left( c_1 + \sum_{i=0,3} \sigma_i c_i k_x + \sigma_1 (c_2 k_y + c_3 k_z) \right); \]
\[ Q; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 \left( c_1 + \sum_{i=0,3} \sigma_i c_i k_x + \sqrt{3} k_y \right) + \sigma_1 \left[ c_2 \left( \sqrt{3} k_x + k_y \right) + c_3 k_z \right]; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_3 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]

\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k_x \sigma_+ + h.c.); \]

\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k_x \sigma_+ + h.c.); \]

\[ \{ R_1 \}, \{ R_5 \} : \sigma_0 (c_1 + c_3 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]

\[ \{ R_2 \}, \{ R_6 \} : \sigma_0 (c_1 + c_3 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]

\[ \{ R_2 \}, \{ R_7 \} : \sigma_0 \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k_x \sigma_+ + h.c.); \]

\[ \{ R_2 \}, \{ R_8 \} : \sigma_0 \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k_x \sigma_+ + h.c.); \]

\[ \{ R_2 \}, \{ R_9 \} : \sigma_0 (c_1 + c_3 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]

\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_3 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]

**SG 169**

\[ \Gamma_h: \{ C_0^2 \}, T; \text{ Non-Centrosymmetric, without SOC} \]

\[ \Gamma: \{ R_2, R_6 \} : \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_3 k_z + (\alpha_1 \sigma_+ k_x^2 + h.c.); \]

\[ \{ R_3, R_5 \} : \left[ c_1 + c_2 k_x^2 + k_y^2 + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_3 k_z + (\alpha_1 \sigma_+ k_x^2 + h.c.); \]

\[ \{ R_4, R_12 \} : c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_4, R_10 \} : c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_6, R_8 \} : c_1 \sigma_0 + c_3 \sigma_3 k_z; \]

\[ \{ R_7, R_4 \} : c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ \{ R_2, R_3 \} : c_1 \sigma_0 + c_2 \left( \sigma_1 k_x + \sigma_2 k_y \right) + c_3 \left( \sigma_1 k_y - \sigma_2 k_x \right) + c_4 \sigma_3 k_z; \]

\[ \{ R_1, R_11 \} : c_1 \sigma_0 + (c_2 \sigma_1 - c_3 \sigma_2 + c_2 \sigma_3) k_z; \]

\[ \{ R_9, R_2 \} : c_1 \sigma_0 + c_3 \sigma_3 k_z; \]

**S:** \{ R_1, R_1 \} : \left( c_1 + c_2 k_x + c_3 k_y \right) \sigma_0 + \left( c_4 \sigma_1 + c_5 \sigma_2 + c_6 \sigma_3 \right) k_z;

**S':** \{ R_1, R_1 \} : \left( c_1 + c_2 k_x + c_3 k_y \right) \sigma_0 + \left( c_4 \sigma_1 + c_5 \sigma_2 + c_6 \sigma_3 \right) k_z;

**R:** \{ R_1, R_1 \} : \left( c_1 + c_2 k_x + c_3 k_y \right) \sigma_0 + \left( c_4 \sigma_1 + c_5 \sigma_2 + c_6 \sigma_3 \right) k_z;
Accidental degeneracies on high symmetry line
\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z + \alpha_1 k_y + h.c.) \];
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z] + (\alpha_1 k_y + h.c.) \];
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z] + (\alpha_1 k_y + h.c.) \];
\[ \{ R_1 \}, \{ R_5 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z] + (\alpha_1 k_y + h.c.) \];
\[ \{ R_1 \}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z] + (\alpha_1 k_y + h.c.) \];
\[ \{ R_1 \}, \{ R_7 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z] + (\alpha_1 k_y + h.c.) \];
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z] + (\alpha_1 k_y + h.c.) \];
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z] + (\alpha_1 k_y + h.c.) \];
\[ \{ R_2 \}, \{ R_5 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z] + (\alpha_1 k_y + h.c.) \];
\[ \{ R_2 \}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z] + (\alpha_1 k_y + h.c.) \];
\[ \{ R_2 \}, \{ R_7 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z] + (\alpha_1 k_y + h.c.) \];
\[ U; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_x + \sigma_1 k_y + \sigma_2 k_y + \sigma_3 k_z) \];
\[ P; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_y + \sigma_1 k_x + \sigma_2 k_x + \sigma_3 k_z) \];
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_y + \sigma_1 k_x + \sigma_2 k_x + \sigma_3 k_z) \];
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_y + \sigma_1 k_x + \sigma_2 k_x + \sigma_3 k_z) \];

SG 170
\Gamma_h; \{ C_6^2 \}; \Gamma; \text{Non-Centrosymmetric, without SOC}
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k - \sigma_+ + h.c.); \]
\[ \{R_1\}, \{R_2\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{i,1} k^2 + c_{i,2} k_x + c_{i,3} k_z] + (\alpha_1 \sigma_+ k^2 + h.c.); \]
\[ \{R_1\}, \{R_3\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{i,1} k^2 + c_{i,2} k_x + c_{i,3} k_z (1 + c_{i,4} k^2 + c_{i,5} k_z^2)] + [(\alpha_1 k^2 + \alpha_2 k_z^2) \sigma_+ + h.c.]; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{i,1} k^2 + c_{i,2} k_x + c_{i,3} k_z] + (\alpha_1 \sigma_+ k^2 + h.c.); \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k + \sigma_+ + h.c.); \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k - \sigma_+ + h.c.); \]
\[ \{R_2\}, \{R_4\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{i,1} k^2 + c_{i,2} k_x + c_{i,3} k_z] + (\alpha_1 \sigma_+ k^2 + h.c.); \]
\[ \{R_2\}, \{R_5\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{i,1} k^2 + c_{i,2} k_x + c_{i,3} k_z (1 + c_{i,4} k^2 + c_{i,5} k_z^2)] + [(\alpha_1 k^2 + \alpha_2 k_z^2) \sigma_+ + h.c.]; \]
\[ \{R_2\}, \{R_6\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{i,1} k^2 + c_{i,2} k_x + c_{i,3} k_z] + (\alpha_1 \sigma_+ k^2 + h.c.); \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k - \sigma_+ + h.c.); \]
\[ \{R_3\}, \{R_5\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{i,1} k^2 + c_{i,2} k_x + c_{i,3} k_z] + (\alpha_1 \sigma_+ k^2 + h.c.); \]
\[ \{R_3\}, \{R_6\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{i,1} k^2 + c_{i,2} k_x + c_{i,3} k_z (1 + c_{i,4} k^2 + c_{i,5} k_z^2)] + [(\alpha_1 k^2 + \alpha_2 k_z^2) \sigma_+ + h.c.]; \]
\[ \{R_4\}, \{R_5\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k - \sigma_+ + h.c.); \]
\[ \{R_4\}, \{R_6\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{i,1} k^2 + c_{i,2} k_x + c_{i,3} k_z] + (\alpha_1 \sigma_+ k^2 + h.c.); \]
\[ \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k - \sigma_+ + h.c.); \]

U: \[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sigma_1 (c_1 k_x + c_2 k_y) + \sigma_2 (c_3 k_x + c_4 k_y); \]

P: \[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k - \sigma_+ + h.c.); \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k + \sigma_+ + h.c.); \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k - \sigma_+ + h.c.); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (\alpha_1 k_x \sigma_x + \text{h.c.}) ; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z^2 + (\alpha_1 k_x \sigma_x + \text{h.c.})] ; \]
\[ \{ R_1 \}, \{ R_4 \} : \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z^2 + (\alpha_1 k_x \sigma_x + \text{h.c.})] ; \]
\[ \{ R_1 \}, \{ R_6 \} : \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z^2 + (\alpha_1 k_x \sigma_x + \text{h.c.})] ; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z^2 + (\alpha_1 k_x \sigma_x + \text{h.c.})] ; \]
\[ \{ R_2 \}, \{ R_5 \} : \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z^2 + (\alpha_1 k_x \sigma_x + \text{h.c.})] ; \]
\[ \{ R_2 \}, \{ R_7 \} : \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z^2 + (\alpha_1 k_x \sigma_x + \text{h.c.})] ; \]
\[ \{ R_2 \}, \{ R_8 \} : \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z^2 + (\alpha_1 k_x \sigma_x + \text{h.c.})] ; \]
\[ \{ R_4 \}, \{ R_5 \} : \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z^2 + (\alpha_1 k_x \sigma_x + \text{h.c.})] ; \]
\[ \{ R_4 \}, \{ R_6 \} : \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z^2 + (\alpha_1 k_x \sigma_x + \text{h.c.})] ; \]
\[ \{ R_4 \}, \{ R_7 \} : \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [c_i k_x^2 + c_i k_y^2 + c_i k_z^2 + (\alpha_1 k_x \sigma_x + \text{h.c.})] ; \]

\[ U: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k_z \sigma_z + \text{h.c.}) ; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k_z \sigma_z + \text{h.c.}) ; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k_z \sigma_z + \text{h.c.}) ; \]
\[ \{ R_2 \}, \{ R_5 \} : \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k_z \sigma_z + \text{h.c.}) ; \]

\[ P: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (\alpha_1 k_x \sigma_x + \text{h.c.}) ; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (\alpha_1 k_x \sigma_x + \text{h.c.}) ; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (\alpha_1 k_x \sigma_x + \text{h.c.}) ; \]
\[ \{ R_2 \}, \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + (\alpha_1 k_x \sigma_x + \text{h.c.}) ; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
{R_1}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
{R_1}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
{R_1}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
{R_2}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
{R_2}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
{R_2}, \{ R_7 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
{R_3}, \{ R_5 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
{R_3}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
{R_3}, \{ R_7 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 \left[ c_{i,1} k^2 + c_{i,2} k_z^2 + c_{i,3} k_z \right] + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
U; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sigma_1 (c_1 k_x + c_2 k_y) + \sigma_2 (c_3 k_x + c_4 k_y) \; ; \\
P; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
\{ R_1 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
\{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ;

SG 173

Γh; \{ C^+_0 \langle 00\frac{1}{2} \rangle \}, T; Non-Centrosymmetric; without SOC

Γ; \{ R_2, R_6 \}; \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_3 k_z + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
\{ R_3, R_5 \}; \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \sigma_3 k_z + (\alpha_1 k^2 + \sigma_+ + h.c.) \; ; \\
A; \{ R_2, R_{12} \}; c_1 \sigma_0 + c_2 \sigma_3 k_z \; ; \\
\{ R_4, R_{10} \}; c_1 \sigma_0 + c_2 \sigma_3 k_z \; ; \\
\{ R_6, R_8 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z \; ; \\
L; \{ R_2, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z \; ; \\
K; \{ R_2, R_3 \}; c_1 \sigma_0 + c_2 (\sigma_1 k_x + \sigma_2 k_y) + c_3 (\sigma_1 k_y - \sigma_2 k_x) + c_4 \sigma_3 k_z \; ; \\
H; \{ R_1, R_1 \}; (c_3 \sigma_1 - c_1 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0 \; ; \\
\{ R_2, R_2 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z \; ; \\
S; \{ R_1, R_1 \}; (c_1 + c_2 k_x + c_3 k_y) \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2 + c_6 \sigma_3) k_z \; ; \\
S'; \{ R_1, R_1 \}; (c_1 + c_2 k_x + c_3 k_y) \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2 + c_6 \sigma_3) k_z \; ; \\
R; \{ R_1, R_1 \}; (c_1 + c_2 k_x + c_3 k_y) \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2 + c_6 \sigma_3) k_z \; ;
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{1,i} k_x^2 + c_{2,i} k_x^2 + c_{3,i} k_z] + (\alpha_1 \sigma_+ k^2 + \text{h.c.}) ; \]
\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{1,i} k_x^2 + c_{2,i} k_x^2 + c_{3,i} k_z + \{1 + c_{1,i} k^2 + c_{3,i} k^2\}] + \left[(\alpha_1 k_\perp^2 + \alpha_2 k^2_\perp) \sigma_+ + \text{h.c.}\right] ; \]
\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{1,i} k_x^2 + c_{2,i} k_x^2 + c_{3,i} k_z + \alpha_1 \sigma_+ k^2_\perp + \text{h.c.}] ; \]
\[ \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{1,i} k_x^2 + c_{2,i} k_x^2 + c_{3,i} k_z + \alpha_1 \sigma_+ k^2_\perp + \text{h.c.}] ; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 [c_{1,i} k_x^2 + c_{2,i} k_x^2 + c_{3,i} k_z + \alpha_1 \sigma_+ k^2_\perp + \text{h.c.}] ; \]
\[ \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_4 \}, \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_4 \}, \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_5 \}, \{ R_1 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_5 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_5 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_5 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]

SG 174

\[ \Gamma_h; \{ S_3^2 \}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \{ R_2, R_6 \} : [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (\alpha_1 \sigma_+ k^2 + \text{h.c.}) ; \]
\[ \{ R_3, R_6 \} : [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (\alpha_1 \sigma_+ k^2 + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \} : [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (\alpha_1 \sigma_+ k^2 + \text{h.c.}) ; \]
\[ \{ R_5, R_6 \} : [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + (\alpha_1 \sigma_+ k^2 + \text{h.c.}) ; \]
\[ \Delta: \{ R_2, R_3 \} : [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + (\alpha_1 \sigma_+ k^2 + \text{h.c.}) ; \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2, R_3 \} : \left[\sqrt{3} A_1 (c_3 - 2c_4) + \sqrt{3} A_2 (c_4 - 2c_3) + 3 (A_4 c_3 + A_6 c_4) \right] k_z^2 + 3 (A_1 c_3 - A_2 c_4) k_y + \sqrt{3} (2 A_4 + A_6) c_4 - (A_4 + 2 A_6) c_3 k_y + A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) (c_5 + c_6 k_x) ; \]
\[ P: \{ R_1 \}, \{ R_2 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_1 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (\alpha_1 k_\perp \sigma_+ + \text{h.c.}) ; \]
\[ T: \{ R_1 \}, \{ R_2 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 (c_{1,i} k_x + c_{2,i} k_y) + (c_2 \sigma_1 + c_3 \sigma_2) k_z ; \]
\[ S: \{ R_1 \}, \{ R_2 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 (c_{1,i} k_x + c_{2,i} k_y) + (c_2 \sigma_1 + c_3 \sigma_2) k_z ; \]
\[ T': \{ R_1 \}, \{ R_2 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 (c_{1,i} k_x + c_{2,i} k_y) + (c_2 \sigma_1 + c_3 \sigma_2) k_z ; \]
\[ S': \{ R_1 \}, \{ R_2 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 (c_{1,i} k_x + c_{2,i} k_y) + (c_2 \sigma_1 + c_3 \sigma_2) k_z ; \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 (c_{1,i} k_x + c_{2,i} k_y) + (c_2 \sigma_1 + c_3 \sigma_2) k_z ; \]
\[ R: \{ R_1 \}, \{ R_2 \} : \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 (c_{1,i} k_x + c_{2,i} k_y) + (c_2 \sigma_1 + c_3 \sigma_2) k_z ; \]
$\Gamma$: \{R_2, R_3\}; $[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (\alpha_1\sigma_+k_z^2 + \text{h.c.})$;
$\{R_5, R_6\}$; $[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (\alpha_1\sigma_+k_z^2 + \text{h.c.})$;
$\{R_8, R_9\}$; $[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (\alpha_1\sigma_+k_z^2 + \text{h.c.})$;
$\{R_{11}, R_{12}\}$; $[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (\alpha_1\sigma_+k_z^2 + \text{h.c.})$;

$A$: \{R_2, R_3\}; $[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (\alpha_1\sigma_+k_z^2 + \text{h.c.})$;
$\{R_6, R_9\}$; $[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (\alpha_1\sigma_+k_z^2 + \text{h.c.})$;
$\{R_{11}, R_{12}\}$; $[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (\alpha_1\sigma_+k_z^2 + \text{h.c.})$;

$K$: \{R_2, R_6\}; $c_5(\sigma_2k_x + \sigma_1k_y) + c_2(\sigma_1k_x - \sigma_2k_y) + c_1\sigma_0$;
$\{R_3, R_5\}$; $c_3(\sigma_1k_y - \sigma_2k_x) + c_2(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0$;
$H$: \{R_2, R_6\}; $c_5(\sigma_2k_x + \sigma_1k_y) + c_2(\sigma_1k_x - \sigma_2k_y) + c_1\sigma_0$;
$\{R_3, R_5\}$; $c_3(\sigma_1k_y - \sigma_2k_x) + c_2(\sigma_1k_x + \sigma_2k_y) + c_1\sigma_0$;

$\Delta$: \{R_2, R_6\}; $[c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + (\alpha_1\sigma_1k_z^2 + \text{h.c.})$;
$\{R_3, R_5\}$; $[c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + (\alpha_1\sigma_1k_z^2 + \text{h.c.})$;
$P$: \{R_2, R_3\}; $(c_1 + c_2k_x) \sigma_0 + \sigma_1(c_3k_x + c_4k_y) - \sigma_2(c_4k_x - c_3k_y)$;

**Accidental degeneracies on high symmetry line**

$\Delta$: \{R_1\}, \{R_4\}; $\sigma_0(c_1 + c_2k_x) + c_3\sigma_3k_x$;
$\{R_1\}, \{R_2, R_6\}$; $A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) (c_5 + c_6k_x) + [(A_4 + A_6) c_3 + (A_2 - A_1) c_4] k_x + [(A_1 - A_2) c_3 + (A_4 + A_6) c_4] k_y$;
$\{R_1\}, \{R_3, R_5\}$; $A_0 (c_1 + c_2k_x + c_3k^2 + c_4k_z^2) + (\sqrt{3}A_5 + A_8) (c_6k_x + c_10k^2 + c_11k_z^2) + 2(2A_1c_5 + 3A_7c_7 + (A_4 + A_6) c_4 + A_7c_9) k_y + [2(A_4 + A_6) c_5 + 3A_7c_7 + (A_2 - A_1) c_3 - A_3c_9] (k_x^2 - k_y^2)$;

$\{R_2, R_6\}, \{R_3, R_5\}$; $A_0 (c_1 + c_2k_x + c_3k^2 + c_4k_z^2) + A_8 (c_7k_x + c_10k^2 + c_11k_z^2) + 2(-2A_1c_5 + 2A_2 - A_3) c_3 + A_4c_8 + (A_6 + A_7) c_9) k_y + [2A_4c_5 + 2(A_6 + A_7) c_6 + A_1c_8 + (A_3 - A_2) c_9] (k_x^2 - k_y^2)$;

$\{R_2, R_6\}, \{R_3, R_5\}$; $\Gamma_{1,0} (c_3k_x + c_4k_y) + \Gamma_{2,3} (c_3k_y - c_4k_x) + \Gamma_{0,0} (c_1 + c_2k_x) + \Gamma_{3,0} (c_5 + c_6k_x)$;

$U$: \{R_1\}, \{R_2\}; $\sigma_0(c_1 + c_2k_x) + c_1\sigma_3k_x + c_1 (c_5k_x + c_5k_y)$;
$P$: \{R_1\}, \{R_2, R_3\}; $A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) c_7k_x + [(A_4 + A_6) c_3 + A_7c_4 + (A_2 - A_1) c_5 - A_3c_9] k_x + [(A_1 - A_2) c_3 + A_4c_4 + (A_4 + A_6) c_5 + A_7c_9] k_y$;

$T$: \{R_1\}, \{R_2\}; $\sigma_0c_1 + \sum_{i=0,3} \sigma_0(c_i,1k_x + c_i,2k_y) + c_2\sigma_1k_x$;
$S$: \{R_1\}, \{R_2\}; $\sigma_0c_1 + \sum_{i=0,3} \sigma_0(c_i,1k_x + c_i,2k_y) + c_2\sigma_1k_x$;
$T'$: \{R_1\}, \{R_2\}; $\sigma_0c_1 + \sum_{i=0,3} \sigma_0(c_i,1k_x + c_i,2k_y) + c_2\sigma_1k_x$;

$S'$: \{R_1\}, \{R_2\}; $\sigma_0c_1 + \sum_{i=0,3} \sigma_0(c_i,1k_x + c_i,2k_y) + c_2\sigma_1k_x$;
$\Sigma$: \{R_1\}, \{R_2\}; $\sigma_0c_1 + \sum_{i=0,3} \sigma_0(c_i,1k_x + c_i,2k_y) + c_2\sigma_1k_x$;
$R$: \{R_1\}, \{R_2\}; $\sigma_0c_1 + \sum_{i=0,3} \sigma_0(c_i,1k_x + c_i,2k_y) + c_2\sigma_1k_x$;
Accidental degeneracies on high symmetry line

$\Delta$: \(\{R_2, R_3\}\), \(\{R_4, R_5\}\); 
\(\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \)
\(\{R_1, R_2, R_3\}\), \(\{R_2, R_5, R_6, R_7\}\); 
\(A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) (c_5 + c_6 k_z) + [(A_4 + A_6) c_6] k_x + [(A_1 + A_7) c_3 + (A_4 + A_6) c_4] k_z; \)
\(\{R_1, R_2, R_3\}\), \(\{R_3, R_5\}\); 
\(A_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2_0) + (\sqrt{3} A_5 + A_8) (c_5 k_x + c_6 k_z + c_10 k^2 + c_11 k^2_z) + 
2 [2 (A_1 - A_2) c_4 + 2 A_3 c_7 + (A_4 + A_6) c_8 + A_7 c_9] k_y k_z + 
2 [2 (A_3 + A_6) c_3 + 2 A_7 c_7 + (A_1 - A_2) c_8 - A_3 c_9] (k_x^2 - k_y^2); \)
\(\{R_2, R_6, R_7\}\), \(\{R_3, R_4, R_5\}\); 
\(A_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2_0) + A_8 (c_7 k_x + c_10 k^2 + c_11 k^2_z) + 
2 [-2 A_5 c_5 + 2 (A_2 - A_3) c_6 + A_4 c_4 + (A_5 + A_7) c_9] k_y k_z + 
2 [2 A_4 c_5 + 2 (A_5 + A_7) c_6 + A_1 c_8 + (A_2 - A_3) c_9] (k_x^2 - k_y^2); \)
\(\{R_2, R_6, R_7\}\), \(\{R_3, R_5\}\); 
\(\Gamma_{1,0} (c_3 k_x + c_4 k_y) + \Gamma_{2,3} (c_6 k_y - c_4 k_x) + \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} (c_5 + c_6 k_z) ; \)
\(\{R_3, R_5, R_6\}\), \(\{R_4, R_5\}\); 
\(A_0 (c_1 + c_2 k_x) + A_8 (c_5 + c_6 k_z) + [(A_4 + A_7) c_3 + (A_3 - A_2) c_4] k_x + [(A_2 - A_1) c_3 + (A_6 + A_7) c_4] k_y; \)

$U$: \(\{R_1, R_2\}\), \(\{R_3, R_4\}\); 
\(\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + \sigma_1 (c_5 k_x + c_6 k_z); \)

$P$: \(\{R_1, R_2, R_3\}\); 
\(A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_7 k_x + [(A_4 + A_6) c_8 + A_7 c_4 + (A_2 - A_1) c_3 - A_3 c_6] k_x + 
[(A_2 - A_1) c_3 + A_4 c_4 + (A_4 + A_6) c_5 + A_7 c_6] k_y; \)

$T$: \(\{R_1, R_2\}\); 
\(\sigma_0 c_1 + \sum_{\alpha=0,3} \sigma_0 (c_1 k_x + c_3 k_y) + c_2 \sigma_1 k_z; \)

$T'$: \(\{R_1, R_2\}\); 
\(\sigma_0 c_1 + \sum_{\alpha=0,3} \sigma_0 (c_1 k_x + c_3 k_y) + c_2 \sigma_1 k_z; \)

$\Sigma$: \(\{R_1, R_2\}\); 
\(\sigma_0 c_1 + \sum_{\alpha=0,3} \sigma_0 (c_1 k_x + c_3 k_y) + c_2 \sigma_1 k_z; \)
\[ \Delta: \{ R_1 \}, \{ R_2 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + c_2 \left[ (\sigma_1 - \sqrt{3} \sigma_2) k_x + (\sqrt{3} \sigma_1 + \sigma_2) k_y \right]; \\
\{ R_1 \}, \{ R_3 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 - i \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
\{ R_1 \}, \{ R_4 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 + i \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
\{ R_1 \}, \{ R_5 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 + \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
\{ R_1 \}, \{ R_6 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 + i \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
\{ R_2 \}, \{ R_3 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (\sigma_1 - \sqrt{3} \sigma_2) k_x + (\sqrt{3} \sigma_1 + \sigma_2) k_y \right]; \\
\{ R_2 \}, \{ R_4 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 - i \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
\{ R_2 \}, \{ R_5 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 + i \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
\{ R_2 \}, \{ R_6 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 + \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
\{ R_3 \}, \{ R_4 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (\sigma_1 - \sqrt{3} \sigma_2) k_x + (\sqrt{3} \sigma_1 + \sigma_2) k_y \right]; \\
\{ R_3 \}, \{ R_5 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 - i \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
\{ R_3 \}, \{ R_6 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 + i \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
\{ R_4 \}, \{ R_5 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (\sigma_1 - \sqrt{3} \sigma_2) k_x + (\sqrt{3} \sigma_1 + \sigma_2) k_y \right]; \\
\{ R_4 \}, \{ R_6 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 - i \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
\{ R_5 \}, \{ R_6 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + \left[ (1 + i \sqrt{3}) c_2 \sigma_4 k^2 + h.c. \right]; \\
U: \{ R_1 \}, \{ R_2 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + c_2 \sigma_1 k_x + c_3 \sigma_2 k_y; \\
P: \{ R_1 \}, \{ R_3 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + c_2 \sigma_1 k_x + c_4 \sigma_2 \left( k_y - \frac{k_x}{\sqrt{3}} \right); \\
\{ R_1 \}, \{ R_4 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + c_2 \left( 3 \sigma_1 + \sqrt{3} \sigma_2 \right) k_x + \left( \sqrt{3} \sigma_1 - 3 \sigma_2 \right) k_y; \\
\{ R_2 \}, \{ R_3 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + c_2 \sigma_1 k_x + c_4 \sigma_2 \left( k_y - \frac{k_x}{\sqrt{3}} \right); \\
T: \{ R_1 \}, \{ R_2 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + c_2 \sigma_1 \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \\
S: \{ R_1 \}, \{ R_3 \}; \; \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_i k_i + c_2 \sigma_1 \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \\
T': \{ R_1 \}, \{ R_2 \}; \; \sigma_1 c_1 + c_2 k_x + c_3 \sigma_2 k_y + c_4 \sigma_1 k_z; \\
S': \{ R_1 \}, \{ R_2 \}; \; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_2 k_y + c_4 \sigma_1 k_z; \\
\Sigma: \{ R_1 \}, \{ R_2 \}; \; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_2 k_y + c_4 \sigma_1 k_z; \\
R: \{ R_1 \}, \{ R_2 \}; \; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_2 k_y + c_4 \sigma_1 k_z; \\
\text{Accidental degeneracies on high symmetry line}
\]
\[ \Gamma_k: \{C_{6h}^{[00\bar{1}]}, C_{3z}^{[000]}\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \quad R_5; \left[ c_1 + c_2(k_x^2 + k_y^2) + c_6k_z^2 \right] - c_4 \left[ 2\sigma_1k_xk_y - \sigma_3 \left( k_x^2 - k_y^2 \right) \right] + c_5\sigma_3k_z; \]
\[ R_6; \left[ c_1 + c_2(k_x^2 + k_y^2) + c_6k_z^2 \right] - c_4 \left[ 2\sigma_1k_xk_y + \sigma_3 \left( k_x^2 - k_y^2 \right) \right] + c_5\sigma_3k_z; \]

\[ A; \quad R_7; c_1\sigma_0 + c_2\sigma_3k_z; \]
\[ R_8; c_1\sigma_0 + c_2\sigma_3k_z; \]
\[ R_9; c_1\sigma_0 + c_2\sigma_3k_z; \]

\[ L; \quad R_5; c_1\sigma_0 + c_2\sigma_3k_z; \]

\[ K; \quad R_5; c_1\sigma_0 + c_2(\sigma_1k_x + \sigma_3k_y) + c_3\sigma_2k_z; \]

\[ H; \quad \{ R_1, R_2 \}; c_1\sigma_0 + (c_2\sigma_1 + c_3\sigma_2)k_z; \]
\[ R_3; c_1\sigma_0 + c_2\sigma_3k_z; \]

\[ S; \quad \{ R_2, R_3 \}; c_1 + c_2(\sqrt{3}k_x + k_y) \left[ \sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z \right]; \]

\[ S'; \quad \{ R_2, R_3 \}; c_1 + c_2(\sqrt{3}k_x + k_y) \left[ \sigma_0 + (c_3\sigma_1 + c_4\sigma_2)k_z \right]; \]

\[ R; \quad \{ R_1, R_2 \}; c_1 + c_2(k_x + c_1)(c_3\sigma_1 + c_4\sigma_2)k_z; \]

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**Accidental degeneracies on high symmetry line**

\[ \Delta; \quad \{ R_1, R_2 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_i c_{i+1}k_z + c_2 \left[ (\sigma_1 - \sqrt{3}\sigma_2)k_x + (\sqrt{3}\sigma_1 + \sigma_2)k_y \right]; \]
\[ \{ R_1, R_3 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_0 \left[ c_i k_x^2 + c_i k_y^2 + c_i k_z \right] + (1 - i\sqrt{3}) c_2\sigma_3k_z^2 + h.c.; \]
\[ \{ R_1, R_4 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_0 \left[ c_i k_x^2 + c_i k_y^2 + c_i k_z \right] + (1 + i\sqrt{3}) c_2\sigma_3k_z^2 + h.c.; \]
\[ \{ R_1, R_5 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_0 \left[ c_i k_x^2 + c_i k_y^2 + c_i k_z \right] + (1 + i\sqrt{3}) c_2\sigma_3k_z^2 + h.c.; \]
\[ \{ R_1, R_6 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_0 \left[ c_i k_x^2 + c_i k_y^2 + c_i k_z \right] + (1 - i\sqrt{3}) c_2\sigma_3k_z^2 + h.c.; \]
\[ \{ R_2, R_3 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_0 \left[ c_i k_x^2 + c_i k_y^2 + c_i k_z \right] + (1 + i\sqrt{3}) c_2\sigma_3k_z^2 + h.c.; \]
\[ \{ R_2, R_4 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_0 \left[ c_i k_x^2 + c_i k_y^2 + c_i k_z \right] + (1 + i\sqrt{3}) c_2\sigma_3k_z^2 + h.c.; \]
\[ \{ R_2, R_5 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_0 \left[ c_i k_x^2 + c_i k_y^2 + c_i k_z \right] + (1 - i\sqrt{3}) c_2\sigma_3k_z^2 + h.c.; \]
\[ \{ R_2, R_6 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_0 \left[ c_i k_x^2 + c_i k_y^2 + c_i k_z \right] + (1 - i\sqrt{3}) c_2\sigma_3k_z^2 + h.c.; \]

\[ U; \quad \{ R_1, R_2 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_i c_{i+1}k_z + c_2\sigma_3k_z + c_3\sigma_3k_z; \]
\[ P; \quad \{ R_1, R_2 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_i c_{i+1}k_z + c_2\sigma_3 \left( k_x + \frac{\sqrt{3}}{3}k_y \right) + c_3\sigma_3 \left( k_y - \frac{\sqrt{3}}{3}k_x \right); \]
\[ \{ R_1, R_3 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_i c_{i+1}k_z + c_2 \left[ 3\sigma_1 + \sqrt{3}\sigma_2 \right] k_x + (\sqrt{3}\sigma_1 - 3\sigma_2)k_y; \]
\[ \{ R_2, R_3 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_i c_{i+1}k_z + c_2 \sigma_3 \left( k_x + \frac{\sqrt{3}}{3}k_y \right) + c_3\sigma_3 \left( k_y - \frac{\sqrt{3}}{3}k_x \right); \]
\[ T; \quad \{ R_1, R_2 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_i c_{i+1} \left( \sqrt{3}k_x + k_y \right) + c_2\sigma_3 \left( \sqrt{3}k_y - k_x \right) + c_3\sigma_1k_z; \]
\[ T'; \quad \{ R_1, R_2 \}; c_1\sigma_0 + \sum_{i=0}^{3} c_i\sigma_i c_{i+1} \left( \sqrt{3}k_x + k_y \right) + c_2\sigma_3 \left( \sqrt{3}k_y - k_x \right) + c_3\sigma_1k_z; \]

\[ \Sigma; \quad \{ R_1, R_2 \}; c_0 \left[ c_1 + c_2k_x \right] + c_3\sigma_3k_y + c_5\sigma_1k_x + c_6\sigma_2k_z; \]
\[ \Gamma_6: \{ c_0 + c_3 (k_x^2 + k_y^2) + c_5 k_z^2 \} \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y - \sigma_3 (k_y^2 - k_x^2) \right] + c_5 \sigma_2 k_z; \]
\[ \Gamma_9: \{ c_0 + c_3 (k_x^2 + k_y^2) + c_5 k_z^2 \} \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y + \sigma_3 (k_y^2 - k_x^2) \right] + c_5 \sigma_2 k_z; \]
\[ A_7: \ c_1 \sigma_0 + c_3 \sigma_2 k_z; \]
\[ A_8: \ c_1 \sigma_0 + c_3 \sigma_2 k_z; \]
\[ A_9: \ c_1 \sigma_0 + c_3 \sigma_2 k_z; \]
\[ L_5: \ c_1 \sigma_0 + c_3 \sigma_2 k_z; \]
\[ K_1: \ c_1 \sigma_0 + c_2 (\sigma_1 k_z + \sigma_3 k_y) + c_3 \sigma_2 k_z; \]
\[ H_{11}: \{ R_1, R_2 \}; \ c_1 \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z; \]
\[ R_3: \ c_1 \sigma_0 + c_3 \sigma_2 k_z; \]
\[ S: \{ R_2, R_3 \}; \ c_1 \sigma_0 + (c_2 \sqrt{3} k_z + k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ S': \{ R_2, R_3 \}; \ c_1 \sigma_0 + (c_2 \sqrt{3} k_z + k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]
\[ R: \{ R_1, R_2 \}; \ c_0 (c_2 k_x + c_1) + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]

**Accidental degeneracies on high symmetry line**

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 c_i k_z + c_2 \left[ (\sigma_1 - \sqrt{3} \sigma_2) k_z + (\sqrt{3} \sigma_1 + \sigma_2) k_y \right]; \]
\[ \{ R_1 \}, \{ R_3 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 - i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_1 \}, \{ R_4 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 + i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_1 \}, \{ R_5 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 + i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_1 \}, \{ R_6 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 + i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_2 \}, \{ R_3 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 - i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_2 \}, \{ R_4 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 - i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_2 \}, \{ R_5 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 - i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_2 \}, \{ R_6 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 - i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_3 \}, \{ R_4 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 + i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_3 \}, \{ R_5 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 + i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_3 \}, \{ R_6 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 + i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_3 \}, \{ R_6 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 + i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_4 \}, \{ R_5 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 - i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_4 \}, \{ R_6 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 - i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ \{ R_5 \}, \{ R_6 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 \left[ c_i k^2 + c_i k_x^2 + c_i k_z \right] + \left[ (1 - i \sqrt{3}) c_2 \sigma_1 k^2 + h.c. \right]; \]
\[ U: \{ R_1 \}, \{ R_2 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 c_i k_z + c_2 \sigma_0 k_z + c_3 \sigma_2 k_z; \]
\[ P: \{ R_1 \}, \{ R_2 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 c_i k_z + c_2 \sigma_1 \left( k_x + \frac{\sqrt{3}}{3} k_y \right) + c_3 \sigma_2 \left( k_y - \frac{\sqrt{3}}{3} k_x \right); \]
\[ T: \{ R_1 \}, \{ R_2 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 c_i \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \]
\[ T': \{ R_1 \}, \{ R_2 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 c_i \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \ c_0 c_1 + \sum_{i=0}^{i=3} \sigma_0 c_i k_z + c_2 \sigma_0 k_z + c_3 \sigma_2 k_z + c_4 \sigma_3 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( (\sigma_1 - \sqrt{3}\sigma_2) k_x + (\sqrt{3}\sigma_1 + \sigma_2) k_y \right) + \text{h.c.}; \]

\[ \{ R_1 \}, \{ R_3 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( (1 - \sqrt{3}) c_2 \sigma_4 k^2 + \text{h.c.} \right); \]

\[ \{ R_3 \}, \{ R_4 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( 1 + c_2 k^2 + \text{h.c.} \right); \]

\[ \{ R_1 \}, \{ R_2 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( 1 - \sqrt{3} k^2 + \text{h.c.} \right); \]

\[ \{ R_2 \}, \{ R_6 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( 1 + \sqrt{3} k^2 + \text{h.c.} \right); \]

\[ \{ R_3 \}, \{ R_4 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( \sigma_1 - 3 \sigma_2 \right) k_x + \sqrt{3} \sigma_1 \sigma_2 k_y; \]

\[ \{ R_2 \}, \{ R_6 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( \sigma_1 - 3 \sigma_2 \right) k_x + \sqrt{3} \sigma_1 \sigma_2 k_y; \]

\[ \{ R_3 \}, \{ R_4 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( \sigma_1 - 3 \sigma_2 \right) k_x + \sqrt{3} \sigma_1 \sigma_2 k_y; \]

\[ \{ R_2 \}, \{ R_6 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( \sigma_1 - 3 \sigma_2 \right) k_x + \sqrt{3} \sigma_1 \sigma_2 k_y; \]

\[ \{ R_3 \}, \{ R_4 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( \sigma_1 - 3 \sigma_2 \right) k_x + \sqrt{3} \sigma_1 \sigma_2 k_y; \]

\[ \{ R_1 \}, \{ R_2 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( \sigma_1 - 3 \sigma_2 \right) k_x + \sqrt{3} \sigma_1 \sigma_2 k_y; \]

\[ \{ R_2 \}, \{ R_3 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( \sigma_1 - 3 \sigma_2 \right) k_x + \sqrt{3} \sigma_1 \sigma_2 k_y; \]

\[ \{ R_3 \}, \{ R_4 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( \sigma_1 - 3 \sigma_2 \right) k_x + \sqrt{3} \sigma_1 \sigma_2 k_y; \]

\[ \{ R_4 \}, \{ R_5 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \left( \sigma_1 - 3 \sigma_2 \right) k_x + \sqrt{3} \sigma_1 \sigma_2 k_y; \]

U: \{ R_1 \}, \{ R_2 \}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_0 c_{i,1} k_z + c_2 \sigma_1 \left( k_x + \frac{k_y}{\sqrt{3}} \right) + c_2 \sigma_2 \left( k_y - \frac{k_x}{\sqrt{3}} \right);
SG 181

\( \Gamma_h: \{ C_{10}^2[00\frac{3}{2}], C_{10}^2[0000], T \}; \) Non-Centrosymmetric; without SOC

\( \Gamma_i: R_5: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2)] + c_5 \sigma_2 k_z; \\
R_6: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] + c_5 \sigma_2 k_z; \\
A_i: R_5: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2)] + c_5 \sigma_2 k_z; \\
R_6: [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] + c_5 \sigma_2 k_z; \\
K_i: R_3: c_1\sigma_0 + c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_3 \sigma_2 k_z; \\
H_i: R_3: c_1\sigma_0 + c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_3 \sigma_2 k_z; \\

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 k_i + c_2 [(\sigma_1 - \sqrt{3}\sigma_2) k_x + (\sqrt{3}\sigma_1 + \sigma_2) k_y]; \\
\{ R_1 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 [c_1 k_i^2 + c_2 k_i^2 + c_3 k_i^2] + [(1 - i\sqrt{3}) c_2 \sigma_4 k_i^2 + h.c.]; \\
\{ R_1 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 [c_1 k_i^2 + c_2 k_i^2 + c_3 k_i^2] + [(1 + i\sqrt{3}) c_2 \sigma_4 k_i^2 + h.c.]; \\
\{ R_2 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 [c_1 k_i^2 + c_2 k_i^2 + c_3 k_i^2] + [(1 - \sqrt{3}) c_2 \sigma_4 k_i^2 + h.c.]; \\
\{ R_2 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 [c_1 k_i^2 + c_2 k_i^2 + c_3 k_i^2] + [(1 + \sqrt{3}) c_2 \sigma_4 k_i^2 + h.c.]; \\
\{ R_3 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 [c_1 k_i^2 + c_2 k_i^2 + c_3 k_i^2] + [(1 - i\sqrt{3}) c_2 \sigma_4 k_i^2 + h.c.]; \\
\{ R_3 \}, \{ R_5 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 [c_1 k_i^2 + c_2 k_i^2 + c_3 k_i^2] + [(1 + i\sqrt{3}) c_2 \sigma_4 k_i^2 + h.c.]; \\
\{ R_3 \}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 [c_1 k_i^2 + c_2 k_i^2 + c_3 k_i^2] + [(1 - \sqrt{3}) c_2 \sigma_4 k_i^2 + h.c.]; \\
\{ R_4 \}, \{ R_5 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 [c_1 k_i^2 + c_2 k_i^2 + c_3 k_i^2] + [(1 + \sqrt{3}) c_2 \sigma_4 k_i^2 + h.c.]; \\
\{ R_4 \}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 [c_1 k_i^2 + c_2 k_i^2 + c_3 k_i^2] + [(1 - i\sqrt{3}) c_2 \sigma_4 k_i^2 + h.c.]; \\
\{ R_5 \}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 [c_1 k_i^2 + c_2 k_i^2 + c_3 k_i^2] + [(1 + i\sqrt{3}) c_2 \sigma_4 k_i^2 + h.c.]; \\

U: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 k_i + c_2 \sigma_1 k_i + c_3 \sigma_2 k_i; \\
P: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 k_i + c_2 \sigma_1 \left( k_x + \frac{\sqrt{3} k_y}{2} \right) + c_3 \sigma_2 \left( k_y - \frac{\sqrt{3} k_x}{2} \right); \\
\{ R_1 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 k_i + c_2 \left( 3\sigma_1 + \sqrt{3}\sigma_2 \right) k_x + \left( \sqrt{3}\sigma_1 - 3\sigma_2 \right) k_y; \\
\{ R_2 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 k_i + c_2 \left( 3\sigma_1 + \sqrt{3}\sigma_2 \right) k_x + \left( \sqrt{3}\sigma_1 - 3\sigma_2 \right) k_y; \\
T: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \\
S: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \\
T': \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \\
S': \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \\
\Sigma: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \\
R: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=1}^{3} \sigma_0 c_1 \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \\
\}
\[ \Gamma_h; \{ C_{0}^{2}[00 \frac{1}{2}], [C_{2}^{1}[000], T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \{ R_5; [ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 ] \sigma_0 + c_4 [2 \sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2)] + c_5 \sigma_2 k_z; \]

\[ R_6; [ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 ] \sigma_0 + c_4 [2 \sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] + c_5 \sigma_2 k_z; \]

\[ A; \{ R_7; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ R_8; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ R_9; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ L; \{ R_5; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ K; \{ R_5; c_1 \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_3 \sigma_2 k_z; \]

\[ H; \{ R_1, R_2; c_1 \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z; \]

\[ R_3; c_1 \sigma_0 + c_2 \sigma_3 k_z; \]

\[ S; \{ R_2, R_3; [ c_1 + c_2 (\sqrt{3} k_x + k_y)] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]

\[ S'; \{ R_2, R_4; \sigma_0 (c_2 k_y + c_1) + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]

\[ R; \{ R_1, R_2; \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 + c_4 \sigma_2) k_z; \]

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 c_{i+1} k_z + c_2 [ (\sigma_1 - \sqrt{3} \sigma_2) k_z + (\sqrt{3} \sigma_1 + \sigma_2) k_y ]; \]

\[ R_1 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(1 - i \sqrt{3}) c_2 \sigma_3 k^2 + h.c.]; \]

\[ R_1 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(1 + i \sqrt{3}) c_2 \sigma_3 k^2 + h.c.]; \]

\[ R_1 \}, \{ R_5 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(c_2 k_x^2 + c_2 k_y^2 ) \sigma_3 + h.c.]; \]

\[ R_1 \}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(1 + i \sqrt{3}) c_2 \sigma_3 k^2 + h.c.]; \]

\[ R_2 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(1 - i \sqrt{3}) c_2 \sigma_3 k^2 + h.c.]; \]

\[ R_2 \}, \{ R_5 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(c_2 k_x^2 + c_2 k_y^2 ) \sigma_3 + h.c.]; \]

\[ R_2 \}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(1 + i \sqrt{3}) c_2 \sigma_3 k^2 + h.c.]; \]

\[ R_3 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(1 - i \sqrt{3}) c_2 \sigma_3 k^2 + h.c.]; \]

\[ R_3 \}, \{ R_5 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(c_2 k_x^2 + c_2 k_y^2 ) \sigma_3 + h.c.]; \]

\[ R_3 \}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(1 + i \sqrt{3}) c_2 \sigma_3 k^2 + h.c.]; \]

\[ R_5 \}, \{ R_6 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 [ c_i k_x^2 + c_2 k_x^2 + c_3 k_z ] + [(1 - i \sqrt{3}) c_2 \sigma_3 k^2 + h.c.]; \]

\[ U; \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 c_{i+1} k_z + c_2 \sigma_1 k_x + c_3 \sigma_2 k_y; \]

\[ P; \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 c_{i+1} k_z + c_2 \sigma_1 \left( k_x + \frac{k_y}{\sqrt{3}} \right) + c_3 \sigma_2 \left( k_y - \frac{k_x}{\sqrt{3}} \right); \]

\[ T; \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0}^{3} \sigma_0 c_{i+1} \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_1 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_2 k_z; \]

\[ T'; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_2 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \]

\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_2 k_y + c_4 \sigma_1 k_x + c_5 \sigma_1 k_z; \]

Accidental degeneracies on high symmetry line
Accidental degeneracies on high symmetry line

$$
\Delta: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
$$
$$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
$$
$$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
$$
$$\{R_1\}, \{R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z;
$$
$$\{R_1\}, \{R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z + (A_6 c_5 - A_2 c_6) k_x + (A_1 c_6 - A_4 c_5) k_y;
$$
$$\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
$$
$$\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
$$
$$\{R_2\}, \{R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z + (A_6 c_5 - A_2 c_6) k_x + (A_1 c_6 - A_4 c_5) k_y;
$$
$$\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
$$
$$\{R_3\}, \{R_5\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z + (A_4 c_5 - A_1 c_6) k_x + (A_2 c_6 - A_4 c_5) k_y;
$$
$$\{R_3\}, \{R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z;
$$
$$\{R_4\}, \{R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z + (A_4 c_5 - A_1 c_6) k_x + (A_2 c_6 - A_4 c_5) k_y;
$$
$$\{R_4\}, \{R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z;
$$
$$\{R_5\}, \{R_6\}; c_1 \Gamma_{0.0} + \sum_{i=0.1} \Gamma_{1.0i} k_x + c_2 (\Gamma_{1.2} k_y - \Gamma_{2.0} k_x) + c_3 (\Gamma_{1.0} k_x + \Gamma_{2.2} k_y);
$$
$$U: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y;
$$
$$\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y + (c_3 \sigma_1 + c_6 \sigma_2) k_x;
$$
$$\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y + (c_3 \sigma_1 + c_6 \sigma_2) k_y;
$$
$$\{R_1\}, \{R_5\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y + (c_3 \sigma_1 + c_6 \sigma_2) k_x;
$$
$$\{R_1\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y + (c_3 \sigma_1 + c_6 \sigma_2) k_y;
$$
$$\{R_1\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y;
$$
$$P: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;
$$
$$\{R_1\}, \{R_3\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + 2(A_6 c_3 + A_2 c_4 - A_2 c_6) k_x + [(\sqrt{3} A_8 - A_3) c_4 + 2(A_4 c_6 - A_4 c_5)] k_y;
$$
$$\{R_2\}, \{R_4\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + 2(A_6 c_3 + A_2 c_4 - A_2 c_6) k_x + [(\sqrt{3} A_8 - A_3) c_4 + 2(A_4 c_6 - A_4 c_5)] k_y;
$$
$$T: \{R_1\}, \{R_2\}; \sigma_0 \left( c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right) + \sigma_3 \sigma_2 \left( \sqrt{3} k_x + k_y \right) + c_5 \sigma_2 \left( k_x - \sqrt{3} k_y \right);
$$
$$S: \{R_1\}, \{R_2\}; \sigma_0 \left( c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right) + \sigma_3 \sigma_2 \left( \sqrt{3} k_x + k_y \right) + c_5 \sigma_2 \left( k_x - \sqrt{3} k_y \right);
$$
$$T': \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x;
$$
$$S': \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x;
$$
$$\Sigma: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_2 k_y;
$$
$$R: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_2 k_y;
Γ; \( R_5; \) \( [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \left[ 2\sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2) \right] \)
\( R_6; \) \( [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \left[ 2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right] \)
A; \( \{R_3, R_4\}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( \{R_6, R_3\}; [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \) \( \Gamma_{0,0} + \sum_{i=1}^{3} [c_{i,1} \Gamma_{i,0} k_z + c_{i,2} (k_x^2 - k_y^2) - 2c_{i,2} \Gamma_{i,1} k_x k_y] \)
\( \{R_9, R_{10}\}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( \{R_{11}, R_{12}\}; [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \) \( \Gamma_{0,0} + \sum_{i=1}^{3} [c_{i,1} \Gamma_{i,0} k_z + c_{i,2} (k_x^2 - k_y^2) - 2c_{i,2} \Gamma_{i,1} k_x k_y] \)
L; \( \{R_2, R_4\}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( \{R_6, R_8\}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
K; \( R_3; \) \( c_1 \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y) \)
H; \( \{R_3, R_4\}; c_1 \sigma_0 + c_2 \sigma_3 k_z; \)
\( \{R_6, R_7\}; [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \Gamma_{0,0} + \sum_{i=1}^{3} [c_{i,1} \Gamma_{i,0} k_z + c_{i,2} (\Gamma_{i,1} k_x + \Gamma_{i,1} k_y)] \)
Δ; \( R_5; \) \( [c_1 + c_2 k_x + c_3 (k_x^2 + k_z^2) + c_4 k_y^2] \sigma_0 + c_5 \left[ 2\sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2) \right] \)
\( R_6; \) \( [c_1 + c_2 k_x + c_3 (k_x^2 + k_z^2) + c_4 k_y^2] \sigma_0 + c_5 \left[ 2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right] \)
P; \( R_3; \) \( (c_1 + c_2 k_x) \sigma_0 + c_3 (\sigma_1 k_x + \sigma_3 k_y) \)
S; \( \{R_1, R_2\}; [c_1 + c_2 (\sqrt{3} k_x + k_y)] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) (k_x - \sqrt{3} k_y) + c_5 \sigma_3 k_z \)
S'; \( \{R_1, R_2\}; [c_1 + c_2 k_y] \sigma_0 + (c_2 \sigma_1 + c_4 \sigma_2) k_x + c_5 \sigma_3 k_z \)
R; \( \{R_1, R_2\}; (c_1 + c_2 k_x) \sigma_0 + (c_2 \sigma_1 + c_4 \sigma_2) k_y + c_5 \sigma_3 k_z \)
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\} \cup \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3k_z; \]

\[ \{R_1\} \cup \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3k_z; \]

\[ \{R_1\} \cup \{R_3\}; A_0 (c_1 + c_2k_z) + (\sqrt{3} A_5 + A_8) c_3k_z; \]

\[ \{R_1\} \cup \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3} A_5 + A_8) c_3k_z + c_4 (A_1k_x + A_2k_y) + c_6 (A_4k_x + A_6k_y); \]

\[ \{R_2\} \cup \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3k_z; \]

\[ \{R_2\} \cup \{R_4\}; \sigma_0 (c_1 + c_3k_x) + c_3 \sigma_3k_z; \]

\[ \{R_2\} \cup \{R_5\}; A_0 (c_1 + c_2k_z) + (\sqrt{3} A_5 + A_8) c_3k_z; \]

\[ \{R_2\} \cup \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3} A_5 + A_8) c_3k_z + (A_6c_5 - A_2c_6) k_x + (A_1c_6 - A_4c_5) k_y; \]

\[ \{R_3\} \cup \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3k_z; \]

\[ \{R_3\} \cup \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3} A_5 + A_8) c_3k_z + (A_4c_5 - A_1c_6) k_x + (A_2c_6 - A_6c_5) k_y; \]

\[ \{R_4\} \cup \{R_5\}; A_0 (c_1 + c_2k_z) + (\sqrt{3} A_5 + A_8) c_3k_z; \]

\[ \{R_4\} \cup \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3} A_5 + A_8) c_3k_z + c_4 (A_2k_x + A_1k_y) + c_6 (A_6k_x + A_4k_y); \]

\[ \{R_4\} \cup \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3} A_5 + A_8) c_3k_z; \]

\[ \{R_6\}; c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0} c_{i,1}k_x + c_2 (\Gamma_{1,2}k_y - \Gamma_{2,0}k_x) + c_3 (\Gamma_{1,0}k_x + \Gamma_{2,2}k_y); \]

\[ U; \{R_1\} \cup \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3k_z; \]

\[ \{R_1\} \cup \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]

\[ \{R_1\} \cup \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{R_2\} \cup \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]

\[ \{R_2\} \cup \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3 \sigma_3k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_x; \]

\[ \{R_3\} \cup \{R_4\}; \sigma_0 (c_1 + c_3k_x) + c_3 \sigma_3k_z; \]

\[ \{R_3\} \cup \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3} A_5 + A_8) c_3k_z + 2 (A_6c_3 + A_7c_4 - A_2c_6) k_x + [(\sqrt{3} A_8 - A_5) c_4 + 2 (A_1c_6 - A_4c_3)] k_y; \]

\[ \{R_4\} \cup \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3} A_5 + A_8) c_3k_z + 2 (A_4c_3 + A_7c_4 - A_1c_6) k_x + [(\sqrt{3} A_8 - A_5) c_4 + 2 (A_6c_3 - A_2c_6)] k_y; \]

\[ T; \{R_1\} \cup \{R_2\}; \sigma_0 [c_1 + c_2 (\sqrt{3} k_x + k_y)] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_5 \sigma_2 (k_x - \sqrt{3} k_y); \]

\[ T'; \{R_1\} \cup \{R_2\}; \sigma_0 (c_1 + c_3k_x) + c_3 \sigma_3k_y + c_5 \sigma_1k_x; \]

\[ \Sigma; \{R_1\} \cup \{R_2\}; \sigma_0 (c_1 + c_3k_y) + c_3 \sigma_3k_y + c_5 \sigma_2k_y; \]
\( \Gamma_h; \{ C \Gamma^z_0 \{ 00 \frac{1}{2} \}, \{ \sigma \varepsilon_1 \{ 00 \frac{1}{2} \} \} \}, T; \) Non-Centrosymmetric; without SOC

\[
\Gamma; \begin{array}{l}
R_5: \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2) \right]; \\
R_6: \quad [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right];
\end{array}
\]

\( A; \) \( \{ R_4, R_{10} \}; \) \( c_1 \sigma_0 + c_2 \sigma_3 k_z; \)

\( \{ R_5, R_{11} \}; \) \( c_1 \sigma_0 + c_2 \sigma_3 k_z; \)

\( \{ R_6, R_{12} \}; \) \( [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \Gamma_{0,0} + c_4 \Gamma_{3,0} k_z + c_5 \left[ 2 \Gamma_{0,1} k_x k_y + \Gamma_{0,3} (k_x^2 - k_y^2) \right] + [\alpha_1 k_z (k_x \Gamma_{1,0} + k_y \Gamma_{2,0}) + h.c.]; \)

\( L; \) \( \{ R_2, R_4 \}; \) \( c_1 \sigma_0 + c_2 \sigma_3 k_z; \)

\( \{ R_6, R_8 \}; \) \( c_1 \sigma_0 + c_2 \sigma_3 k_z; \)

\( K; \) \( R_3; \) \( c_1 \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y); \)

\( H; \) \( \{ R_1, R_1 \}; \) \( c_1 \sigma_0 + (c_3 \sigma_1 - c_4 \sigma_2 + c_2 \sigma_3) k_z; \)

\( \{ R_2, R_2 \}; \) \( c_1 \sigma_0 + (c_3 \sigma_1 - c_4 \sigma_2 + c_2 \sigma_3) k_z; \)

\( \{ R_3, R_3 \}; \) \( c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,1} k_z + \Gamma_{0,3} k_y) + \sum^{3}_{i=1} c_{i,1} \Gamma_{i,0} k_z; \)

\( \Delta; \) \( R_5; \) \( [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2) \right]; \)

\( R_6; \) \( [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right]; \)

\( P; \) \( R_3; \) \( \sigma_0 (c_1 + c_2 k_z) + c_3 (\sigma_1 k_x + \sigma_3 k_y); \)

\( S; \) \( \{ R_1, R_1 \}; \) \( [c_1 + c_2 (3k_x + k_y)] \sigma_0 + \sum^{3}_{i=1} c_{i,1} \Gamma_{i,0} k_z; \)

\( \{ R_2, R_2 \}; \) \( [c_1 + c_2 (3k_x + k_y)] \sigma_0 + \sum^{3}_{i=1} c_{i,1} \Gamma_{i,0} k_z; \)

\( S'; \) \( \{ R_1, R_1 \}; \) \( (c_1 + c_2 k_y) \sigma_0 + \sum^{3}_{i=1} c_{i,1} \Gamma_{i,0} k_z; \)

\( \{ R_2, R_2 \}; \) \( (c_1 + c_2 k_y) \sigma_0 + \sum^{3}_{i=1} c_{i,1} \Gamma_{i,0} k_z; \)

\( R; \) \( \{ R_1, R_2 \}; \) \( (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_z; \)
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_5 \}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{ R_1 \}, \{ R_6 \}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z + c_4 (A_1 k_x + A_2 k_y) + c_6 (A_4 k_x + A_8 k_y); \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_5 \}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{ R_2 \}, \{ R_6 \}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z + (A_1 c_6 - A_4 c_5) k_y; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_5 \}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z + (A_1 c_6 - A_4 c_5) k_y; \]
\[ \{ R_3 \}, \{ R_6 \}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{ R_4 \}, \{ R_5 \}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z + c_4 (A_2 k_x + A_1 k_y) + c_6 (A_4 k_x + A_8 k_y); \]
\[ \{ R_4 \}, \{ R_6 \}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z; \]
\[ \{ R_5 \}, \{ R_6 \}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_i k_z + c_2 (\Gamma_{1,2} k_y - \Gamma_{2,0} k_x) + c_3 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \]

\[ U: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_y; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 + c_6 \sigma_2) k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ P: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z + 2(\Lambda_4 c_3 + A_7 c_4 - A_2 c_5) k_x + [(\sqrt{3} A_8 - A_5) c_4 + 2(A_1 c_6 - A_4 c_5)] k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_4 k_z + 2(\Lambda_4 c_3 + A_7 c_4 - A_2 c_5) k_x + [(\sqrt{3} A_8 - A_5) c_4 + 2(A_1 c_6 - A_4 c_5)] k_y; \]

\[ T: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 [c_1 + c_2 (\sqrt{3} k_x + k_y)] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_5 \sigma_2 (k_x - \sqrt{3} k_y); \]
\[ S: \{ R_1, R_1 \}, \{ R_2, R_2 \}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_i k_x + [(\alpha_1 \Gamma_{1,1} + c_2 \Gamma_{1,3} + c_3 \Gamma_{2,0}) k_x - \sqrt{3} k_y) + (\alpha_2 \Gamma_{0,1} + \alpha_3 \Gamma_{3,1} + c_4 \Gamma_{0,3} + c_5 \Gamma_{3,3}) k_z + h.c.]; \]
\[ T': \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_2 k_z; \]
\[ S': \{ R_1, R_1 \}, \{ R_2, R_2 \}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_i k_x + [(\alpha_1 \Gamma_{1,1} + c_2 \Gamma_{1,3} + c_3 \Gamma_{2,0}) k_x + (\alpha_2 \Gamma_{0,1} + \alpha_3 \Gamma_{3,1} + c_4 \Gamma_{0,3} + c_5 \Gamma_{3,3}) k_z + h.c.]; \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_2 k_y; \]
Γ:\ R_5; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4 [2\sigma_1k_xk_y - \sigma_3(k_x^2 - k_y^2)];
\quad R_6; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4 [2\sigma_1k_xk_y + \sigma_3(k_x^2 - k_y^2)];
A:\ \{R_4, R_{10}\}; \quad c_1\sigma_0 + c_2\sigma_3k_z;
\quad \{R_5, R_{11}\}; \quad c_1\sigma_0 + c_2\sigma_3k_z;
\quad \{R_6, R_{12}\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \Gamma_{0,0} + c_4\Gamma_{3,0}k_z + c_5 [2\Gamma_{0,1}k_xk_y + \Gamma_{0,3}(k_x^2 - k_y^2)] + [\alpha_1k_z(\Gamma_{3,3} - k_y\Gamma_{+1}) + h.c.];
L:\ \{R_2, R_4\}; \quad c_1\sigma_0 + c_2\sigma_3k_z;
\quad \{R_6, R_8\}; \quad c_1\sigma_0 + c_2\sigma_3k_z;
K:\ R_3; \quad c_1\sigma_0 + c_2(\sigma_1k_x + \sigma_3k_y);
H:\ \{R_3, R_4\}; \quad c_1\sigma_0 + c_2\sigma_3k_z;
\quad \{R_6\}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4 (\sigma_1k_xk_z - \sigma_3k_yk_z);
\Delta:\ \{R_5\}; \quad \Gamma_{0,0} + c_4\Gamma_{3,0}k_z + c_5 [2\Gamma_{0,1}k_xk_y + \Gamma_{0,3}(k_x^2 - k_y^2)];
\quad \{R_6\}; \quad [c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_x^2] \sigma_0 + c_4 [2\sigma_1k_xk_y - \sigma_3(k_x^2 - k_y^2)];
P:\ \{R_3\}; \quad \sigma_0(c_1 + c_2k_x) + c_3(\sigma_1k_x + \sigma_3k_y);
S:\ \{R_1, R_2\}; \quad [c_1 + c_2(\sqrt{3}k_x + k_y)] \sigma_0 + c_3\sigma_3k_z;
S':\ \{R_1, R_2\}; \quad (c_1 + c_2k_y)\sigma_0 + c_3\sigma_3k_z;
R:\ \{R_1, R_3\}; \quad (c_1 + c_2k_x)\sigma_0 + \sum_{i=1}^3 c_{i,1}\Gamma_{i,0}k_z;
\quad \{R_2, R_4\}; \quad (c_1 + c_2k_x)\sigma_0 + \sum_{i=1}^3 c_{i,1}\Gamma_{i,0}k_z;
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_1 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_1 k_x + A_2 k_y) + c_6 (A_2 k_x + A_6 k_y); \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_2 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_1 k_x + A_2 k_y) + c_6 (A_2 k_x + A_6 k_y); \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_1 k_x + A_2 k_y) + c_6 (A_2 k_x + A_6 k_y); \]
\[ \{ R_3 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_4 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_1 k_x + A_2 k_y) + c_6 (A_2 k_x + A_6 k_y); \]
\[ \{ R_4 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ U: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 c_6 k_x; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 c_1 + c_6 c_2) k_x; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 c_1 + c_6 c_2) k_y; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_5 c_1 + c_6 c_2) k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ P: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + 2 (A_4 c_3 + A_7 c_4 - A_2 c_6) k_x + [(\sqrt{3} A_8 - A_3) c_4 + 2 (A_1 c_6 - A_4 c_3)] k_y; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + 2 (A_4 c_3 + A_7 c_4 - A_2 c_6) k_x + [(\sqrt{3} A_8 - A_3) c_4 + 2 (A_1 c_6 - A_4 c_3)] k_y; \]
\[ T: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 [c_1 + c_2 (\sqrt{3} k_x + k_y)] + \sigma_0 [c_3 (\sqrt{3} k_x + k_y)] + \sigma_0 [c_2 (k_x - \sqrt{3} k_y)]; \]
\[ T': \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x; \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_2 k_y; \]
\[ R: \{ R_1, R_2 \}, \{ R_2, R_3 \}; \quad \sum_{i=0,3} \Gamma_{i,0} (c_{i,1} + c_{i,2} k_z) + [k_y (\alpha_1 \Gamma_{1,1} + c_1 \Gamma_{1,3} + c_2 \Gamma_{2,0}) + k_z (\alpha_2 \Gamma_{0,1} + \alpha_3 \Gamma_{3,1} + c_3 \Gamma_{0,3} + c_4 \Gamma_{3,3}) + h.c.]; \]

SG 187
\[ \Gamma_h: \{ S^h_1 \} \{ 000 \}, \{ C_{2s}^h \} \{ 000 \}, T; \text{ Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \{ R_5 \}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right]; \]
\[ \{ R_6 \}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2) \right]; \]
\[ A: \{ R_5 \}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right]; \]
\[ \{ R_6 \}; \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2) \right]; \]
\[ \Delta: \{ R_3 \}; \quad \left[ c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right]; \]
Accidental degeneracies on high symmetry line

\[\{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]

\[\Delta; \{R_1\}, \{R_3\}; A_0 (c_1 + c_2 k_z) + (\sqrt{A_0} + A_0) c_3 k_z + c_4 (A_1 k_x + A_2 k_y);\]

\[\{R_2\}, \{R_3\}; A_0 (c_1 + c_2 k_z) + (\sqrt{A_0} + A_0) c_3 k_z + c_4 (A_1 k_y - A_2 k_x);\]

\[U; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_y;\]

\[P; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \left[ \sigma_1 \left( k_x - \frac{k_y}{\sqrt{2}} \right) + \sigma_2 \left( \frac{k_y}{\sqrt{2}} + k_y \right) \right];\]

\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \left[ (\sqrt{3} \sigma_2 - 3 \sigma_1) k_x + (\sqrt{3} \sigma_1 + 3 \sigma_2) k_y \right];\]

\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \left[ \sigma_1 \left( k_x - \frac{k_y}{\sqrt{2}} \right) + \sigma_2 \left( \frac{k_y}{\sqrt{2}} + k_y \right) \right];\]

\[T; \{R_1\}, \{R_2\}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_5 \sigma_2 k_z;\]

\[S; \{R_1\}, \{R_2\}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_5 \sigma_2 k_z;\]

\[T'; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_2 k_z;\]

\[S'; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_2 k_z;\]

\[\Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 k_z;\]

\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_3 \sigma_1 - c_6 \sigma_2) k_z;\]

\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 k_z + (c_3 \sigma_1 - c_6 \sigma_2) k_y;\]

\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_3 \sigma_1 - c_6 \sigma_2) k_z;\]

\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]

\[R; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]

\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_3 \sigma_1 - c_6 \sigma_2) k_z;\]

\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_3 \sigma_1 - c_6 \sigma_2) k_y;\]

\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_3 \sigma_1 - c_6 \sigma_2) k_y;\]

\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + (c_3 \sigma_1 - c_6 \sigma_2) k_z;\]

\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;\]

SG 188

\[\Gamma_h; \{S_3^+ | 000\}, \{C_2^+ | 000 \frac{1}{2}\}, T; \text{Non-Centrosymmetric; without SOC}\]

\[\Gamma; \{R_5\}; \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \left[ 2\sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2) \right];\]

\[R_6; \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \left[ 2\sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2) \right];\]

\[A; \{R_7, R_8\}; \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \Gamma_{0,0} + c_4 (\Gamma_{0,1} k_x - \Gamma_{3,2} k_y) k_z + \left[ 2\alpha_1 k_x k_y \Gamma_{+0} + i\alpha_1 \Gamma_{+3} (k_x^2 - k_y^2) + \alpha_2 k_z \Gamma_{+2} + h.c. \right];\]

\[R_9; c_1 \sigma_0 + c_2 \sigma_1 k_z;\]

\[L; \{R_5\}; c_1 \sigma_0 + c_2 \sigma_2 k_z;\]

\[H; \{R_1, R_4\}; c_1 \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z;\]

\[\{R_2, R_3\}; c_1 \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z;\]

\[\{R_3, R_6\}; c_1 \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_z;\]

\[\Delta; \{R_3\}; \left[ c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 \left[ 2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right];\]

\[S; \{R_1, R_2\}; \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] \sigma_0 + c_3 \sigma_3 (k_x - \sqrt{3} k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 k_z;\]

\[S'; \{R_1, R_2\}; \left[ c_1 + c_2 k_y \right] \sigma_0 + c_3 \sigma_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) k_z;\]

\[R; \{R_5\}; \left[ c_1 + c_2 k_x \right] \sigma_0 + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z;\]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ {R_1}, \{R_2\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_0 + A_0) c_3 k_z + c_4 (A_1 k_x + A_2 k_y); \]
\[ \{R_2\}, \{R_3\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_0 + A_0) c_3 k_z + c_4 (A_1 k_y - A_2 k_x); \]
\[ U: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_y; \]
\[ P: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + c_5 \left[ \sigma_1 \left( k_x - \frac{k_y}{\sqrt{3}} \right) + \sigma_2 \left( \frac{k_x}{\sqrt{3}} + k_y \right) \right]; \]
\[ T: \{R_1\}, \{R_2\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 \sigma_3 \left( \sqrt{3} k_x + k_y \right) + c_5 \sigma_2 k_z; \]
\[ T': \{R_1\}, \{R_2\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 \sigma_3 \left( \sqrt{3} k_x + k_y \right) + c_5 \sigma_2 k_z; \]
\[ \Sigma: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 - c_6 \sigma_2) k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 - c_6 \sigma_2) k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 - c_6 \sigma_2) k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_5 \sigma_1 - c_6 \sigma_2) k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

SG 189

\( \Gamma_h: \{S_4^+ \{000\}, \{C_2h\} \{000\}, T\}; \) Non-Centrosymmetric; without SOC

\[ \Gamma: \quad R_5: [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y + \sigma_3 \left( k_x^2 - k_y^2 \right) \right]; \]
\[ R_6: [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 \left[ 2 \sigma_1 k_x k_y - \sigma_3 \left( k_x^2 - k_y^2 \right) \right]; \]
\[ \Delta: \quad R_5: [c_1 + c_2 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_5 \left[ 2 \sigma_1 k_x k_y + \sigma_3 \left( k_x^2 - k_y^2 \right) \right]; \]
\[ P: \quad (c_1 + c_2 k_x) \sigma_0 + c_3 (\sigma_1 k_x + \sigma_3 k_y); \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; A_0 (c_1 + c_2 k_z) + 2 (A_1 c_3 + A_7 c_4 - A_2 c_6) k_x + \left[ \sqrt{3} A_8 - A_5 \right] c_1 + 2 (A_1 c_6 - A_4 c_3) k_y; \]
\[ \{R_2\}, \{R_3\}; A_0 (c_1 + c_2 k_z) + 2 (A_1 c_3 + A_7 c_4 - A_2 c_6) k_x + \left[ \sqrt{3} A_8 - A_5 \right] c_1 + 2 (A_1 c_6 - A_4 c_3) k_y; \]

\[ U; \{R_2\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_z; \]

\[ P; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_3\}; A_0 (c_1 + c_2 k_z) + 2 (A_1 c_3 + A_7 c_4 - A_2 c_6) k_x + \left[ \sqrt{3} A_8 - A_5 \right] c_1 + 2 (A_1 c_6 - A_4 c_3) k_y; \]
\[ \{R_2\}, \{R_3\}; A_0 (c_1 + c_2 k_z) + 2 (A_1 c_3 + A_7 c_4 - A_2 c_6) k_x + \left[ \sqrt{3} A_8 - A_5 \right] c_1 + 2 (A_1 c_6 - A_4 c_3) k_y; \]

\[ T; \{R_1\}, \{R_2\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right); \]
\[ \{R_1\}, \{R_3\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + (c_5 \sigma_1 - c_6 \sigma_2) k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + (c_5 \sigma_1 - c_6 \sigma_2) (k_x - \sqrt{3} k_y); \]
\[ \{R_2\}, \{R_3\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + (c_5 \sigma_1 - c_6 \sigma_2) (k_x - \sqrt{3} k_y); \]
\[ \{R_2\}, \{R_4\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + (c_5 \sigma_1 - c_6 \sigma_2) k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right); \]

\[ S; \{R_1\}, \{R_2\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right); \]
\[ \{R_1\}, \{R_3\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + (c_5 \sigma_1 - c_6 \sigma_2) k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + (c_5 \sigma_1 - c_6 \sigma_2) k_x + \sqrt{3} k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + (c_5 \sigma_1 - c_6 \sigma_2) k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + (c_5 \sigma_1 - c_6 \sigma_2) k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 \left[ c_1 + c_2 \left( \sqrt{3} k_x + k_y \right) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right); \]

\[ T'; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ S'; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_2 k_z; \]

\[ R; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_z; \]
\[ \Gamma_h; \{ S_i^+ |000 \}, \{ C''_{ij} |000 \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \]
\[ R_5: \quad [c_1 + c_3(k_x^2 + k_y^2) + c_2k_x] \sigma_0 + c_3(2\sigma_1k_xk_y + \sigma_3(k_z^2 - k_y^2)); \]
\[ R_6: \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x] \sigma_0 + c_4(2\sigma_1k_xk_y - \sigma_3(k_z^2 - k_y^2)); \]
\[ A; \{ R_7, R_8 \}; \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2 \Gamma_{0,0} + c_4(\Gamma_{0,1}k_y + \Gamma_{3,2}k_x)k_z + [2\alpha_1k_xk_{yz}\Gamma_{+0} + i\alpha_1\Gamma_{+,3} (k_x^2 - k_y^2) + \alpha_2k_x\Gamma_{+,2} + h.c.] ; \]
\[ R_9: \quad c_1\sigma_0 + c_3\sigma_1k_z; \]
\[ L; \quad R_5: \quad c_1\sigma_0 + c_2\sigma_2k_z; \]
\[ K; \quad R_5: \quad c_1\sigma_0 + c_2(\sigma_1k_x + \sigma_3k_y); \]
\[ R_6: \quad c_1\sigma_0 + c_2(\sigma_1k_x - \sigma_3k_y); \]
\[ H; \]
\[ R_7: \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4(\sigma_2k_x + \sigma_3k_y); \]
\[ R_8: \quad [c_1 + c_2(k_x^2 + k_y^2) + c_3k_x^2] \sigma_0 + c_4(\sigma_2k_x - \sigma_3k_y); \]
\[ R_9: \quad c_1\sigma_0 + c_2\sigma_1k_z; \]
\[ \Delta; \]
\[ R_3: \quad [c_1 + c_2k_x + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + c_5(2\sigma_1k_xk_y + \sigma_3(k_z^2 - k_y^2)); \]
\[ P; \quad R_3: \quad (c_1 + c_2k_x) \sigma_0 + c_3(\sigma_1k_x + \sigma_3k_y); \]
\[ S; \quad R_5: \quad [c_1 + c_2(\sqrt{3}k_x + k_y)] \sigma_0 + c_3\sigma_3(k_x - \sqrt{3}k_y) + c_4\sigma_1k_z; \]
\[ S'; \quad R_5: \quad [c_1 + c_2k_y] \sigma_0 + c_3\sigma_3k_x + c_4\sigma_1 + c_5\sigma_2; \]
\[ R; \quad \{ R_1, R_2 \}; \quad (c_1 + c_2k_x) \sigma_0 + c_3\sigma_3k_y + (c_4\sigma_1 + c_5\sigma_2)k_z; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_6) c_3k_x + c_4 (A_1k_y - A_2k_x); \]
\[ \{ R_2 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_6) c_3k_x + c_4 (A_1k_x + A_2k_y); \]
\[ U; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_3k_x) + c_3\sigma_3k_x + c_4\sigma_2k_z; \]
\[ P; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_6) c_3k_x + 2(A_6c_5 + A_1c_4 - A_2c_6)c_x + \left( [\sqrt{3}A_8 - A_5] c_4 + 2 (A_1c_6 - A_2c_5) \right)k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_6) c_3k_x + 2(A_6c_4 + A_1c_3 - A_2c_6)c_x + \left( [\sqrt{3}A_8 - A_5] c_4 + 2 (A_6c_3 - A_2c_6) \right)k_y; \]
\[ T; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 [c_1 + c_2(\sqrt{3}k_x + k_y)] + \sigma_3\sigma_3 (\sqrt{3}k_x + k_y); \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 [c_1 + c_2(\sqrt{3}k_x + k_y)] + \sigma_3\sigma_3 (\sqrt{3}k_x + k_y) + (c_3\sigma_1 - c_5\sigma_2)k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 [c_1 + c_2(\sqrt{3}k_x + k_y)] + \sigma_3\sigma_3 (\sqrt{3}k_x + k_y) + (c_3\sigma_1 - c_5\sigma_2)k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 [c_1 + c_2(\sqrt{3}k_x + k_y)] + \sigma_3\sigma_3 (\sqrt{3}k_x + k_y) + (c_3\sigma_1 - c_5\sigma_2)k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 [c_1 + c_2(\sqrt{3}k_x + k_y)] + \sigma_3\sigma_3 (\sqrt{3}k_x + k_y) + (c_3\sigma_1 - c_5\sigma_2)k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 [c_1 + c_2k_y] + c_3\sigma_3k_y; \]
\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_x + c_4\sigma_2k_z; \]
21. SG 191-200

Γ, \{C_3^+|000\}, \{C_{21}^+|000\}, \{C_2|000\}, \{I|000\}, T; Centrosymmetric; without SOC

\[\begin{align*}
\Gamma: & \quad R_3: [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] ; \\
& \quad R_6: [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] ; \\
& \quad R_9: [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] ; \\
& \quad R_{12}: [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] ; \\
A: & \quad R_3: [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] ; \\
& \quad R_6: [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] ; \\
& \quad R_9: [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] ; \\
& \quad R_{12}: [c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2] \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] ; \\
K: & \quad R_5: c_1 \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y) ; \\
& \quad R_6: c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_3 k_y) ; \\
H: & \quad R_5: c_1 \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y) ; \\
& \quad R_6: c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_3 k_y) ; \\
\Delta: & \quad R_5: [c_1 + c_3 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_5 [2\sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2)] ; \\
& \quad R_6: [c_1 + c_3 k_x + c_3 (k_x^2 + k_y^2) + c_4 k_z^2] \sigma_0 + c_5 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)] ; \\
P: & \quad (c_1 + c_2 k_z) \sigma_0 + c_3 (\sigma_1 k_x + \sigma_3 k_y) ;
\end{align*}\]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_1 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_1 k_x + A_2 k_y); \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_3 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_2 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_1 k_y - A_2 k_x); \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_3 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_5 \}; A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_2 k_y - A_1 k_x); \]
\[ \{ R_4 \}, \{ R_5 \}; A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_4 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_2 k_x + A_1 k_y); \]
\[ \{ R_6 \}, \{ R_5 \}; A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_6 \}, \{ R_5 \}; c_1 \Gamma_0, 0 + k_x \sum_{\alpha=0,3} \Gamma_{\delta \gamma} c_{1, \delta} k_z + c_2 (\Gamma_{1, 0} k_x + \Gamma_{2, 2} k_y); \]

\( U; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \)
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_x; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\( P; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \)
\[ \{ R_1 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + (2 A_1 c_4 - A_2 c_5) k_x + [c_3 A_1 - c_4 (A_5 - \sqrt{3} A_8)] k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + (2 A_1 c_4 - A_2 c_5) k_x - [c_3 A_2 + c_4 (A_5 - \sqrt{3} A_8)] k_y; \]

\( T; \{ R_1 \}, \{ R_2 \}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y); \)
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y); \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_5 \sigma_1 (k_x - \sqrt{3} k_y); \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_5 \sigma_1 (k_x - \sqrt{3} k_y); \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y); \]
\[ \{ R_3 \}, \{ R_5 \}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y); \]
\[ \{ R_3 \}, \{ R_6 \}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{ R_4 \}, \{ R_5 \}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{ R_4 \}, \{ R_6 \}; \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_5 \sigma_1 k_z; \]

\( T'; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \)
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\( S'; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \)
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[\Sigma; \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]
\[\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y;\]
\[\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y;\]
\[\{R_2\}, \{R_1\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;\]
\[\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]
\[R; \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]
\[\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;\]
\[\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y;\]
\[\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y;\]
\[\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]
\[R; \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]
\[\{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;\]
\[\{R_1\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y;\]
\[\{R_2\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y;\]
\[\{R_3\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;\]

\[\Gamma_h; \{C_{3v}^0[000]\}, \{C_{3v}[00\frac{1}{2}]\}, \{C_2[000]\}, \{I[000]\}, \bar{T}; \text{Centrosymmetric; without SOC}\]

\[\Gamma; \quad R_3: \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \left[ 2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right];\]
\[R_6: \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \left[ 2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right];\]
\[R_9: \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \left[ 2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right];\]
\[R_{12}: \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \sigma_0 + c_4 \left[ 2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right];\]
\[A; \quad \{R_7, R_8\}: \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \Gamma_{0,0} + \left[ 2\sigma_1 k_x k_y \Gamma_{+,0} + i\sigma_1 \Gamma_{+,3} (k_x^2 - k_y^2) \right] + \alpha_2 k_z \Gamma_{+,2} + h.c.;\]
\[R_9: \quad c_1 \sigma_0 + c_2 \sigma_1 k_z;\]
\[\{R_{16}, R_{17}\}: \quad \left[ c_1 + c_2 (k_x^2 + k_y^2) + c_3 k_z^2 \right] \Gamma_{0,0} + \left[ 2\sigma_1 k_x k_y \Gamma_{+,0} + i\sigma_1 \Gamma_{+,3} (k_x^2 - k_y^2) \right] + \alpha_2 k_z \Gamma_{+,2} + h.c.;\]
\[R_{18}: \quad c_1 \sigma_0 + c_2 \sigma_1 k_z;\]
\[L; \quad R_5: \quad c_1 \sigma_0 + c_2 \sigma_2 k_z;\]
\[R_{10}: \quad c_1 \sigma_0 + c_2 \sigma_2 k_z;\]
\[K; \quad R_5: \quad c_1 \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y);\]
\[R_8: \quad c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_3 k_y);\]
\[H; \quad \{R_7, R_8\}: \quad \sigma_1 \Gamma_{0,0} + [\alpha_1 (k_x \Gamma_{+,3} + i k_y \Gamma_{+,0}) + \alpha_2 k_z \Gamma_{+,2} + h.c.];\]
\[R_9: \quad c_1 \sigma_0 + c_2 \sigma_3 k_z;\]
\[\Delta; \quad R_5: \quad \left[ c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 \left[ 2\sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2) \right];\]
\[R_6: \quad \left[ c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2 \right] \sigma_0 + c_5 \left[ 2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2) \right];\]
\[P; \quad R_5: \quad (c_1 + c_2 k_z) \sigma_0 + c_3 (\sigma_1 k_x + \sigma_3 k_y);\]
\[S; \quad R_5: \quad \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] \sigma_0 + c_3 \sigma_3 (k_x - \sqrt{3} k_y) + c_4 \sigma_1 k_z;\]
\[S'; \quad R_5: \quad \left[ c_1 + c_2 k_y \right] \sigma_0 + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;\]
\[R; \quad R_5: \quad (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z;\]
Accidental degeneracies on high symmetry line

$\Delta$: \{R\_1\}, \{R\_2\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z$;
\{R\_1\}, \{R\_3\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z$;
\{R\_1\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z$;
\{R\_1\}, \{R\_5\}; $A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_z$;
\{R\_1\}, \{R\_6\}; $A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_x + c_4 (A_1 k_x + A_2 k_y)$;
\{R\_2\}, \{R\_3\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z$;
\{R\_2\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z$;
\{R\_2\}, \{R\_5\}; $A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_z$;
\{R\_2\}, \{R\_6\}; $A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_x + c_4 (A_1 k_x + A_2 k_y)$;
\{R\_3\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z$;
\{R\_3\}, \{R\_5\}; $A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_z$;
\{R\_3\}, \{R\_6\}; $A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_x + c_4 (A_1 k_x + A_2 k_y)$;
\{R\_4\}, \{R\_5\}; $A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_z$;
\{R\_4\}, \{R\_6\}; $c_1 \Gamma_{0,0} + k_x \sum_{\alpha = 0,3} \Gamma_{0,1} c_{1,1} k_z + c_2 (\Gamma_{1,0} k_x + \Gamma_{2,1} k_y)$;

$U$: \{R\_1\}, \{R\_2\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z$;
\{R\_1\}, \{R\_3\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z$;
\{R\_1\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y$;
\{R\_2\}, \{R\_3\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y$;
\{R\_2\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z$;
\{R\_3\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z$;

$P$: \{R\_1\}, \{R\_2\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x$;
\{R\_1\}, \{R\_3\}; $A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_x + (2A_7 c_4 - A_2 c_5) k_x + [c_5 A_1 - c_4 (A_5 - \sqrt{3}A_8)] k_y$;
\{R\_2\}, \{R\_3\}; $A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_x + (2A_7 c_4 - A_1 c_5) k_x + [c_5 A_2 + c_4 (A_5 - \sqrt{3}A_8)] k_y$;

$T$: \{R\_1\}, \{R\_2\}; $\sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3 c_3 (\sqrt{3}k_x + k_y)$;
\{R\_1\}, \{R\_3\}; $\sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3 c_3 (\sqrt{3}k_x + k_y) + c_5 \sigma_1 k_z$;
\{R\_1\}, \{R\_4\}; $\sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3 c_3 (\sqrt{3}k_x + k_y) + c_5 \sigma_1 (k_x - \sqrt{3}k_y)$;
\{R\_2\}, \{R\_3\}; $\sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3 c_3 (\sqrt{3}k_x + k_y) + c_5 \sigma_1 (k_y - \sqrt{3}k_x)$;
\{R\_2\}, \{R\_4\}; $\sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3 c_3 (\sqrt{3}k_x + k_y) + c_5 \sigma_1 k_z$;
\{R\_3\}, \{R\_4\}; $\sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3 c_3 (\sqrt{3}k_x + k_y)$;

$T'$: \{R\_1\}, \{R\_2\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
\{R\_1\}, \{R\_3\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_z$;
\{R\_1\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x$;
\{R\_2\}, \{R\_3\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z$;
\{R\_2\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x$;
\{R\_3\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;

$\Sigma$: \{R\_1\}, \{R\_2\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z$;
\{R\_1\}, \{R\_3\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z$;
\{R\_1\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y$;
\{R\_2\}, \{R\_3\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y$;
\{R\_2\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z$;
\{R\_3\}, \{R\_4\}; $\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x$;
Γ; $R_3$: $\{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3(k_x^2 - k_y^2)];$
$R_6$: $\{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3(k_x^2 - k_y^2)];$
$R_9$: $\{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3(k_x^2 - k_y^2)];$
$R_{12}$: $\{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \sigma_0 + c_4 [2\sigma_1 k_x k_y + \sigma_3(k_x^2 - k_y^2)];$
$A; R_{13}$: $c_1 \sigma_0 + c_2 \sigma_3 k_z;
R_{14}$: $c_1 \sigma_0 + c_2 \sigma_3 k_z;
R_{15}$: $\{c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2\} \Gamma_{0,0} + c_4 \Gamma_{0,3} k_z + c_5 k_z \Gamma_{0,1} k_y + [c_4 \Gamma_{+0} (k_x^2 - k_y^2) - 2ic_4 k_x k_y \Gamma_{+,3} + h.c.];$
$L; R_5$: $c_1 \sigma_0 + c_2 \sigma_3 k_z;
R_{10}$: $c_1 \sigma_0 + c_2 \sigma_3 k_z;
K; R_5$: $c_1 \sigma_0 + c_2 (\sigma_1 k_x + \sigma_3 k_y);
R_6$: $c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_3 k_y);
H; \{R_1, R_4\}: c_1 \sigma_0 + (c_2 \sigma_1 - c_3 \sigma_2) k_z;
\{R_2, R_3\}: c_1 \sigma_0 + (c_2 \sigma_1 - c_3 \sigma_2) k_z;
\{R_5, R_6\}: c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,1} k_x + \Gamma_{0,3} k_y) + k_z (c_3 \Gamma_{1,0} + c_4 \Gamma_{2,0});$
$\Delta; R_5$: $\{c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2\} \sigma_0 + c_5 [2\sigma_1 k_x k_y - \sigma_3 (k_x^2 - k_y^2)];$
$R_6$: $\{c_1 + c_2 k_z + c_3 (k_x^2 + k_y^2) + c_4 k_z^2\} \sigma_0 + c_5 [2\sigma_1 k_x k_y + \sigma_3 (k_x^2 - k_y^2)];$
$P; R_3$: $(c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z;
S; \{R_2, R_4\}: (c_1 + c_2 (\sqrt{3} k_x + k_y)) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z;
\{R_6, R_8\}: (c_1 + c_2 (\sqrt{3} k_x + k_y)) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z;
S'; \{R_2, R_4\}: (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z;
\{R_6, R_8\}: (c_1 + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_z;
R; R_5$: $(c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1 k_z;$
Accidental degeneracies on high symmetry line

\[\Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x) + c_4\sigma_3k_z;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_4\sigma_3k_z;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;\]
\[\{R_1\}, \{R_5\}; A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) c_3k_z;\]
\[\{R_1\}, \{R_6\}; A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) c_3k_z + c_4 (A_1k_x + A_2k_y);\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;\]
\[\{R_2\}, \{R_5\}; A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) c_3k_z;\]
\[\{R_2\}, \{R_6\}; A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) c_3k_z + c_4 (A_2k_y - A_1k_x);\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;\]
\[\{R_3\}, \{R_5\}; A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) c_3k_z;\]
\[\{R_3\}, \{R_6\}; A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) c_3k_z + c_4 (A_2k_x + A_1k_y);\]
\[\{R_4\}, \{R_5\}; A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) c_3k_z;\]
\[\{R_4\}, \{R_6\}; A_1\Gamma_{0,0} + k_x \sum_{i=0,3} \Gamma_{i,0} c_1k_z + c_2 (\Gamma_{1,0}k_x + \Gamma_{2,2}k_y);\]

\[U; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z + c_5\sigma_1k_z;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_z;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z + c_5\sigma_1k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_5\sigma_1k_z;\]
\[\{R_4\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;\]

\[P; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_x) + c_3\sigma_3k_z;\]
\[\{R_1\}, \{R_3\}; A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) c_3k_z + (2A_7c_4 - A_2c_5) k_x + [c_5A_1 - c_4 (A_5 - \sqrt{3}A_8)] k_y;\]
\[\{R_2\}, \{R_3\}; A_0 (c_1 + c_2k_x) + (\sqrt{3}A_5 + A_8) c_3k_z + (2A_7c_4 - A_1c_5) k_x - [c_5A_2 + c_4 (A_5 - \sqrt{3}A_8)] k_y;\]

\[T; \{R_1\}, \{R_2\}; \sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3c_3 (\sqrt{3}k_x + k_y);\]
\[\{R_1\}, \{R_3\}; \sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3c_3 (\sqrt{3}k_x + k_y) + c_5\sigma_1k_z;\]
\[\{R_1\}, \{R_4\}; \sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3c_3 (\sqrt{3}k_x + k_y) + c_5\sigma_1 (k_x - \sqrt{3}k_y);\]
\[\{R_2\}, \{R_3\}; \sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3c_3 (\sqrt{3}k_x + k_y) + c_5\sigma_1 (k_x - \sqrt{3}k_y);\]
\[\{R_2\}, \{R_4\}; \sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3c_3 (\sqrt{3}k_x + k_y) + c_5\sigma_1k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3c_3 (\sqrt{3}k_x + k_y);\]

\[S; \{R_2\}, \{R_4\}, \{R_6\}, \{R_6\}; c_1\Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_1 (\sqrt{3}k_x + k_y) + [\alpha_1 \Gamma_{1,0} (k_z - \sqrt{3}k_y)] + (\alpha_2 \Gamma_{0,0} + \alpha_3 \Gamma_{3,3}) k_z + h.c.;\]

\[T'; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y + c_5\sigma_1k_z;\]
\[\{R_4\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + c_3\sigma_3k_y;\]

\[S'; \{R_2\}, \{R_4\}, \{R_6\}, \{R_6\}; \sum_{i=0,3} \Gamma_{i,0} (c_1 + c_2k_y) + [\alpha_1 \Gamma_{1,0} + k_z (\alpha_2 \Gamma_{0,0} + \alpha_3 \Gamma_{3,3}) + h.c.];\]

\[\Sigma; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;\]
\[\{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_4\sigma_1k_z;\]
\[\{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_4\sigma_1k_z;\]
\[\{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_4\sigma_1k_z;\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z + c_4\sigma_1k_z;\]
\[\{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + c_3\sigma_3k_z;\]
$\Gamma_h$: \{C_3^0|000\}, \{C_2^1|00\}, \{C_2^2|00\}, \{I|000\}, \Gamma; Centrosymmetric; without SOC

$\Gamma$: $R_\delta$: 
\begin{align*} 
&[c_1 + c_3(k_x^2 + k_y^2) + c_5k_z^2] \sigma_0 + c_4 \left[2\sigma_1k_xk_y + \sigma_3(k_x^2 - k_y^2)\right]; \\
&[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4 \left[2\sigma_1k_xk_y + \sigma_3(k_x^2 - k_y^2)\right]; \\
&[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4 \left[2\sigma_1k_xk_y + \sigma_3(k_x^2 - k_y^2)\right]; \\
&[c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + c_4 \left[2\sigma_1k_xk_y + \sigma_3(k_x^2 - k_y^2)\right]; \\
&A: \{R_{13}\}: \ c_1\sigma_0 + c_2\sigma_3k_z; \\
&\{R_{14}\}: \ c_1\sigma_0 + c_2\sigma_3k_z; \\
&\{R_{15}\}: \ [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \Gamma_{0,0} + c_4\Gamma_{0,3}k_x + c_5k_z \left(\Gamma_{0,1}k_x - \Gamma_{3,2}k_y\right) + \left[c_6\Gamma_{+0} \left(k_x^2 - k_y^2\right) - 2ic_6k_xk_y\Gamma_{+3} + h.c.\right]; \\
&\{R_{16}\}: \ c_1\sigma_0 + c_2\sigma_3k_z; \\
&\{R_{17}\}: \ c_1\sigma_0 + c_2 \left(\sigma_1k_x - \sigma_3k_y\right); \\
&\{R_{18}\}: \ c_1\sigma_0 + c_2 \left(\sigma_1k_x - \sigma_3k_y\right); \\
&\{R_{19}\}: \ [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (ic_4k_xk_3\sigma_+ + h.c.); \\
&\{R_{20}\}: \ [c_1 + c_2(k_x^2 + k_y^2) + c_3k_z^2] \sigma_0 + (ic_4k_xk_3\sigma_+ + h.c.); \\
&\{R_{21}\}: \ c_1\sigma_0 + c_2\sigma_3k_z; \\
&\{R_\Delta\}: \ [c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + c_5 \left[2\sigma_1k_xk_y - \sigma_3 \left(k_x^2 - k_y^2\right)\right]; \\
&\{R_\Sigma\}: \ [c_1 + c_2k_z + c_3(k_x^2 + k_y^2) + c_4k_z^2] \sigma_0 + c_5 \left[2\sigma_1k_xk_y + \sigma_3 \left(k_x^2 - k_y^2\right)\right]; \\
&\{P\}: \ [c_1 + c_2k_z + c_3k_z + c_4k_z] \sigma_0 \quad \text{h.c.}; \\
\} \{R_{25}\}: \ [c_1 + c_2k_y] \sigma_0 \quad \text{h.c.}; \\
\} \{S\}: \ [c_1 + c_2 \left(\sqrt{3}k_x + k_y\right)] \sigma_0 \quad \text{h.c.}; \\
\} \{S'\}: \ [c_1 + c_2k_y] \sigma_0 \quad \text{h.c.}; \\
\} \{R\}: \ \{R_{25}\}; \ (c_1 + c_2k_z) \sigma_0 \quad \text{h.c.}; \\
\} \{R_{25}\}; \ [c_1 + c_2k_z + c_3\sigma_1 + c_4\sigma_2 + c_5k_z]; \\
\} \{R_{25}\}; \ [c_1 + c_2k_z + c_3\sigma_1 + c_4\sigma_2 + c_5k_z];
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_5 \}; \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_1 \}, \{ R_6 \}; \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_1 k_x + A_2 k_y); \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_2 \}, \{ R_5 \}; \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_2 \}, \{ R_6 \}; \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_2 k_y - A_1 k_x); \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_3 \}, \{ R_5 \}; \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_2 k_y - A_1 k_x); \]
\[ \{ R_3 \}, \{ R_6 \}; \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_4 \}, \{ R_5 \}; \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + c_4 (A_2 k_y + A_1 k_x); \]
\[ \{ R_4 \}, \{ R_6 \}; \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z; \]
\[ \{ R_6 \}, \{ R_6 \}; \quad c_1 \Gamma_{0,0} + k_z \sum_{i=0,3} \Gamma_{i,0} c_1 k_x + c_2 \left( \Gamma_{1,0} k_x + \Gamma_{2,2} k_y \right); \]

\[ U: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_x; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_x; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_x; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_4 \sigma_1 k_x; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ P: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + (2 A_7 c_4 - A_2 c_5) k_x + [c_5 A_1 - c_4 (A_5 - \sqrt{3} A_8)] k_y; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + (2 A_7 c_4 - A_2 c_5) k_x - [c_5 A_2 + c_4 (A_5 - \sqrt{3} A_8)] k_y; \]

\[ T: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right); \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + c_5 \sigma_1 (k_x - \sqrt{3} k_y); \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right) + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 \left[ c_1 + c_2 (\sqrt{3} k_x + k_y) \right] + \sigma_3 c_3 \left( \sqrt{3} k_x + k_y \right); \]

\[ T': \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]

\[ R: \{ R_2, R_4 \}, \{ R_6, R_8 \}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_1 k_x + k_y (c_2 \Gamma_{1,0} + c_3 \Gamma_{2,3}) + k_x (c_4 \Gamma_{0,1} + c_5 \Gamma_{0,2} + c_6 \Gamma_{3,1} + c_7 \Gamma_{3,2}); \]
\[ \Gamma_c: \{C_{3v}^+|000\}, \{C_{2v}|000\}, \{C_{2v}|000\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \{R_2, R_3\}: (c_1 + c_2 k^2) \sigma_0 + \sqrt{3} \sigma_1 \left[ c_2 k_x^2 + c_4 k_y^2 - (c_3 + c_4) k_z^2 \right] + \sigma_2 \left[ c_4 \left( -2k_x^2 + k_y^2 + k_z^2 \right) - c_3 \left( k_x^2 - 2k_y^2 + k_z^2 \right) \right] + c_5 \sigma_3 k_x k_y k_z; \]
\[ R_4: \quad c_1 A_0 + c_2 \left( A_3 k_x - A_2 k_y + A_1 k_z \right); \]
\[ R: \{R_2, R_3\}: (c_1 + c_2 k^2) \sigma_0 + \sqrt{3} \sigma_1 \left[ c_2 k_x^2 + c_4 k_y^2 - (c_3 + c_4) k_z^2 \right] + \sigma_2 \left[ c_4 \left( -2k_x^2 + k_y^2 + k_z^2 \right) - c_3 \left( k_x^2 - 2k_y^2 + k_z^2 \right) \right] + c_5 \sigma_3 k_x k_y k_z; \]
\[ R_4: \quad c_1 A_0 + c_2 \left( A_3 k_x - A_2 k_y + A_1 k_z \right); \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \]
\[ \Lambda: \{R_1\}, \{R_2\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_i k_x + (a_1 \sigma_+ q_- + h.c.); \]
\[ R_2, \{R_3\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_i k_x + (a_1 \sigma_+ q_- + h.c.); \]
\[ R_2, \{R_3\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_i k_x + (a_1 \sigma_+ q_- + h.c.); \]
\[ Z: \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]
\[ T: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_2 k_x + c_6 \sigma_1 k_y; \]

SG 196

\[ \Gamma^v; \{C_{3v}^+|000\}, \{C_{2v}|000\}, \{C_{2v}|000\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \{R_2, R_3\}: (c_1 + c_2 k^2) \sigma_0 + \sqrt{3} \sigma_1 \left[ c_2 k_x^2 + c_4 k_y^2 - (c_3 + c_4) k_z^2 \right] + \sigma_2 \left[ c_4 \left( -2k_x^2 + k_y^2 + k_z^2 \right) - c_3 \left( k_x^2 - 2k_y^2 + k_z^2 \right) \right] + c_5 \sigma_3 k_x k_y k_z; \]
\[ R_4: \quad c_1 A_0 + c_2 \left( A_3 k_x - A_2 k_y + A_1 k_z \right); \]
\[ L: \{R_2, R_3\}: \left[ c_1 + c_2 (q_x^2 + q_y^2) + c_3 q_z^2 \right] \sigma_0 + c_4 q_x \sigma_3 + \left[ \sigma_+ (a_1 q_x^2 + a_2 q_y q_-) + h.c. \right]; \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \]
\[ \Lambda: \{R_1\}, \{R_2\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_i k_x + (a_1 \sigma_+ q_- + h.c.); \]
\[ \{R_1\}, \{R_2\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_i k_x + (a_1 \sigma_+ q_- + h.c.); \]
\[ \{R_2\}, \{R_3\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_i k_x + (a_1 \sigma_+ q_- + h.c.); \]
\[ Z: \{R_1\}, \{R_3\}: \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]

SG 197

\[ \Gamma^v; \{C_{3v}^+|000\}, \{C_{2v}|000\}, \{C_{2v}|000\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \{R_2, R_3\}: (c_1 + c_2 k^2) \sigma_0 + \sqrt{3} \sigma_1 \left[ c_2 k_x^2 + c_4 k_y^2 - (c_3 + c_4) k_z^2 \right] + \sigma_2 \left[ c_4 \left( -2k_x^2 + k_y^2 + k_z^2 \right) - c_3 \left( k_x^2 - 2k_y^2 + k_z^2 \right) \right] + c_5 \sigma_3 k_x k_y k_z; \]
\[ R_4: \quad c_1 A_0 + c_2 \left( A_3 k_x - A_2 k_y + A_1 k_z \right); \]
\[ H: \{R_2, R_3\}: (c_1 + c_2 k^2) \sigma_0 + \sqrt{3} \sigma_1 \left[ c_2 k_x^2 + c_4 k_y^2 - (c_3 + c_4) k_z^2 \right] + \sigma_2 \left[ c_4 \left( -2k_x^2 + k_y^2 + k_z^2 \right) - c_3 \left( k_x^2 - 2k_y^2 + k_z^2 \right) \right] + c_5 \sigma_3 k_x k_y k_z; \]
\[ R_4: \quad c_1 A_0 + c_2 \left( A_3 k_x - A_2 k_y + A_1 k_z \right); \]
\[ P: \quad c_1 A_0 + c_2 \left( A_7 k_x + A_6 k_y + A_4 k_z \right) + c_5 \left( A_3 k_x - A_2 k_y + A_1 k_z \right); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \]

\[ \Lambda: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i,1} q_x + (a_1 \sigma_4 q_+ + h.c.); \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i,1} q_x + (a_1 \sigma_4 q_+ + h.c.); \]
\[ \{ R_2 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i,1} q_x + (a_1 \sigma_4 q_+ + h.c.); \]

\[ D: \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (a_{i,1} k_x + c_{i,2} k_y); \]

\[ F: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i,1} p_x + (a_1 \sigma_4 p_+ + h.c.); \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i,1} p_x + (a_1 \sigma_4 p_+ + h.c.); \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i,1} p_x + (a_1 \sigma_4 p_+ + h.c.); \]

SG 198
\[ \Gamma_c; \{ C_3^z \}[000], \{ C_2x \}[\frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}], \{ C_2y \}[\frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}], T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \{ R_2, R_3 \}; (c_1 + c_2 k^2) \sigma_0 + \sqrt{3} \sigma_1 [c_3 k_y^2 + c_4 k_z^2 - (c_4 + c_4) k_y^2] + \sigma_2 [c_4 (-2 k_x^2 + k_y^2) - c_4 (k_x^2 - 2 k_y^2) + c_5 \sigma_3 k_y k_z]; \]
\[ R_4; \quad c_1 A_0 + c_2 (A_3 k_x - A_2 k_y + A_1 k_z); \]

\[ \chi; \{ R_5 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_y; \]

\[ M; \{ R_2, R_4 \}; (c_1 + \sum_{i=0,3} c_{i,1} k_i^2) \sigma_0 + [a_1 \sigma_4 k_x k_y + h.c.]; \]
\[ \{ R_6, R_8 \}; (c_1 + \sum_{i=0,3} c_{i,1} k_i^2) \sigma_0 + [a_1 \sigma_4 k_x k_y + h.c.]; \]

\[ \Gamma; \{ R_4, R_4 \}; c_1 \Gamma_0, 0 + c_2 (\Gamma_0, k_x - \Gamma_0, 2 k_y - \Gamma_0, 3 k_z); \]
\[ R_5, R_6; c_1 \Gamma_0, 0 + c_2 (\Gamma_3, k_x - \Gamma_0, 2 k_y - \Gamma_3, 3 k_z); \]

\[ S; \{ R_1, R_1 \}; \sigma_0 (c_1 k_x + c_3 k_z + c_1) + \sum_{i=1}^{3} c_{i,1} \sigma_1 k_y; \]

\[ Z; \{ R_2, R_2 \}; \quad \sigma_0 (c_1 k_x + c_3 k_z + c_1) + \sum_{i=1}^{3} c_{i,1} k_i^2; \]

\[ T; \{ R_2, R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x + \sum_{i=1}^{3} c_{i,1} k_i^2) + c_5 \sigma_3 k_y k_z + [a_1 \sigma_4 k_x k_y + h.c.]; \]
\[ \{ R_4, R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x + \sum_{i=1}^{3} c_{i,1} k_i^2) + c_5 \sigma_3 k_y k_z + [a_1 \sigma_4 k_x k_y + h.c.]; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_z + c_6 \sigma_2 k_z; \]

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i,1} q_x + (a_1 \sigma_4 q_+ + h.c.); \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i,1} q_x + (a_1 \sigma_4 q_+ + h.c.); \]
\[ \{ R_2 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i,1} q_x + (a_1 \sigma_4 q_+ + h.c.); \]

\[ T; \{ R_2, R_2 \}, \{ R_4, R_4 \}; \quad c_1 \Gamma_0, 0 + \sum_{i=0,3} \Gamma_1, 0 c_{i,1} k_x + c_2 \Gamma_2, 0 k_x + c_3 \Gamma_3, 0 k_y + \sum_{i=1}^{3} (c_{i,2} \Gamma_1, i k_x + c_{i,3} \Gamma_2, i k_y); \]

SG 199
\[ \Gamma_c; \{ C_3^z \}[000], \{ C_2x \}[\frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}], \{ C_2y \}[\frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}], T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \{ R_2, R_3 \}; (c_1 + c_2 k^2) \sigma_0 + \sqrt{3} [c_3 k_y^2 + c_4 k_z^2 - (c_4 + c_4) k_y^2] \sigma_1 + [c_4 (-2 k_x^2 + k_y^2) - c_4 (k_x^2 - 2 k_y^2) + c_5 \sigma_3 k_y k_z]; \]
\[ R_4; \quad c_1 A_0 + c_2 (A_3 k_x - A_2 k_y + A_1 k_z); \]

\[ H; \{ R_4, R_3 \}; (c_1 + c_2 k^2) \sigma_0 + \sqrt{3} [c_3 k_y^2 + c_4 k_z^2 - (c_4 + c_4) k_y^2] \sigma_1 + [c_4 (-2 k_x^2 + k_y^2) - c_4 (k_x^2 - 2 k_y^2) + c_5 \sigma_3 k_y k_z]; \]
\[ R_6; \quad A_0 c_1 + c_2 (A_3 k_x + A_1 k_y - A_2 k_z); \]

\[ P; \{ R_7 \}; \quad c_1 \sigma_0 + c_2 q_+ \sigma_3 + c_2 (q_+ \sigma_+ + h.c.); \]
\[ R_8; \quad c_1 \sigma_0 + c_2 q_+ \sigma_3 + c_2 (q_+ \sigma_+ + h.c.); \]
\[ R_9; \quad c_1 \sigma_0 + c_2 q_+ \sigma_3 + c_2 (q_+ \sigma_+ + h.c.); \]
Accidental degeneracies on high symmetry line

$\Delta$: $\{R_1\}, \{R_2\}$; $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z + c_6 \sigma_2 k_x$;

$\Lambda$: $\{R_1\}, \{R_2\}$; $\sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i1} q_x + (\alpha_1 \sigma_4 q_+ + h.c.)$;

$\{R_1\}, \{R_3\}$; $\sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i1} q_x + (\alpha_1 \sigma_4 q_+ + h.c.)$;

$\{R_2\}, \{R_3\}$; $\sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i1} q_x + (\alpha_1 \sigma_4 q_+ + h.c.)$;

$D$: $\{R_2\}, \{R_4\}$; $\sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + \sum_{i=1}^2 \sigma_i (c_{i1} k_x + c_{i2} k_y)$;

$F$: $\{R_2\}, \{R_4\}$; $\sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i1} p_x + (\alpha_1 \sigma_4 p_+ + h.c.)$;

$\{R_2\}, \{R_6\}$; $\sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i1} p_x + (\alpha_1 \sigma_4 p_+ + h.c.)$;

$\{R_4\}, \{R_6\}$; $\sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i1} p_x + (\alpha_1 \sigma_4 p_+ + h.c.)$;

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SG 200

$\Gamma_c$: $\{S_0^+|000\}, \{C_{2v}|000\}, \{C_2v|000\}, T$; Centrosymmetric; without SOC

$\Gamma$: $\{R_2, R_3\}$; $(c_1 + c_2 q^2) \sigma_0 + [\alpha_1 (2\sqrt{2}q_+ q_- + q_3^2) \sigma_+ + h.c.]$;

$\{R_2, R_3\}$; $c_1 A_0 + \text{diag} [c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2, c_6 k_x^2 + c_6 k_y^2 + c_7 k_x^2 + c_7 k_y^2] + c_5 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y) k_z$;

$\{R_6, R_7\}$; $(c_1 + c_2 q^2) \sigma_0 + [\alpha_1 (2\sqrt{2}q_+ q_- + q_3^2) \sigma_+ + h.c.]$;

$\{R_8\}$; $c_1 A_0 + \text{diag} [c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2, c_6 k_x^2 + c_6 k_y^2 + c_7 k_x^2 + c_7 k_y^2, c_6 k_x^2 + c_6 k_y^2 + c_7 k_x^2 + c_7 k_y^2] + c_5 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y) k_z$;

$\{R_9\}$; $(c_1 + c_2 q^2) \sigma_0 + [\alpha_1 (2\sqrt{2}q_+ q_- + q_3^2) \sigma_+ + h.c.]$;

$\{R_{10}, R_{11}\}$; $(c_1 + c_2 q^2) \sigma_0 + [\alpha_1 (2\sqrt{2}q_+ q_- + q_3^2) \sigma_+ + h.c.]$;

$\{R_{12}\}$; $c_1 A_0 + \text{diag} [c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2, c_6 k_x^2 + c_6 k_y^2 + c_7 k_x^2 + c_7 k_y^2, c_6 k_x^2 + c_6 k_y^2 + c_7 k_x^2 + c_7 k_y^2] + c_5 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y) k_z$;

$\Lambda$: $\{R_2, R_3\}$; $(c_1 + c_2 q_3) \sigma_0 + (\alpha_1 \sigma_4 q_- + h.c.)$;
Accidental degeneracies on high symmetry line

Δ: \{R_1\} \cup \{R_2\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
\{R_1\} \cup \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_1\} \cup \{R_3\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x;
\{R_2\} \cup \{R_3\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;
\{R_2\} \cup \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x;
\{R_3\} \cup \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;

Σ: \{R_1\} \cup \{R_2\} : \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + c_5 \sigma_1 k_z;
\{R_1\} \cup \{R_2, R_3\} : A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_y + (c_4 k_x - c_5 k_y) (A_4 + A_6) + (c_4 k_y + c_5 k_x) (A_1 - A_2) + A_7 (c_6 k_x - c_7 k_y) + A_3 (c_7 k_x + c_6 k_y);
\{R_2\} \cup \{R_3\} : \sigma_0 (c_1 + c_2 k_x + c_3 k_x) + c_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_y;
\{R_3\} \cup \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;
\{R_1\} \cup \{R_3\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;
\{R_1\} \cup \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;
\{R_2\} \cup \{R_3\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;
\{R_2\} \cup \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;
\{R_3\} \cup \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;

Τ: \{R_1\} \cup \{R_2\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;
\{R_1\} \cup \{R_3\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;
\{R_1\} \cup \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;
\{R_2\} \cup \{R_3\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_y;
\{R_2\} \cup \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z;
\{R_3\} \cup \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;
Accidental degeneracies on high symmetry line

$$\Delta: \{ R_1 \}, \{ R_2 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$

$$\{ R_1 \}, \{ R_3 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$

$$\{ R_1 \}, \{ R_4 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$

$$\{ R_2 \}, \{ R_3 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$

$$\{ R_2 \}, \{ R_4 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$

$$\{ R_3 \}, \{ R_4 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$

$$\Sigma: \{ R_1 \}, \{ R_2 \}: \quad \sigma_0 (c_1 + c_2 k_y + c_5 k_y) + c_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z;$$

$$\Lambda: \{ R_1 \}, \{ R_2, R_3 \}: \quad A_0 (c_1 + c_2 k_y) + \sqrt{3} A_0 + A_8 c_3 k_y + [c_4 (A_4 + A_6) + c_5 (A_1 - A_2) + A_7 c_6 + A_3 c_7] q_x + [c_4 (A_1 - A_2) - c_5 (A_4 + A_6) + A_3 c_6 - A_7 c_7] q_y;$$

$$S: \{ R_2 \}, \{ R_4 \}: \quad \sigma_0 (c_1 + c_2 k_y + c_5 k_y) + c_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_y;$$

$$T: \{ R_2 \}, \{ R_4 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_x;$$

$$\{ R_2 \}, \{ R_6 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;$$

$$\{ R_2 \}, \{ R_6 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;$$

$$\{ R_4 \}, \{ R_6 \}: \quad \sigma_0 (c_1 + c_2 k_y + c_5 k_y) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;$$

$$\{ R_4 \}, \{ R_6 \}: \quad \sigma_0 (c_1 + c_2 k_y + c_5 k_y) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y;$$

$$\{ R_6 \}, \{ R_8 \}: \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_x;$$
Accidental degeneracies on high symmetry line

\Delta: \{R_1\}, \{R_2\}:
\begin{align*}
\sigma_0, (c_1 + c_2 k_y) + c_3 \sigma_2 k_y; \\
\{R_1\}, \{R_3\}:
\sigma_0, (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \\
\{R_1\}, \{R_4\}:
\sigma_0, (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \\
\{R_2\}, \{R_3\}:
\sigma_0, (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \\
\{R_2\}, \{R_4\}:
\sigma_0, (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z; \\
\{R_3\}, \{R_4\}:
\sigma_0, (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \\
\Lambda: \{R_1\}, \{R_2, R_3\}:
A_0, (c_1 + c_2 q_z) + (\sqrt{3} A_3 + A_3) c_3 q_z + [c_4 (A_4 + A_6) + c_5 (A_1 - A_2) + \alpha_0 c_6 - A_3 c_7] q_z + \\
[c_4 (A_1 - A_2) - c_5 (A_1 + A_6) + A_5 c_6 - A_3 c_7] q_y; \\
\Sigma: \{R_1\}, \{R_2\}:
\sigma_0, (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \\
\{R_1\}, \{R_4\}:
\sigma_0, (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \\
\{R_2\}, \{R_4\}:
\sigma_0, (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z; \\
\{R_2\}, \{R_3\}:
\sigma_0, (c_1 + c_2 k_x + c_3 k_y) + c_4 \sigma_1 k_z; \\
\{R_3\}, \{R_4\}:
\sigma_0, (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \\
\{R_3\}, \{R_4\}:
\sigma_0, (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \\
\{R_4\}, \{R_4\}:
\sigma_0, (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \\
\{R_4\}, \{R_3\}:
\sigma_0, (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \\
\{R_4\}, \{R_3\}:
\sigma_0, (c_1 + c_2 k_x) + c_3 \sigma_3 k_z;
Accidental degeneracies on high symmetry line

$$\Delta: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$
$$\{ R_1 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_1 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_2 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_3 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$

$$\Lambda: \{ R_1 \}, \{ R_2, R_3 \} : \quad A_0 (c_1 + c_2 q_y) + \left(\sqrt{3} A_5 + A_8\right) c_3 q_z + [c_4 (A_4 + A_6) + c_5 (A_1 - A_2) + A_7 c_6 + A_3 c_7] q_x + [c_4 (A_1 - A_2) - c_5 (A_4 + A_6) + A_3 c_6 - A_7 c_7] q_y;$$
$$\Sigma: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z;$$
$$\{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_y;$$

SG 204

$$\Gamma_{\nu}^\prime: \{ S_0^+ |000\}, \{ C_{2y} |000\}, \{ C_{2y} |000\}, T; \text{ Centrosymmetric; without SOC}$$

$$\Gamma: \{ R_2, R_3 \} : \quad (c_1 + c_2 q^2) \sigma_0 + \left[\alpha_1 \left(2 \sqrt{2} q_+ + q_2^+\right)\sigma_+ + h.c.\right];$$

$$\{ R_4 \} : \quad c_1 A_0 + \text{diag} [c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2, c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2, c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2] + c_5 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z);$$

$$\{ R_6, R_7 \} : \quad (c_1 + c_2 q^2) \sigma_0 + \left[\alpha_1 \left(2 \sqrt{2} q_+ + q_2^+\right)\sigma_+ + h.c.\right];$$

$$\{ R_8 \} : \quad c_1 A_0 + \text{diag} [c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2, c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2, c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2] + c_5 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z);$$

$$\{ R_9 \} : \quad (c_1 + c_2 q^2) \sigma_0 + \left[\alpha_1 \left(2 \sqrt{2} q_+ + q_2^+\right)\sigma_+ + h.c.\right];$$

$$\{ R_{10} \} : \quad c_1 A_0 + \text{diag} [c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2, c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2, c_2 k_x^2 + c_3 k_y^2 + c_4 k_y^2] + c_5 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z);$$

Accidental degeneracies on high symmetry line

$$\Sigma: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z;$$
$$\Delta: \{ R_1 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$
$$\{ R_1 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_1 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_2 \}, \{ R_3 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_2 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z;$$
$$\{ R_3 \}, \{ R_4 \} : \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;$$

$$\Lambda: \{ R_1 \}, \{ R_2, R_3 \} : \quad A_0 (c_1 + c_2 q_y) + \left(\sqrt{3} A_5 + A_8\right) c_3 q_z + [c_4 (A_4 + A_6) + c_5 (A_1 - A_2) + A_7 c_6 + A_3 c_7] q_x + \left[c_4 (A_1 - A_2) - c_5 (A_4 + A_6) + A_3 c_6 - A_7 c_7\right] q_y;$$

$$D: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y);$$
$$G: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_6 \sigma_1 k_z;$$
$$F: \{ R_1 \}, \{ R_2, R_3 \} : \quad A_0 (c_1 + c_2 p_x) + \left(\sqrt{3} A_5 + A_8\right) c_3 p_y - [c_4 (A_4 + A_6) + A_7 c_3] \left(\sqrt{3} p_x + p_y\right) + [c_4 (A_1 - A_2) + A_3 c_3] (p_x - \sqrt{3} p_y) + c_6 \left[(A_2 - A_1) p_x + (A_4 + A_6) p_y\right] + c_7 \left(A_7 p_y - A_3 p_x\right);$$
\( \Gamma_c: \{ S_{0}^{+}[000], \{ C_{2z}[\frac{1}{2}] \}, \{ C_{2y}[\frac{1}{2}] \} \}, T; \text{Centrosymmetric; without SOC} \)

\( \Gamma: \{ R_2, R_3 \}; \quad (c_1 + c_2 q_1^2) \sigma_0 + [\alpha_1 \left(2\sqrt{2} q_1 q_2 + \frac{q_2^2}{2}\right) \sigma_+ + h.c.] \);

\( R_4; \quad c_1 A_0 + \text{diag} \left[ c_2 k_2^2 + c_3 k_2^2 + c_4 k_2^2, c_2 k_2^2 + c_3 k_2^2 + c_4 k_2^2, c_2 k_2^2 + c_3 k_2^2 + c_4 k_2^2 \right] + c_5 (A_1 k_x k_y + A_6 k_x k_z + A_7 k_y k_z) ; \)

\( \{ R_6, R_7 \}; \quad (c_1 + c_2 q_1^2) \sigma_0 + [\alpha_1 \left(2\sqrt{2} q_1 q_2 + \frac{q_2^2}{2}\right) \sigma_+ + h.c.] ; \)

\( R_8; \quad c_1 A_0 + \text{diag} \left[ c_2 k_2^2 + c_3 k_2^2 + c_4 k_2^2, c_2 k_2^2 + c_3 k_2^2 + c_4 k_2^2, c_2 k_2^2 + c_3 k_2^2 + c_4 k_2^2 \right] + c_5 (A_1 k_x k_y + A_6 k_x k_z + A_7 k_y k_z) ; \)

\( X: \{ R_5 \}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y ; \)

\( R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y ; \)

\( M: \{ R_9, R_{10} \}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + k_y (c_3 \Gamma_{1,2} + c_4 \Gamma_{2,2}) ; \)

\( R: \{ R_4, R_4 \}; \quad (c_1 + c_2 q_1^2) \Gamma_{0,0} + \sum_{i=1} c_{1,i} \left\{ \Gamma_{1,3} (q_1^2 + q_2^2 - 2q_1^2) - \left[ \sqrt{2} e^{i\frac{2\pi}{7}} \Gamma_{1,4} (\sqrt{2} q_1 q_2 - q_2^3) + h.c. \right] \right\} ; \)

\( \{ R_6, R_6 \}; \quad c_1 \Gamma_{0,0} ; \)

\( R_{11}, R_{11} ; \quad (c_1 + c_2 q_1^2) \Gamma_{0,0} + \sum_{i=1} c_{1,i} \left\{ \Gamma_{1,3} (q_1^2 + q_2^2 - 2q_1^2) - \left[ \sqrt{2} e^{i\frac{2\pi}{7}} \Gamma_{1,4} (\sqrt{2} q_1 q_2 - q_2^3) + h.c. \right] \right\} ; \)

\( \{ R_{12}, R_{13} \}; \quad c_1 \Gamma_{0,0} ; \)

\( \Lambda: \{ R_2, R_3 \}; \quad (c_1 + c_2 q_1^2) \sigma_0 + (c_4 \sigma_+ q_- + h.c.) ; \)

\( S: \{ R_2, R_4 \}; \quad (c_1 + c_2 k_x + c_3 k_y + c_4 k_2) \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_y ; \)

\( Z: \{ R_2, R_4 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_y ; \)

\( \{ R_6, R_6 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_y ; \)

\( T: \{ R_2, R_5 \}; \quad (c_1 + c_2 k_x) \Gamma_{0,0} + \sum_{i=1} (c_{1,3} \Gamma_{1,3} k_x + c_{1,2} \Gamma_{1,2} k_y) ; \)

\( Z': \{ R_5 \}; \quad (c_1 + c_2 k_y) \sigma_0 + c_5 \sigma_1 k_x ; \)

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Accidental degeneracies on high symmetry line

\( \Delta: \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y ; \)

\( \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \)

\( \{ R_1 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \)

\( \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \)

\( \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_z ; \)

\( \{ R_5 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y ; \)

\( \{ R_5 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 (c_4 k_x + c_5 k_y) + c_5 \sigma_1 k_z ; \)

\( \Sigma: \{ R_1 \}, \{ R_2 \}; \quad A_0 (c_1 + c_2 q_1^2) + (\sqrt{3} A_5 + A_8) c_4 q_1 + \left| c_4 (A_4 + A_6) + c_5 (A_1 - A_2) + A_7 c_0 + A_5 c_7 \right| q_2 + \left| c_4 (A_1 - A_2 c_3) - c_5 (A_4 + A_6) + A_3 c_0 - A_7 c_7 \right| q_3 ; \)

\( \Lambda: \{ R_1 \}, \{ R_2, R_3 \}; \quad A_0 (c_1 + c_2 q_1^2) + (\sqrt{3} A_5 + A_8) c_4 q_1 + \left| c_4 (A_4 + A_6) + c_5 (A_1 - A_2) + A_7 c_0 + A_5 c_7 \right| q_2 + \left| c_4 (A_1 - A_2 c_3) - c_5 (A_4 + A_6) + A_3 c_0 - A_7 c_7 \right| q_3 ; \)

\( Z: \{ R_2, R_4 \}, \{ R_6, R_8 \}; \quad c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0} c_{i,1} k_x + k_y (c_2 \Gamma_{0,1} - c_3 \Gamma_{0,2} + c_4 \Gamma_{3,1} + c_5 \Gamma_{3,2}) + k_z (c_6 \Gamma_{1,1} - c_7 \Gamma_{1,2}) ; \)
\[
\Gamma; \{\Gamma_0, \Gamma_1, \Gamma_2, \Gamma_3\}, \{\Gamma_4, \Gamma_5, \Gamma_6\}, \{\Gamma_7, \Gamma_8\}; \text{Centrosymmetric; without SOC}
\]

\[
\Gamma; \{\Gamma_1, \Gamma_2, \Gamma_3\}:
(c_1 + c_2 q^2) \sigma_0 + [a_1 (2 \sqrt{2} q x + q^2) + a_2 (2 \sqrt{2} q y + q^2)] \sigma_+ + \text{h.c.};
\]

\[
\Gamma_4; c_1 \Gamma_0 + \text{diag} (c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2 + c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2 + c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2) + c_5 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z);
\]

\[
\Gamma_6; c_1 \Gamma_0 + \text{diag} (c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2 + c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2 + c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2) + c_5 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z);
\]

\[
H; \{\Gamma_1, \Gamma_2, \Gamma_3\}:
(c_1 + c_2 q^2) \sigma_0 + [a_1 (2 \sqrt{2} q x + q^2) + a_2 (2 \sqrt{2} q y + q^2)] \sigma_+ + \text{h.c.};
\]

\[
\Gamma_13, \Gamma_14; c_1 \Gamma_0 + \text{diag} (c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2 + c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2 + c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2) + c_5 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z);
\]

\[
\Gamma_16; c_1 \Gamma_0 + \text{diag} (c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2 + c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2 + c_2 k_x^2 + c_2 k_y^2 + c_2 k_z^2) + c_5 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z);
\]

\[
P; \{\Gamma_2, \Gamma_3\}:
c_1 \Gamma_0 + \sum_{i=1}^{3} c_1 \Gamma_{i+} \left[ \frac{1}{2} \left( -1 \right)^{i} \sigma_{-} + \frac{1}{2} \right] \sigma_{+} + \text{h.c.};
\]

\[
N; \{\Gamma_2, \Gamma_3\}:
c_1 \Gamma_0 + \sigma_2 (c_2 k_x + c_2 k_y);
\]

\[
\Lambda; \{\Gamma_2, \Gamma_3\}:
(c_1 + c_2 q) \sigma_0 + \left( a_1 c_1 + c_2 q + \text{h.c.} \right);
\]

\[
D; \{\Gamma_2, \Gamma_3\}:
(c_1 + c_2 k_x) \sigma_0 + a_1 (c_3 k_x + c_3 k_y) + \sigma_2 (c_5 k_x + c_5 k_y);
\]

\[
F; \{\Gamma_2, \Gamma_3\}:
(c_1 + c_2 p_2) \sigma_0 + \left( a_1 \sigma_1 + p_2 \right) + \text{h.c.};
\]

\[
\Sigma; \{\Gamma_1, \Gamma_2\}:
\sigma_0 (c_2 k_x + c_2 k_y) + \sigma_3 (c_3 k_x + c_3 k_y) + c_6 \sigma_1 k_x;
\]

\[
\Delta; \{\Gamma_1, \Gamma_2\}:
\sigma_0 (c_2 k_y + c_2 k_x) + \sigma_3 k_x;
\]

\[
\{\Gamma_1, \Gamma_2\}:
\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y;
\]

\[
\{\Gamma_1, \Gamma_2\}:
\sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x;
\]

\[
\{\Gamma_1, \Gamma_2\}:
\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x;
\]

\[
\{\Gamma_1, \Gamma_2\}:
\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x;
\]

\[
\{\Gamma_1, \Gamma_2\}:
\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x;
\]

\[
\{\Gamma_1, \Gamma_2\}:
\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x;
\]

\[
\{\Gamma_1, \Gamma_2\}:
\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \sigma_1 k_x;
\]

\[
\Lambda; \{\Gamma_1, \Gamma_2, \Gamma_3\}:
A_0 (c_1 + c_2 q) + \sigma_0 (c_4 k_x + c_4 k_y) + c_5 (A_1 - A_2) + A_7 c_6 + A_3 c_7 q_y + \left( c_4 k_x + A_4 c_3 \right) - c_5 (A_4 + A_5) + A_3 c_6 - A_1 c_7 - A_2 q_y;
\]

\[
G; \{\Gamma_1, \Gamma_2\}:
\sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 (c_3 k_x + c_3 k_y) + c_6 \sigma_1 k_x;
\]

\[
F; \{\Gamma_1, \Gamma_2, \Gamma_3\}:
A_0 (c_1 + c_2 p_2) + A_3 c_3 p_3 + \left( \sqrt{3} A_4 + A_1 \right) c_5 + \left( \sqrt{3} (A_6 + A_7) + A_3 c_6 + A_4 c_6 + (A_6 + A_7) \right) c_7 + A_1 c_6 + (A_3 - A_2) c_7 p_x + \left( A_4 - A_3 A_1 \right) c_5 + \left( \sqrt{3} A_2 + A_4 \right) c_7 c_7 + A_4 c_6 + (A_6 + A_7) c_7 p_y;
\]

\[
\Gamma_0; \{\Gamma_0, \Gamma_1, \Gamma_2, \Gamma_3, \Gamma_4, \Gamma_5, \Gamma_6, \Gamma_7, \Gamma_8\}; \text{Centrosymmetric; without SOC}
\]

\[
\Gamma_0; \{\Gamma_1, \Gamma_2, \Gamma_3, \Gamma_4, \Gamma_5, \Gamma_6, \Gamma_7, \Gamma_8\}; \text{Non-Centrosymmetric; without SOC}
\]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 + c_0 k^2 + c_3 \sigma_3 k^2 + c_5 \left( (\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z \right) \]

\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_i k^2 + c_i k^2_z) + [\sigma_+ (c_2 k_x k_z + i c_3 (k_x^2 - k_z^2)) + \text{h.c.}] \]

\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 [(\sigma_1 + \sigma_2) k_x + (\sigma_2 - \sigma_1) k_z] \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_y + c_i k^2 + c_i k^2_y) + [\sigma_+ (c_2 k_x k_y + i c_3 (k_y^2 - k_x^2)) + \text{h.c.}] \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z] \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_i k_y) + c_2 \sigma_2 (k_y - k_z) + c_3 \sigma_1 k_z \]

\[ \Lambda: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \left( (\sigma_1 - \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 + \sigma_2) q_y \right) \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 q_y) + \sigma_3 c_3 q_y + c_4 \left( (\sigma_1 + \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 - \sigma_2) q_y \right) \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 q_z) + \sigma_3 c_3 q_z + c_4 \left( (\sigma_1 - \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 + \sigma_2) q_y \right) \]

\[ S: \{ R_2 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_i k_y) + c_2 \sigma_2 (k_z - k_x) + c_3 \sigma_1 k_y \]

\[ Z: \{ R_3 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_i k_x + c_2 \sigma_2 k_y + c_3 \sigma_1 k_z \]

\[ T: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 (\sigma_1 k_x + \sigma_2 k_y) \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_i k_y + c_i k^2 + c_i k^2_y) + [\sigma_+ \left( c_2 (k_x^2 - k_y^2) + i c_3 k_x k_y \right) + \text{h.c.}] \]

\[ \{ R_4 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 (\sigma_1 k_x + \sigma_2 k_y) \]

\[ \Gamma_c: \{ C_{31}, [000], \{ C_{24}, [000], \{ C_{22}, [000], \{ C_{2a}, [\frac{1}{2} 0 \frac{1}{2} \frac{1}{2} \} \} \}ight)

\[ \Gamma: \{ R_3 \}; \left( c_1 + c_2 k^2 \right) \sigma_0 + c_3 \left[ \sqrt{3} (k_x^2 - k_y^2) \sigma_1 + (k_x^2 + k_y^2 - 2k_z^2) \sigma_3 \right] + c_4 k_x k_y k_z \sigma_2 \]

\[ \{ R_4 \}; A_1 c_1 - c_2 (A_4 k_x - A_2 k_y + A_1 k_z) \]

\[ \{ R_5 \}; A_0 c_1 - c_2 (A_1 k_x - A_2 k_y + A_1 k_z) \]

\[ X: \{ R_5 \}; \sigma_0 (c_1 + c_2 k^2 + c_3 k_y^2) + c_4 \sigma_1 k_x k_z + c_3 (k_z^2 - k_y^2) + c_6 \sigma_2 k_y \]

\[ M: \{ R_5 \}; \sigma_0 (c_1 + c_2 k^2 + c_3 k_y^2) + c_4 \sigma_1 k_x k_z + c_3 (k_z^2 - k_y^2) + c_6 \sigma_2 k_y \]

\[ R: \{ R_5 \}; (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sqrt{3} (k_x^2 - k_y^2) \sigma_1 + (k_x^2 + k_y^2 - 2k_z^2) \sigma_3 \right] + c_4 k_x k_y k_z \sigma_2 \]

\[ \{ R_4 \}; A_1 c_1 - c_2 (A_4 k_x - A_2 k_y + A_1 k_z) \]

\[ \{ R_5 \}; A_0 c_1 - c_2 (A_1 k_x - A_2 k_y + A_1 k_z) \]

\[ T; \text{Non-Centrosymmetric; without SOC} \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z]); \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_y + c_{2i} k^2 + c_{3i} k_y^2) + [\sigma_3 (c_2 k_y k_x + ic_3 (k_x^2 - k_y^2)) + h.c.]; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_5 [(\sigma_1 + \sigma_2) k_x + (\sigma_2 - \sigma_1) k_z]); \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_y + c_{2i} k^2 + c_{3i} k_y^2) + [\sigma_3 (c_2 k_y k_x + ic_3 (k_x^2 - k_y^2)) + h.c.]; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_y + c_{2i} k^2 + c_{3i} k_y^2) + [\sigma_3 (c_2 k_y k_x + ic_3 (k_x^2 - k_y^2)) + h.c.]; \]
\[ \{ R_1 \}, \{ R_5 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_{1i} k_y) + c_2 \sigma_2 (k_y - k_z) + c_3 \sigma_1 k_z; \]
\[ \Lambda:\{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_4 [(\sigma_1 - \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 + \sigma_2) q_y]); \]
\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_4 [(\sigma_1 + \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 - \sigma_2) q_y]); \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_4 [(\sigma_1 - \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 + \sigma_2) q_y]); \]
\[ \{ R_3 \}, \{ R_5 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_{1i} k_y) + c_2 \sigma_2 (k_x - k_z) + c_3 \sigma_1 k_z; \]
\[ \{ R_6 \}, \{ R_7 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_{1i} k_y) + c_2 \sigma_2 (k_x - k_z) + c_3 \sigma_1 k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_{1i} k_y) + c_2 \sigma_2 (k_x - k_z) + c_3 \sigma_1 k_z; \]
\[ \{ R_7 \}, \{ R_8 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_{1i} k_y) + c_2 \sigma_2 (k_x - k_z) + c_3 \sigma_1 k_z; \]

\[ \Sigma: \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z]); \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_5 [(\sigma_1 + \sigma_2) k_x + (\sigma_2 - \sigma_1) k_z]); \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z]); \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z]); \]
\[ \{ R_1 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z]); \]
\[ \{ R_2 \}, \{ R_7 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z]); \]
\[ \{ R_3 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z]); \]

SG 209

\[ \Gamma': \{ C_{3v}, |000\}; \{ C_{2v}, |000\}; \{ C_{2v}, |000\}; \{ C_{2v}, |000\}, T; \text{Non-Centrosymmetric; without SOC} \]

\[ \begin{align*}
    
    \Gamma: & \quad R_3: \quad (c_1 + c_2 k_x) \sigma_0 + c_3 \sqrt{(k_x^2 - k_y^2)} \sigma_1 + (k_x^2 + k_y^2 - 2k_x^2) \sigma_3 + c_1 k_x k_y k_z \sigma_2 \\
    & \quad R_4: \quad A_0 c_0 - c_2 (A_1 k_x - A_2 k_y + A_1 k_z); \\
    & \quad R_5: \quad A_0 c_0 - c_2 (A_3 k_x - A_2 k_y + A_1 k_z); \\
    X: & \quad R_5: \quad \sigma_0 (c_1 + c_2 k_x + c_3 k_y + c_4 \sigma_1 k_x k_z + c_5 \sigma_3 (k_x^2 - k_z^2)) + c_0 \sigma_2 k_y; \\
    L: & \quad R_3: \quad [(c_1 + c_2 (q_x^2 + q_y^2)) \sigma_0 + [c_1 (q_x^2 - q_y^2) - c_2 q_x q_y] \sigma_3 + [(2c_4 q_x q_y + c_5 q_y q_z + ic_6 q_z) \sigma_3 + h.c.]; \\
    W: & \quad \{ R_3, R_4 \}; \quad (c_1 + c_2 k^2 + c_3 k_x^2) \sigma_0 + c_6 \sigma_3 k_y k_z + [\sigma_3 (\alpha_1 k_x + \alpha_2 (k_x^2 - k_z^2)) + h.c.];
\end{align*} \]
Accidental degeneracies on high symmetry line

\[\Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \left[(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z\right];\]

\[\{R_3\}, \{R_4\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_3\}, \{R_5\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_5\}, \{R_6\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_5\}, \{R_7\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_7\}, \{R_8\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_7\}, \{R_9\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_9\}, \{R_{10}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_{10}\}, \{R_{11}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_{11}\}, \{R_{12}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_{12}\}, \{R_{13}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_{13}\}, \{R_{14}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_{14}\}, \{R_{15}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

Accidental degeneracies on high symmetry line

\[\Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 \left[(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z\right];\]

\[\{R_3\}, \{R_4\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_5\}, \{R_6\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_5\}, \{R_7\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_7\}, \{R_8\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_7\}, \{R_9\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_9\}, \{R_{10}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_{10}\}, \{R_{11}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_{11}\}, \{R_{12}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_{12}\}, \{R_{13}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_{13}\}, \{R_{14}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]

\[\{R_{14}\}, \{R_{15}\}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left(c_{1,i} k_y + c_{1,i} k^2 + c_{1,i} k^2_0\right) + \left[\sigma_+ \left(c_2 k_x k_z + i c_3 (k_x^2 - k_y^2)\right)\right] + h.c.;\]
SG 211

Γ': \{C_{3z}|000\}, \{C_{2y}|000\}, \{C_{2x}|000\}, \{C_{2a}|000\}, T; Non-Centrosymmetric; without SOC

Γ:
R_5: (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sqrt{3} (k_x^2 - k_y^2) \sigma_1 + (k_x^2 + k_y^2 - 2k_z^2) \sigma_3 \right] + c_4 k_x k_y k_z \sigma_2
R_4: A_0 c_1 - c_2 (A_3 k_x - A_2 k_y + A_1 k_z);
R_5: A_0 c_1 - c_2 (A_3 k_x - A_2 k_y + A_1 k_z);
H:
R_3: (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sqrt{3} (k_x^2 - k_y^2) \sigma_1 + (k_x^2 + k_y^2 - 2k_z^2) \sigma_3 \right] + c_4 k_x k_y k_z \sigma_2
R_4: A_0 c_1 - c_2 (A_3 k_x - A_2 k_y + A_1 k_z);
R_5: A_0 c_1 - c_2 (A_3 k_x - A_2 k_y + A_1 k_z);
P:
R_4: \sigma_0 + c_2 (A_7 k_x + A_6 k_y + A_4 k_z) + c_3 (A_3 k_x - A_2 k_y + A_1 k_z);

Accidental degeneracies on high symmetry line

Σ: \{R_1\}, \{R_2\}: \sigma_0 \left[ c_1 + c_2 (k_x + k_y) \right] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_x + c_6 \sigma_2 (k_y - k_z);
Δ: \{R_1\}, \{R_2\}: \sigma_0 \left( c_1 + c_2 k_y \right) + c_3 \sigma_3 k_y + c_5 \left[ (\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z \right];
\{R_1\}, \{R_3\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_1 \left( c_{i,1} k_y + c_{i,3} k_x^2 + c_{i,3} k_y^2 \right) + \sigma_1 \left( c_2 k_x k_z + ic_3 (k_x^2 - k_z^2) \right) + h.c.;
\{R_1\}, \{R_4\}: \sigma_0 \left( c_1 + c_3 k_y \right) + c_3 \sigma_3 k_y + c_5 \left[ (\sigma_1 + \sigma_2) k_x + (\sigma_2 - \sigma_1) k_z \right];
\{R_2\}, \{R_3\}: \sigma_0 \left( c_1 + c_3 k_y \right) + c_3 \sigma_3 k_y + c_5 \left[ \left( \sigma_1 + \sigma_2 \right) k_x - \left( \sigma_1 - \sigma_2 \right) k_z \right];
\{R_2\}, \{R_4\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_1 \left( c_{i,1} k_y + c_{i,3} k_x^2 + c_{i,3} k_y^2 \right) + \sigma_1 \left( c_2 k_x k_z + ic_3 (k_x^2 - k_z^2) \right) + h.c.;
\{R_3\}, \{R_4\}: \sigma_0 \left( c_1 + c_3 k_y \right) + c_3 \sigma_3 k_y + c_5 \left[ \left( \sigma_1 - \sigma_2 \right) k_x + \left( \sigma_1 + \sigma_2 \right) k_z \right];
Λ: \{R_1\}, \{R_2\}: \sigma_0 \left( c_1 + c_2 q_x \right) + c_3 \sigma_3 q_x + c_4 \left[ (\sigma_1 - \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 + \sigma_2) q_y \right];
\{R_1\}, \{R_3\}: \sigma_0 \left( c_1 + c_2 q_x \right) + c_3 \sigma_3 q_x + c_4 \left[ (\sigma_1 + \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 - \sigma_2) q_y \right];
\{R_2\}, \{R_3\}: \sigma_0 \left( c_1 + c_2 q_x \right) + c_3 \sigma_3 q_x + c_4 \left[ (\sigma_1 - \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 + \sigma_2) q_y \right];
\{R_2\}, \{R_4\}: \sigma_0 \left( c_1 + c_2 k_x \right) + c_3 \sigma_3 k_x + c_5 \sigma_1 (k_x + k_y) + c_6 \sigma_2 (k_y - k_z);
G: \{R_2\}, \{R_4\}: \sigma_0 \left[ c_1 + c_2 (k_x - k_y) \right] + \sigma_1 c_3 (k_x - k_y) + c_4 \sigma_1 (k_x + k_y) + c_5 \sigma_2 k_z;
F: \{R_1\}, \{R_2\}: \sigma_0 \left( c_1 + c_2 p_x \right) + c_3 \sigma_3 p_x + c_5 \left[ (\sigma_1 + \sqrt{3} \sigma_2) p_x + (\sigma_2 - \sqrt{3} \sigma_1) p_y \right];
\{R_1\}, \{R_3\}: \sigma_0 \left( c_1 + c_2 p_x \right) + c_3 \sigma_3 p_x + c_5 \left[ (\sqrt{3} \sigma_2 - \sigma_1) p_x + (\sqrt{3} \sigma_1 + \sigma_2) p_y \right];
\{R_2\}, \{R_4\}: \sigma_0 \left( c_1 + c_2 p_x \right) + c_3 \sigma_3 p_x + c_5 \left[ (\sigma_1 + \sqrt{3} \sigma_2) p_x + (\sigma_2 - \sqrt{3} \sigma_1) p_y \right];
Γ; $\{C_{3v}|000\}$, $\{C_{2v}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$, $\{C_{2s}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}$, $\{C_{2a}|\frac{1}{4}\frac{3}{4}\frac{3}{4}\}$, $\mathcal{T}$; Non-Centrosymmetric; without SOC

$\Gamma$: $R_3$: $(c_1 + c_2 k^2)\sigma_0 + c_3 \left[\sqrt{3}(k_x^2 - k_y^2)\sigma_1 + (k_x^2 + k_y^2 - 2k_z^2)\sigma_3 + c_4 k_x k_y k_z \sigma_2\right]$

$R_4$: $A_0 c_1 - c_2 (A_1 k_x - A_2 k_y + A_1 k_z)$

$R_5$: $A_0 c_1 - c_2 (A_3 k_x - A_2 k_y + A_1 k_z)$

$X$: $R_6$: $c_1 \sigma_0 + c_2 \sigma_2 k_y$

$R_7$: $c_1 \sigma_0 + c_2 \sigma_2 k_y$

$M$: $\{R_3, R_6\}$; $(c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + c_4 \sigma_1 k_x k_y + c_5 \sigma_2 k_x k_y$

$\{R_7, R_8\}$; $(c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + c_4 \sigma_1 k_x k_y + c_5 \sigma_2 k_x k_y$

$R_9$: $(c_1 + c_2 k^2 + c_3 k_y^2)\sigma_0 + c_4 \sigma_3 k_x k_y$

$R$: $\{R_4, R_5\}$; $c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,0} q_x + \Gamma_{3,1} q_y - \Gamma_{3,3} q_z)$

$R_6$: $c_1 \Gamma_{0,0} + c_2 \left[\Gamma_{0,2} (k_x + k_y) + \Gamma_{3,3} (k_x - k_y) + \sqrt{2}\Gamma_{3,1} k_z\right]$

$S$: $\{R_4, R_8\}$; $(c_1 + c_2 (k_x + k_y))\sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_y$

$Z$: $\{R_2, R_4\}$; $(c_1 + c_2 k^2)\sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) k_y$

$T$: $\{R_2, R_4\}$; $(c_1 + c_2 k^2 + c_3 k_y^2 + c_4 k_z)\sigma_0 + c_5 \sigma_1 k_x k_y + c_5 \sigma_2 k_x k_y$

$\{R_6, R_8\}$; $(c_1 + c_2 k^2 + c_3 k_y^2 + c_4 k_z)\sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_2 k_x k_y$

Accidental degeneracies on high symmetry line

$\Delta$: $\{R_1\}, \{R_2\}$

$\{R_1\}, \{R_3\}$

$\{R_1\}, \{R_4\}$

$\{R_2\}, \{R_1\}$

$\{R_2\}, \{R_4\}$

$\{R_3\}, \{R_1\}$

$\{R_3\}, \{R_2\}$

$\{R_3\}, \{R_4\}$

$\Sigma$: $\{R_1\}, \{R_2\}$

$\{R_1\}, \{R_3\}$

$\{R_1\}, \{R_4\}$

$\{R_2\}, \{R_1\}$

$\{R_2\}, \{R_3\}$

$\{R_2\}, \{R_4\}$

$\Lambda$: $\{R_1\}, \{R_2\}$

$\{R_1\}, \{R_3\}$

$\{R_1\}, \{R_4\}$

$\{R_2\}, \{R_1\}$

$\{R_2\}, \{R_3\}$

$\{R_2\}, \{R_4\}$

$T$: $\{R_5, R_7\}, \{R_6, R_8\}$; $c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{i,0} c_2 k_z + c_3 (\Gamma_{1,0} k_x + \Gamma_{2,0} k_y) + [k_x (\alpha \Gamma_{1,0} + c_4 \Gamma_{2,3}) + k_y (\alpha \Gamma_{1,0} + c_4 \Gamma_{1,3}) + h.c.]$
\[ \Gamma_c; \{ C_{3v}^{000} \}, \{ C_{2v}^{1 \frac{1}{2} 0} \}, \{ C_{2v}^{0 \frac{1}{2} 1} \}, \{ C_{2v}^{1 \frac{1}{2} \frac{1}{2} 0} \}, \{ C_{2v}^{0 \frac{1}{2} 1 \frac{1}{2} \frac{1}{2}} \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \]
\[ R_3; (c_1 + c_2 k^2) \sigma_0 + c_3 \sqrt{3}(k_x^2 - k_y^2) \sigma_1 + (k_x^2 + k_y^2 - 2k_z^2) \sigma_3 + c_4 k_x k_y k_z \sigma_2 \]
\[ R_4; A_0 c_1 - c_2 (A_3 k_x - A_2 k_y + A_1 k_z) ; \]
\[ R_5; A_0 c_1 - c_2 (A_3 k_x - A_2 k_y + A_1 k_z) ; \]
\[ X; R_6; c_1 \sigma_0 + c_2 \sigma_0 k_y ; \]
\[ R_7; c_1 \sigma_0 + c_2 \sigma_0 k_y ; \]
\[ M; \{ R_3, R_6 \}; (c_1 + c_2 k^2 + c_3 k_x^2) \sigma_0 + c_4 \sigma_1 k_x k_y + c_5 \sigma_2 k_x k_y ; \]
\[ \{ R_7, R_8 \}; (c_1 + c_2 k^2 + c_3 k_x^2) \sigma_0 + c_4 \sigma_1 k_x k_y + c_5 \sigma_2 k_x k_y ; \]
\[ R_9; (c_1 + c_2 k^2 + c_3 k_x^2) \sigma_0 + c_4 \sigma_3 k_x k_y ; \]
\[ R; \{ R_4, R_5 \}; c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2} q_x + \Gamma_{3,1} q_y - \Gamma_{3,3} q_z); \]
\[ R_6; c_1 \Gamma_{0,0} + c_2 \left[ \Gamma_{0,2} (k_x + k_y) + \Gamma_{3,3} (k_x - k_y) + \sqrt{2} \Gamma_{3,1} k_z \right] ; \]
\[ S; \{ R_2, R_4 \}; (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y ; \]
\[ Z; \{ R_2, R_4 \}; (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y ; \]
\[ T; \{ R_2, R_4 \}; (c_1 + c_2 k^2 + c_3 k_x^2 + c_4 k_x) \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_2 k_x k_y ; \]
\[ \{ R_6, R_8 \}; (c_1 + c_2 k^2 + c_3 k_x^2 + c_4 k_x) \sigma_0 + c_5 \sigma_1 k_x k_y + c_6 \sigma_2 k_x k_y ; \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_x + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z] ; \]
\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 c_1 + \sum_{\alpha=0,3} \sigma_1 (c_{1+} k_x + c_{1-} k_x^2 + c_{3,5} k_x^2) + [\sigma_4 (c_2 k_x k_z + i c_3 (k_x^2 - k_z^2)) + \text{h.c.}] ; \]
\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 [(\sigma_1 + \sigma_2) k_x + (\sigma_2 - \sigma_1) k_z] ; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z] ; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 [(\sigma_1 + \sigma_2) k_x - \sigma_2 - \sigma_1) k_z] ; \]
\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z] ; \]
\[ \{ R_5 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_5 [(\sigma_1 + \sigma_2) k_x - (\sigma_1 + \sigma_2) k_z] ; \]
\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 [(c_1 + c_2 k_x) k_y] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_x + c_6 \sigma_2 (k_y - k_z) ; \]
\[ \{ R_3 \}, \{ R_4 \}; c_3 \sigma_3 c_{2y} + c_1 [(\sigma_1 - \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 + \sigma_2) q_y] ; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 q_x) + c_3 \sigma_3 c_{2y} + c_1 [(\sigma_1 + \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 - \sigma_2) q_y] ; \]
\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 q_x) + c_3 \sigma_3 c_{2y} + c_1 [(\sigma_1 + \sqrt{3} \sigma_2) q_x + (\sqrt{3} \sigma_1 - \sigma_2) q_y] ; \]
\[ T; \{ R_5, R_7 \}, \{ R_6, R_8 \}; c_1 \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,i} c_{2x} + c_3 \left[ \Gamma_{1,0} k_x + \Gamma_{2,0} k_y \right] + \left[ k_z (\alpha \Gamma_{2, \alpha} - c_4 \Gamma_{2, \alpha}) + k_y (\alpha \Gamma_{1, +} + c_4 \Gamma_{1, +}) + \text{h.c.} \right] ; \]

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\[ \Gamma_c; \{ C_{3v}^{000} \}, \{ C_{2v}^{1 \frac{1}{2} 0} \}, \{ C_{2v}^{0 \frac{1}{2} 1} \}, \{ C_{2v}^{1 \frac{1}{2} \frac{1}{2} 0} \}, \{ C_{2v}^{0 \frac{1}{2} 1 \frac{1}{2} \frac{1}{2}} \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \]
\[ R_3; (c_1 + c_2 k^2) \sigma_0 + c_3 \sqrt{3}(k_x^2 - k_y^2) \sigma_1 + (k_x^2 + k_y^2 - 2k_z^2) \sigma_3 + c_4 k_x k_y k_z \sigma_2 \]
\[ R_4; A_0 c_1 - c_2 (A_3 k_x - A_2 k_y + A_1 k_z) ; \]
\[ R_5; A_0 c_1 - c_2 (A_3 k_x - A_2 k_y + A_1 k_z) ; \]
\[ H; R_6; (c_1 + c_2 k^2) \sigma_0 + c_3 \sqrt{3} \sigma_1 (k_x^2 - k_y^2) + \sigma_3 (k_x^2 + k_y^2 - 2k_z^2) + c_4 \sigma_2 k_x k_y k_z ; \]
\[ R_9; A_0 c_1 - c_2 (A_3 k_x + A_1 k_y + A_2 k_z) ; \]
\[ R_{10}; A_0 c_1 - c_2 (A_3 k_x + A_1 k_y + A_2 k_z) ; \]
\[ P; \]
\[ R_7; c_1 \sigma_0 + c_2 \left[ q_3 \sigma_3 - (-1)^{7/12} q_4 \sigma_- + \text{h.c.} \right] ; \]
\[ R_8; c_1 \sigma_0 + c_2 \left[ q_3 \sigma_3 - (-1)^{7/12} q_4 \sigma_- + \text{h.c.} \right] ; \]
\[ R_9; c_1 \sigma_0 + c_2 \left[ q_3 \sigma_3 - (-1)^{7/12} q_4 \sigma_- + \text{h.c.} \right] ; \]
Accidental degeneracies on high symmetry line

\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 \left( c_1 + c_2 (k_x + k_y) \right) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z + c_6 \sigma_2 (k_y - k_x) ; \]

\[ \Delta; \{ R_3 \}, \{ R_4 \}; \sigma_0 \left( c_1 + c_2 k_y \right) + c_3 \sigma_3 k_y + c_5 \left( \sigma_1 - \sigma_2 \right) k_x - \left( \sigma_1 + \sigma_2 \right) k_z ; \]

\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left( c_1 k_y + c_3 k_y^2 + c_4 k_y^3 \right) + \left[ \sigma_+ \left( c_2 k_x k_z + i c_3 \left( k_x^2 - k_y^2 \right) \right) \right] + h.c. ; \]

\[ \{ R_1 \}, \{ R_4 \}; \sigma_0 c_1 + c_2 k_y + c_5 \sigma_3 k_y + c_5 \left( \sigma_1 + \sigma_2 \right) k_x + \left( \sigma_2 - \sigma_1 \right) k_z ; \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 c_1 + c_2 k_y + c_3 \sigma_3 k_y + c_5 \left( \sigma_1 - \sigma_2 \right) k_x - \left( \sigma_1 + \sigma_2 \right) k_z ; \]

\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i \left( c_1 k_y + c_3 k_y^2 + c_4 k_y^3 \right) + \left[ \sigma_+ \left( c_2 k_x k_z + i c_3 \left( k_x^2 - k_y^2 \right) \right) \right] + h.c. ; \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 c_1 + c_3 k_y + c_5 \sigma_3 k_y + c_5 \left( \sigma_1 - \sigma_2 \right) k_x - \left( \sigma_1 + \sigma_2 \right) k_z ; \]

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_3 \sigma_3 k_x + c_4 \left[ \left( \sigma_1 - \sqrt{3} \sigma_2 \right) q_x + \left( \sqrt{3} \sigma_1 + \sigma_2 \right) q_y \right] ; \]

\[ \{ R_1 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_3 \sigma_3 k_x + c_4 \left[ \left( \sigma_1 + \sqrt{3} \sigma_2 \right) q_x + \left( \sqrt{3} \sigma_1 - \sigma_2 \right) q_y \right] ; \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_3 \sigma_3 k_x + c_4 \left[ \left( \sigma_1 - \sqrt{3} \sigma_2 \right) q_x + \left( \sqrt{3} \sigma_1 + \sigma_2 \right) q_y \right] ; \]

\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_3 \sigma_3 k_x + c_4 \left[ \left( \sigma_1 + \sqrt{3} \sigma_2 \right) q_x + \left( \sqrt{3} \sigma_1 - \sigma_2 \right) q_y \right] ; \]

\[ \{ R_4 \}, \{ R_5 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_3 \sigma_3 k_x + c_5 \left( \sigma_1 - \sigma_2 \right) \left( k_x - k_y \right) ; \]

\[ \Gamma; \{ C_{3v}|000 \}, \{ C_{2v}|000 \}, \{ C_{2v}|000 \}, \{ \sigma_{vi}|000 \}, T; \text{ Non-Centrosymmetric; without SOC} \]

\[ \Gamma; \{ R_3 \}; \left( c_1 + c_2 k_x \right) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) - \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_x^2 \right)}{\sqrt{3}} \right] ; \]

\[ \{ R_4 \}; \left( c_1 + c_2 k_x \right) A_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_x^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right) ; \]

\[ \{ R_5 \}; \left( c_1 + c_2 k_x \right) A_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_x^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right) ; \]

\[ \{ R_6 \}; \left( c_1 + c_2 k_x \right) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) - \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_x^2 \right)}{\sqrt{3}} \right] ; \]

\[ \{ R_7 \}; \left( c_1 + c_2 k_x \right) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) - \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_x^2 \right)}{\sqrt{3}} \right] ; \]

\[ \{ R_8 \}; \left( c_1 + c_2 k_x \right) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) - \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_x^2 \right)}{\sqrt{3}} \right] ; \]

\[ \{ R_9 \}; \left( c_1 + c_2 k_x \right) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) - \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_x^2 \right)}{\sqrt{3}} \right] ; \]

\[ \{ R_{10} \}; \left( c_1 + c_2 k_x \right) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) - \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_x^2 \right)}{\sqrt{3}} \right] ; \]

\[ \{ R_{11} \}; \left( c_1 + c_2 k_x \right) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) - \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_x^2 \right)}{\sqrt{3}} \right] ; \]

\[ \{ R_{12} \}; \left( c_1 + c_2 k_x \right) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) - \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_x^2 \right)}{\sqrt{3}} \right] ; \]

\[ \{ R_{13}, R_4 \}; \left( c_1 + c_2 k_x \right) \sigma_0 + c_3 \sigma_1 k_x k_y + \left[ \sigma_0 \left( k_x^2 - k_y^2 \right) \right] + h.c. ; \]

\[ \{ R_3 \}, \{ R_4 \}; \left( c_1 + c_2 k_x \right) \sigma_0 + c_3 \sigma_1 k_x k_y + \left[ \sigma_0 \left( k_x^2 - k_y^2 \right) \right] + h.c. ; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3, R_4 \} : \quad A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + [(A_1 + A_9) c_4 + (A_2 - A_1) c_5] k_x + [(A_6 - A_4) c_1 + (A_1 + A_2) c_3] k_z; \]
\[ \{ R_2 \}, \{ R_3, R_4 \} : \quad A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y - [(A_6 - A_4) c_4 + (A_1 + A_2) c_5] k_x + [(A_4 + A_6) c_1 + (A_2 - A_1) c_3] k_z; \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_3 (k_x - k_y); \]
\[ \Lambda: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 q_x) \alpha + c_3 \sigma_3 q_x; \]
\[ \{ R_1 \}, \{ R_3 \} : \quad A_0 (c_1 + c_2 q_x) + (\sqrt{3} A_5 + A_8) c_3 q_x + [c_5 (A_5 - \sqrt{3} A_8) + 2\sqrt{2} (A_1 c_6 - A_4 c_4)] q_x + 2 \sqrt{3} (A_2 c_6 - A_6 c_4) + A_7 c_5 q_x; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad A_0 (c_1 + c_2 q_x) + (\sqrt{3} A_5 + A_8) c_3 q_x + [c_5 (A_5 - \sqrt{3} A_8) + 2(A_2 c_5 - A_6 c_4)] q_x + 2(A_4 c_4 + A_7 c_5 - A_1 c_6) q_y; \]
\[ S: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_3 (k_x - k_z); \]
\[ Z: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_3 k_x; \]
\[ T: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3, R_4 \} : \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + [(A_6 - A_4) c_5 + (A_1 + A_2) c_6] k_x + [(A_4 + A_6) c_5 + (A_2 - A_1) c_6] k_z; \]
\[ \{ R_2 \}, \{ R_3, R_4 \} : \quad A_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_8) c_3 k_z + [(A_6 - A_4) c_5 + (A_2 - A_1) c_6] k_x - [(A_6 - A_4) c_5 + (A_1 + A_2) c_6] k_z; \]

SG 216
\[ \Gamma_v^2: \{ C_{3v} \}, \{ C_{2v} \}, \{ C_{2v} \}, \{ \sigma_d \}, \{ T \}; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \{ R_3 \} : \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k^2 - k_x^2) - \frac{\sigma_3 (k^2 + k_x^2 - 2k_z^2)}{\sqrt{3}} \right]; \]
\[ \{ R_4 \} : \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \]
\[ \{ R_5 \} : \quad A_0 (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \]
\[ \{ R_6 \} : \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \]
\[ \{ R_7 \} : \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \]
\[ \{ R_8 \} : \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \]
\[ \{ R_9 \} : \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \quad (c_1 + c_2 k^2) \quad \mathcal{A} \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_3, R_4 \} : \quad A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + [(A_1 + A_9) c_4 + (A_2 - A_1) c_5] k_x + [(A_6 - A_4) c_1 + (A_1 + A_2) c_3] k_z; \]
\[ \{ R_2 \}, \{ R_3, R_4 \} : \quad A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y - [(A_6 - A_4) c_4 + (A_1 + A_2) c_5] k_x + [(A_4 + A_6) c_1 + (A_2 - A_1) c_3] k_z; \]
\[ \Lambda: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 (c_1 + c_2 q_x) \alpha + c_3 \sigma_3 q_x; \]
\[ \{ R_1 \}, \{ R_3 \} : \quad A_0 (c_1 + c_2 q_x) + (\sqrt{3} A_5 + A_8) c_3 q_x + [c_5 (A_5 - \sqrt{3} A_8) + 2\sqrt{2} (A_1 c_6 - A_4 c_4)] q_x + 2 \sqrt{3} (A_2 c_6 - A_6 c_4) + A_7 c_5 q_x; \]
\[ \{ R_2 \}, \{ R_3 \} : \quad A_0 (c_1 + c_2 q_x) + (\sqrt{3} A_5 + A_8) c_3 q_x + [c_5 (A_5 - \sqrt{3} A_8) + 2(A_2 c_5 - A_6 c_4)] q_x + 2(A_4 c_4 + A_7 c_5 - A_1 c_6) q_y; \]
\[ \Sigma: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_3 (k_x - k_y); \]
\[ S: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_3 (k_x - k_z); \]
\[ Z: \{ R_1 \}, \{ R_2 \} : \quad \sigma_0 [c_1 + c_2 k_z] + c_3 \sigma_3 k_z + c_5 \sigma_3 k_x; \]
Accidental degeneracies on high symmetry line

\[ \begin{align*}
\Sigma: & \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \\
\Delta: & \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 [c_1 + c_2 k_y] + c_3 \sigma_1 k_y; \\
& \{ R_3 \}, \{ R_4 \}; \quad A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_5 + A_8) c_3 k_y - [(A_6 - A_4) c_1 + (A_1 + A_2) c_5] k_x + [(A_4 + A_6) c_1 + (A_2 - A_1) c_5] k_z; \\
& \{ R_2 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_5 + A_8) c_3 k_y + [(A_1 + A_6) c_4 + (A_2 - A_1) c_5] k_x + [(A_6 - A_4) c_4 + (A_1 + A_2) c_5] k_z; \\
\Lambda: & \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 [c_1 + c_2 q_x] + c_3 \sigma_3 q_x; \\
& \{ R_3 \}, \{ R_4 \}; \quad A_0 (c_1 + c_2 q_x) + (\sqrt{3}A_5 + A_8) c_3 q_x + [c_5 (A_5 - \sqrt{3}A_8) + 2\sqrt{3}(A_1 c_6 - A_4 c_1)] q_x + 2\sqrt{3}(A_2 c_6 - A_6 c_4) + A c_5 q_y; \\
& \{ R_2 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2 q_x) + (\sqrt{3}A_5 + A_8) c_3 q_x + [c_5 (A_5 - \sqrt{3}A_8) + 2(A_2 c_6 - A_6 c_4)] q_x + 2(A_1 c_6 + A_5 c_3) q_y; \\
D: & \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 [c_1 + c_2 k_x] + c_3 \sigma_3 k_x; \\
& \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 [c_1 + c_2 k_x] + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) (k_x - k_y); \\
& \{ R_1 \}, \{ R_3 \}; \quad \sigma_0 [c_1 + c_2 k_x] + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) (k_x - k_y); \\
& \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 [c_1 + c_2 k_x] + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) (k_x - k_y); \\
& \{ R_1 \}, \{ R_5 \}; \quad \sigma_0 [c_1 + c_2 k_x] + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) (k_x - k_y); \\
& \{ R_2 \}, \{ R_5 \}; \quad \sigma_0 [c_1 + c_2 k_x] + c_3 \sigma_3 k_x + (c_5 \sigma_1 + c_6 \sigma_2) (k_x - k_y); \\
G: & \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 [c_1 + c_2 (k_x - k_y)] + c_5 \sigma_3 (k_x - k_y) + c_5 \sigma_2 (k_x + k_y); \\
F: & \{ R_1 \}, \{ R_2 \}; \quad \sigma_0 [c_1 + c_2 p_x] + c_5 \sigma_3 p_x; \\
& \{ R_1 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2 p_x) + (\sqrt{3}A_5 + A_8) c_3 p_x + (A_6 c_4 - c_7 A_2 - 2c_3 A_1) (\sqrt{3}p_x - p_y) + [c_5 A_1 - A_6 c_4 + c_5 (A_5 - \sqrt{3}A_8)] (p_x + \sqrt{3}p_y); \\
& \{ R_2 \}, \{ R_3 \}; \quad A_0 (c_1 + c_2 p_x) + (\sqrt{3}A_5 + A_8) c_3 p_x + (A_6 c_4 - A_4 c_1 - 2c_5 A_1) (\sqrt{3}p_x - p_y) + [c_5 (A_5 - \sqrt{3}A_8) - A_6 c_4 + A_2 c_6] (p_x + \sqrt{3}p_y); \\
\end{align*} \]
\( \Gamma_c; \{ C_{33} | 000 \}, \{ C_{2z} | 000 \}, \{ \sigma_{da} | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}; T; \) Non-Centrosymmetric; without SOC

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\begin{align*}
\Gamma: & \quad R_3: \quad (c_1 + c_2 k_x^2) \sigma_0 + c_3 \left[ \sigma_x (k_y^2 - k_z^2) - \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \\
& \quad R_4: \quad (c_1 + c_2 k_x^2) A_0 + c_1 \sqrt{3} A_5 (k_z^2 - k_y^2) + A_3 (k_x^2 + k_y^2 - 2k_z^2) ] + c_4 (A_4 k_x k_y + A_5 k_z k_x); \\
& \quad R_5: \quad (c_1 + c_2 k_x^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_z^2 - k_x^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) ] + c_4 (A_4 k_x k_y + A_5 k_z k_x) + A_5 k_y k_z); \\
X: & \quad \{ R_5, R_6 \}: \quad (c_1 + c_2 k_x^2 + c_3 k_y^2) \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) (k_x^2 - k_y^2); \\
& \quad \{ R_7, R_8 \}: \quad (c_1 + c_2 k_x^2 + c_3 k_y^2) \sigma_0 + (c_4 \sigma_1 + c_5 \sigma_2) (k_x^2 - k_y^2); \\
& \quad R_9: \quad (c_1 + c_2 k_x^2 + c_3 k_y^2) \sigma_0 + c_6 \sigma_3 (k_x^2 - k_y^2) + c_5 \sigma_2 k_y; \\
M: & \quad R_5: \quad (c_1 + c_2 k_x^2 + c_3 k_y^2) \sigma_0 + c_6 \sigma_3 k_y k_x + c_5 \sigma_3 (k_x^2 - k_y^2); \\
R: & \quad \{ R_3, R_4 \}: \quad (c_1 + c_2 k_x^2) \sigma_0 + c_3 \sigma_3 k_y k_x; \\
& \quad \{ R_6, R_8 \}: \quad (c_1 + c_2 k_x^2) \Gamma_{0,0} + \sqrt{3} (c_3 \Gamma_{3,1} + c_4 \Gamma_{1,1} + c_5 \Gamma_{2,1}) (k_x^2 - k_y^2) - (c_6 \Gamma_{3,2} + c_4 \Gamma_{1,2} + c_5 \Gamma_{2,2}) (k_x^2 + k_y^2 - 2k_z^2) \\
& \quad \quad + (c_6 \Gamma_{1,0} + c_7 \Gamma_{2,0} + c_8 \Gamma_{3,0}) k_x k_y k_z; \\
\Delta: & \quad \{ R_9, R_{10} \}: \quad c_1 S_{0,0} + c_2 (S_{1,1} k_x + S_{1,2} k_y - S_{1,3} k_z) + c_3 (S_{2,1} k_x + S_{2,2} k_y - S_{2,3} k_z) + c_4 (S_{3,1} k_x - S_{2,1} k_y - S_{2,1} k_z); \\
\Lambda: & \quad \{ R_9, R_{10} \}: \quad (c_1 + c_2 k_x + c_3 k_z^2) \sigma_0 + c_4 \sigma_3 k_x k_z + [a_1 \sigma_4 (k_x^2 - k_y^2) + h.c.]; \\
S: & \quad \{ R_1, R_2 \}: \quad (c_1 + c_2 k_x + c_3 k_z^2) \sigma_0 + c_4 \sigma_3 k_x k_z + [a_1 \sigma_4 (k_x^2 - k_y^2) + h.c.]; \\
T: & \quad \{ R_1, R_2 \}: \quad (c_1 + c_2 k_x + c_3 k_z^2) \sigma_0 + c_4 \sigma_3 k_x k_z + [a_1 \sigma_4 (k_x^2 - k_y^2) + h.c.]; \\

\text{Accidental degeneracies on high symmetry line}
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\begin{align*}
\Delta: & \quad \{ R_1 \}, \{ R_2 \}: \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \\
& \quad \{ R_1 \}, \{ R_3 \}, \{ R_4 \}: \quad A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + (A_1 + A_6) c_4 + (A_2 - A_1) c_5 + (A_6 - A_4) c_4 + (A_1 + A_2) c_5) k_x; \\
& \quad \{ R_1 \}, \{ R_3 \}, \{ R_4 \}: \quad A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + (A_1 + A_6) c_4 + (A_2 - A_1) c_5) k_x + [(A_6 - A_4) c_4 + (A_1 + A_2) c_5) k_x; \\
\Sigma: & \quad \{ R_1 \}, \{ R_2 \}: \quad \sigma_0 (c_1 + c_2 k_x + k_y) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \\
\Lambda: & \quad \{ R_1 \}, \{ R_2 \}: \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y; \\
& \quad \{ R_1 \}, \{ R_3 \}: \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + [c_5 (A_3 - \sqrt{3} A_8) + 2\sqrt{2} (A_1 c_6 - A_2 c_4)] q_x + \\
& \quad \quad 2 \sqrt{3} (A_2 c_6 - A_1 c_4) + A_1 c_5] q_y; \\
& \quad \{ R_2 \}, \{ R_3 \}: \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + [c_5 (A_3 - \sqrt{3} A_8) + 2(A_2 c_6 - A_1 c_4)] q_x + 2(A_4 c_4 + A_7 c_5 - A_1 c_6) q_y; \\
Z: & \quad \{ R_1 \}, \{ R_3 \}: \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_1 k_y + c_5 \sigma_1 k_z; \\
T: & \quad \{ R_1, R_2 \}, \{ R_3 \}: \quad A_0 (c_1 + c_2 k_x) + A_8 c_3 k_x + [(A_6 - A_7) c_4 - (A_2 + A_3) c_5) k_x - [(A_6 + A_7) c_4 + (A_3 - A_2) c_5]) k_y; \\
& \quad \{ R_1, R_2 \}, \{ R_4 \}: \quad A_0 (c_1 + c_2 k_x) + A_8 c_3 k_x + [(A_6 + A_7) c_4 + (A_3 - A_2) c_5] k_x + [(A_6 - A_7) c_4 - (A_2 + A_3) c_5] k_y; \\
& \quad \{ R_3 \}, \{ R_4 \}: \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; 
\]
Accidental degeneracies on high symmetry line

$$
\Delta: \{R_1\}, \{R_2\}: \quad \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z;
\{R_1\}, \{R_3, R_4\}: \quad A_0 (c_1 + c_2 k_y) + \sqrt{3} A_5 (k_z - k_x) c_3 k_y + [A_4 + A_6 + (A_4 + A_6) c_4 + (A_2 - A_1) c_3] k_x + [(A_6 - A_4) c_4 + (A_1 + A_2) c_5] k_z;
\{R_2\}, \{R_3, R_4\}: \quad A_0 (c_1 + c_2 k_y) + \sqrt{3} A_5 (k_z - k_x) c_3 k_y - [(A_6 - A_4) c_4 + (A_1 + A_2) c_5] k_x + [(A_4 + A_6) c_4 + (A_2 - A_1) c_5] k_z;
\Lambda: \{R_1\}, \{R_2\}: \quad \sigma_0 (c_1 + c_2 q_y) + c_3 \sigma_3 q_y;
\{R_1\}, \{R_3\}: \quad A_0 (c_1 + c_2 q_y) + \sqrt{3} A_5 (A_8 + A_6) c_3 q_y + [c_5 (A_5 - \sqrt{3} A_8) + 2 \sqrt{2} (A_4 c_6 - A_3 c_4)] q_x + 2 \sqrt{2} (A_2 c_6 - A_4 c_4) A_3 c_5 q_y;
\{R_2\}, \{R_1\}: \quad A_0 (c_1 + c_2 q_y) + \sqrt{3} A_5 (A_8 + A_6) c_3 q_y + [c_5 (A_5 - \sqrt{3} A_8) + 2 (A_2 c_6 - A_4 c_4)] q_x + 2 (A_4 c_4 + A_7 c_5 - A_1 c_6) q_y;
\Sigma: \{R_1\}, \{R_2\}: \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y);
\Theta: \{R_1\}, \{R_2\}: \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_2 (k_x - k_y);
\Omega: \{R_1\}, \{R_2\}: \quad \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x + c_5 \sigma_2 k_y + c_6 \sigma_1 k_z;
\[ \Gamma_v; \{ C_{220} \}; \{ C_{23}, \frac{1}{2} C_{4} \}; \{ C_{2z}, \frac{1}{2} C_{4} \}; \{ \sigma_{da}, \frac{1}{2} C_{4} \}; T; \text{Non-Centrosymmetric; without SOC} \]

\[ \Gamma: \]
- \( R_3: \) \( (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) - \frac{\sigma_3 (k_x^2 + k_y^2 - 2 k_z^2)}{\sqrt{3}} \right] \);
- \( R_4: \) \( (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2 k_z^2) \right] + c_4 \left( A_4 k_x k_y + A_6 k_z k_x + A_7 k_y k_z \right) \);
- \( R_5: \) \( (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2 k_z^2) \right] + c_4 \left( A_4 k_x k_y + A_6 k_z k_x + A_7 k_y k_z \right) \);

\[ H: \]
- \( \{ R_3, R_4 \}: \) \( (c_1 + c_2 k^2) \sigma_0 + c_3 \sigma_3 k_x k_y k_z \);
- \( \{ R_6, R_8 \}: \) \( (c_1 + c_2 k^2) \Gamma_{0,0} + \sqrt{3} (c_3 \Gamma_{3,1} + c_4 \Gamma_{1,1} + c_5 \Gamma_{2,1}) (k_x^2 - k_y^2) - (c_3 \Gamma_{3,1} + c_4 \Gamma_{1,2} + c_5 \Gamma_{2,2}) (k_x^2 + k_y^2 - 2 k_z^2) + \left( c_6 \Gamma_{1,0} + c_7 \Gamma_{2,0} + c_8 \Gamma_{3,0} \right) k_x k_y k_z \);
- \( \{ R_5, R_{10} \}: \) \( c_1 S_{0,0} + c_2 (S_{1,1} k_x + S_{1,2} k_y - S_{1,3} k_z) + c_3 (S_{2,1} k_x + S_{2,2} k_y - S_{2,3} k_z) + c_4 (S_{3,4} k_x - S_{3,6} k_y - S_{3,7} k_z) \);

\[ P: \]
- \( R_9: \) \( c_1 \sigma_0 \);
- \( R_{10}: \) \( c_1 \sigma_0 \);
- \( R_{16}: \) \( c_1 \Gamma_{0,0} + \sqrt{6} (c_2 - c_1) (\Gamma_{3,1} k_y + \Gamma_{3,2} k_x) + k_x [(3 - i) c_2 + 4 i c_3] \Gamma_{+3} + (k_y \Gamma_{+1} - k_z \Gamma_{+2}) [(2 i c_2 + (3 + i) c_3)] \);

\[ N: \]
- \( R_5: \) \( c_1 \sigma_0 + c_2 \sigma_2 (k_x + k_y) \);
- \( R_{16}: \) \( c_1 \Gamma_{0,0} + \sqrt{6} (c_2 - c_1) (\Gamma_{3,1} k_y + \Gamma_{3,2} k_x) + k_x [(3 - i) c_2 + 4 i c_3] \Gamma_{+3} + (k_y \Gamma_{+1} - k_z \Gamma_{+2}) [(2 i c_2 + (3 + i) c_3)] \);
\[ \Gamma: R_5; \quad (c_1 + c_2k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \]
\[ R_6; \quad (c_1 + c_2k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \]
\[ R_7; \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4k_xk_y + A_6k_zk_x + A_7k_yk_z); \]
\[ R_8; \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4k_xk_y + A_6k_zk_x + A_7k_yk_z); \]
\[ R_9; \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4k_xk_y + A_6k_zk_x + A_7k_yk_z); \]
\[ R_{10}; \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4k_xk_y + A_6k_zk_x + A_7k_yk_z); \]
\[ \ldots \]
\[ \Lambda: R_5; \quad (c_1 + c_2k^2 + c_4k_y^2) \sigma_0 + c_5 \sigma_1 k_xk_z + c_6 \sigma_3 (k_x^2 - k_y^2); \]
\[ R_6; \quad (c_1 + c_2k^2 + c_4k_y^2) \sigma_0 + c_5 \sigma_1 k_xk_z + c_6 \sigma_3 (k_x^2 - k_y^2); \]
\[ R_7; \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4k_xk_y + A_6k_zk_x + A_7k_yk_z); \]
\[ R_8; \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4k_xk_y + A_6k_zk_x + A_7k_yk_z); \]
\[ R_9; \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4k_xk_y + A_6k_zk_x + A_7k_yk_z); \]
\[ R_{10}; \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4k_xk_y + A_6k_zk_x + A_7k_yk_z); \]
\[ \Delta: R_5; \quad (c_1 + c_2k^2 + c_4k_y^2) \sigma_0 + c_5 \sigma_1 k_xk_z + c_6 \sigma_3 (k_x^2 - k_y^2); \]
\[ \ldots \]
\[ T: R_5; \quad (c_1 + c_2k_x + c_3k^2 + c_4k_y^2) \sigma_0 + c_5 \sigma_1 k_xk_y + c_6 \sigma_3 (k_x^2 - k_y^2); \]
Accidental degeneracies on high symmetry line

$Δ$: {R}_1, {R}_2; σ_0 (c_1 + c_2 k_y) + c_3 σ_3 k_y;
{R}_1, {R}_2; σ_0 (c_1 + c_2 k_y) + c_3 σ_3 k_y;
{R}_1, {R}_2; σ_0 (c_1 + c_2 k_y) + c_3 σ_3 k_y;
{R}_1, {R}_2; A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + c_4 (A_1 k_x - A_2 k_z);
{R}_2, {R}_3; σ_0 (c_1 + c_2 k_y) + c_3 σ_3 k_y;
{R}_2, {R}_3; σ_0 (c_1 + c_2 k_y) + c_3 σ_3 k_y;
{R}_2, {R}_3; A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + c_4 (A_1 k_z - A_2 k_x);
{R}_3, {R}_4; σ_0 (c_1 + c_2 k_y) + c_3 σ_3 k_y;
{R}_3, {R}_4; A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + c_4 (A_2 k_x + A_1 k_z);
{R}_4, {R}_5; A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + c_4 (A_2 k_z - A_1 k_x);

$Σ$: {R}_1, {R}_2; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y);
{R}_1, {R}_2; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 (k_x - k_y);
{R}_1, {R}_2; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 k_x;
{R}_2, {R}_3; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 k_x;
{R}_2, {R}_3; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 k_x;
{R}_3, {R}_4; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y);

$L$: {R}_1, {R}_2; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y);
{R}_1, {R}_2; A_0 (c_1 + c_2 q_x) + (\sqrt{3} A_5 + A_8) c_3 q_x + c_4 (A_5 q_x - \sqrt{3} A_8 q_x + 2 A_7 q_y) + c_5 (A_1 q_x + A_2 q_y);
{R}_2, {R}_3; A_0 (c_1 + c_2 q_x) + (\sqrt{3} A_5 + A_8) c_3 q_x + c_4 (A_5 q_x - \sqrt{3} A_8 q_x + 2 A_7 q_y) + c_5 (A_2 q_x - A_1 q_y);

$S$: {R}_1, {R}_2; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y);
{R}_1, {R}_2; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 (k_x - k_y);
{R}_1, {R}_2; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 k_x;
{R}_2, {R}_3; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 k_x;
{R}_2, {R}_3; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y) + c_5 σ_1 k_x;
{R}_3, {R}_4; σ_0 [c_1 + c_2 (k_x + k_y)] + c_3 σ_3 (k_x + k_y);

$Z$: {R}_1, {R}_2; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x;
{R}_1, {R}_2; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x + c_5 σ_1 k_y;
{R}_1, {R}_2; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x + c_4 σ_1 k_y;
{R}_2, {R}_3; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x + c_4 σ_1 k_y;
{R}_2, {R}_3; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x + c_5 σ_1 k_y;
{R}_3, {R}_4; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x;

$T$: {R}_1, {R}_2; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x;
{R}_1, {R}_2; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x;
{R}_1, {R}_2; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x;
{R}_1, {R}_2; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_y + c_4 (A_2 k_y - A_1 k_x);
{R}_2, {R}_3; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x;
{R}_2, {R}_3; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x;
{R}_2, {R}_3; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_y + c_4 (A_2 k_x + A_1 k_y);
{R}_3, {R}_4; σ_0 [c_1 + c_2 k_x] + c_3 σ_3 k_x;
{R}_3, {R}_4; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + c_4 (A_1 k_y - A_2 k_x);
$\Gamma: \{S_{01}'|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}, \{\sigma_x|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}, \{\sigma_z|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}, \{C_{2v}|000\}, T; \text{Centrosymmetric; without SOC}\]

\[
\begin{align*}
\Gamma: & \quad R_{5}\;: \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_z^2 \right)}{\sqrt{3}} \right]; \\
& \quad R_{6}\;: \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_z^2 \right)}{\sqrt{3}} \right]; \\
& \quad R_{7}\;: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3}A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A k_y k_z \right); \\
& \quad R_{8}\;: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3}A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A k_y k_z \right); \\
& \quad R_{9}\;: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3}A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A k_y k_z \right); \\
& \quad R_{10}\;: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3}A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A k_y k_z \right); \\
\end{align*}
\]

$X:\; R_{10}\;: \quad c_1\sigma_0 + c_2\sigma_2 k_y; \\
R_{11}\;: \quad c_1\sigma_0 + c_2\sigma_2 k_y; \\
\{R_{12}, R_{13}\}: \quad (c_1 + c_2 k^2 + c_5 k^2) \Gamma_{0,0} + \left[ \alpha_1 \Gamma_{+,0} \left( k_x^2 - k_y^2 \right) + \alpha_2 k_x k_z \Gamma_{+,3} + \alpha_3 k_y \Gamma_{+,2} + h.c. \right]; \\
M:\; R_{0}\;: \quad (c_1 + c_2 k^2 + c_5 k^2) \sigma_0 + c_4\sigma_3 k_x k_y; \\
R_{11}\;: \quad c_1\sigma_0 + c_2\sigma_2 k_z; \\
R_{12}\;: \quad (c_1 + c_2 k^2 + c_5 k^2) \sigma_0 + c_4\sigma_3 k_x k_y; \\
R_{14}\;: \quad c_1\sigma_0 + c_2\sigma_2 k_z; \\
R:\; R_{7}\;: \quad (c_1 + c_2 k^2) \sigma_0 + c_3\sigma_2 k_x k_y; \\
\{R_{8}, R_{9}\}: \quad (c_1 + c_2 k^2) \Gamma_{0,0} + \sqrt{3} \left( c_3 \Gamma_{1,3} - c_4 \Gamma_{2,3} \right) \left( k_y^2 - k_z^2 \right) + \left( c_5 \Gamma_{2,0} + c_4 \Gamma_{1,0} \right) \left( 2k_x^2 - k_y^2 - k_z^2 \right) + (c_5 \Gamma_{1,2} + c_6 \Gamma_{2,2}) k_x k_y k_z; \\
R_{14}\;: \quad c_1 S_{0,0} + c_2 \left( k_x S_{1}^1 + k_y S_{2}^2 + k_z S_{1}^3 \right) + c_3 \left( k_x S_4^1 + k_y S_5^2 + k_z S_6^3 \right); \\
\Delta:\; R_{5}\;: \quad (c_1 + c_2 k_y + c_5 k^2 + c_4 k_0^2) \sigma_0 + c_5\sigma_1 k_x k_z + c_6\sigma_3 \left( k_x^2 - k_y^2 \right); \\
\Lambda:\; R_{3}\;: \quad (c_1 + c_2 k_y) \sigma_0 - c_3 \left( \sigma_3 q_x - \sigma_1 q_y \right); \\
S:\; R_{5}\;: \quad [c_1 + c_2 (k_x + k_z)] \sigma_0 + c_3\sigma_1 k_x + c_4\sigma_2 (k_x - k_z); \\
Z:\; R_{5}\;: \quad (c_1 + c_2 k_x) \sigma_0 + c_3\sigma_1 k_y + c_4\sigma_2 k_z; \\
T:\; R_{0}\;: \quad (c_1 + c_2 k_z + c_3 k^2 + c_4 k_0^2) \sigma_0 + c_5\sigma_3 k_x k_y + c_6\sigma_2 \left( k_x^2 - k_y^2 \right); \\
\]

Here, $S_{0,1}' = 3S_{0,1} - 2S_{2,0} + 2\sqrt{3}S_{2,8} - 3S_{3,1}; S_{2}' = 3(-S_{1,1} + S_{1,2} + S_{2,4} + S_{2,6}); S_{3}' = 3(S_{0,3} - S_{1,1} - S_{2,4} + S_{3,3}); S_{4}' = 3(-S_{0,3} + S_{1,2} - S_{2,6} + S_{3,3}); S_5' = -(3S_{1,3} + 2S_{2,0} + 3S_{2,5} + 3S_{2,7} + 3\sqrt{3}S_{2,8}); S_6' = (3S_{0,2} - 2S_{2,0} + 3S_{2,5} - \sqrt{3}S_{2,8} + 3S_{3,2}).$
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_2\}; A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_1 k_x - A_2 k_y); \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_3\}; A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_1 k_x + A_2 k_y); \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_3\}, \{R_4\}; A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_1 k_x + A_2 k_y); \]
\[ \{R_4\}, \{R_5\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_5\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_5\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_6\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_7\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_7\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_7\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_8\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma; \{R_1\}, \{R_2\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_2\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_1\}, \{R_3\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_1\}, \{R_4\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_2\}, \{R_3\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_2\}, \{R_4\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_3\}, \{R_4\}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]

\[ \Lambda; \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 q_x) + c_3 \sigma_3 q_x; \]
\[ \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 q_x) + c_3 \sigma_3 q_x; \]
\[ \{R_1\}, \{R_3\}; A_0 (c_1 + c_2 q_x) + (\sqrt{3}A_2 + A_8) c_5 q_x + c_4 (A_5 q_x - \sqrt{3}A_8 q_x + 2A_7 q_y) + c_5 (A_1 q_x + A_2 q_y); \]
\[ \{R_2\}, \{R_3\}; A_0 (c_1 + c_2 q_x) + (\sqrt{3}A_2 + A_8) c_5 q_x + c_4 (A_5 q_x - \sqrt{3}A_8 q_x + 2A_7 q_y) + c_5 (A_2 q_x - A_1 q_y); \]

\[ T; \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_5\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_5\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_6\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_7\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\( \Gamma_c: \{ S_{g1}^0, \sigma_x^0, \sigma_z^0, C_{2\overline{2}}^1 \}, T; \) Centrosymmetric; without SOC

\[ \begin{align*}
\Gamma: & \quad R_5: \quad (c_1 + c_2k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{2}} \right]; \\
& \quad R_6: \quad (c_1 + c_2k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{2}} \right]; \\
& \quad R_7: \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_3 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z); \\
& \quad R_8: \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_3 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z); \\
& \quad R_9: \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_3 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z); \\
& \quad R_{10:} \quad (c_1 + c_2k^2) A_0 + c_3 \left[ \sqrt{3} A_3 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z); \\
X: & \quad R_6: \quad c_1 \sigma_0 + c_2 \sigma_3 k_y; \\
& \quad R_{11:} \quad (c_1 + c_2k^2 + c_3k_y^2) \sigma_0 + c_4 \sigma_3 (k_x^2 - k_y^2); \\
& \quad R_{12:} \quad c_1 \sigma_0 + c_2 \sigma_3 k_y; \\
& \quad R_{14:} \quad (c_1 + c_2k^2 + c_3k_y^2) \sigma_0 + c_4 \sigma_3 (k_x^2 - k_y^2); \\
M: & \quad R_6: \quad (c_1 + c_2k^2 + c_3k_y^2) \sigma_0 + c_4 \sigma_3 k_x k_y + c_3 \sigma_3 (k_x^2 - k_y^2); \\
& \quad R_{10:} \quad (c_1 + c_2k^2 + c_3k_y^2) \sigma_0 + c_4 \sigma_3 k_x k_y + c_3 \sigma_3 (k_x^2 - k_y^2); \\
R: & \quad R_7: \quad (c_1 + c_2k^2) \Gamma_{0,0} + \sqrt{3} (c_3 \Gamma_{1,3} - c_4 \Gamma_{2,3}) (k_x^2 - k_y^2) + (c_3 \Gamma_{1,2} + c_4 \Gamma_{1,0}) (2k_x^2 - k_y^2 - k_z^2) + (c_3 \Gamma_{1,2} + c_4 \Gamma_{2,2}) k_x k_y k_z; \\
& \quad R_{14:} \quad c_1 S_{0,0} + c_2 (k_x S_1' + k_y S_3' + k_z S_3') + c_3 (k_x S_1' + k_y S_3' + k_z S_3'); \\
\Delta: & \quad R_5: \quad (c_1 + c_2k_y + c_3k^2 + c_4k_y^2) \sigma_0 + c_5 \sigma_3 k_x k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \\
& \quad R_3: \quad (c_1 + c_2k_y) \sigma_0 + c_3 (\sigma_3 q_x - \sigma_2 q_y); \\
S: & \quad R_5: \quad (c_1 + c_2 k_x k_z) \sigma_0 + c_3 \sigma_3 k_y + c_4 \sigma_2 (k_x - k_y); \\
T: & \quad R_{10:} \quad (c_1 + c_2 k_x + c_3k^2 + c_4k_x^2) \sigma_0 + c_5 \sigma_3 k_x k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \\
\end{align*} \]

Definition of \( S_i' \), see SG 222.
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_5\}; A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_5 + A_8) c_3 k_y + c_4 (A_1 k_x - A_2 k_x); \]
\[ \{R_2\}, \{R_5\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_7\}; A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_5 + A_8) c_3 k_y + c_4 (A_1 k_x + A_2 k_x); \]
\[ \{R_3\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_3\}, \{R_8\}; A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_5 + A_8) c_3 k_y + c_4 (A_2 k_x + A_1 k_x); \]
\[ \{R_4\}, \{R_8\}; A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_5 + A_8) c_3 k_y + c_4 (A_2 k_x - A_1 k_x); \]
\[ \Sigma: \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_4 \sigma_4 (k_x + k_y); \]
\[ \{R_1\}, \{R_9\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_4 \sigma_4 (k_x - k_y); \]
\[ \{R_2\}, \{R_9\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_4 \sigma_4 (k_x - k_y); \]
\[ \{R_2\}, \{R_{10}\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_4 \sigma_4 (k_x - k_y); \]
\[ \Lambda: \{R_3\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_4 k_x; \]
\[ \{R_3\}, \{R_{11}\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_4 k_x; \]
\[ \{R_3\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_4 k_x + c_4 \sigma_4 (k_x + k_y); \]
\[ \{R_3\}, \{R_{12}\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_4 k_x + c_4 \sigma_4 (k_x + k_y); \]
\[ \{R_4\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_4 k_x; \]
\[ \{R_4\}, \{R_{13}\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_4 k_x; \]
\[ \{R_4\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_4 k_x; \]
\[ \{R_5\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_4 k_x; \]
\[ \{R_5\}, \{R_{14}\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_4 k_x; \]
\[ \{R_5\}, \{R_{15}\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_4 k_x; \]
\[ T: \{R_6\}, \{R_{16}\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_x + c_4 (A_2 k_x + A_1 k_y); \]
\[ \{R_6\}, \{R_{17}\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_6\}, \{R_{18}\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_7\}, \{R_{19}\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_x + c_4 (A_2 k_y - A_1 k_x); \]
\[ \{R_7\}, \{R_{20}\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_7\}, \{R_{21}\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_8\}, \{R_{22}\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_x + c_4 (A_1 k_y - A_2 k_x); \]
\[ \{R_8\}, \{R_{23}\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_x; \]
\[ \{R_9\}, \{R_{24}\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3}A_5 + A_8) c_3 k_x + c_4 (A_1 k_x + A_2 k_y); \]
\[ \Gamma: \]
\[ R_5: \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_z^2 \right)}{\sqrt{3}} \right]; \]
\[ R_6: \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_z^2 \right)}{\sqrt{3}} \right]; \]

\[ R_7: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_0 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_z k_x + A_7 k_y k_z \right); \]
\[ R_8: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_0 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_z k_x + A_7 k_y k_z \right); \]
\[ R_9: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_0 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_z k_x + A_7 k_y k_z \right); \]
\[ R_{10}: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_0 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_z k_x + A_7 k_y k_z \right); \]

\[ X: \]
\[ R_6: \quad (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_3 k_x k_z; \]
\[ R_{11}: \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ R_{12}: \quad (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_3 k_x k_z; \]
\[ R_{14}: \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]

\[ M: \]
\[ R_6: \quad (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_3 k_x k_z; \]
\[ R_{11}: \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]
\[ R_{12}: \quad (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_3 k_x k_z; \]
\[ R_{14}: \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \]

\[ R: \]
\[ R_5: \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_z^2 \right)}{\sqrt{3}} \right]; \]
\[ R_6: \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_3 \left( k_x^2 + k_y^2 - 2k_z^2 \right)}{\sqrt{3}} \right]; \]

\[ R_7: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_0 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_z k_x + A_7 k_y k_z \right); \]
\[ R_8: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_0 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_z k_x + A_7 k_y k_z \right); \]
\[ R_9: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_0 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_z k_x + A_7 k_y k_z \right); \]
\[ R_{10}: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_0 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_z k_x + A_7 k_y k_z \right); \]

\[ \Delta: \]
\[ R_5: \quad (c_1 + c_2 k_y + c_3 k^2 + c_4 k_y^2) \sigma_0 + c_5 \sigma_1 k_x k_z + c_6 \sigma_3 \left( k_x^2 - k_y^2 \right); \]

\[ N: \]
\[ R_3: \quad (c_1 + c_2 q_x) \sigma_0 - c_3 \sigma_3 q_x - \sigma_1 q_y; \]

\[ Z: \]
\[ R_5: \quad (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z; \]

\[ T: \]
\[ R_{10}: \quad (c_1 + c_2 k_y + c_3 k^2 + c_4 k_y^2) \sigma_0 + c_5 \sigma_3 k_x k_y + c_6 \sigma_2 \left( k_x^2 - k_y^2 \right); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_5\} : A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + c_4 (A_1 k_x - A_2 k_x); \]
\[ \{R_2\}, \{R_5\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_6\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_7\} : A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + c_4 (A_1 k_x + A_2 k_x); \]
\[ \{R_3\}, \{R_5\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_3\}, \{R_6\} : A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_5 + A_8) c_3 k_y + c_4 (A_1 k_x + A_2 k_x); \]
\[ \{R_4\}, \{R_5\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \Sigma: \{R_1\}, \{R_2\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_3\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_1\}, \{R_4\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_5\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_3\}, \{R_4\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_4\}, \{R_6\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_y; \]
\[ \{R_3\}, \{R_7\} : A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + c_4 [(-A_1 + A_2 + A_4 + A_6) k_y - (A_1 + A_2 - A_4 + A_6) k_x]; \]
\[ \{R_5\}, \{R_8\} : \sigma_0 [c_1 + c_2 k_x] + c_3 \sigma_3 k_x; \]
\[ \{R_5\}, \{R_9\} : \sigma_0 [c_1 + c_2 k_x] + c_3 \sigma_3 k_x; \]
\[ \{R_6\}, \{R_9\} : A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + c_4 [(-A_1 + A_2 + A_4 + A_6) k_y - (A_1 + A_2 - A_4 + A_6) k_x]; \]
\[ \{R_6\}, \{R_7\} : \sigma_0 [c_1 + c_2 k_x] + c_3 \sigma_3 k_x; \]
\[ \{R_7\}, \{R_8\} : \sigma_0 [c_1 + c_2 k_x] + c_3 \sigma_3 k_x; \]
\[ \{R_8\}, \{R_9\} : A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + c_4 [(A_1 - A_2 - A_4 - A_6) k_y - (A_1 + A_2 - A_4 + A_6) k_x]; \]
\( \Gamma \): 
\[
\begin{align*}
R_5: & \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_2(k_x^2+k_y^2-2k_z^2)}{\sqrt{2}} \right]; \\
R_6: & \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_2(k_x^2+k_y^2-2k_z^2)}{\sqrt{2}} \right]; \\
R_7: & \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) \right] + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) + c_4 (A_4 k_x k_y + A_6 k_z k_z + A_7 k_y k_z); \\
R_8: & \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) \right] + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) + c_4 (A_4 k_x k_y + A_6 k_z k_z + A_7 k_y k_z); \\
R_9: & \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) \right] + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) + c_4 (A_4 k_x k_y + A_6 k_z k_z + A_7 k_y k_z); \\
R_{10}: & \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) \right] + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) + c_4 (A_4 k_x k_y + A_6 k_z k_z + A_7 k_y k_z); \\
X: & \quad (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_1 k_x k_z + c_5 \sigma_3 \left( k_x^2 - k_y^2 \right); \\
R_{10}: & \quad (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_1 k_x k_z + c_5 \sigma_3 \left( k_x^2 - k_y^2 \right); \\
L: & \quad (c_1 + c_2 q^2 + c_3 q_y^2) \sigma_0 + \sigma_1 q_y \left( 2c_4 q_x + c_5 q_z \right) - \sigma_3 \left( c_4 q_y^2 - c_4 q_y q_z \right); \\
R_6: & \quad (c_1 + c_2 q^2 + c_3 q_y^2) \sigma_0 + \sigma_1 q_y \left( 2c_4 q_x + c_5 q_z \right) + \sigma_3 \left( c_4 q_y^2 - c_4 q_y q_z \right); \\
W: & \quad \sigma_0 \sigma_3 + c_2 \sigma_1 k_z; \\
\Delta: & \quad (c_1 + c_2 k_y + c_3 k^2 + c_4 k_y^2) \sigma_0 + c_5 \sigma_1 k_x k_z + c_6 \sigma_3 \left( k_x^2 - k_y^2 \right); \\
\Lambda: & \quad (c_1 + c_2 q_y) \sigma_0 - c_3 (\sigma_3 q_x - \sigma_1 q_y); \\
\end{align*}
\]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \{ R_1 \}, \{ R_2 \}; A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_2 + A_8) c_3 k_y + c_4 (A_1 k_x - A_2 k_z); \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]

\[ \{ R_3 \}, \{ R_4 \}; A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_2 + A_8) c_3 k_y + c_4 (A_2 k_x + A_1 k_z); \]

\[ \{ R_4 \}, \{ R_5 \}; A_0 (c_1 + c_2 k_y) + (\sqrt{3} A_2 + A_8) c_3 k_y + c_4 (A_2 k_x - A_1 k_z); \]

\[ \Lambda; \{ R_1 \}, \{ R_2 \}; \sigma_0 (c_1 + c_2 q_z) + c_3 \sigma_3 q_z; \]

\[ \{ R_1 \}, \{ R_2 \}; A_0 (c_1 + c_2 q_z) + (\sqrt{3} A_2 + A_8) c_3 q_z + c_4 (A_5 q_z - \sqrt{3} A_8 q_x + 2 A_7 q_y) + c_5 (A_1 q_x + A_2 q_y); \]

\[ \{ R_2 \}, \{ R_3 \}; A_0 (c_1 + c_2 q_z) + (\sqrt{3} A_2 + A_8) c_3 q_z + c_4 (A_5 q_z - \sqrt{3} A_8 q_x + 2 A_7 q_y) + c_5 (A_2 q_x - A_1 q_y); \]

\[ \Sigma; \{ R_1 \}, \{ R_2 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]

\[ \{ R_1 \}, \{ R_2 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]

\[ \{ R_3 \}, \{ R_4 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]

\[ \{ R_4 \}, \{ R_5 \}; \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]

\[ \{ R_5 \}, \{ R_6 \}; \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z); \]

\[ \{ R_6 \}, \{ R_7 \}; \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_1 (k_x - k_z); \]

\[ \{ R_7 \}, \{ R_8 \}; \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_1 (k_x - k_z); \]

\[ \{ R_8 \}, \{ R_9 \}; \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z); \]

\[ \{ R_9 \}, \{ R_{10} \}; \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z); \]

\[ \{ R_{10} \}, \{ R_{11} \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_{11} \}, \{ R_{12} \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]

\[ \{ R_{12} \}, \{ R_{13} \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]

\[ \{ R_{13} \}, \{ R_{14} \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_{14} \}, \{ R_{15} \}; \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]

\[ \{ R_{15} \}, \{ R_{16} \}; \sigma_0 [c_1 + c_2 (k_y - k_z)] + c_3 \sigma_3 (k_y - k_z) + c_5 [c_4 k_x + c_5 (k_y + k_z)]; \]
\[ \Gamma^f; \{ \sigma_{\alpha}^2 \}, \sigma_{\alpha}^2, \{ \sigma_{\alpha}^2 \}, \{ C_{2z} ||000 \}, T; \text{Centrosymmetric; without SOC} \]

\[ \begin{align*}
\Gamma: & \quad R_5: \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \sigma_3 \frac{(k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right] ; \\
& \quad R_6: \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{(k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right] ; \\
& \quad R_7: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z) ; \\
& \quad R_8: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z) ; \\
& \quad R_9: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z) ; \\
& \quad R_{10}: \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 (A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z) ; \\
X: & \quad R_5: \quad (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_1 k_x k_z + c_5 \sigma_3 (k_x^2 - k_y^2) ; \\
& \quad R_{10}: \quad (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_1 k_x k_z + c_5 \sigma_3 (k_x^2 - k_y^2) ; \\
L: & \quad \{ R_7, R_8 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,1} q_x + \Gamma_{0,2} q_y) + q_z (c_3 \Gamma_{1,2} + c_4 \Gamma_{2,2}) ; \\
& \quad R_5: \quad c_1 \sigma_0 + c_2 \sigma_1 q_z ; \\
W: & \quad \{ R_{13}, R_{16} \}; \quad c_1 \sigma_0 + (c_2 \sigma_1 - c_3 \sigma_2) k_z ; \\
& \quad \{ R_{14}, R_{15} \}; \quad c_1 \sigma_0 + (c_2 \sigma_1 - c_3 \sigma_2) k_z ; \\
& \quad R_{20}: \quad c_1 \sigma_0 + c_2 \sigma_2 k_z ; \\
\Delta: & \quad R_5: \quad (c_1 + c_2 k_y + c_3 k^2 + c_4 k_y^2) \sigma_0 + c_5 \sigma_1 k_x k_z + c_6 \sigma_3 (k_x^2 - k_y^2) ; \\
& \quad R_3: \quad (c_1 + c_2 q_z) \sigma_0 - c_3 (\sigma_3 q_x - \sigma_1 q_y) ; \\
Q: & \quad \{ R_3, R_2 \}; \quad [c_1 + c_2 (k_y - k_z)] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x + (c_5 \sigma_1 + c_6 \sigma_2) (k_y + k_z) ;
\]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_1 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_2 \}, \{ R_3 \}: A_0 (c_1 + c_3 k_y) + (\sqrt{3} A_2 + A_3) c_2 k_y + c_4 (A_1 k_x - A_2 k_y); \]
\[ \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{ R_3 \}, \{ R_2 \}: A_0 (c_1 + c_3 k_y) + (\sqrt{3} A_2 + A_3) c_2 k_y + c_4 (A_1 k_x + A_2 k_y); \]
\[ \{ R_3 \}, \{ R_4 \}: A_0 (c_1 + c_3 k_y) + (\sqrt{3} A_2 + A_3) c_2 k_y + c_4 (A_1 k_x - A_1 k_y); \]
\[ \Sigma: \{ R_1 \}, \{ R_3 \}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{ R_1 \}, \{ R_4 \}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{ R_1 \}, \{ R_4 \}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_3 \}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{ R_2 \}, \{ R_4 \}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{ R_3 \}, \{ R_4 \}: \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y); \]
\[ S: \{ R_1 \}, \{ R_2 \}: \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z); \]
\[ \{ R_1 \}, \{ R_3 \}: \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_1 (k_x - k_z); \]
\[ \{ R_1 \}, \{ R_4 \}: \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \}: \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \}: \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_1 (k_x - k_z); \]
\[ \{ R_3 \}, \{ R_4 \}: \sigma_0 [c_1 + c_2 (k_x + k_z)] + c_3 \sigma_3 (k_x + k_z); \]
\[ Z: \{ R_1 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \{ R_1 \}, \{ R_2 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_1 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_3 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z + c_5 \sigma_1 k_y; \]
\[ \{ R_3 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + c_3 \sigma_3 k_z; \]
\[ \Gamma; \quad R_5; \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_3 \left( k_x^2 - k_y^2 \right)}{\sqrt{3}} \right]; \\
R_6; \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_3 \left( k_x^2 - k_y^2 \right)}{\sqrt{3}} \right]; \\
R_7; \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_z k_y + A_6 k_x k_z + A_7 k_y k_z \right); \\
R_8; \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_z k_y + A_6 k_x k_z + A_7 k_y k_z \right); \\
R_9; \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_z k_y + A_6 k_x k_z + A_7 k_y k_z \right); \\
R_{10}; \quad (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_z k_y + A_6 k_x k_z + A_7 k_y k_z \right); \\
X; \quad R_{10}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
R_{11}; \quad (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_3 k_x k_z; \\
R_{13}; \quad c_1 \sigma_0 + c_2 \sigma_2 k_y; \\
R_{14}; \quad (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_3 k_x k_z; \\
L; \quad R_5; \quad (c_1 + c_2 q^2 + c_3 q_y^2) \sigma_0 + \sigma_3 q_y \left( 2c_4 q_x + c_5 q_z \right) - \sigma_3 \left( c_3 q_y^2 - c_4 q_y^2 - c_5 q_z q_x \right); \\
R_6; \quad (c_1 + c_2 q^2 + c_3 q_y^2) \sigma_0 + \sigma_3 q_y \left( 2c_4 q_x + c_5 q_z \right) + \sigma_3 \left( c_3 q_y^2 - c_4 q_y^2 - c_5 q_z q_x \right); \\
W; \quad R_{11}; \quad c_1 \sigma_0 + c_2 \left[ (\sigma_1 - \sigma_2) k_y - (\sigma_1 + \sigma_2) k_z \right]; \\
R_{12}; \quad c_1 \sigma_0 + c_2 \left[ (\sigma_1 + \sigma_2) k_y + (\sigma_2 - \sigma_1) k_z \right]; \\
\Delta; \quad R_5; \quad (c_1 + c_2 k_y + c_4 k^2) \sigma_0 + c_5 \sigma_1 k_x k_z + c_6 \sigma_3 \left( k^2 - k_y^2 \right); \\
X; \quad R_3; \quad (c_1 + c_2 q_y) \sigma_0 - c_3 (\sigma_2 q_x - \sigma_1 q_y); \\
Z; \quad R_5; \quad (c_1 + c_2 k_z) \sigma_0 + c_3 \sigma_3 k_y + c_4 \sigma_2 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_3\}; A_0 (c_1 + c_3 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_1 k_x - A_2 k_z); \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_5\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_6\}; A_0 (c_1 + c_3 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_1 k_x + A_2 k_z); \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y; \]
\[ \{R_3\}, \{R_5\}; A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_2 k_x + A_1 k_z); \]
\[ \{R_4\}, \{R_5\}; A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_2 k_x - A_1 k_z); \]

\[ \Lambda: \{R_1\}, \{R_2\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_1\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_x; \]
\[ \{R_2\}, \{R_3\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y); \]

\[ \Sigma: \{R_2\}, \{R_5\}; \sigma_0 (c_1 + c_2 (k_x + k_z)) + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_1 k_y; \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 (k_x + k_z)) + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_1 (k_x - k_z); \]
\[ \{R_3\}, \{R_5\}; \sigma_0 (c_1 + c_2 (k_x + k_z)) + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_1 k_z; \]
\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 (k_x + k_z)) + c_3 \sigma_3 (k_x + k_z) + c_5 \sigma_1 (k_x - k_z); \]

\[ Q: \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 (k_y - k_z)) + \sigma_3 c_3 (k_y - k_z) + \sigma_1 [c_4 k_x + c_5 (k_y + k_z)]; \]
\[ \Gamma_i; \{S_{60}^1, S_{60}^2, \sigma_x, \sigma_y, \sigma_z, C_{2x}, C_{2y}, C_{2z}\}; T; \text{Centrosymmetric; without SOC} \]

\[
\Gamma: R_6: (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \\
R_6: (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 \left( k_x^2 - k_y^2 \right) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \\
R_7: (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_8 k_y k_z \right); \\
R_8: (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_8 k_y k_z \right); \\
R_9: (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_8 k_y k_z \right); \\
R_{10}: (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sqrt{3} A_5 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_8 k_y k_z \right); \\
X: R_6: (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_3 k_x k_z; \\
R_{11}: c_1 \sigma_0 + c_2 \sigma_3 k_y; \\
R_{12}: (c_1 + c_2 k^2 + c_3 k_y^2) \sigma_0 + c_4 \sigma_3 k_x k_z; \\
R_{14}: c_1 \sigma_0 + c_2 \sigma_3 k_y; \\
L: \{R_7, R_8\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{2,0} q_x + \Gamma_{0,2} q_y + q_x (c_3 \Gamma_{1,2} + c_4 \Gamma_{2,2}); \\
R_9: c_1 \sigma_0 + c_2 \sigma_1 q_y; \\
W: \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + c_4 \Gamma_{0,1} \left( k_y + k_z \right) - c_3 \Gamma_{3,2} \left( k_y - k_z \right) + \left[ c_1 \Gamma_{1,2} \Gamma_{0,1} - i \alpha_2 \Gamma_{1,0} \left( k_y - k_z \right) + \alpha_2 \Gamma_{1,0} \left( k_y + k_z \right) + h.c. \right]; \\
\Delta: R_5: (c_1 + c_2 k_y + c_3 k^2 + c_4 k_0^2) \sigma_0 + c_5 \sigma_1 k_x k_z + c_6 \sigma_3 \left( k_x^2 - k_z^2 \right); \\
\Lambda: R_3: \left( c_1 + c_2 q_x \right) \sigma_0 - c_3 \left( \sigma_3 q_x - \sigma_1 q_y \right); \\
Z: R_5: (c_1 + c_2 k_y) \sigma_0 + c_3 \sigma_3 k_y + c_4 \sigma_2 k_z; \\
Q: \{R_4, R_8\}; \left[ c_1 + c_2 \left( k_y - k_z \right) \right] \sigma_0 + \left( c_3 \sigma_1 + c_4 \sigma_2 \right) k_x + \left( c_5 \sigma_1 + c_6 \sigma_2 \right) \left( k_y + k_z \right); \]
Accidental degeneracies on high symmetry line

$\Delta$: $\{R_1\}, \{R_2\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
$\{R_1\}, \{R_2\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
$\{R_1\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
$\{R_1\}, \{R_5\}$: $A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_1 k_x - A_2 k_z)$;
$\{R_2\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
$\{R_2\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
$\{R_1\}, \{R_6\}$: $A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_1 k_x + A_2 k_z)$;
$\{R_3\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y$;
$\{R_5\}, \{R_4\}$: $A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_2 k_x + A_1 k_z)$;
$\{R_6\}, \{R_4\}$: $A_0 (c_1 + c_2 k_y) + (\sqrt{3}A_2 + A_8) c_5 k_y + c_4 (A_2 k_x - A_1 k_z)$;

$\Lambda$: $\{R_1\}, \{R_2\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y)$;
$\{R_1\}, \{R_3\}$: $A_0 (c_1 + c_2 (k_x + k_y)) + (\sqrt{3}A_2 + A_8) c_3 q_x + c_4 (A_5 q_x - \sqrt{3}A_8 q_x + 2A_7 q_y) + c_5 (A_1 q_x + A_2 q_y)$;
$\{R_2\}, \{R_3\}$: $A_0 (c_1 + c_2 (k_x + k_y)) + (\sqrt{3}A_2 + A_8) c_3 q_x + c_4 (A_5 q_x - \sqrt{3}A_8 q_x + 2A_7 q_y) + c_5 (A_2 q_y - A_1 q_x)$;

$\Sigma$: $\{R_1\}, \{R_2\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y)$;
$\{R_1\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y)$;
$\{R_1\}, \{R_5\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y)$;
$\{R_2\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y)$;
$\{R_5\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y)$;

$S$: $\{R_2\}, \{R_3\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x)$;
$\{R_2\}, \{R_4\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y)$;
$\{R_2\}, \{R_5\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y)$;
$\{R_4\}, \{R_5\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y)$;
$\{R_5\}, \{R_7\}$: $\sigma_0 (c_1 + c_2 (k_x + k_y)) + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y)$;
\[ \Gamma; \ R_5: \ (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \]
\[ R_6: \ (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \]
\[ R_7: \ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_2 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ R_8: \ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_2 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ R_9: \ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_2 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ R_{10}: \ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_2 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ H; \ R_5: \ (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \]
\[ R_6: \ (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \]
\[ R_7: \ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_2 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ R_8: \ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_2 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ R_9: \ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_2 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ R_{10}: \ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_2 \left( k_x^2 - k_y^2 \right) + A_8 \left( k_x^2 + k_y^2 - 2k_z^2 \right) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ P; \ R_5: \ (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \]
\[ R_4: \ c_1 A_0 + c_2 \left( A_r k_x + A_u k_y + A_i k_z \right); \]
\[ R_5: \ c_1 A_0 + c_2 \left( A_r k_x + A_u k_y + A_i k_z \right); \]
\[ \Delta; \ R_5: \ (c_1 + c_2 k^2 + c_4 k_x^2) \sigma_0 + c_3 \sigma_1 k_x k_z + c_6 \sigma_3 \left( k_x^2 - k_y^2 \right); \]
\[ \Lambda; \ R_5: \ (c_1 + c_2 q_x) \sigma_0 - c_3 \left( \sigma_3 q_x - \sigma_1 q_y \right); \]
\[ F; \ R_5: \ [c_1 + c_2 \left( k_x - k_y + k_z \right)] \sigma_0 + c_3 \sigma_1 \left( k_x + k_y \right) + \frac{c_3 \sigma_3 \left( k_x - k_y - 2k_z \right)}{\sqrt{3}}; \]
Accidental degeneracies on high symmetry line

\[ \{R_1\}, \{R_2\} : \sigma_0 \left[ c_1 + c_2 (k_x + k_y) \right] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_4\} : \sigma_0 \left[ c_1 + c_2 (k_x + k_y) \right] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_1\}, \{R_3\} : \sigma_0 \left[ c_1 + c_2 (k_x + k_y) \right] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_3\} : \sigma_0 \left[ c_1 + c_2 (k_x + k_y) \right] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 \left[ c_1 + c_2 (k_x + k_y) \right] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y); \]
\[ \{R_3\}, \{R_4\} : \sigma_0 \left[ c_1 + c_2 (k_x + k_y) \right] + c_3 \sigma_3 (k_x + k_y); \]
\[ \{R_1\}, \{R_2\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_3\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_4\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_y; \]
\[ \{R_1\}, \{R_5\} : A_0 \left[ c_1 + c_2 k_x \right] + \left( \sqrt{2} A_2 + A_3 \right) c_3 k_y + c_4 \left( A_1 k_z - A_2 k_x \right); \]
\[ \{R_2\}, \{R_3\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_4\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_y; \]
\[ \{R_2\}, \{R_5\} : A_0 \left[ c_1 + c_2 k_x \right] + \left( \sqrt{2} A_2 + A_3 \right) c_3 k_y + c_4 \left( A_1 k_z + A_2 k_x \right); \]
\[ \{R_3\}, \{R_4\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_y; \]
\[ \{R_3\}, \{R_5\} : A_0 \left[ c_1 + c_2 k_x \right] + \left( \sqrt{2} A_2 + A_3 \right) c_3 k_y + c_4 \left( A_1 k_z + A_2 k_x \right); \]
\[ \{R_4\}, \{R_5\} : A_0 \left[ c_1 + c_2 k_x \right] + \left( \sqrt{2} A_2 + A_3 \right) c_3 k_y + c_4 \left( A_2 k_x - A_1 k_z \right); \]
\[ \{R_1\}, \{R_6\} : \sigma_0 \left[ c_1 + c_2 q_x \right] + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_7\} : A_0 \left[ c_1 + c_2 q_x \right] + \left( \sqrt{2} A_5 + A_6 \right) c_3 q_x + c_4 \left( A_5 q_x - \sqrt{2} A_6 q_y + 2A_7 q_y \right) + c_5 \left( A_1 q_x + A_2 q_y \right); \]
\[ \{R_2\}, \{R_3\} : A_0 \left[ c_1 + c_2 q_x \right] + \left( \sqrt{2} A_5 + A_6 \right) c_3 q_x + c_4 \left( A_5 q_x - \sqrt{2} A_6 q_y + 2A_7 q_y \right) + c_5 \left( A_2 q_x - A_1 q_y \right); \]
\[ \{R_1\}, \{R_8\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_z; \]
\[ \{R_1\}, \{R_9\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_z + c_5 \sigma_1 \left( k_x + k_y \right); \]
\[ \{R_1\}, \{R_4\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_z + c_5 \sigma_1 \left( k_x - k_y \right); \]
\[ \{R_2\}, \{R_4\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_z + c_5 \sigma_1 \left( k_x - k_y \right); \]
\[ \{R_3\}, \{R_4\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_z + c_5 \sigma_1 \left( k_x + k_y \right); \]
\[ \{R_3\}, \{R_6\} : \sigma_0 \left[ c_1 + c_2 k_x \right] + c_3 \sigma_3 k_z; \]
\[ \{R_4\}, \{R_6\} : \sigma_0 \left[ c_1 + c_2 (k_x - k_y) \right] + c_3 \sigma_3 (k_x - k_y); \]
\[ \{R_1\}, \{R_5\} : \sigma_0 \left[ c_1 + c_2 (k_x - k_y) \right] + c_3 \sigma_3 (k_x - k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_1\}, \{R_8\} : \sigma_0 \left[ c_1 + c_2 (k_x - k_y) \right] + c_3 \sigma_3 (k_x - k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_8\} : \sigma_0 \left[ c_1 + c_2 (k_x - k_y) \right] + c_3 \sigma_3 (k_x - k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_2\}, \{R_9\} : \sigma_0 \left[ c_1 + c_2 (k_x - k_y) \right] + c_3 \sigma_3 (k_x - k_y) + c_5 \sigma_1 k_z; \]
\[ \{R_3\}, \{R_9\} : \sigma_0 \left[ c_1 + c_2 (k_x - k_y) \right] + c_3 \sigma_3 (k_x - k_y); \]
\[ \{R_1\}, \{R_7\} : A_0 \left[ c_1 + c_2 p_x \right] + \left( \sqrt{3} A_2 + A_3 \right) \left[ c_3 + c_4 p_x \right] + c_5 \left[ (A_5 - \sqrt{3} A_6) (p_x + \sqrt{3} p_y) + 2A_7 (p_y - \sqrt{3} p_x) \right] + c_6 \left[ (A_1 - \sqrt{3} A_2) p_x + (\sqrt{3} A_4 + A_2) p_y \right]; \]
\[ \{R_2\}, \{R_8\} : A_0 \left[ c_1 + c_2 p_x \right] + \left( \sqrt{3} A_2 + A_3 \right) \left[ c_3 + c_4 p_x \right] + c_5 \left[ (A_5 - \sqrt{3} A_6) (p_x + \sqrt{3} p_y) + 2A_7 (p_y - \sqrt{3} p_x) \right] + c_6 \left[ A_2 (p_x + \sqrt{3} p_y) + A_1 (\sqrt{3} p_x - p_y) \right]; \]
\[ \Gamma_v; \{ S_{01} | 00 \}, \{ \sigma_x \frac{1}{2} \frac{1}{2} 0 \}, \{ \sigma_x \frac{1}{2} 0 \frac{1}{2} \}, \{ C_{2v} | 00 \frac{1}{2} \}, T; \text{Centrosymmetric; without SOC} \]

\[ \Gamma; R_5; \]
\[ (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \]
\[ R_6; \]
\[ (c_1 + c_2 k^2) \sigma_0 + c_3 \left[ \sigma_1 (k_x^2 - k_y^2) + \frac{\sigma_3 (k_x^2 + k_y^2 - 2k_z^2)}{\sqrt{3}} \right]; \]
\[ R_7; \]
\[ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ R_8; \]
\[ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ R_9; \]
\[ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ R_{10}; \]
\[ (c_1 + c_2 k^2) A_0 + c_3 \left[ \sqrt{3} A_5 (k_x^2 - k_y^2) + A_8 (k_x^2 + k_y^2 - 2k_z^2) \right] + c_4 \left( A_4 k_x k_y + A_6 k_x k_z + A_7 k_y k_z \right); \]
\[ H; R_7; \]
\[ (c_1 + c_2 k^2) \sigma_0 + c_3 \sigma_2 k_x k_y k_z; \]
\[ \{ R_8, R_9 \}; \]
\[ (c_1 + c_2 k^2) \Gamma_{00} + \sqrt{3} (c_3 \Gamma_{13} + c_4 \Gamma_{23}) (k_x^2 - k_y^2) + \left( c_4 \Gamma_{10} - c_3 \Gamma_{20} \right) (k_x^2 + k_y^2 - 2k_z^2) + \left( c_5 \Gamma_{1,2} + c_6 \Gamma_{2,3} \right) k_x k_y k_z; \]
\[ R_{14}; \]
\[ c_1 S_{0,0} + c_2 (S_{2,3} k_x + S_{2,1} k_y + S_{2,2} k_z) + c_3 (S_{3,7} k_x + S_{3,4} k_y - S_{3,6} k_z); \]
\[ P; \{ R_9, R_{10} \}; \]
\[ c_1 \Gamma_{0,0} + \left[ \alpha_1 (q'_x \Gamma_{+,0} - q'_y \Gamma_{+,3} + i q'_z \Gamma_{+,1}) + h.c. \right]; \]
\[ R_{16}; \]
\[ c_1 \Gamma_{0,0} + \left( c_2 - c_3 \right) (\Gamma_{3,2} k_x + \Gamma_{3,1} k_y) + \left[ 2i c_2 + (3 + i) c_3 \right] (k_y \Gamma_{+,1} - k_x \Gamma_{+,2}) + \left[ (3 - i) c_2 + 4i c_3 \right] k_x \Gamma_{+,3} + h.c.; \]
\[ N; R_5; \]
\[ c_1 \sigma_0 + c_2 \sigma_2 (k_x + k_y); \]
\[ R_{10}; \]
\[ c_1 \sigma_0 + c_2 \sigma_2 (k_x + k_y); \]
\[ \Delta; R_5; \]
\[ (c_1 + c_2 k_x + c_3 k^2 + c_4 k_y^2) \sigma_0 + c_5 \sigma_3 k_x k_y + c_6 \sigma_3 (k_x^2 - k_y^2); \]
\[ N; R_5; \]
\[ (c_1 + c_2 q_x) \sigma_0 - c_3 (\sigma_3 q_x - \sigma_1 q_y); \]
\[ D; R_5; \]
\[ (c_1 + c_2 k_x) \sigma_0 + c_3 \sigma_1 (k_x - k_y) + c_4 \sigma_3 (k_x + k_y); \]
\[ G; R_5; \]
\[ \left[ c_1 + c_2 (k_x - k_y) \right] \sigma_0 + c_3 \sigma_1 (k_x + k_y) + c_4 \sigma_3 k_z; \]
\[ F; R_6; \]
\[ \left[ c_1 + c_2 (k_x - k_y + k_z) \right] \sigma_0 + c_3 \sigma_1 (k_x + k_y) - \frac{c_4 \sigma_3 (k_x - k_y - 2k_z)}{\sqrt{3}}; \]

Here, \( \{ q_x', q_y', q_z' \} = \{(1 + \sqrt{3}) k_x - 2k_y + (\sqrt{3} - 1) k_z, (1 - \sqrt{3}) k_x - 2k_y - (1 + \sqrt{3}) k_z, -2k_x - 2k_y + 2k_z \} \).
Accidental degeneracies on high symmetry line

\[ \Sigma: \{R_1\} , \{R_2\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) ; \]

\[ \{R_1\} , \{R_3\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z ; \]

\[ \{R_2\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 k_z ; \]

\[ \{R_2\} , \{R_4\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) + c_5 \sigma_1 (k_x - k_y) ; \]

\[ \{R_3\} , \{R_4\} : \sigma_0 [c_1 + c_2 (k_x + k_y)] + c_3 \sigma_3 (k_x + k_y) ; \]

\[ \Delta: \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y ; \]

\[ \{R_1\} , \{R_3\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y ; \]

\[ \{R_1\} , \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y ; \]

\[ \{R_2\} , \{R_4\} : A_0 (c_1 + c_2 k_y) + \left( \sqrt{3} A_1 + A_2 \right) c_3 k_y + c_4 (A_1 k_z - A_2 k_z) ; \]

\[ \{R_2\} , \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y ; \]

\[ \{R_2\} , \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y ; \]

\[ \{R_2\} , \{R_4\} : A_0 (c_1 + c_2 k_y) + \left( \sqrt{3} A_1 + A_2 \right) c_3 k_y + c_4 (A_1 k_z + A_2 k_z) ; \]

\[ \{R_3\} , \{R_4\} : \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y ; \]

\[ \{R_3\} , \{R_4\} : A_0 (c_1 + c_2 k_y) + \left( \sqrt{3} A_1 + A_2 \right) c_3 k_y + c_4 (A_1 k_z + A_2 k_z) ; \]

\[ \{R_4\} , \{R_4\} : A_0 (c_1 + c_2 k_y) + \left( \sqrt{3} A_1 + A_2 \right) c_3 k_y + c_4 (A_2 k_z - A_1 k_z) ; \]

\[ \Lambda: \{R_1\} , \{R_2\} : \sigma_0 (c_1 + c_2 q_z) + c_3 \sigma_3 q_z ; \]

\[ \{R_1\} , \{R_3\} : A_0 (c_1 + c_2 q_z) + \left( \sqrt{3} A_1 + A_2 \right) c_3 q_z + c_4 (A_2 q_x - \sqrt{3} A_8 q_y + 2 A_7 q_y) + c_5 (A_1 q_x + A_2 q_y) ; \]

\[ \{R_2\} , \{R_3\} : A_0 (c_1 + c_2 q_z) + \left( \sqrt{3} A_1 + A_2 \right) c_3 q_z + c_4 (A_2 q_x - \sqrt{3} A_8 q_y + 2 A_7 q_y) + c_5 (A_2 q_x - A_1 q_y) ; \]

\[ F: \{R_3\} , \{R_4\} : \sigma_0 (c_1 + c_2 p_z) + c_3 \sigma_3 p_z ; \]

\[ \{R_3\} , \{R_4\} : A_0 (c_1 + c_2 p_z) + \left( \sqrt{3} A_1 + A_2 \right) (c_3 p_z) + c_4 \left[ (A_5 - \sqrt{3} A_8) (p_x + \sqrt{3} p_y) + 2 A_7 (\sqrt{3} p_x - p_y) \right] + c_5 \left[ (A_1 + \sqrt{3} A_2) p_x + (\sqrt{3} A_1 - A_2) p_y \right] ; \]

\[ \{R_4\} , \{R_6\} : A_0 (c_1 + c_2 p_z) + \left( \sqrt{3} A_1 + A_2 \right) (c_3 + c_4 p_z) + c_5 \left[ (A_5 - \sqrt{3} A_8) (p_x + \sqrt{3} p_y) + 2 A_7 (\sqrt{3} p_x - p_y) \right] + c_6 \left[ A_2 (p_x + \sqrt{3} p_y) + A_1 (p_y - \sqrt{3} p_y) \right] ; \]
S8. ENCYCLOPEDIA OF EMERGENT PARTICLES IN 3D CRYSTALS WITH SOC EFFECT

A. The double-valued corepresentations of the 230 type-II MSGs and the essential degeneracies

1. Notes to Sec. S8 A

(i) For each table in Sec. S8 A, the first two lines present the SG number, the BZ type, the generating elements of the type II MSG (translations are not included here), whether centrosymmetry is contained in the group and whether SOC is considered.

(ii) Below the first two lines, the columns from left to right (separated by the semicolons) are the high-symmetry momentum \( \mathbf{k} \), the location of \( \mathbf{k} \) [with respect to reciprocal vectors \( \mathbf{g}_1, \mathbf{g}_2, \mathbf{g}_3 \)], the generating elements of the little group at \( \mathbf{k} \) (only point-group operators are presented and a full expression of each generating element can be found in Ref. [17] and in Sec. S5), the deduced corep of the little group at \( \mathbf{k} \), the dimension of the corep, the matrix representations of the generating elements, the species and the topological charge of the essential degeneracy.

(iii) A correspondence between the notation of the corep used here (\( R_i \)) and the band-representation notations can be found in Refs. [17, 18]. Moreover, Ref. [18] has established a SpaceGroupIrep package to analyze the band representation based on the notation of Ref. [17].

2. SG 1-10
SG 1
\[ \Gamma_1; \{E|000\}, T; \text{Non-Centrosymmetric; with SOC} \]

\( \Gamma; (000); E,T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \text{C-1 WP; 1} \)

\( B; (\frac{1}{2}00); E,T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \text{C-1 WP; 1} \)

\( F; (0\frac{1}{2}0); E,T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \text{C-1 WP; 1} \)

\( G; (00\frac{1}{2}); E,T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \text{C-1 WP; 1} \)

SG 2
\[ \Gamma_2; \{I|000\}, \{E|000\}, T; \text{Centrosymmetric; with SOC} \]

\( \Gamma; (000); I,E,T; \{R_2, R_2\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \)

\( \quad \{R_4, R_4\}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \)

\( B; (\frac{1}{2}00); I,E,T; \{R_2, R_2\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \)

\( \quad \{R_4, R_4\}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \)

\( F; (0\frac{1}{2}0); I,E,T; \{R_2, R_2\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \)

\( \quad \{R_4, R_4\}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \)

\( G; (00\frac{1}{2}); I,E,T; \{R_2, R_2\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \)

\( \quad \{R_4, R_4\}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \)

SG 3
\[ \Gamma_m; \{C_{2z}|000\}, T; \text{Non-Centrosymmetric; with SOC} \]

\( \Gamma; (000); C_{2z}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \)

\( B; (\frac{1}{2}00); C_{2z}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \)

\( Y; (0\frac{1}{2}0); C_{2z}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \)

\( Z; (00\frac{1}{2}); C_{2z}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \)

\( C; (0\frac{1}{2}\frac{1}{2}); C_{2z}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \)

\( D; (\frac{1}{2}0\frac{1}{2}); C_{2z}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \)

\( A; (\frac{1}{2}\frac{1}{2}0); C_{2z}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \)

\( E; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{2z}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \)

\( \Lambda; \Gamma Z; C_{2z}; R_2; 1; i; \)

\( R_4; 1; -i; \)

\( V; \text{BD; } C_{2z}; R_2; 1; i; \)

\( R_4; 1; -i; \)

\( W; \text{YC; } C_{2z}; R_2; 1; i; \)

\( R_4; 1; -i; \)

\( U; \text{AE; } C_{2z}; R_2; 1; i; \)

\( R_4; 1; -i; \)
\Gamma\_m; \{C\_2z, \{00\_\frac{1}{2}\}, T\}; Non-Centrosymmetric; with SOC

\Gamma; (000); C\_2z, T; \{R\_2, R\_4\}; 2; i\sigma\_3, -i\sigma\_2; C-1 WP; 1
B; (\frac{1}{2}00); C\_2z, T; \{R\_2, R\_4\}; 2; i\sigma\_3, -i\sigma\_2; C-1 WP; 1
Y; (0\_\frac{1}{2}0); C\_2z, T; \{R\_2, R\_4\}; 2; i\sigma\_3, -i\sigma\_2; C-1 WP; 1
Z; (00\_\frac{1}{2}); C\_2z, E, T; \{R\_5, R\_5\}; 2; \sigma\_0, -\sigma\_0, -i\sigma\_2; P-NSZCDE;
\{R\_7, R\_7\}; 2; -\sigma\_0, -\sigma\_0, -i\sigma\_2; P-NSZCDE;
C; (0\_\frac{1}{2}0); C\_2z, E, T; \{R\_5, R\_5\}; 2; \sigma\_0, -\sigma\_0, -i\sigma\_2; P-NSZCDE;
\{R\_7, R\_7\}; 2; -\sigma\_0, -\sigma\_0, -i\sigma\_2; P-NSZCDE;
D; (\frac{1}{2}0\_\frac{1}{2}); C\_2z, E, T; \{R\_5, R\_5\}; 2; \sigma\_0, -\sigma\_0, -i\sigma\_2; P-NSZCDE;
\{R\_7, R\_7\}; 2; -\sigma\_0, -\sigma\_0, -i\sigma\_2; P-NSZCDE;
A; (\frac{1}{2}0\_\frac{1}{2}); C\_2z, T; \{R\_2, R\_4\}; 2; i\sigma\_3, -i\sigma\_2; C-1 WP; 1
E; (\frac{1}{2}0\_\frac{1}{2}); C\_2z, E, T; \{R\_5, R\_5\}; 2; \sigma\_0, -\sigma\_0, -i\sigma\_2; P-NSZCDE;
\{R\_7, R\_7\}; 2; -\sigma\_0, -\sigma\_0, -i\sigma\_2; P-NSZCDE;

A; \Gamma Z; \quad C\_2z; \quad R\_2; \quad 1; i;
\quad R\_4; \quad 1; -i;
V; \quad BD; \quad C\_2z; \quad R\_2; \quad 1; i;
\quad R\_4; \quad 1; -i;
W; \quad YC; \quad C\_2z; \quad R\_2; \quad 1; i;
\quad R\_4; \quad 1; -i;
U; \quad AE; \quad C\_2z; \quad R\_2; \quad 1; i;
\quad R\_4; \quad 1; -i;

\Gamma\_m\_0; \{C\_2z, \{000\}\}, T; Non-Centrosymmetric; with SOC

\Gamma; (000); C\_2z, T; \{R\_2, R\_4\}; 2; i\sigma\_3, -i\sigma\_2; C-1 WP; 1
A; (\frac{1}{2}00); C\_2z, T; \{R\_2, R\_4\}; 2; i\sigma\_3, -i\sigma\_2; C-1 WP; 1
Z; (0\_\frac{1}{2}0); C\_2z, T; \{R\_2, R\_4\}; 2; i\sigma\_3, -i\sigma\_2; C-1 WP; 1
M; (\frac{1}{2}0\_\frac{1}{2}); C\_2z, T; \{R\_2, R\_4\}; 2; i\sigma\_3, -i\sigma\_2; C-1 WP; 1
L; (\frac{1}{2}0\_\frac{1}{2}); E, T; \{R\_2, R\_2\}; 2; -\sigma\_0, -i\sigma\_2; C-1 WP; 1
V; (00\_\frac{1}{2}); E, T; \{R\_2, R\_2\}; 2; -\sigma\_0, -i\sigma\_2; C-1 WP; 1
A; \Gamma Z; \quad C\_2z; \quad R\_2; \quad 1; i;
\quad R\_4; \quad 1; -i;
U; \quad AM; \quad C\_2z; \quad R\_2; \quad 1; i;
\quad R\_4; \quad 1; -i;
SG 6
\[ \Gamma_m; \{\sigma_z|000\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[
\Gamma; (000); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
B; (\frac{1}{2}00); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
Y; (0\frac{1}{2}0); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
Z; (00\frac{1}{2}); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
C; (0\frac{1}{2}\frac{1}{2}); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
D; (\frac{1}{2}0\frac{1}{2}); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
A; (\frac{1}{2}\frac{1}{2}0); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
E; (\frac{1}{2}0\frac{1}{2}\frac{1}{2}); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
A; \Gamma Z; \vec{E}, T \sigma_z; R_2; 1; -1, 1;
\]

\[
V; \text{BD}; \vec{E}, T \sigma_z; R_2; 1; -1, 1;
\]

\[
W; \text{YC}; \vec{E}, T \sigma_z; R_2; 1; -1, 1;
\]

\[
U; \text{AE}; \vec{E}, T \sigma_z; R_2; 1; -1, 1;
\]

SG 7
\[ \Gamma_m; \{\sigma_z|\frac{1}{2}00\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[
\Gamma; (000); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
B; (\frac{1}{2}00); \sigma_z, \vec{E}, T; \{R_5, R_3\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \text{P-WNL}_{BD};
\]

\[
Y; (0\frac{1}{2}0); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
Z; (00\frac{1}{2}); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
C; (0\frac{1}{2}\frac{1}{2}); \sigma_z, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \text{P-WNL;}
\]

\[
D; (\frac{1}{2}0\frac{1}{2}); \sigma_z, \vec{E}, T; \{R_5, R_3\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \text{P-WNL}_{BD};
\]

\[
A; (\frac{1}{2}\frac{1}{2}0); \sigma_z, \vec{E}, T; \{R_5, R_3\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \text{P-WNL}_{AE};
\]

\[
E; (\frac{1}{2}0\frac{1}{2}\frac{1}{2}); \sigma_z, \vec{E}, T; \{R_5, R_3\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \text{P-WNL}_{AE};
\]

\[
A; \Gamma Z; \vec{E}, T \sigma_z; R_2; 1; -1, 1;
\]

\[
V; \text{BD}; \vec{E}, T \sigma_z; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \text{WNL; } \pi
\]

\[
W; \text{YC}; \vec{E}, T \sigma_z; R_2; 1; -1, 1;
\]

\[
U; \text{AE}; \vec{E}, T \sigma_z; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \text{WNL; } \pi
\]
SG 8

\[ \Gamma^{b}_{m}; \{ \sigma_{z}|000 \}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \ (000); \ \sigma_{z}, T; \ \{ R_{2}, R_{4} \}; 2; i\sigma_{3}, -i\sigma_{2}; \ P-WNL; \]
\[ A; \ (\frac{1}{2}00); \ \sigma_{z}, T; \ \{ R_{2}, R_{4} \}; 2; i\sigma_{3}, -i\sigma_{2}; \ P-WNL; \]
\[ Z; \ (0\frac{1}{2}\frac{1}{2}); \ \sigma_{z}, T; \ \{ R_{2}, R_{4} \}; 2; i\sigma_{3}, -i\sigma_{2}; \ P-WNL; \]
\[ M; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \ \sigma_{z}, T; \ \{ R_{2}, R_{4} \}; 2; i\sigma_{3}, -i\sigma_{2}; \ P-WNL; \]
\[ L; \ (\frac{1}{2}0\frac{1}{2}); \ \bar{E}, T; \ \{ R_{2}, R_{2} \}; 2; -\sigma_{0}, -i\sigma_{2}; \ C-1 \text{ WP}; 1 \]
\[ V; \ (00\frac{1}{2}); \ \bar{E}, T; \ \{ R_{2}, R_{2} \}; 2; -\sigma_{0}, -i\sigma_{2}; \ C-1 \text{ WP}; 1 \]
\[ \Lambda; \ \Gamma Z; \ \bar{E}, T \sigma_{z}; \ R_{2}; \ 1; -1, 1; \]
\[ U; \ \Lambda M; \ \bar{E}, T \sigma_{z}; \ R_{2}; \ 1; -1, 1; \]

SG 9

\[ \Gamma^{b}_{m}; \{ \sigma_{z} | \frac{1}{2}00 \}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \ (000); \ \sigma_{z}, T; \ \{ R_{2}, R_{4} \}; 2; i\sigma_{3}, -i\sigma_{2}; \ P-WNL; \]
\[ A; \ (\frac{1}{2}00); \ \sigma_{z}, T; \ \{ R_{2}, R_{4} \}; 2; \sigma_{0}, -i\sigma_{2}; \ P-WNL_{AM}; \]
\[ \quad \{ R_{3}, R_{3} \}; 2; -\sigma_{0}, -i\sigma_{2}; \ P-WNL_{AM}; \]
\[ Z; \ (0\frac{1}{2}\frac{1}{2}); \ \sigma_{z}, T; \ \{ R_{2}, R_{4} \}; 2; i\sigma_{3}, -i\sigma_{2}; \ P-WNL; \]
\[ M; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \ \sigma_{z}, T; \ \{ R_{1}, R_{1} \}; 2; \sigma_{0}, -i\sigma_{2}; \ P-WNL_{AM}; \]
\[ \quad \{ R_{3}, R_{3} \}; 2; -\sigma_{0}, -i\sigma_{2}; \ P-WNL_{AM}; \]
\[ L; \ (\frac{1}{2}0\frac{1}{2}); \ \bar{E}, T; \ \{ R_{2}, R_{2} \}; 2; -\sigma_{0}, -i\sigma_{2}; \ C-1 \text{ WP}; 1 \]
\[ V; \ (00\frac{1}{2}); \ \bar{E}, T; \ \{ R_{2}, R_{2} \}; 2; -\sigma_{0}, -i\sigma_{2}; \ C-1 \text{ WP}; 1 \]
\[ \Lambda; \ \Gamma Z; \ \bar{E}, T \sigma_{z}; \ R_{2}; \ 1; -1, 1; \]
\[ U; \ \Lambda M; \ \bar{E}, T \sigma_{z}; \ R_{2}; \ 2; -\sigma_{0}, -i\sigma_{2}; \ \text{WN}; \ \pi \]
Γ; (000); \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, \sigma_0, -i\sigma_2 \); 
\{R_6, R_8\}; 2; \( \sigma_3, -\sigma_0, -i\sigma_2 \);

B; (\( \frac{1}{2}00 \)); \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, \sigma_0, -i\sigma_2 \); 
\{R_6, R_8\}; 2; \( \sigma_3, -\sigma_0, -i\sigma_2 \);

Y; (0\( \frac{1}{2}0 \)); \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, \sigma_0, -i\sigma_2 \); 
\{R_6, R_8\}; 2; \( \sigma_3, -\sigma_0, -i\sigma_2 \);

Z; (00\( \frac{1}{2} \)); \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, \sigma_0, -i\sigma_2 \); 
\{R_6, R_8\}; 2; \( \sigma_3, -\sigma_0, -i\sigma_2 \);

C; (0\( \frac{1}{2} \frac{1}{2} \)); \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, \sigma_0, -i\sigma_2 \); 
\{R_6, R_8\}; 2; \( \sigma_3, -\sigma_0, -i\sigma_2 \);

D; (\( \frac{1}{2}0\frac{1}{2} \)); \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, \sigma_0, -i\sigma_2 \); 
\{R_6, R_8\}; 2; \( \sigma_3, -\sigma_0, -i\sigma_2 \);

A; (\( \frac{1}{2} \frac{1}{2} \ \frac{1}{2} \)); \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, \sigma_0, -i\sigma_2 \); 
\{R_6, R_8\}; 2; \( \sigma_3, -\sigma_0, -i\sigma_2 \);

E; (\( \frac{1}{2} \frac{1}{2} \frac{1}{2} \)); \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, \sigma_0, -i\sigma_2 \); 
\{R_6, R_8\}; 2; \( \sigma_3, -\sigma_0, -i\sigma_2 \);

A; ΓZ; \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, -i\sigma_2 \);

V; BD; \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, -i\sigma_2 \);

W; YC; \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, -i\sigma_2 \);

U; AE; \( C_{2z}, I, T \); \{R_2, R_4\}; 2; \( \sigma_3, -i\sigma_2 \);
3. SG 11-20

| Γ₀; {C₂;[00\frac{1}{2}]}, {I}[00\frac{1}{2}], T; Centrosymmetric; with SOC |
|---------------------------------------------------------------|
| Γ; (000); C₂, I, T; {R₂, R₄}; 2; iσ₃, σ₀, −iσ₂; |
| {R₆, R₈}; 2; iσ₃, −σ₀, −iσ₂; |
| B; (\frac{1}{2}00); C₂, I, T; {R₂, R₄}; 2; iσ₃, σ₀, −iσ₂; |
| {R₆, R₈}; 2; iσ₃, −σ₀, −iσ₂; |
| Y; (0\frac{1}{2}0); C₂, I, T; {R₂, R₄}; 2; iσ₃, σ₀, −iσ₂; |
| {R₆, R₈}; 2; iσ₃, −σ₀, −iσ₂; |
| Z; (00\frac{1}{2}); C₂, E, I, T; {R₉, R₀}; 4; Γ₀₁, −Γ₀₀, Γ₀₃, iΓ₂₀; P-DNL; 0 |
| C; (\frac{1}{2}\frac{1}{2}); C₂, E, I, T; {R₉, R₀}; 4; Γ₀₁, −Γ₀₀, Γ₀₃, iΓ₂₀; P-DNL; 0 |
| D; (\frac{1}{2}\frac{1}{2}); C₂, E, I, T; {R₉, R₀}; 4; Γ₀₁, −Γ₀₀, Γ₀₃, iΓ₂₀; P-DNL; 0 |
| A; (\frac{1}{2}\frac{1}{2}0); C₂, I, T; {R₂, R₄}; 2; iσ₃, σ₀, −iσ₂; |
| {R₆, R₈}; 2; iσ₃, −σ₀, −iσ₂; |
| E; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C₂, E, I, T; {R₉, R₀}; 4; Γ₀₁, −Γ₀₀, Γ₀₃, iΓ₂₀; P-DNL; 0 |
| Λ; ΓZ; C₂, I, T; {R₂, R₄}; 2; iσ₃, −iσ₂; |
| V; BD; C₂, I, T; {R₂, R₄}; 2; iσ₃, −iσ₂; |
| W; YC; C₂, I, T; {R₂, R₄}; 2; iσ₃, −iσ₂; |
| U; AM; C₂, I, T; {R₂, R₄}; 2; iσ₃, −iσ₂; |

---

| Γ₀; {C₂;[0000]}, {I}[0000], T; Centrosymmetric; with SOC |
|---------------------------------------------------------------|
| Γ; (000); C₂, I, T; {R₂, R₄}; 2; iσ₃, σ₀, −iσ₂; |
| {R₆, R₈}; 2; iσ₃, −σ₀, −iσ₂; |
| A; (\frac{1}{2}00); C₂, I, T; {R₂, R₄}; 2; iσ₃, σ₀, −iσ₂; |
| {R₆, R₈}; 2; iσ₃, −σ₀, −iσ₂; |
| Z; (0\frac{1}{2}\frac{1}{2}); C₂, I, T; {R₂, R₄}; 2; iσ₃, σ₀, −iσ₂; |
| {R₆, R₈}; 2; iσ₃, −σ₀, −iσ₂; |
| M; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C₂, I, T; {R₂, R₄}; 2; iσ₃, σ₀, −iσ₂; |
| {R₆, R₈}; 2; iσ₃, −σ₀, −iσ₂; |
| L; (\frac{1}{2}\frac{1}{2}); I, E, T; {R₂, R₂}; 2; σ₀, −σ₀, −iσ₂; |
| {R₄, R₄}; 2; −σ₀, −σ₀, −iσ₂; |
| V; (00\frac{1}{2}); I, E, T; {R₂, R₂}; 2; σ₀, −σ₀, −iσ₂; |
| {R₄, R₄}; 2; −σ₀, −σ₀, −iσ₂; |
| Λ; ΓZ; C₂, I, T; {R₂, R₄}; 2; iσ₃, −iσ₂; |
| U; AM; C₂, I, T; {R₂, R₄}; 2; iσ₃, −iσ₂; |
\[ \Gamma; \ (000); \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \quad \{R_6, R_8\}; \quad 2; \quad i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ B; \ (\frac{1}{2}00); \quad \sigma_z, E, I, T; \quad \{R_0, R_3\}; \quad 4; \quad \Gamma_{0.1}, -\Gamma_{0.0}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad \text{DP}; \quad 0 \]

\[ Y; \ (0\frac{1}{2}0); \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \quad \{R_6, R_8\}; \quad 2; \quad i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ Z; \ (00\frac{1}{2}); \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \quad \{R_6, R_8\}; \quad 2; \quad i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ C; \ (0\frac{1}{2}\frac{1}{2}); \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \quad \{R_6, R_8\}; \quad 2; \quad i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ D; \ (\frac{1}{2}0\frac{1}{2}); \quad \sigma_z, E, I, T; \quad \{R_0, R_3\}; \quad 4; \quad \Gamma_{0.1}, -\Gamma_{0.0}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad \text{DP}; \quad 0 \]

\[ A; \ (\frac{1}{2}\frac{1}{2}0); \quad \sigma_z, E, I, T; \quad \{R_0, R_3\}; \quad 4; \quad \Gamma_{0.1}, -\Gamma_{0.0}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad \text{DP}; \quad 0 \]

\[ E; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad \sigma_z, E, I, T; \quad \{R_0, R_3\}; \quad 4; \quad \Gamma_{0.1}, -\Gamma_{0.0}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad \text{DP}; \quad 0 \]

\[ \Lambda; \ \Gamma_{Z}; \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, -i\sigma_2; \]

\[ V; \ BD; \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_0, -i\sigma_2; \]
\[ \quad \{R_4, R_4\}; \quad 2; \quad -i\sigma_0, -i\sigma_2; \]

\[ W; \ YC; \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, -i\sigma_2; \]

\[ U; \ AE; \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_0, -i\sigma_2; \]
\[ \quad \{R_4, R_4\}; \quad 2; \quad -i\sigma_0, -i\sigma_2; \]
SG 14

Γₗₚ; \{C₂₂[00\frac{1}{2}], \{\frac{1}{2}0\frac{1}{2}\}\}; T; Centrosymmetric; with SOC

Γ; (000); C₂₂,Ι,Τ; \{R₂,R₄\}; 2; \text{iσ}_3,\text{σ}_0, -\text{iσ}_2;
\{R₆,R₈\}; 2; \text{iσ}_3, -\text{σ}_0, -\text{iσ}_2;

B; (\frac{1}{2}00); σ₂,E,Ι,Τ; \{R₉,R₀\}; 4; Γ₀,₁, -Γ₀,₀,Γ₀,₃, iΓ₂₀; DP; 0

Y; (0\frac{1}{2}0); C₂₂,Ι,Τ; \{R₂,R₄\}; 2; \text{iσ}_3,\text{σ}_0, -\text{iσ}_2;
\{R₆,R₈\}; 2; \text{iσ}_3, -\text{σ}_0, -\text{iσ}_2;

Z; (00\frac{1}{2}); C₂₂,Ε,Ι,Τ; \{R₉,R₀\}; 4; Γ₀,₁, -Γ₀,₀,Γ₀,₃, iΓ₂₀; P-DNL; 0

C; (0\frac{1}{2}0); C₂₂,Ε,Ι,Τ; \{R₉,R₀\}; 4; Γ₀,₁, -Γ₀,₀,Γ₀,₃, iΓ₂₀; P-DNL; 0

D; (\frac{1}{2}0\frac{1}{2}); C₂₂,Ι,Τ; \{R₁,R₃\}; 2; \text{σ}_0,\text{σ}_0, -\text{σ}_2;
\{R₃,R₅\}; 2; -\text{σ}_0,\text{σ}_0, -\text{σ}_2;
\{R₅,R₅\}; 2; \text{σ}_0, -\text{σ}_0, -\text{iσ}_2;
\{R₇,R₇\}; 2; -\text{σ}_0, -\text{σ}_0, -\text{iσ}_2;

A; (\frac{1}{2}\frac{1}{2}0); σ₂,E,Ι,Τ; \{R₉,R₀\}; 4; Γ₀,₁, -Γ₀,₀,Γ₀,₃, iΓ₂₀; DP; 0

E; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C₂₂,Ι,Τ; \{R₁,R₃\}; 2; \text{σ}_0,\text{σ}_0, -\text{σ}_2;
\{R₃,R₅\}; 2; -\text{σ}_0,\text{σ}_0, -\text{iσ}_2;
\{R₅,R₅\}; 2; \text{σ}_0, -\text{σ}_0, -\text{iσ}_2;
\{R₇,R₇\}; 2; -\text{σ}_0, -\text{σ}_0, -\text{iσ}_2;

SG 15

Γₗₚ; \{C₂₂[000], \{\frac{1}{2}0\frac{1}{2}\}\}; T; Centrosymmetric; with SOC

Γ; (000); C₂₂,Ι,Τ; \{R₂,R₄\}; 2; \text{iσ}_3,\text{σ}_0, -\text{iσ}_2;
\{R₆,R₈\}; 2; \text{iσ}_3, -\text{σ}_0, -\text{iσ}_2;

A; (\frac{1}{2}00); σ₂,E,Ι,Τ; \{R₉,R₀\}; 4; Γ₀,₁, -Γ₀,₀,Γ₀,₃, iΓ₂₀; DP; 0

Z; (0\frac{1}{2}\frac{1}{2}); C₂₂,Ι,Τ; \{R₂,R₄\}; 2; \text{iσ}_3,\text{σ}_0, -\text{iσ}_2;
\{R₆,R₈\}; 2; \text{iσ}_3, -\text{σ}_0, -\text{iσ}_2;

M; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); σ₂,E,Ι,Τ; \{R₉,R₀\}; 4; Γ₀,₁, -Γ₀,₀,Γ₀,₃, iΓ₂₀; DP; 0

L; (\frac{1}{2}\frac{1}{2}0); I,Ι,Τ; \{R₂,R₄\}; 2; \text{σ}_0, -\text{σ}_0, -\text{iσ}_2;
\{R₄,R₄\}; 2; -\text{σ}_0, -\text{σ}_0, -\text{iσ}_2;

V; (00\frac{1}{2}); I,Ι,Τ; \{R₂,R₄\}; 2; \text{σ}_0, -\text{σ}_0, -\text{iσ}_2;
\{R₄,R₄\}; 2; -\text{σ}_0, -\text{σ}_0, -\text{iσ}_2;

Λ; Γζ; C₂₂,Ι,Τ; \{R₂,R₄\}; 2; \text{iσ}_3, -\text{iσ}_2;

U; AM; C₂₂,Ι,Τ; \{R₂,R₄\}; 2; \text{iσ}_0, -\text{iσ}_2;
\{R₄,R₄\}; 2; -\text{iσ}_0, -\text{iσ}_2;
\( \Gamma \): (000); \( C_2x, C_2y, T \); \( R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \); C-1 WP; 1

\( Y \); (00\( \frac{1}{2} \)); \( C_2x, C_2y, T \); \( R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \); C-1 WP; 1

\( X \); (0\( \frac{1}{2} \)0); \( C_2x, C_2y, T \); \( R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \); C-1 WP; 1

\( Z \); (00\( \frac{3}{2} \)); \( C_2x, C_2y, T \); \( R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \); C-1 WP; 1

\( U \); (0\( \frac{1}{2} \)\( \frac{1}{2} \)); \( C_2x, C_2y, T \); \( R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \); C-1 WP; 1

\( T \); (0\( \frac{1}{2} \)0\( \frac{1}{2} \)); \( C_2x, C_2y, T \); \( R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \); C-1 WP; 1

\( S \); (0\( \frac{1}{2} \)\( \frac{1}{2} \)0); \( C_2x, C_2y, T \); \( R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \); C-1 WP; 1

\( \Delta \); \( \Gamma Y \); \( C_2y, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( D \); \( XS \); \( C_2y, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( P \); \( UR \); \( C_2y, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( B \); \( ZT \); \( C_2y, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( \Sigma \); \( \Gamma X \); \( C_2x, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( C \); \( YS \); \( C_2x, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( E \); \( TR \); \( C_2x, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( A \); \( ZU \); \( C_2x, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( \Lambda \); \( \Gamma Z \); \( C_2x, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( H \); \( YT \); \( C_2x, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( Q \); \( SR \); \( C_2x, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;

\( G \); \( XU \); \( C_2x, \tilde{T}C_{2x} \); \( R_2 \); 1; 1, 1;
\[ \Gamma; (000); C_{2z}, C_{2y}, T; \quad R_5; \quad 2; \quad i \sigma_2, i \sigma_1, -i \sigma_2; \quad C-1 \text{ WP}; 
\]
\[ \Psi; (010); C_{2z}, C_{2y}, T; \quad R_5; \quad 2; \quad i \sigma_2, i \sigma_1, -i \sigma_2; \quad C-1 \text{ WP}; 
\]
\[ \Psi; (0 \frac{1}{2} 0); C_{2z}, C_{2y}, T; \quad \{R_5, R_4\}; \quad 2; \quad -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-NS}_{\text{ZUTR}}; 
\]
\[ \Psi; (0 \frac{1}{2} \frac{1}{2}); C_{2z}, C_{2y}, T; \quad \{R_5, R_4\}; \quad 2; \quad -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-NS}_{\text{ZUTR}}; 
\]
\[ \Psi; (\frac{1}{2} 0 \frac{1}{2}); C_{2z}, C_{2y}, T; \quad \{R_5, R_4\}; \quad 2; \quad -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-NS}_{\text{ZUTR}}; 
\]
\[ \Psi; (\frac{1}{2} \frac{1}{2} 0); C_{2z}, C_{2y}, T; \quad \{R_5, R_4\}; \quad 2; \quad -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-NS}_{\text{ZUTR}}; 
\]
\[ \Delta; \quad C_{2z}, T C_{2z}; \quad R_2; \quad 1; \quad i, 1; 
\]
\[ \Delta; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Delta; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Delta; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Psi; \quad C_{2z}, T C_{2z}; \quad R_2; \quad 1; \quad i, 1; 
\]
\[ \Psi; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Psi; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Psi; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Psi; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Psi; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Psi; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Psi; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Psi; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]
\[ \Psi; \quad C_{2z}, T C_{2z}; \quad R_4; \quad 1; \quad i, 1; 
\]

Non-Centrosymmetric; with SOC
\[\Gamma_0; \{C_{2v}[000], \{C_{2v}\}_{4 1 0}\}, T; \text{Non-Centrosymmetric; with SOC}\]

| \(\Gamma\) | \((000)\) | \(C_{2y}, C_{2z}, T\) | \(R_5\) | \(2; i\sigma_2, i\sigma_1, -i\sigma_2\); C-1 WP; | 1 |
| \(Y\) | \((\frac{1}{2}00)\) | \(C_{2x}, C_{2z}, T\) | \(R_5, R_6\) | \(2; -i\sigma_0, i\sigma_3, -i\sigma_2\); P-NSYTSR; |
| \(X\) | \((0\frac{1}{2}0)\) | \(C_{2x}, C_{2z}, T\) | \(R_5, R_6\) | \(-\sigma_0, i\sigma_3, -i\sigma_2\); P-NSYTSR; |
| \(Z\) | \((00\frac{1}{2})\) | \(C_{2x}, C_{2y}, T\) | \(R_5\) | \(2; i\sigma_2, i\sigma_1, -i\sigma_2\); C-1 WP; | 1 |
| \(U\) | \((\frac{1}{2}\frac{1}{2}0)\) | \(C_{2x}, C_{2z}, T\) | \(R_5, R_6\) | \(2; -\sigma_0, i\sigma_3, -i\sigma_2\); P-NSYTSR; |
| \(T\) | \((\frac{1}{2}0\frac{1}{2})\) | \(C_{2y}, C_{2z}, T\) | \(R_5, R_6\) | \(-\sigma_0, i\sigma_3, -i\sigma_2\); P-NSYTSR; |
| \(S\) | \((\frac{1}{2}0\frac{1}{2})\) | \(C_{2x}, C_{2z}, T\) | \(R_9, R_0\) | \(4; \Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{2.1}\); C-2 DP; | 2 |
| \(R\) | \((\frac{1}{2}\frac{1}{2}\frac{1}{2})\) | \(C_{2x}, C_{2z}, T\) | \(R_0, R_0\) | \(4; \Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{2.1}\); C-2 DP; | 2 |

| \(\Delta; \Gamma Y\) | \(C_{2y}, T C_{2z}\) | \(R_2\) | \(1; i, 1\); |
| \(D; XS\) | \(C_{2y}, E, T C_{2z}\) | \(R_5, R_7\) | \(-i\sigma_3, -\sigma_0, -i\sigma_2\); L-NSXUSR; |
| \(P; UR\) | \(C_{2y}, E, T C_{2z}\) | \(R_5, R_7\) | \(-i\sigma_3, -\sigma_0, -i\sigma_2\); L-NSXUSR; |
| \(B; ZT\) | \(C_{2y}, T C_{2z}\) | \(R_2\) | \(1; i, 1\); |
| \(\Sigma; \Gamma X\) | \(C_{2x}, T C_{2z}\) | \(R_2\) | \(1; i, 1\); |
| \(C; YS\) | \(C_{2x}, E, T C_{2z}\) | \(R_5, R_7\) | \(2; i\sigma_3, -\sigma_0, \sigma_1\); L-NSYTSR; |
| \(E; TR\) | \(C_{2x}, E, T C_{2z}\) | \(R_5, R_7\) | \(2; i\sigma_3, -\sigma_0, \sigma_1\); L-NSYTSR; |
| \(A; ZU\) | \(C_{2x}, T C_{2z}\) | \(R_2\) | \(1; i, 1\); |
| \(\Lambda; \Gamma Z\) | \(C_{2x}, T C_{2z}\) | \(R_2\) | \(1; i, 1\); |
| \(H; YT\) | \(C_{2x}, T C_{2z}\) | \(R_2, R_4\) | \(2; i\sigma_3, \sigma_1\); L-NSYTSR; |
| \(Q; SR\) | \(C_{2x}, T C_{2z}\) | \(R_2, R_4\) | \(2; i\sigma_0, -i\sigma_2\); L-NS; |
| \(G; XU\) | \(C_{2x}, T C_{2z}\) | \(R_2, R_4\) | \(2; i\sigma_3, -i\sigma_2\); L-NSXUSR; |
Γ₀: \{C_{2x} \begin{bmatrix} \frac{1}{2} \end{bmatrix}, C_{2y} \begin{bmatrix} \frac{1}{2} \end{bmatrix}, T\}; Non-Centrosymmetric; with SOC

Γ; (000); \{C_{2x},C_{2y},T;\} \{R_5, R_6\}; 2; i\sigma_2, i\sigma_1, -i\sigma_2; C-1 WP; 1

Y; ( \begin{bmatrix} \frac{1}{2} \end{bmatrix} 0 0 ); \{C_{2y},C_{2z},T;\} \{R_5, R_6\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; P-NS_{YSTR};
\{R_7, R_8\}; 2; \sigma_0, -i\sigma_3, -i\sigma_2; P-NS_{YSTR};

X; ( \begin{bmatrix} 0 \frac{1}{2} \end{bmatrix} 0 ); \{C_{2x},C_{2z},T;\} \{R_5, R_6\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; P-NS_{XUSR};
\{R_7, R_8\}; 2; \sigma_0, -i\sigma_3, -i\sigma_2; P-NS_{XUSR};

Z; ( \begin{bmatrix} 0 \frac{1}{2} \end{bmatrix} 0 ); \{C_{2x},C_{2y},T;\} \{R_5, R_6\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; P-NS_{ZUTR};
\{R_7, R_8\}; 2; \sigma_0, -i\sigma_3, -i\sigma_2; P-NS_{ZUTR};

U; ( \begin{bmatrix} \frac{1}{2} \frac{1}{2} \end{bmatrix} 0 ); \{C_{2y},C_{2z},T;\} \{R_5, R_6\}; 4; i\Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{2.1}; C-2 DP; 2

T; ( \begin{bmatrix} \frac{1}{2} \end{bmatrix} \frac{1}{2} \frac{1}{2} \); \{C_{2x},C_{2y},T;\} \{R_5, R_6\}; 4; i\Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{2.1}; C-2 DP; 2

S; ( \begin{bmatrix} \frac{1}{2} \frac{1}{2} \end{bmatrix} \frac{1}{2} \frac{1}{2} \); \{C_{2x},C_{2y},T;\} \{R_5, R_6\}; 4; i\Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{2.1}; C-2 DP; 2

R; ( \begin{bmatrix} \frac{1}{2} \frac{1}{2} \end{bmatrix} \frac{1}{2} \frac{1}{2} \); \{C_{2x},C_{2y},\tilde{E},T;\} \{R_5, R_6\}; 2; \sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2; P-NSs;
\{R_7, R_8\}; 2; \sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2; P-NSs;
\{R_9, R_8\}; 2; -\sigma_0, \sigma_0, -\sigma_0, -i\sigma_2; P-NSs;
\{R_9, R_9\}; 2; -\sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2; P-NSs;

Δ; ΓY; \{C_{2y},\tilde{T}C_{2z};\} \{R_2\}; 2; 1; i; 1;
\{R_4\}; 1; -i; 1;

D; XS; \{C_{2y},\tilde{E},T_{C_{2z}};\} \{R_5, R_7\}; 2; -i\sigma_3, -\sigma_0, -i\sigma_2; L-NS_{XUSR};

P; UR; \{C_{2y},\tilde{E},T_{C_{2z}};\} \{R_5, R_3\}; 2; -i\sigma_0, -\sigma_0, -i\sigma_2; L-NSs;
\{R_7, R_7\}; 2; i\sigma_0, -\sigma_0, -i\sigma_2; L-NSs;

B; ZT; \{C_{2y},\tilde{T}C_{2z};\} \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; P-NS_{ZUTR};

Σ; ΓX; \{C_{2x},\tilde{T}C_{2z};\} \{R_2\}; 1; i; 1;
\{R_4\}; 1; -i; 1;

C; YS; \{C_{2x},T_{C_{2z}};\} \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; P-NS_{YSTR};

E; TR; \{C_{2x},\tilde{E},T_{C_{2z}};\} \{R_5, R_5\}; 2; -i\sigma_0, -\sigma_0, -i\sigma_2; L-NSs;
\{R_7, R_7\}; 2; i\sigma_0, -\sigma_0, -i\sigma_2; L-NSs;

A; ZU; \{C_{2x},\tilde{E},T_{C_{2z}};\} \{R_5, R_7\}; 2; -i\sigma_3, -\sigma_0, -i\sigma_2; P-NS_{ZUTR};

Λ; ΓZ; \{C_{2x},\tilde{T}C_{2z};\} \{R_2\}; 1; i; 1;
\{R_4\}; 1; -i; 1;

H; YT; \{C_{2x},\tilde{E},T_{C_{2z}};\} \{R_5, R_7\}; 2; i\sigma_3, -\sigma_0, \sigma_1; P-NS_{YSTR};

Q; SR; \{C_{2x},\tilde{E},T_{C_{2z}};\} \{R_5, R_5\}; 2; i\sigma_0, -\sigma_0, -i\sigma_2; L-NSs;
\{R_7, R_7\}; 2; -i\sigma_0, -\sigma_0, -i\sigma_2; L-NSs;

G; XU; \{C_{2x},\tilde{T}C_{2z};\} \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; L-NS_{XUSR};
\( \Gamma^0; \{C_{2z}(00\frac{1}{2}), C_{2y}(00\frac{1}{2})\}, T; \) Non-Centrosymmetric; with SOC

| Point | Symmetry | \( \Gamma \) | \( Y \) | \( Z \) | \( T \) | \( S \) | \( R \) |
|-------|---------|-------------|-------------|-------------|-------------|-------------|-------------|
| \( \Gamma \); (000) | \( C_{2z}, C_{2y}, T \) | \( R_{5}; \) | \( 2; i\sigma_2, -i\sigma_1, -i\sigma_2; \) | C-1 WP; 1 |
| \( Y \); (0\( \frac{1}{2} \)0) | \( C_{2z}, C_{2y}, T \) | \( R_{5}; \) | \( 2; i\sigma_2, i\sigma_1, -i\sigma_2; \) | C-1 WP; 1 |
| \( Z \); (00\( \frac{1}{2} \)) | \( C_{2z}, C_{2y}, T \) | \( \{R_{5}, R_{6}\}; \) | \( 2; -\sigma_0, i\sigma_3, -i\sigma_2; \) | P-NS ZTR;  |
| | | | \( \{R_{7}, R_{8}\}; \) | \( 2; \sigma_0, -i\sigma_3, -i\sigma_2; \) | P-NS ZTR;  |
| \( T \); (0\( \frac{1}{2} \)\( \frac{1}{2} \)) | \( C_{2z}, C_{2y}, T \) | \( \{R_{5}, R_{6}\}; \) | \( 2; -\sigma_0, i\sigma_3, -i\sigma_2; \) | P-NS ZTR;  |
| | | | \( \{R_{7}, R_{8}\}; \) | \( 2; \sigma_0, -i\sigma_3, -i\sigma_2; \) | P-NS ZTR;  |
| \( S \); (0\( \frac{1}{2} \)0) | \( C_{2z}, T \) | \( \{R_{2}, R_{4}\}; \) | \( 2; i\sigma_3, -i\sigma_2; \) | C-1 WP; 1 |
| \( R \); (0\( \frac{1}{2} \)\( \frac{1}{2} \)) | \( C_{2z}, E, T \) | \( \{R_{5}, R_{6}\}; \) | \( 2; \sigma_0, -\sigma_0, -i\sigma_2; \) | P-NS ZTR;  |
| | | | \( \{R_{7}, R_{8}\}; \) | \( 2; -\sigma_0, -\sigma_0, -i\sigma_2; \) | P-NS ZTR;  |
| \( \Lambda \); \( \Gamma \)Z | \( C_{2z}, TC_{2z} \) | \( R_{2}; \) | \( 1; i, 1; \) |  |
| | | | \( R_{4}; \) | \( 1; -i, 1; \) |  |
| \( H \); \( \Gamma \)T | \( C_{2z}, TC_{2z} \) | \( R_{2}; \) | \( 1; i, 1; \) |  |
| | | | \( R_{4}; \) | \( 1; -i, 1; \) |  |
| \( D \); \( \Gamma \)R | \( C_{2z} \) | \( R_{2}; \) | \( 1; i; \) |  |
| | | | \( R_{4}; \) | \( 1; -i; \) |  |
| \( A \); \( \Gamma \)ZT | \( C_{2z}, TC_{2z} \) | \( \{R_{2}, R_{4}\}; \) | \( 2; i\sigma_3, -i\sigma_2; \) | L-NS ZTR;  |
| \( \Sigma \); \( \Gamma \)Y | \( C_{2z}, TC_{2z} \) | \( R_{2}; \) | \( 1; i, 1; \) |  |
| | | | \( R_{4}; \) | \( 1; -i, 1; \) |  |
| \( \Delta \); \( \Gamma \)DA | \( C_{2y}, TC_{2z} \) | \( R_{2}; \) | \( 1; i, 1; \) |  |
| | | | \( R_{4}; \) | \( 1; -i, 1; \) |  |
| \( B \); \( \Gamma \)ZB | \( C_{2y}, E, TC_{2z} \) | \( \{R_{5}, R_{7}\}; \) | \( 2; -i\sigma_3, -\sigma_0, \sigma_1; \) | L-NS ZTR;  |
| \( G \); \( \Gamma \)TG | \( C_{2y}, E, TC_{2z} \) | \( \{R_{5}, R_{7}\}; \) | \( 2; -i\sigma_3, -\sigma_0, \sigma_1; \) | L-NS ZTR;  |
| \( F \); \( \Gamma \)YF | \( C_{2y}, TC_{2z} \) | \( R_{2}; \) | \( 1; i, 1; \) |  |
| | | | \( R_{4}; \) | \( 1; -i, 1; \) |  |
| \( E \); \( \Gamma \)TE | \( C_{2z}, TC_{2z} \) | \( \{R_{2}, R_{4}\}; \) | \( 2; i\sigma_3, -i\sigma_2; \) | L-NS ZTR;  |
| \( C \); \( \Gamma \)YC | \( C_{2z}, TC_{2z} \) | \( R_{2}; \) | \( 1; i, 1; \) |  |
| | | | \( R_{4}; \) | \( 1; -i, 1; \) |  |
4. SG 21-30

\[ \Gamma_{21}^b; \{C_{2z}|000\}, \{C_{2y}|000\}, \mathcal{T}; \text{Non-Centrosymmetric; with SOC} \]

| \( \Gamma \) | \( \{000\} \) | \( C_{2z}, C_{2y}, T \) | \( R_5 \) | \( \{R_2, R_4\} \) | \( \{R_2, R_4\} \) | \( 2; i\sigma_2, i\sigma_1, -i\sigma_2 \) | \( 2; i\sigma_2, i\sigma_1, -i\sigma_2 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
|---|---|---|---|---|---|---|---|---|---|
| \( \Gamma \) | \( \{000\} \) | \( C_{2z}, C_{2y}, T \) | \( R_5 \) | \( \{R_2, R_4\} \) | \( \{R_2, R_4\} \) | \( 2; i\sigma_2, i\sigma_1, -i\sigma_2 \) | \( 2; i\sigma_2, i\sigma_1, -i\sigma_2 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Lambda \) | \( \{1, 0, 0\} \) | \( C_{2z}, T \) | \( R_2 \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Sigma \) | \( \{0, 0, 1\} \) | \( C_{2z}, T \) | \( R_2 \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Delta \) | \( \{1, 0, 0\} \) | \( C_{2y}, \mathcal{T} \) | \( \{R_2, R_4\} \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Lambda \) | \( \{1, 0, 0\} \) | \( C_{2z}, \mathcal{T} \) | \( \{R_2, R_4\} \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Lambda \) | \( \{1, 0, 0\} \) | \( C_{2z}, \mathcal{T} \) | \( \{R_2, R_4\} \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Lambda \) | \( \{1, 0, 0\} \) | \( C_{2z}, \mathcal{T} \) | \( \{R_2, R_4\} \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Lambda \) | \( \{1, 0, 0\} \) | \( C_{2z}, \mathcal{T} \) | \( \{R_2, R_4\} \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Lambda \) | \( \{1, 0, 0\} \) | \( C_{2z}, \mathcal{T} \) | \( \{R_2, R_4\} \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Lambda \) | \( \{1, 0, 0\} \) | \( C_{2z}, \mathcal{T} \) | \( \{R_2, R_4\} \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Lambda \) | \( \{1, 0, 0\} \) | \( C_{2z}, \mathcal{T} \) | \( \{R_2, R_4\} \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
| \( \Lambda \) | \( \{1, 0, 0\} \) | \( C_{2z}, \mathcal{T} \) | \( \{R_2, R_4\} \) | \( 1; i, 1 \) | \( R_4 \) | \( 1; -i, 1 \) | \( \text{C-1 WP; 1} \) | \( \text{C-1 WP; 1} \) |
\[
\begin{align*}
\Gamma_0^I; \{C_{2z}|000\}, \{C_{2y}|000\}, T; \text{Non-Centrosymmetric; with SOC} \\
\Gamma; (000); & \quad C_{2x},C_{2y},T; R_5; \quad 2; i\sigma_2,i\sigma_1,-i\sigma_2; \text{C-1 WP; 1} \\
Y; (0\frac{1}{2}\frac{1}{2}) ; & \quad C_{2x},C_{2y},T; R_5; \quad 2; i\sigma_2,i\sigma_1,-i\sigma_2; \text{C-1 WP; 1} \\
X; (\frac{1}{2}0\frac{1}{2}) ; & \quad C_{2x},C_{2y},T; R_5; \quad 2; i\sigma_2,i\sigma_1,-i\sigma_2; \text{C-1 WP; 1} \\
Z; (\frac{1}{2}\frac{1}{2}0) ; & \quad C_{2x},C_{2y},T; R_5; \quad 2; i\sigma_2,i\sigma_1,-i\sigma_2; \text{C-1 WP; 1} \\
L; (\frac{1}{2}00) ; & \quad \tilde{E},T; \quad \{R_2,R_2\}; \quad 2; -\sigma_0,-i\sigma_2; \text{C-1 WP; 1} \\
\Lambda; \Gamma Z/\Gamma \Lambda; & \quad C_{2x},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
G; XG/XY; & \quad C_{2x},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
H; YH/YX; & \quad C_{2x},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
Q; ZQ; & \quad C_{2x},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
\Sigma; \Gamma X/\Gamma \Sigma; & \quad C_{2x},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
C; YC/YZ; & \quad C_{2x},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
A; ZA/ZY; & \quad C_{2x},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
U; XU; & \quad C_{2x},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
\Delta; \Gamma Y/\Gamma \Delta; & \quad C_{2y},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
D; XD/XZ; & \quad C_{2y},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
B; ZB/ZX; & \quad C_{2y},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; \\
R; YR; & \quad C_{2y},T C_{2x}; R_2; \quad 1; i,1; \\
& \quad R_4; \quad 1; -i,1; 
\end{align*}
\]
\begin{align*}
\Gamma^0: \{C_{2z}|000\}, \{C_{2y}|000\}, T; \text{Non-Centrosymmetric; with SOC} \\
\Gamma: (000); C_{2z}, C_{2y}, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; C-1 \text{ WP}; 1 \\
X: \left(\frac{1}{2} \frac{1}{2} \frac{1}{2}\right); C_{2z}, C_{2y}, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; C-1 \text{ WP}; 1 \\
R: \left(\frac{1}{2} 0 0\right); C_{2y}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; C-1 \text{ WP}; 1 \\
S: \left(\frac{1}{2} 0 \frac{1}{2}\right); C_{2z}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; C-1 \text{ WP}; 1 \\
T: \left(\frac{1}{2} \frac{1}{2} 0\right); C_{2z}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; C-1 \text{ WP}; 1 \\
W: \left(\frac{1}{2} \frac{1}{4} \frac{1}{4}\right); C_{2z}, C_{2y}; R_5; 2; i\sigma_2, i\sigma_3; C-1 \text{ WP}; 1 \\
\Lambda: \Gamma\Lambda/\Gamma X; C_{2z}, TC_{2z}; R_2; 1; i, 1; R_4; 1; -i, 1; \\
G: \Gamma X; C_{2z}, TC_{2z}; R_2; 1; i, 1; R_4; 1; -i, 1; \\
P: \Gamma X; C_{2z}; R_2; 1; i; R_4; 1; -i; \\
\Sigma: \Gamma\Sigma/\Gamma X; C_{2z}, TC_{2z}; R_2; 1; i, 1; R_4; 1; -i, 1; \\
F: \Gamma X; C_{2z}, TC_{2z}; R_2; 1; i, 1; R_4; 1; -i, 1; \\
D: \Gamma X; C_{2z}; R_2; 1; i; R_4; 1; -i; \\
\Delta: \Gamma\Delta/\Gamma X; C_{2y}, TC_{2z}; R_2; 1; i, 1; R_4; 1; -i, 1; \\
U: \Gamma X; C_{2y}, TC_{2z}; R_2; 1; i, 1; R_4; 1; -i, 1; \\
Q: \Gamma X; C_{2y}; R_2; 1; i; R_4; 1; -i;
\end{align*}
\[ \Gamma_0^v: \{ C_{2z}, |\frac{1}{2} 0 \frac{1}{2} \}, \{ C_{2y}, |\frac{1}{2} \frac{1}{2} \}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \begin{array}{llll}
\Gamma; (000): & C_{2z}, C_{2y}, T; & R_5; & 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{C-1 WP; 1} \\
X; (\frac{1}{2} \frac{1}{2} \frac{1}{2}): & C_{2z}, C_{2y}, T; & R_5; & 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{C-1 WP; 1} \\
R; (\frac{1}{2} 00): & C_{2y}, T; & \{ R_2, R_4 \}; & 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \\
S; (\frac{1}{2} 0 \frac{1}{2}): & C_{2x}, T; & \{ R_2, R_4 \}; & 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \\
T; (\frac{1}{2} \frac{1}{2} 0): & C_{2x}, T; & \{ R_2, R_4 \}; & 2; i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \\
W; (\frac{3}{4} \frac{1}{4} \frac{1}{4}): & C_{2x}, C_{2y}; & R_1; & 1; 1, 1; \\
& & R_2; & 1; 1, -1; \\
& & R_3; & 1; -1, 1; \\
& & R_4; & 1; -1, -1; \\
\Lambda; \Gamma \Lambda / \Gamma X: & C_{2x}, T C_{2z}; & R_2; & 1; i, 1; \\
& & R_4; & 1; -i, 1; \\
G; XG: & C_{2x}, T C_{2z}; & R_2; & 1; -i, 1; \\
& & R_4; & 1; i, 1; \\
P; TW: & C_{2z}, E; & R_5; & 1; -i, -1; \\
& & R_7; & 1; i, -1; \\
\Sigma; \Gamma \Sigma / \Gamma X: & C_{2z}, T C_{2z}; & R_2; & 1; i, 1; \\
& & R_4; & 1; -i, 1; \\
F; XF: & C_{2x}, T C_{2z}; & R_2; & 1; -i, 1; \\
& & R_4; & 1; i, 1; \\
D; SW: & C_{2x}, E; & R_5; & 1; i, -1; \\
& & R_7; & 1; -i, -1; \\
\Delta; \Gamma \Delta / \Gamma X: & C_{2y}, T C_{2z}; & R_2; & 1; i, 1; \\
& & R_4; & 1; -i, 1; \\
U; XU: & C_{2y}, T C_{2z}; & R_2; & 1; i, 1; \\
& & R_4; & 1; -i, 1; \\
Q; RW: & C_{2y}, E; & R_5; & 1; -i, -1; \\
& & R_7; & 1; i, -1; \\
\end{array} \]
$\Gamma_o; \{C_{2z|000}, \{\sigma_y|000\}, T\}; $ Non-Centrosymmetric; with SOC

$\Gamma; (000); C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; $ P-WNL_{P-Z};

$Y; (1\frac{1}{2}0); C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; $ P-WNL_{YT};

$X; (0\frac{1}{2}0); C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; $ P-WNL_{XU};

$Z; (00\frac{1}{2}); C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; $ P-WNL_{XU};

$T; (\frac{1}{2}0\frac{1}{2}); C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; $ P-WNL_{YT};

$S; (\frac{1}{2}\frac{1}{2}0); C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; $ P-WNL_{SR};

$R; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; $ P-WNL_{SR};

$\Delta; \Gamma Y; \sigma_x, TC_{2z}; R_2; 1; i, 1; R_4; 1; -i, 1;$

$D; XS; \sigma_x, TC_{2z}; R_2; 1; i, 1; R_4; 1; -i, 1;$

$P; UR; \sigma_x, TC_{2z}; R_2; 1; i, 1; R_4; 1; -i, 1;$

$B; ZT; \sigma_x, TC_{2z}; R_2; 1; i, 1; R_4; 1; -i, 1;$

$\Sigma; \Gamma X; \sigma_y, T \sigma_z; R_2; 1; i, 1; R_4; 1; -i, 1;$

$C; YS; \sigma_y, T \sigma_z; R_2; 1; i, 1; R_4; 1; -i, 1;$

$E; TR; \sigma_y, T \sigma_z; R_2; 1; i, 1; R_4; 1; -i, 1;$

$A; ZU; \sigma_y, T \sigma_z; R_2; 1; i, 1; R_4; 1; -i, 1;$

$\Lambda; \Gamma Z; C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1; \ $ WNL; $\pi$

$H; YT; C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1; \ $ WNL; $\pi$

$Q; SR; C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1; \ $ WNL; $\pi$

$G; XU; C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1; \ $ WNL; $\pi$
$\Gamma_0; \{C_{2z}[00\frac{1}{2}], \{\sigma_y[00\frac{1}{2}\}]; \Gamma; \text{Non-Centrosymmetric; with SOC}\$

$\Gamma; (000); C_{2z}, \sigma_y, \Gamma; R_5; \{\sigma_2, i\sigma_1, -i\sigma_2\}; P\text{-WNL}_{TZ};$

$\gamma; (\frac{1}{2}00); C_{2z}, \sigma_y, \Gamma; R_5; \{\sigma_2, i\sigma_1, -i\sigma_2\}; P\text{-WNL}_{VT};$

$\chi; (0\frac{1}{2}0); C_{2z}, \sigma_y, \Gamma; R_5; \{\sigma_2, i\sigma_1, -i\sigma_2\}; P\text{-WNL}_{XU};$

$Z; (00\frac{1}{2}); \sigma_z, \sigma_y, \Gamma; \{R_0, R_0\}; \{\Gamma_0, 3, \Gamma_0, 1, -\Gamma_2, 1\}; \text{DP}; 0$

$U; (\frac{1}{2}\frac{1}{2}0); \sigma_z, \sigma_y, \Gamma; \{R_0, R_0\}; \{i\Gamma_0, 3, \Gamma_0, 1, -\Gamma_2, 1\}; \text{DP}; 0$

$T; (\frac{1}{2}0\frac{1}{2}); \sigma_z, \sigma_y, \Gamma; \{R_0, R_0\}; \{i\Gamma_0, 3, \Gamma_0, 1, -\Gamma_2, 1\}; \text{DP}; 0$

$S; (\frac{1}{2}\frac{1}{2}0); C_{2z}, \sigma_y, \Gamma; \{R_0, R_0\}; \{\sigma_2, i\sigma_1, -i\sigma_2\}; P\text{-WNL}_{SR};$

$R; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \sigma_z, \sigma_y, \Gamma; \{R_0, R_0\}; \{i\Gamma_0, 3, \Gamma_0, 1, -\Gamma_2, 1\}; \text{DP}; 0$

$\Delta; (\gamma Y); \sigma_z, TC_{2z}; \{R_2, R_2\}; 1; i, 1$

$D; (\gamma X); \sigma_z, TC_{2z}; \{R_2, R_2\}; 1; i, 1$

$P; (\Gamma U); \sigma_z, TC_{2z}; \{R_2, R_2\}; 2; i\sigma_0, -i\sigma_2; L\text{-NS}_{ZUTR};$

$B; (\Gamma Z); \sigma_z, TC_{2z}; \{R_2, R_2\}; 2; -i\sigma_0, -i\sigma_2; L\text{-NS}_{ZUTR};$

$\Sigma; (\gamma X); \sigma_z, TC_{2z}; \{R_2, R_2\}; 1; i, 1$

$C; (\gamma Y); \sigma_z, TC_{2z}; \{R_2, R_2\}; 1; i, 1$

$E; (\Gamma R); \sigma_z, TC_{2z}; \{R_4, R_4\}; 2; \sigma_3, \sigma_1; L\text{-NS}_{ZUTR};$

$A; (\gamma Z); \sigma_z, TC_{2z}; \{R_2, R_4\}; 2; \sigma_3, \sigma_1; L\text{-NS}_{ZUTR};$

$H; (\Gamma T); C_{2z}, \sigma_y; \{R_5\}; 2; i\sigma_2, i\sigma_1; \text{WNL}; \pi$

$Q; (\gamma R); C_{2z}, \sigma_y; \{R_5\}; 2; i\sigma_2, i\sigma_1; \text{WNL}; \pi$

$G; (\gamma U); C_{2z}, \sigma_y; \{R_5\}; 2; i\sigma_2, i\sigma_1; \text{WNL}; \pi$
Γ: (000); \( C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2 \); P-WNL_{GZ};

Y: \( \left( \frac{1}{2}, 0 \right) \); \( C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2 \); P-WNL_{YT};

X: \( \left( \frac{1}{2}, 0 \right) \); \( C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2 \); P-WNL_{XY};

Z: \( \left( \frac{1}{2}, 0 \right) \); \( C_{2z}, \sigma_z, T; \{ R_0, R_9 \}; 4; i\Gamma_0, \Gamma_0, 1, -\Gamma_{2,1} \); DP; 0

U: \( \left( \frac{1}{2}, \frac{1}{2} \right) \); \( C_{2z}, \sigma_x, T; \{ R_0, R_9 \}; 4; i\Gamma_0, \Gamma_0, 1, -\Gamma_{2,1} \); DP; 0

T: \( \left( \frac{1}{2}, \frac{1}{2} \right) \); \( C_{2z}, \sigma_x, T; \{ R_0, R_9 \}; 4; i\Gamma_0, \Gamma_0, 1, -\Gamma_{2,1} \); DP; 0

S: \( \left( \frac{1}{2}, \frac{1}{2} \right) \); \( C_{2z}, \sigma_y, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2 \); P-WNL_{SR};

R: \( \left( \frac{1}{2}, \frac{1}{2} \right) \); \( C_{2z}, \sigma_z, T; \{ R_0, R_9 \}; 4; i\Gamma_0, \Gamma_0, 1, -\Gamma_{2,1} \); DP; 0

Δ: \( \Gamma Y \); \( \sigma_x, TC_{2z}; R_2; 1; i, 1 \);

\( R_4; 1; -i, 1 \);

D: \( \text{XS} \); \( \sigma_x, TC_{2z}; R_2; 1; i, 1 \);

\( R_4; 1; -i, 1 \);

P: \( \text{UR} \); \( \sigma_x, TC_{2z}; \{ R_2, R_4 \}; 2; \sigma_3, \sigma_1 \); WNL; \( \pi \)

B: \( \text{ZT} \); \( \sigma_x, TC_{2z}; \{ R_2, R_4 \}; 2; \sigma_3, \sigma_1 \); WNL; \( \pi \)

Σ: \( \Gamma X \); \( \sigma_y, T\sigma_x; R_2; 1; i, 1 \);

\( R_4; 1; -i, 1 \);

C: \( \text{YS} \); \( \sigma_y, T\sigma_x; R_2; 1; i, 1 \);

\( R_4; 1; -i, 1 \);

E: \( \text{TR} \); \( \sigma_y, T\sigma_x; \{ R_2, R_4 \}; 2; \sigma_3, -i\sigma_2 \); WNL; \( \pi \)

A: \( \text{ZU} \); \( \sigma_y, T\sigma_x; \{ R_2, R_4 \}; 2; \sigma_3, -i\sigma_2 \); WNL; \( \pi \)

Λ: \( \Gamma Z \); \( C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1 \); WNL; \( \pi \)

H: \( \text{YT} \); \( C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1 \); WNL; \( \pi \)

Q: \( \text{SR} \); \( C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1 \); WNL; \( \pi \)

G: \( \text{XU} \); \( C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1 \); WNL; \( \pi \)
\[\begin{align*}
\Gamma: (000): & \quad C_{2z}, \sigma_y, T; \quad R_5; \quad 2; \quad \sigma_2, \sigma_1, -i\sigma_2; \quad \text{P-WNL}_{T_2}; \\
Y: (\frac{1}{2}00): & \quad \sigma_2, \sigma_y, T; \quad \{R_5, R_6\}; \quad 2; \quad -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{P-WNL}_{YS}; \\
& \quad \{R_7, R_8\}; \quad 2; \quad \sigma_0, -\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{YS}; \\
X: (0\frac{1}{2}0): & \quad C_{2z}, \sigma_y, T; \quad R_5; \quad 2; \quad \sigma_2, \sigma_1, -i\sigma_2; \quad \text{P-WNL}_{XY}; \\
Z: (00\frac{1}{2}): & \quad C_{2z}, \sigma_y, T; \quad R_5; \quad 2; \quad \sigma_2, \sigma_1, -i\sigma_2; \quad \text{P-WNL}_{T_2}; \\
U: (0\frac{1}{2}\frac{1}{2}): & \quad C_{2z}, \sigma_y, T; \quad R_5; \quad 2; \quad \sigma_2, \sigma_1, -i\sigma_2; \quad \text{P-WNL}_{XY}; \\
T: (\frac{1}{2}0\frac{1}{2}): & \quad \sigma_2, \sigma_y, T; \quad \{R_5, R_6\}; \quad 2; \quad -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{P-WNL}_{TR}; \\
& \quad \{R_7, R_8\}; \quad 2; \quad \sigma_0, -\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{TR}; \\
S: (\frac{1}{2}\frac{1}{2}0): & \quad \sigma_2, \sigma_y, T; \quad \{R_5, R_6\}; \quad 2; \quad -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{P-WNL}_{YS}; \\
& \quad \{R_7, R_8\}; \quad 2; \quad \sigma_0, -\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{YS}; \\
R: (\frac{1}{2}\frac{1}{2}\frac{1}{2}): & \quad \sigma_2, \sigma_y, T; \quad \{R_5, R_6\}; \quad 2; \quad -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{P-WNL}_{TR}; \\
& \quad \{R_7, R_8\}; \quad 2; \quad \sigma_0, -\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{TR}; \\
\Delta; \quad \Gamma Y: & \quad \sigma_2, T C_{2z}; \quad R_2; \quad 1; \quad i, i; \\
& \quad R_4; \quad 1; \quad -i, 1; \\
D; \quad \Gamma Z: & \quad \sigma_2, T C_{2z}; \quad R_2; \quad 1; \quad i, i; \\
& \quad R_4; \quad 1; \quad -i, 1; \\
\Sigma; \quad \Gamma X: & \quad \sigma_y, T \sigma_s; \quad R_2; \quad 1; \quad i, i; \\
& \quad R_4; \quad 1; \quad -i, 1; \\
C; \quad \Gamma Y: & \quad \sigma_y, T \sigma_s; \quad \{R_2, R_4\}; \quad 2; \quad \sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \\
E; \quad \Gamma Z: & \quad \sigma_y, T \sigma_s; \quad \{R_2, R_4\}; \quad 2; \quad \sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \\
A; \quad \Gamma Z: & \quad C_{2z}, \sigma_y; \quad R_5; \quad 2; \quad \sigma_2, \sigma_1; \quad \text{WNL}; \quad \pi \\
H; \quad \Gamma Z: & \quad C_{2z}, \sigma_y; \quad R_5; \quad 1; \quad -i, i; \\
& \quad R_6; \quad 1; \quad -i, -i; \\
& \quad R_7; \quad 1; \quad i, -i; \\
& \quad R_8; \quad 1; \quad i, i; \\
Q; \quad \Gamma Y: & \quad C_{2z}, \sigma_y; \quad R_5; \quad 1; \quad -i, i; \\
& \quad R_6; \quad 1; \quad -i, -i; \\
& \quad R_7; \quad 1; \quad i, -i; \\
& \quad R_8; \quad 1; \quad i, i; \\
G; \quad \Gamma Y: & \quad C_{2z}, \sigma_y; \quad R_5; \quad 2; \quad \sigma_2, \sigma_1; \quad \text{WNL}; \quad \pi \\
\end{align*}\]
\[ T \{ 000 \}; C_{2z}, \sigma_y, T; \{ R_5, R_6 \}; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{EZ}; \\
Y \{ (001) \}; \sigma_x, C_{2z}, T; \{ R_5, R_6 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{YS}; \\
X \{ (010) \}; C_{2z}, \sigma_y, T; \{ R_5, R_6 \}; 2; i\sigma_2, -i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{XU}; \\
Z \{ (001) \}; \sigma_x, \sigma_y, T; \{ R_0, R_0 \}; 4; i\Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{2.1}; \quad \text{DP}; \quad 0 \\
U \{ (010) \}; \sigma_x, \sigma_y, T; \{ R_0, R_0 \}; 4; i\Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{2.1}; \quad \text{DP}; \quad 0 \\
T \{ (001) \}; \sigma_x, \sigma_y, \bar{E}, T; \{ R_0, R_0 \}; 2; \sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2; \quad \text{P-NS}_{ZUTR}; \\
R \{ (010) \}; \sigma_x, \sigma_y, \bar{E}, T; \{ R_0, R_0 \}; 2; \sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2; \quad \text{P-NS}_{ZUTR}; \\
S \{ (2 \frac{1}{4}) \}; \sigma_x, C_{2z}, T; \{ R_5, R_6 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{YS}; \\
\Delta \{ Y \}; \sigma_x, TC_{2z}; \{ R_3 \}; 1; i, 1; \\
D \{ X \}; \sigma_x, TC_{2z}; \{ R_3 \}; 1; i, 1; \\
P \{ U \}; \sigma_x, TC_{2z}; \{ R_2, R_2 \}; 2; i\sigma_0, -i\sigma_2; \quad \text{L-NS}_{ZUTR}; \\
B \{ Z \}; \sigma_x, TC_{2z}; \{ R_2, R_2 \}; 2; i\sigma_0, -i\sigma_2; \quad \text{L-NS}_{ZUTR}; \\
S \{ \Gamma \}; \sigma_y, Ts_5; \{ R_2 \}; 1; i, 1; \\
C \{ Y \}; \sigma_y, Ts_5; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \\
E \{ \Gamma \}; \sigma_y, Ts_5; \{ R_2, R_4 \}; 2; \sigma_0, -i\sigma_2; \quad \text{L-NS}_{ZUTR}; \\
A \{ X \}; \sigma_y, Ts_5; \{ R_2, R_4 \}; 2; \sigma_3, \sigma_1; \quad \text{L-NS}_{ZUTR}; \\
H \{ \Gamma \}; C_{2z}, \sigma_y; \{ R_5 \}; 2; i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi \\
Q \{ \Gamma \}; C_{2z}, \sigma_y; \{ R_5 \}; 2; -i, i; \\
G \{ \Gamma \}; C_{2z}, \sigma_y; \{ R_5 \}; 2; i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi
\( \Gamma_0; \{C_2, \frac{1}{2}00\}, \{\sigma_y|00\}; T; \text{Non-Centrosymmetric; with SOC} \)

| Γ | (000) | \( C_{2z}, \sigma_y; T \) | \( R_5 \) | 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \); P-WNL\( \mu \; \mu \) | γ |
|---|---|---|---|---|---|
| Y | (\( \frac{1}{2}00 \)) | \( \sigma_x, \sigma_y; T \) | \( \{R_5, R_6\} \) | 2; \(-\sigma_0, i\sigma_3, -i\sigma_2 \); P-WNL\( \nu \; \nu \) | γ |
| X | (0\( \frac{1}{2}0 \)) | \( C_{2z}, \sigma_y; T \) | \( R_5 \) | 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \); P-WNL\( \chi \; \chi \) | γ |
| Z | (00\( \frac{1}{2} \)) | \( C_{2z}, \sigma_x; T \) | \( \{R_0, R_0\} \) | 4; \( \Gamma_0, \Gamma_0, -\Gamma_2, \Gamma_2 \); DP | 0 |
| U | (0\( \frac{3}{2}0 \)) | \( C_{2z}, \sigma_z; T \) | \( \{R_0, R_0\} \) | 4; \( \Gamma_0, \Gamma_0, -\Gamma_2, \Gamma_2 \); DP | 0 |
| T | (\( \frac{1}{2}0\frac{1}{2} \)) | \( \sigma_y, C_{2z}; T \) | \( \{R_5, R_6\} \) | 2; \(-\sigma_0, i\sigma_3, -i\sigma_2 \); P-WNL\( \mu \; \mu \) | γ |
| S | (\( \frac{1}{2}\frac{1}{2} \)) | \( \sigma_x, \sigma_y; T \) | \( \{R_5, R_6\} \) | 2; \(-\sigma_0, i\sigma_3, -i\sigma_2 \); P-WNL\( \nu \; \nu \) | γ |
| R | (\( \frac{1}{2}\frac{1}{2} \)) | \( \sigma_y, C_{2z}; T \) | \( \{R_5, R_6\} \) | 2; \(-\sigma_0, i\sigma_3, -i\sigma_2 \); P-WNL\( \mu \; \mu \) | γ |
| Δ | ΓY | \( \sigma_x, TC_{2z} \) | \( R_2 \) | 1; i, 1; | γ |
| | | | \( R_4 \) | 1; -i, 1; | γ |
| | XS | \( \sigma_x, TC_{2z} \) | \( R_2 \) | 1; i, 1; | γ |
| | | | \( R_4 \) | 1; -i, 1; | γ |
| | UR | \( \sigma_x, TC_{2z} \) | \( \{R_2, R_4\} \) | 2; \( \sigma_3, \sigma_1 \); WNL; π | γ |
| | ZT | \( \sigma_x, TC_{2z} \) | \( \{R_2, R_4\} \) | 2; \( \sigma_3, \sigma_1 \); WNL; π | γ |
| | ΓX | \( \sigma_y, TS_x \) | \( R_2 \) | 1; i, 1; | γ |
| | | | \( R_4 \) | 1; -i, 1; | γ |
| | YS | \( \sigma_y, TS_x \) | \( \{R_2, R_4\} \) | 2; \( i\sigma_3, -i\sigma_2 \); WNL; π | γ |
| | TR | \( \sigma_y, TS_x \) | \( R_2 \) | 1; i, 1; | γ |
| | | | \( R_4 \) | 1; -i, 1; | γ |
| | Zu | \( \sigma_y, TS_x \) | \( \{R_2, R_4\} \) | 2; \( i\sigma_3, -i\sigma_2 \); WNL; π | γ |
| | GZ | \( C_{2z}, \sigma_y \) | \( R_5 \) | 2; \( i\sigma_2, i\sigma_1 \); WNL; π | γ |
| | YT | \( C_{2z}, \sigma_y \) | \( R_5 \) | 1; -i, i; | γ |
| | | | \( R_6 \) | 1; -i, -i; | γ |
| | | | \( R_7 \) | 1; i, -i; | γ |
| | | | \( R_8 \) | 1; i, i; | γ |
| | SR | \( C_{2z}, \sigma_y \) | \( R_5 \) | 2; \( i\sigma_2, i\sigma_1 \); WNL; π | γ |
| | XU | \( C_{2z}, \sigma_y \) | \( R_5 \) | 2; \( i\sigma_2, i\sigma_1 \); WNL; π | γ |
SG 31

Γ: (000); C_{2z}, \sigma_y; T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; P-WNL_{\Gamma Z};

Y: (\frac{1}{2}00); \sigma_z, \sigma_y; \{R_5, R_6\}; 2; -\sigma_0, -i\sigma_3, -i\sigma_2; P-WNL_{\Gamma S};

\{R_7, R_8\}; 2; \sigma_0, -\sigma_3, -\sigma_2; P-WNL_{\Gamma S};

X: (0\frac{1}{2}0); C_{2z}, \sigma_y; T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; P-WNL_{\Gamma U};

Z: (00\frac{1}{2}); \sigma_y, C_{2z}; T; \{R_9, R_0\}; 4; i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1}; DP; 0

U: (0\frac{1}{2}\frac{1}{2}); \sigma_y, C_{2z}; T; \{R_9, R_0\}; 4; i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1}; DP; 0

T: (\frac{1}{2}0\frac{1}{2}); C_{2z}, \sigma_y; T; \{R_5, R_6\}; 2; -\sigma_0, -\sigma_3, -\sigma_2; P-NS_{\Gamma U};

\{R_7, R_8\}; 2; \sigma_0, -\sigma_3, -\sigma_2; P-NS_{\Gamma U};

S: (\frac{1}{2}\frac{1}{2}0); \sigma_z, \sigma_y; T; \{R_5, R_6\}; 2; -\sigma_0, -\sigma_3, -\sigma_2; P-WNL_{\Gamma S};

\{R_7, R_8\}; 2; \sigma_0, -\sigma_3, -\sigma_2; P-WNL_{\Gamma S};

R: (\frac{1}{2}\frac{1}{2}\frac{1}{2}); C_{2z}, \sigma_y; T; \{R_5, R_6\}; 2; -\sigma_0, -\sigma_3, -\sigma_2; P-NS_{\Gamma U};

\{R_7, R_8\}; 2; \sigma_0, -\sigma_3, -\sigma_2; P-NS_{\Gamma U};

Δ: ΓY; \sigma_z, T_{C_{2z}}; R_2; 1; i, 1;

R_4; 1; -i, 1;

D: XS; \sigma_z, T_{C_{2z}}; R_2; 1; i, 1;

R_4; 1; -i, 1;

P: UR; \sigma_z, T_{C_{2z}}; \{R_2, R_4\}; 2; \sigma_3, -i\sigma_2; L-NS_{\Gamma U};

B: ZT; \sigma_z, T_{C_{2z}}; \{R_2, R_4\}; 2; \sigma_3, -i\sigma_2; L-NS_{\Gamma U};

Σ: ΓX; \sigma_y, T_{\sigma_z}; R_2; 1; i, 1;

R_4; 1; -i, 1;

C: YS; \sigma_y, T_{\sigma_z}; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; WNL; π

E: TR; \sigma_y, T_{\sigma_z}; \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; L-NS_{\Gamma U};

A: ZU; \sigma_y, T_{\sigma_z}; \{R_2, R_4\}; 2; i\sigma_0, -i\sigma_2; L-NS_{\Gamma U};

L: ΓZ; C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1; WNL; π

H: YT; C_{2z}, \sigma_y; R_5; 1; -i, i;

R_6; 1; -i, -i;

R_7; 1; i, -i;

R_8; 1; i, i;

Q: SR; C_{2z}, \sigma_y; R_5; 1; -i, i;

R_6; 1; -i, -i;

R_7; 1; i, -i;

R_8; 1; i, i;

G: XU; C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1; WNL; π
\[ \Gamma \cdot \{ C_{2z}, \sigma_y, \sigma_z \}, \ T; \text{Non-Centrosymmetric with SOC} \]

| \( \Gamma \) | \( (000) \) | \( C_{2z}, \sigma_y, T \) | \( R_5 \) | \( \{ i \sigma_2, i \sigma_1, -i \sigma_2 \} \) | P-WNL\(_{\bar{E}Z} \) |
| \( Y \) | \( (\frac{1}{2}00) \) | \( \sigma_y, C_{2z}, T \) | \( \{ R_5, R_6 \} \) | \( \{ 2 \} \) | P-WNL\(_{Y\bar{S}} \) |
| \( X \) | \( (0, \frac{1}{2}0) \) | \( \sigma_y, C_{2z}, T \) | \( \{ R_5, R_6 \} \) | \( \{ -2 \} \) | P-WNL\(_{XS} \) |
| \( Z \) | \( (0, 0, \frac{1}{2}) \) | \( C_{2z}, \sigma_y, T \) | \( R_5 \) | \( \{ 2 \} \) | P-WNL\(_{\bar{E}Z} \) |
| \( U \) | \( (0, 1, \frac{1}{2}) \) | \( C_{2z}, \sigma_y, T \) | \( \{ R_5, R_6 \} \) | \( \{ -2 \} \) | P-WNL\(_{UR} \) |
| \( T \) | \( (\frac{1}{2}, 0, \frac{1}{2}) \) | \( C_{2z}, \sigma_y, T \) | \( \{ R_5, R_6 \} \) | \( \{ -2 \} \) | P-WNL\(_{TR} \) |
| \( S \) | \( (\frac{1}{2}, 0, 0) \) | \( C_{2z}, \sigma_y, T \) | \( \{ R_5, R_9 \} \) | \( \{ 4 \} \) | P-WNL\(_{TR} \) |
| \( R \) | \( (\frac{1}{2}, \frac{1}{2}, \frac{1}{2}) \) | \( C_{2z}, \sigma_y, T \) | \( \{ R_5, R_9 \} \) | \( \{ 4 \} \) | P-WNL\(_{TR} \) |

\[ \Delta \cdot \Gamma Y; \ \sigma_y, T C_{2z}; \ R_2 \] | \( 1 \) | \( i, 1 \) |
\[ \Delta \cdot \Gamma Y; \ \sigma_y, T C_{2z}; \ R_4 \] | \( 1 \) | \( -i, 1 \) |

\[ D \cdot \Gamma X; \ \sigma_y, T C_{2z}; \ R_2 \] | \( 1 \) | \( i, 1 \) |
\[ D \cdot \Gamma X; \ \sigma_y, T C_{2z}; \ R_4 \] | \( 1 \) | \( -i, 1 \) |

\[ E \cdot \Gamma Y; \ \sigma_y, T \sigma_z; \ R_2 \] | \( 1 \) | \( i, 1 \) |
\[ E \cdot \Gamma Y; \ \sigma_y, T \sigma_z; \ R_4 \] | \( 1 \) | \( -i, 1 \) |

\[ F \cdot \Gamma Z; \ \sigma_y, T \sigma_z; \ R_5 \] | \( 2 \) | \( i \sigma_2, i \sigma_1 \) |

\[ Q \cdot \Gamma X; \ \sigma_y, T \sigma_z; \ R_{10} \] | \( 2 \) | \( -\sigma_2, \sigma_1, \sigma_0 \) |

\[ G \cdot \Gamma X; \ \sigma_y, T \sigma_z; \ R_{10} \] | \( 1 \) | \( i, 1 \) |
\[ G \cdot \Gamma X; \ \sigma_y, T \sigma_z; \ R_6 \] | \( 1 \) | \( -i, 1 \) |
\( \Gamma_0; \{C_2,|^{1\bar{1}\bar{1}}\}, \{\sigma_y|0^{1\bar{1}\bar{1}}\}, T; \) Non-Centrosymmetric; with SOC

\[ \Gamma; (000); C_2,\sigma_y,T; \{R_5, R_6\}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{P-WNL}_{YZ}; \]

\[ Y; (\frac{1}{2}00); \sigma_x,C_2,\sigma_y,T; \{R_5, R_6\}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{P-WNL}_{YS}; \]

\[ X; (0\frac{1}{2}0); \sigma_y,C_2,\sigma_y,T; \{R_5, R_6\}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{P-WNL}_{XS}; \]

\[ Z; (00\frac{1}{2}); \sigma_x,\sigma_y,T; \{R_5, R_6\}; 4; i\Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{2.1}; \quad \text{DP}; \quad 0 \]

\[ U; (0\frac{1}{2}\frac{1}{2}); C_2,\sigma_y,T; \{R_5, R_6\}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \quad \text{P-NS}_{ZUTR}; \]

\[ T; (\frac{1}{2}0\frac{1}{2}); \sigma_x,\sigma_y,E,T; \{R_5, R_6\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \quad \text{P-NS}_{ZUTR}; \]

\[ S; (\frac{1}{2}\frac{1}{2}0); C_2,\sigma_x,T; \{R_5, R_6\}; 4; i\Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{2.1}; \quad \text{DP}; \quad 0 \]

\[ \Delta; \Gamma_Y; \sigma_x,TC_{2\bar{2}}; \{R_2, R_4\}; 1; i, i; \]

\[ R_2; \quad 1; i, i; \quad R_4; \quad 1; -i, i; \]

\[ D; \text{XS}; \sigma_x,TC_{2\bar{2}}; \{R_2, R_4\}; 2; i\sigma_3, \sigma_1; \quad \text{WNL}; \quad \pi \]

\[ P; \text{UR}; \sigma_x,TC_{2\bar{2}}; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \quad \text{L-NS}_{ZUTR}; \]

\[ B; \text{ZT}; \sigma_x,TC_{2\bar{2}}; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \quad \text{L-NS}_{ZUTR}; \]

\[ \Sigma; \Gamma_X; \sigma_y,TS_x; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \]

\[ C; \text{YS}; \sigma_y,TS_x; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \]

\[ A; \text{ZU}; \sigma_y,TS_x; \{R_2, R_4\}; 2; \sigma_3, \sigma_1; \quad \text{L-NS}_{ZUTR}; \]

\[ \Lambda; \Gamma_Z; C_2,\sigma_y; \{R_5\}; 2; i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi \]

\[ H; \text{YT}; C_2,\sigma_y; \{R_5\}; 1; -i, i; \]

\[ R_6; \quad 1; -i, -i; \quad R_7; \quad 1; i, -i; \quad R_8; \quad 1; i, i; \]

\[ Q; \text{SR}; \sigma_x,\sigma_y,E; \{R_{10}\}; 2; -\sigma_2, \sigma_1, \sigma_0; \quad \text{WNL}; \quad \pi \]

\[ G; \text{XU}; C_2,\sigma_y; \{R_5\}; 1; i, 1; \]

\[ R_6; \quad 1; i, -1; \quad R_7; \quad 1; -i, -1; \quad R_8; \quad 1; -i, 1; \]
\[ \Gamma, \{ C_{2z}, C_{2z}, T \}; R_5; 2; \sigma_2, \sigma_1, -\sigma_2; \text{P-WNL}_{EG}; \]

\[ \gamma, \{ C_{2z}, C_{2z}, T \}; \{ R_5, R_6 \}; 2; -\sigma_0, \sigma_3, -\sigma_2; \text{P-WNL}_S; \]

\[ X, \{ C_{2z}, C_{2z}, T \}; \{ R_5, R_6 \}; 2; -\sigma_0, \sigma_3, -\sigma_2; \text{P-WNL}_S; \]

\[ Z, \{ C_{2z}, C_{2z}, T \}; \{ R_0, R_0 \}; 4; i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1}; \text{DP}; 0 \]

\[ U, \{ C_{2z}, C_{2z}, T \}; \{ R_5, R_6 \}; 2; -\sigma_0, \sigma_3, -\sigma_2; \text{P-WNL}_S; \]

\[ T, \{ C_{2z}, C_{2z}, T \}; \{ R_5, R_6 \}; 2; -\sigma_0, \sigma_3, -\sigma_2; \text{P-WNL}_S; \]

\[ S, \{ C_{2z}, C_{2z}, T \}; \{ R_0, R_0 \}; 4; i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1}; \text{DP}; 0 \]

\[ R, \{ C_{2z}, C_{2z}, T \}; \{ R_5 \}; 2; \sigma_2, \sigma_1, -\sigma_2; \text{P-WNL}_{SR}; \]

\[ D, \{ C_{2z}, C_{2z}, T \}; \{ R_2, R_4 \}; 2; \sigma_3, \sigma_1; \text{WNL}; \pi \]

\[ P, \{ C_{2z}, C_{2z}, T \}; \{ R_2, R_4 \}; 2; 1,1,1; \]

\[ B, \{ C_{2z}, C_{2z}, T \}; \{ R_2, R_4 \}; 2; \sigma_3, \sigma_1; \text{WNL}; \pi \]

\[ C, \{ C_{2z}, C_{2z}, T \}; \{ R_2, R_4 \}; 2; \sigma_3, -\sigma_2; \text{WNL}; \pi \]

\[ A, \{ C_{2z}, C_{2z}, T \}; \{ R_2, R_4 \}; 2; -\sigma_3, -\sigma_2; \text{WNL}; \pi \]

\[ H, \{ C_{2z}, C_{2z}, T \}; \{ R_5 \}; 1; -i,i; \]

\[ Q, \{ C_{2z}, C_{2z}, T \}; \{ R_10 \}; 2; -\sigma_2, \sigma_1, \sigma_0; \text{WNL}; \pi \]

\[ G, \{ C_{2z}, C_{2z}, T \}; \{ R_5 \}; 1; i,1; \]

\[ R_6; 1; -i,-1; \]

\[ R_7; 1; -i,-1; \]

\[ R_8; 1; -i,1; \]
SG 35

$\Gamma^6_0$: $\{C_{2z}|000\}, \{\sigma_y|000\}, \mathcal{T}$; Non-Centrosymmetric; with SOC

| Point | $\mathcal{G}$ | $\{C_{2z},\sigma_y,\mathcal{T}\}$ | $R_5$ | $\mathcal{T}$ | $\{R_2,R_4\}$ | $\{R_2,R_4\}$ | $\{R_2,R_4\}$ | $\{R_2,R_4\}$ | $\{R_2,R_4\}$ |
|-------|----------------|-----------------|---------|-------------|----------------|----------------|----------------|----------------|----------------|
| $\Gamma$ | (000) | $i\sigma_2, i\sigma_1, -i\sigma_2$ | P-WNL$_{G^2}$ | $\{C_{2z},\sigma_y,\mathcal{T}\}$ | $R_5$ | $2; i\sigma_2, i\sigma_1, -i\sigma_2$ | P-WNL$_{G^2}$ |
| $Y$ | $(\frac{1}{2} \frac{1}{2} 0)$ | $\{C_{2z},\sigma_y,\mathcal{T}\}$ | $R_5$ | $2; i\sigma_2, i\sigma_1, -i\sigma_2$ | P-WNL$_{Y^2}$ |
| $Z$ | $(00 \frac{1}{2})$ | $\{C_{2z},\sigma_y,\mathcal{T}\}$ | $R_5$ | $2; i\sigma_2, i\sigma_1, -i\sigma_2$ | P-WNL$_{G^2}$ |
| $T$ | $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $\{C_{2z},\sigma_y,\mathcal{T}\}$ | $R_5$ | $2; i\sigma_2, i\sigma_1, -i\sigma_2$ | P-WNL$_{Y^2}$ |
| $S$ | $(0 \frac{1}{2} 0)$ | $\{C_{2z},\mathcal{T}\}$ | $R_5$ | $2; i\sigma_3, -i\sigma_2$ | C-1 WP | 1 |
| $R$ | $(0 \frac{1}{2} \frac{1}{2})$ | $\{C_{2z},\mathcal{T}\}$ | $R_5$ | $2; i\sigma_3, -i\sigma_2$ | C-1 WP | 1 |
| $\Lambda$ | $\Gamma Z$ | $\{C_{2z},\sigma_y\}$ | $R_5$ | $2; i\sigma_2, i\sigma_1$ | WNL | $\pi$ |
| $H$ | $\mathcal{Y} T$ | $\{C_{2z},\sigma_y\}$ | $R_5$ | $2; i\sigma_2, i\sigma_1$ | WNL | $\pi$ |
| $D$ | $\mathcal{S} R$ | $C_{2z}$ | $R_2$ | $1; i$ | |
| $\Sigma$ | $\Gamma Y$ | $\sigma_y,\mathcal{T}\sigma_x$ | $R_2$ | $1; i, 1$ | |
| $A$ | $\mathcal{Z} T$ | $\sigma_y,\mathcal{T}\sigma_x$ | $R_4$ | $1; -i, 1$ | |
| $\Omega$ | $\Gamma \Omega$ | $\sigma_y,\mathcal{T}\sigma_x$ | $R_4$ | $1; -i, 1$ | |
| $\Delta$ | $\Gamma \Delta$ | $\mathcal{C}_{2z},\mathcal{T}\sigma_x$ | $R_2$ | $1; i, 1$ | |
| $B$ | $\mathcal{Z} B$ | $\mathcal{C}_{2z},\mathcal{T}\sigma_x$ | $R_2$ | $1; i, 1$ | |
| $G$ | $\mathcal{T} G$ | $\mathcal{C}_{2z},\mathcal{T}\sigma_x$ | $R_2$ | $1; i, 1$ | |
| $F$ | $\mathcal{Y} F$ | $\mathcal{C}_{2z},\mathcal{T}\sigma_x$ | $R_2$ | $1; i, 1$ | |
| $E$ | $\mathcal{T} E$ | $\sigma_y,\mathcal{T}\sigma_x$ | $R_2$ | $1; i, 1$ | |
| $C$ | $\mathcal{Y} C$ | $\sigma_y,\mathcal{T}\sigma_x$ | $R_2$ | $1; i, 1$ | |
\( \Gamma_0^\text{b}; \{C_{2z}[00\frac{1}{2}], \{\sigma_y[000]\}, T; \text{Non-Centrosymmetric; with SOC} \)

\[
\begin{align*}
\Gamma; & \; (000); \quad \text{C}_{2z}, \sigma_y, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{\Gamma Z}; \\
Y; & \; (\frac{1}{2}, \frac{1}{2}, 0); \quad \text{C}_{2z}, \sigma_y, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{\Lambda Y}; \\
Z; & \; (000); \quad \sigma_y, C_{2z}, T; \quad \{R_0, R_9\}; \quad 4; \quad i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1}; \quad \text{DP}; \quad 0 \\
T; & \; (\frac{1}{2}, \frac{1}{2}, \frac{1}{2}); \quad \sigma_y, C_{2z}, T; \quad \{R_0, R_9\}; \quad 4; \quad i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1}; \quad \text{DP}; \quad 0 \\
S; & \; (0\frac{1}{2}, 0); \quad \text{C}_{2z}, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, -i\sigma_2; \quad \text{C-1 WP}; \quad 1 \\
R; & \; (0\frac{1}{2}, \frac{1}{2}); \quad \text{C}_{2z}, E, T; \quad \{R_5, R_3\}; \quad 2; \quad \sigma_0, -\sigma_0, -i\sigma_2; \quad \text{P-NS}_{ZTR}; \\
& \quad \{R_7, R_7\}; \quad 2; \quad -\sigma_0, -\sigma_0, -i\sigma_2; \quad \text{P-NS}_{ZTR}; \\
\Lambda; & \; \Gamma Z; \quad \text{C}_{2z}, \sigma_y; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi \\
H; & \; Y T; \quad \text{C}_{2z}, \sigma_y; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi \\
D; & \; S R; \quad \text{C}_{2z}; \quad R_2; \quad 1; \quad i; \quad R_4; \quad 1; \quad -i; \\
A; & \; Z T; \quad \sigma_y, T \sigma_x; \quad \{R_2, R_2\}; \quad 2; \quad i\sigma_0, -i\sigma_2; \quad \text{L-NS}_{ZTR}; \\
& \quad \{R_4, R_4\}; \quad 2; \quad -i\sigma_0, -i\sigma_2; \quad \text{L-NS}_{ZTR}; \\
\Sigma; & \; \Gamma Y; \quad \sigma_y, T \sigma_x; \quad R_2; \quad 1; \quad i, i; \quad R_4; \quad 1; \quad -i, 1; \\
\Delta; & \; \Gamma \Delta; \quad \sigma_z, T \text{C}_{2z}; \quad R_2; \quad 1; \quad i, i; \quad R_4; \quad 1; \quad -i, 1; \\
B; & \; Z B; \quad \sigma_z, T \text{C}_{2z}; \quad \{R_2, R_4\}; \quad 2; \quad \sigma_3, -i\sigma_2; \quad \text{L-NS}_{ZTR}; \\
G; & \; T G; \quad \sigma_z, T \text{C}_{2z}; \quad \{R_2, R_4\}; \quad 2; \quad \sigma_3, -i\sigma_2; \quad \text{L-NS}_{ZTR}; \\
F; & \; Y F; \quad \sigma_z, T \text{C}_{2z}; \quad R_2; \quad 1; \quad i, i; \quad R_4; \quad 1; \quad -i, 1; \\
E; & \; T E; \quad \sigma_z, T \sigma_x; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_0, -i\sigma_2; \quad \text{L-NS}_{ZTR}; \\
& \quad \{R_4, R_4\}; \quad 2; \quad -i\sigma_0, -i\sigma_2; \quad \text{L-NS}_{ZTR}; \\
C; & \; Y C; \quad \sigma_z, T \sigma_x; \quad R_2; \quad 1; \quad i, i; \quad R_4; \quad 1; \quad -i, 1; \\
\end{align*}
\]
\[ \Gamma_0^b; \{ C_{2z}|000\}, \{ \sigma_y|001/2 \}, T; \text{Non-Centrosymmetric; with SOC} \]

| \(\Gamma\) | \((000)\) | \(C_{2z}, \sigma_y, T; R_5\) | \(2; i\sigma_2, i\sigma_1, -i\sigma_2\) | P-WNL \(\Gamma_{C2}\) |
|----------|---------|------------------------|-----------------------------------|-----------------|
| \(Y\)    | \((1/2 1 0)\) | \(C_{2z}, \sigma_y, T; R_5\) | \(2; i\sigma_2, i\sigma_1, -i\sigma_2\) | P-WNL \(\Gamma_T\) |
| \(Z\)    | \((001/2)\) | \(C_{2z}, \sigma_x, T; \{ R_0, R_0 \}\) | \(4; i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1}\); DP; 0 |  |
| \(T\)    | \((1/2 3 1)\) | \(C_{2z}, \sigma_x, T; \{ R_0, R_0 \}\) | \(4; i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1}\); DP; 0 |  |
| \(S\)    | \((01/2 0)\) | \(C_{2z}, T; \{ R_2, R_4 \}\) | \(2; i\sigma_3, -i\sigma_2\) | C-1 WP; 1 |
| \(R\)    | \((01/2 2)\) | \(C_{2z}, T; \{ R_2, R_4 \}\) | \(2; i\sigma_3, -i\sigma_2\) | C-1 WP; 1 |
| \(\Lambda\) | \(\Gamma Z\) | \(C_{2z}, \sigma_y; R_5\) | \(2; i\sigma_2, i\sigma_1\) | WNL; \(\pi\) |
| \(H\)    | \(\Gamma Y\) | \(C_{2z}, \sigma_y; R_5\) | \(2; i\sigma_2, i\sigma_1\) | WNL; \(\pi\) |
| \(D\)    | \(\Gamma R\) | \(C_{2z}; R_2\) | \(1; i\) |  |
|          |         | \(R_4\) | \(1; -i\) |  |
| \(A\)    | \(Z T\) | \(\sigma_y, T \sigma_x; \{ R_2, R_4 \}\) | \(2; \sigma_3, -i\sigma_2\) | WNL; \(\pi\) |
| \(\Sigma\) | \(\Gamma Y\) | \(\sigma_y, T \sigma_x; R_2\) | \(1; i, 1\) |  |
|          |         | \(R_4\) | \(1; -i, 1\) |  |
| \(\Delta\) | \(\Gamma \Delta\) | \(\sigma_x, T \sigma_{2z}; R_2\) | \(1; i, 1\) |  |
|          |         | \(R_4\) | \(1; -i, 1\) |  |
| \(B\)    | \(Z B\) | \(\sigma_x, T \sigma_{2z}; \{ R_2, R_4 \}\) | \(2; \sigma_3, \sigma_1\) | WNL; \(\pi\) |
| \(G\)    | \(T G\) | \(\sigma_x, T \sigma_{2z}; \{ R_2, R_4 \}\) | \(2; \sigma_3, \sigma_1\) | WNL; \(\pi\) |
| \(F\)    | \(Y F\) | \(\sigma_x, T \sigma_{2z}; R_2\) | \(1; i, 1\) |  |
|          |         | \(R_4\) | \(1; -i, 1\) |  |
| \(E\)    | \(T E\) | \(\sigma_y, T \sigma_x; \{ R_2, R_4 \}\) | \(2; \sigma_3, -i\sigma_2\) | WNL; \(\pi\) |
| \(C\)    | \(Y C\) | \(\sigma_y, T \sigma_x; R_2\) | \(1; i, 1\) |  |
|          |         | \(R_4\) | \(1; -i, 1\) |  |
$\Gamma^6_0; \{C_{2y}|000\}, \{\sigma_x|000\}, T; \text{Non-Centrosymmetric; with SOC}$

| Point | Symmetry | $G$ | $\sigma_x, T$ |
|-------|----------|-----|----------------|
| $\Gamma$ | $\{000\}$ | $C_{2y}, \sigma_x, T; R_5$ | $2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{\Gamma \Delta}$ |
| $Y$ | $(\frac{1}{2} \frac{1}{2} 0)$ | $C_{2y}, \sigma_x, T; R_5$ | $2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{YF}$ |
| $Z$ | $(00 \frac{1}{2})$ | $C_{2y}, \sigma_x, T; R_5$ | $2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{ZB}$ |
| $T$ | $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $C_{2y}, \sigma_x, T; R_5$ | $2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{TG}$ |
| $S$ | $(0 \frac{1}{2} 0)$ | $\sigma_x, T; \{R_2, R_4\}$ | $2; i\sigma_3, -i\sigma_2; \text{P-WNL}$ |
| $R$ | $(0 \frac{1}{2} \frac{1}{2})$ | $\sigma_x, T; \{R_2, R_4\}$ | $2; i\sigma_3, -i\sigma_2; \text{P-WNL}$ |
| $\Lambda$ | $\Gamma Z$ | $\sigma_x, T\sigma_z; R_2$ | $1; i, 1; \quad R_4; 1; -i, 1;$ |
| $H$ | $Y T$ | $\sigma_x, T\sigma_z; R_2$ | $1; i, 1; \quad R_4; 1; -i, 1;$ |
| $D$ | $S R$ | $\tilde{E}, T\sigma_z; R_2$ | $1; -1, 1;$ |
| $A$ | $Z T$ | $\sigma_x, T C_{2y}; R_2$ | $1; i, 1; \quad R_4; 1; -i, 1;$ |
| $\Sigma$ | $\Gamma Y$ | $\sigma_x, T C_{2y}; R_2$ | $1; i, 1; \quad R_4; 1; -i, 1;$ |
| $\Delta$ | $\Gamma \Delta$ | $C_{2y}, \sigma_x; R_5$ | $2; i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi$ |
| $B$ | $Z B$ | $C_{2y}, \sigma_x; R_5$ | $2; i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi$ |
| $G$ | $T G$ | $C_{2y}, \sigma_x; R_5$ | $2; i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi$ |
| $F$ | $Y F$ | $C_{2y}, \sigma_x; R_5$ | $2; i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi$ |
| $E$ | $T E$ | $\sigma_x, T C_{2y}; R_2$ | $1; i, 1; \quad R_4; 1; -i, 1;$ |
| $C$ | $Y C$ | $\sigma_x, T C_{2y}; R_2$ | $1; i, 1; \quad R_4; 1; -i, 1;$ |
$\Gamma_b^0$: \{C\_2y[000], (σ\_x | \frac{1}{2} 0)\}, T; Non-Centrosymmetric; with SOC

| Point |  |  |
|-------|---|---|
| Γ; (000) | $C\_2y, \sigma_x, T$; $R_5$; | \(2; i\sigma_2, i\sigma_1, -i\sigma_2\); P-WNL$_\Gamma$; |
| Y; (\(\frac{1}{2} \frac{1}{2} 0\)) | $C\_2y, \sigma_x, T$; $R_5$; | \(2; i\sigma_2, i\sigma_1, -i\sigma_2\); P-WNL$_Y$; |
| Z; (00\(\frac{1}{2}\)) | $C\_2y, \sigma_x, T$; $R_5$; | \(2; i\sigma_2, i\sigma_1, -i\sigma_2\); P-WNL$_Z$; |
| T; (\(\frac{1}{2} \frac{1}{2} \frac{1}{2}\)) | $C\_2y, \sigma_x, T$; $R_5$; | \(2; i\sigma_2, i\sigma_1, -i\sigma_2\); P-WNL$_T$; |
| S; (0\(\frac{1}{2}\)) | $\sigma_z, E, T$; \{ $R_5, R_5$ \}; | \(2; \sigma_0, -\sigma_0, -i\sigma_2\); P-WNL$_S$; |
| R; (0\(\frac{1}{2} \frac{1}{2}\)) | $\sigma_z, E, T$; \{ $R_5, R_5$ \}; | \(2; \sigma_0, -\sigma_0, -i\sigma_2\); P-WNL$_R$; |
| Λ; ΓZ; | $\sigma_z, T\sigma_z$; $R_2$; | \(1; i, 1\); |
| H; YT; | $\sigma_z, T\sigma_z$; $R_2$; | \(1; -i, 1\); |
| D; SR; | $E, T\sigma_z$; \{ $R_2, R_2$ \}; | \(2; -\sigma_0, -i\sigma_2\); WNL; π |
| A; ZT; | $\sigma_z, T\_2y$; $R_2$; | \(1; i, 1\); |
| Σ; ΓY; | $\sigma_z, T\_2y$; $R_2$; | \(1; i, 1\); |
| Δ; ΓΔ; | $C\_2y, \sigma_z$; $R_5$; | \(2; i\sigma_2, i\sigma_1\); WNL; π |
| B; ZB; | $C\_2y, \sigma_z$; $R_5$; | \(2; i\sigma_2, i\sigma_1\); WNL; π |
| G; TG; | $C\_2y, \sigma_z$; $R_5$; | \(2; i\sigma_2, -i\sigma_1\); WNL; π |
| F; YF; | $C\_2y, \sigma_z$; $R_5$; | \(2; i\sigma_2, -i\sigma_1\); WNL; π |
| E; TE; | $\sigma_z, T\_2y$; $R_2$; | \(1; i, 1\); |
| C; YC; | $\sigma_z, T\_2y$; $R_2$; | \(1; i, 1\); |
|   |   | \(1; -i, 1\); |
\[\Gamma_0\{C_{2y}(000), \{\sigma_x(00\frac{1}{2})\}, T; \text{Non-Centrosymmetric with SOC}\]

\[\Gamma; (000); \ C_{2y}, \sigma_x, T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \ \text{P-WNL}_{\Gamma \Delta};
\]

\[Y; (\frac{1}{2} \frac{1}{2} 0); \ C_{2y}, \sigma_x, T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \ \text{P-WNL}_{Y F};
\]

\[Z; (00\frac{1}{2}); \ \sigma_x, C_{2y}, T; \ \{R_5, R_0\}; \ 2; -\sigma_0, i\sigma_3, -i\sigma_2; \ \text{P-WNL}_{Z T};
\]

\[\{R_7, R_8\}; \ 2; \sigma_0, -i\sigma_3, -i\sigma_2; \ \text{P-WNL}_{Z T};
\]

\[T; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ \sigma_x, C_{2y}, T; \ \{R_5, R_0\}; \ 2; -\sigma_0, i\sigma_3, -i\sigma_2; \ \text{P-WNL}_{Z T};
\]

\[\{R_7, R_8\}; \ 2; \sigma_0, -i\sigma_3, -i\sigma_2; \ \text{P-WNL}_{Z T};
\]

\[S; (0 \frac{1}{2} 0); \ \sigma_z, T; \ \{R_2, R_4\}; \ 2; i\sigma_3, -i\sigma_2; \ \text{P-WNL};
\]

\[R; (0 \frac{1}{2} \frac{1}{2}); \ \sigma_z, T; \ \{R_2, R_4\}; \ 2; i\sigma_3, -i\sigma_2; \ \text{P-WNL};
\]

\[\Lambda; \ \Gamma Z; \ \sigma_z, T \sigma_z; \ R_2; \ 1; i, 1;
\]

\[R_4; \ 1; -i, 1;
\]

\[H; \ \Gamma T; \ \sigma_z, T \sigma_z; \ R_2; \ 1; i, 1;
\]

\[R_4; \ 1; -i, 1;
\]

\[D; \ \Gamma R; \ \bar{E}, T \sigma_z; \ R_2; \ 1; -1, 1;
\]

\[A; \ \Gamma Z T; \ \sigma_z, E, T C_{2y}; \ \{R_5, R_7\}; \ 2; -i\sigma_3, -\sigma_0, \sigma_1; \ \text{WNL}; \ \pi
\]

\[\Sigma; \ \Gamma Y; \ \sigma_z, T C_{2y}; \ R_2; \ 1; i, 1;
\]

\[R_4; \ 1; -i, 1;
\]

\[\Delta; \ \Gamma \Delta; \ \sigma_z, C_{2y}; \ R_5; \ 2; i\sigma_2, i\sigma_1; \ \text{WNL}; \ \pi
\]

\[B; \ \Gamma Z B; \ \sigma_z, C_{2y}; \ R_5; \ 1; i, i;
\]

\[R_6; \ 1; i, -i;
\]

\[R_7; \ 1; -i, -i;
\]

\[R_8; \ 1; -i, i;
\]

\[G; \ \Gamma T G; \ \sigma_z, C_{2y}; \ R_5; \ 1; i, i;
\]

\[R_6; \ 1; i, -i;
\]

\[R_7; \ 1; -i, -i;
\]

\[R_8; \ 1; -i, i;
\]

\[F; \ \Gamma F; \ \sigma_z, C_{2y}; \ R_5; \ 2; i\sigma_2, i\sigma_1; \ \text{WNL}; \ \pi
\]

\[E; \ \Gamma E; \ \sigma_z, E, T C_{2y}; \ \{R_5, R_7\}; \ 2; -i\sigma_3, -\sigma_0, \sigma_1; \ \text{WNL}; \ \pi
\]

\[C; \ \Gamma Y C; \ \sigma_z, T C_{2y}; \ R_2; \ 1; i, 1;
\]

\[R_4; \ 1; -i, 1;
\]
SG 41

\[ \Gamma' \circ \{ C_{2y}[000], \{ \sigma_z | \frac{1}{2} \frac{1}{2} \frac{1}{2} \} \}, \mathcal{T} \}; \text{Non-Centrosymmetric; with SOC} \]

\[ \begin{align*}
\Gamma: & (000); C_{2y}, \sigma_x, \mathcal{T}; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{\Delta}; \\
Y: & (\frac{1}{2} \frac{1}{2} 0); C_{2y}, \sigma_x, \mathcal{T}; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{\mathcal{Y}F}; \\
Z: & (00 \frac{1}{2}); \sigma_x, C_{2y}, \mathcal{T}; \{ R_5, R_6 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \text{P-WNL}_{\mathcal{Z}T}; \\
& \{ R_7, R_8 \}; 2; \sigma_0, -i\sigma_3, -i\sigma_2; \text{P-WNL}_{\mathcal{Z}T}; \\
T: & (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \sigma_x, C_{2y}, \mathcal{T}; \{ R_5, R_6 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \text{P-WNL}_{\mathcal{Z}T}; \\
& \{ R_7, R_8 \}; 2; \sigma_0, -i\sigma_3, -i\sigma_2; \text{P-WNL}_{\mathcal{Z}T}; \\
S: & (0 \frac{1}{2} 0); \sigma_z, \mathcal{E}, \mathcal{T}; \{ R_5, R_6 \}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \text{P-WNL}_{SR}; \\
& \{ R_7, R_8 \}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \text{P-WNL}_{SR}; \\
R: & (0 \frac{1}{2} \frac{1}{2}); \sigma_z, \mathcal{E}, \mathcal{T}; \{ R_5, R_6 \}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \text{P-WNL}_{SR}; \\
& \{ R_7, R_8 \}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \text{P-WNL}_{SR}; \\
\Lambda: & \mathcal{G}Z; \sigma_z, \mathcal{T}, \sigma_z; R_2; 1; i, 1; \\
& R_4; 1; -i, 1; \\
H: & \mathcal{Y}T; \sigma_z, \mathcal{T}, \sigma_z; R_2; 1; -i, 1; \\
& R_4; 1; i, 1; \\
D: & \mathcal{S}R; \mathcal{E}, \mathcal{T}, \sigma_z; \{ R_2, R_2 \}; 2; -\sigma_0, -i\sigma_2; \text{WNL}; \pi \\
A: & \mathcal{Z}T; \sigma_z, \mathcal{E}, \mathcal{T}C_{2y}; \{ R_5, R_7 \}; 2; -i\sigma_3, -\sigma_0, \sigma_1; \text{WNL}; \pi \\
\Sigma: & \mathcal{G}Y; \sigma_z, \mathcal{T}C_{2y}; R_2; 1; i, 1; \\
& R_4; 1; -i, 1; \\
\Delta: & \mathcal{G}\Delta; C_{2y}, \sigma_z; R_5; 2; i\sigma_2, i\sigma_1; \text{WNL}; \pi \\
B: & \mathcal{Z}B; \sigma_z, C_{2y}; R_5; 1; i, i; \\
& R_6; 1; i, -i; \\
& R_7; 1; -i, -i; \\
& R_8; 1; -i, i; \\
G: & \mathcal{T}G; \sigma_z, C_{2y}; R_5; 1; -i, i; \\
& R_6; 1; -i, -i; \\
& R_7; 1; i, -i; \\
& R_8; 1; i, i; \\
F: & \mathcal{Y}F; C_{2y}, \sigma_z; R_5; 2; i\sigma_2, -i\sigma_1; \text{WNL}; \pi \\
E: & \mathcal{E}T; \sigma_z, \mathcal{E}, \mathcal{T}C_{2y}; \{ R_5, R_7 \}; 2; -i\sigma_3, -\sigma_0, \sigma_1; \text{WNL}; \pi \\
C: & \mathcal{Y}C; \sigma_z, \mathcal{T}C_{2y}; R_2; 1; i, 1; \\
& R_4; 1; -i, 1;
\[ \Gamma_0^I; \{C_2, |000\}, \{\sigma_y|000\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; (000); C_{2z, \sigma_y, T}; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{\Gamma Z/\Gamma \Lambda}; \]

\[ Y; \left(0\frac{1}{2}\frac{1}{2}\right); C_{2z, \sigma_y, T}; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{\text{YH/YX}}; \]

\[ X; \left(\frac{1}{2}0\frac{1}{2}\right); C_{2z, \sigma_y, T}; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{\text{XG/XY}}; \]

\[ Z; \left(\frac{1}{2}\frac{1}{2}0\right); C_{2z, \sigma_y, T}; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{\text{ZQ}}; \]

\[ L; \left(\frac{1}{2}00\right); \bar{E}, T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \text{C-1 WP}; 1 \]

\[ \Lambda; \Gamma Z/\Gamma \Lambda; C_{2z, \sigma_y}; R_5; 2; i\sigma_2, i\sigma_1; \text{WNL}; \pi \]

\[ G; \text{XG/XY}; C_{2z, \sigma_y}; R_5; 2; i\sigma_2, i\sigma_1; \text{WNL}; \pi \]

\[ H; \text{YH/YX}; C_{2z, \sigma_y}; R_5; 2; i\sigma_2, i\sigma_1; \text{WNL}; \pi \]

\[ Q; \text{ZQ}; C_{2z, \sigma_y}; R_5; 2; i\sigma_2, i\sigma_1; \text{WNL}; \pi \]

\[ \Sigma; \Gamma X/\Gamma \Sigma; \sigma_y, T \sigma_x; R_2; 1; i; 1; \]

\[ R_4; 1; -i; 1; \]

\[ C; \text{YC/YZ}; \sigma_y, T \sigma_x; R_2; 1; i; 1; \]

\[ R_4; 1; -i; 1; \]

\[ A; \text{ZA/ZY}; \sigma_y, T \sigma_x; R_2; 1; i; 1; \]

\[ R_4; 1; -i; 1; \]

\[ U; \text{XU}; \sigma_y, T \sigma_x; R_2; 1; i; 1; \]

\[ R_4; 1; -i; 1; \]

\[ \Delta; \Gamma Y/\Gamma \Delta; \sigma_z, T C_{2z}; R_2; 1; i; 1; \]

\[ R_4; 1; -i; 1; \]

\[ D; \text{XD/XZ}; \sigma_z, T C_{2z}; R_2; 1; i; 1; \]

\[ R_4; 1; -i; 1; \]

\[ B; \text{ZB/ZX}; \sigma_z, T C_{2z}; R_2; 1; i; 1; \]

\[ R_4; 1; -i; 1; \]

\[ R; \text{YR}; \sigma_z, T C_{2z}; R_2; 1; i; 1; \]

\[ R_4; 1; -i; 1; \]
\( \Gamma^I_0; \{C_{2z}|00\frac{1}{2}\}, \{\sigma_y|\frac{1}{2}00\}, T; \text{Non-Centrosymmetric; with SOC} \)

| Γ | (000) | \( C_{2z}, \sigma_y, T; \{R_5, R_5\} \) | 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \) | P-WNL_{\Gamma Z/\Gamma A} |
|---|---|---|---|---|
| Y | (0\frac{1}{2} \frac{1}{2}) | \( \sigma_x, C_{2z}, T; \{R_5, R_6\} \) | 2; \( -\sigma_0, i\sigma_3, -i\sigma_2 \) | P-WNL_{\Gamma C/\Gamma YZ} |
| R_5 | 1; i, 1; | R_6 | 1; i, -1; | R_7 | 1; -i, -1; |
| X | (\frac{1}{2}0\frac{1}{2}) | \( \sigma_y, C_{2z}, T; \{R_5, R_6\} \) | 2; \( -\sigma_0, i\sigma_3, -i\sigma_2 \) | P-WNL_{\Gamma D/\Gamma XZ} |
| R_5 | 1; -i, 1; | R_6 | 1; -i, -1; | R_7 | 1; i, -i; | R_8 | 1; i, i; |
| Z | (\frac{1}{2} \frac{1}{2} 0) | \( C_{2z}, \sigma_y, T; \{R_9, R_9\} \) | 4; \( i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1} \) | DP; 0 |
| L | (\frac{1}{2} \frac{1}{2} 0) | \( E, T; \{R_2, R_2\} \) | 2; \( -\sigma_0, -i\sigma_2 \) | C-1 WP; 1 |
| Δ | ΓZ/ΓA | \( C_{2z}, \sigma_y; \{R_5, R_5\} \) | 2; \( i\sigma_2, i\sigma_1 \) | WNL; π |
| G | XG/XY; \( C_{2z}, \sigma_y; \{R_5, R_5\} \) | 1; i, 1; | R_6 | 1; i, -1; | R_7 | 1; -i, -1; |
| H | YH/YX; \( C_{2z}, \sigma_y; \{R_5, R_5\} \) | 1; -i, 1; | R_6 | 1; -i, -1; | R_7 | 1; i, -i; | R_8 | 1; i, i; |
| Q | ZQ | \( C_{2z}, \sigma_y, E; \{R_5, R_5\} \) | 2; \( i\sigma_2, \sigma_1, -\sigma_0 \) | WNL; π |
| Σ | ΓX/ΓΣ; \( \sigma_y, T \sigma_x; \{R_2, R_2\} \) | 1; i, 1; | R_2 | 1; i, 1; | R_3 | 1; -i, 1; |
| C | YC/YZ; \( \sigma_y, T \sigma_x; \{R_2, R_4\} \) | 2; \( i\sigma_3, -i\sigma_2 \) | WNL; π |
| A | ZA/ZY; \( \sigma_y, T \sigma_x; \{R_2, R_4\} \) | 2; \( -\sigma_0, i\sigma_3 \) | WNL; π |
| U | XU; \( \sigma_y, T \sigma_x; \{R_2, R_2\} \) | 1; 1, 1; | R_2 | 1; 1, 1; | R_3 | 1; -1, 1; |
| Δ | ΓY/ΓΔ; \( \sigma_x, T \sigma_{2z}; \{R_2, R_2\} \) | 1; i, 1; | R_2 | 1; i, 1; | R_3 | 1; -i, 1; |
| D | XD/XZ; \( \sigma_z, T \sigma_{2z}; \{R_2, R_4\} \) | 2; \( i\sigma_3, \sigma_1 \) | WNL; π |
| B | ZB/ZX; \( \sigma_x, T \sigma_{2z}; \{R_2, R_4\} \) | 2; \( -\sigma_0, i\sigma_3 \) | WNL; π |
| R | YR; \( \sigma_x, T \sigma_{2z}; \{R_2, R_4\} \) | 1; 1, 1; | R_2 | 1; 1, 1; | R_3 | 1; -1, 1; |
Γ\(^0\); \{C_{2z}|000\}, \{\sigma_y|000\}, \mathcal{T}; Non-Centrosymmetric; with SOC

\[ \begin{align*}
\Gamma; \quad (000); \quad C_{2z}, \sigma_y, \mathcal{T}; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{\Gamma\Lambda/\Gamma X}; \\
X; \quad (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad C_{2z}, \sigma_y, \mathcal{T}; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{XG}; \\
R; \quad (\frac{1}{2} 00); \quad \sigma_y, \mathcal{T}; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, -i\sigma_2; \quad \text{P-WNL}; \\
S; \quad (\frac{1}{2} 0 \frac{1}{2}); \quad \sigma_z, \mathcal{T}; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, -i\sigma_2; \quad \text{P-WNL}; \\
T; \quad (\frac{1}{2} \frac{3}{2} 0); \quad C_{2z}, \mathcal{T}; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, -i\sigma_2; \quad \text{C-1 WP}; \quad 1 \\
W; \quad (\frac{3}{4} \frac{1}{4} \frac{1}{4}); \quad C_{2z}, \mathcal{T} \sigma_x; \quad R_2; \quad 1; \quad i, 1; \\
\ \\
\Lambda; \quad \Gamma\Lambda/\Gamma X; \quad C_{2z}, \sigma_y; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi \\
G; \quad XG; \quad C_{2z}, \sigma_y; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi \\
P; \quad TW; \quad C_{2z}; \quad R_2; \quad 1; \quad i; \\
\ \\
\Sigma; \quad \Gamma\Sigma/\Gamma X; \quad \sigma_y, \mathcal{T} \sigma_x; \quad R_2; \quad 1; \quad i, 1; \\
\ \\
F; \quad XF; \quad \sigma_y, \mathcal{T} \sigma_x; \quad R_2; \quad 1; \quad i, 1; \\
\ \\
D; \quad SW; \quad \bar{E}, \mathcal{T} \sigma_x; \quad R_2; \quad 1; \quad -1, 1; \\
\Delta; \quad \Gamma\Delta/\Gamma X; \quad \sigma_x, \mathcal{T} C_{2z}; \quad R_2; \quad 1; \quad i, 1; \\
\ \\
U; \quad XU; \quad \sigma_x, \mathcal{T} C_{2z}; \quad R_2; \quad 1; \quad i, 1; \\
\ \\
Q; \quad RW; \quad \bar{E}, \mathcal{T} \sigma_y; \quad R_2; \quad 1; \quad -1, 1; \\
\end{align*} \]
SG 45

$\Gamma_0^v: \{C_2, [000], \{\sigma_y | \frac{1}{2} \frac{1}{2} \frac{1}{2}\}, T; Non-Centrosymmetric; with SOC\}$

| $\Gamma$ | $X$ | $R$ | $S$ | $T$ | $W$ | $P$ | $\Lambda$ | $G$ | $\Sigma$ | $F$ | $D$ | $\Delta$ | $U$ | $Q$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (000) | $C_{2z} \sigma_y T$ | $R_5$ | 2; $i \sigma_2, i \sigma_1, -i \sigma_2$ | P-WNL_{GA/TX}; | | | | | | | | | | | |
| $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $C_{2z} \sigma_y T$ | $R_5$ | 2; $i \sigma_2, i \sigma_1, -i \sigma_2$ | P-WNL_{XG}; | | | | | | | | | | | | |
| $(\frac{1}{4} \frac{3}{4} \frac{1}{4})$ | $\sigma_y \bar{E} T$ | $(R_5, R_5)$ | 2; $\sigma_0, -\sigma_0, -i \sigma_2$ | P-WNL_{RW}; | | | | | | | | | | | | |
| $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $\sigma_y \bar{E} T$ | $(R_5, R_5)$ | 2; $\sigma_0, -\sigma_0, -i \sigma_2$ | P-WNL_{RW}; | | | | | | | | | | | | |
| $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $\sigma_y \bar{E} T$ | $(R_5, R_5)$ | 2; $\sigma_0, -\sigma_0, -i \sigma_2$ | P-WNL_{RW}; | | | | | | | | | | | | |
| $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $\sigma_y \bar{E} T$ | $(R_5, R_5)$ | 2; $\sigma_0, -\sigma_0, -i \sigma_2$ | P-WNL_{RW}; | | | | | | | | | | | | |
| $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $\sigma_y \bar{E} T$ | $(R_5, R_5)$ | 2; $\sigma_0, -\sigma_0, -i \sigma_2$ | P-WNL_{RW}; | | | | | | | | | | | | |
| $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $\sigma_y \bar{E} T$ | $(R_5, R_5)$ | 2; $\sigma_0, -\sigma_0, -i \sigma_2$ | P-WNL_{RW}; | | | | | | | | | | | | |
| $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $\sigma_y \bar{E} T$ | $(R_5, R_5)$ | 2; $\sigma_0, -\sigma_0, -i \sigma_2$ | P-WNL_{RW}; | | | | | | | | | | | | |
| $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $\sigma_y \bar{E} T$ | $(R_5, R_5)$ | 2; $\sigma_0, -\sigma_0, -i \sigma_2$ | P-WNL_{RW}; | | | | | | | | | | | | |
| $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $\sigma_y \bar{E} T$ | $(R_5, R_5)$ | 2; $\sigma_0, -\sigma_0, -i \sigma_2$ | P-WNL_{RW}; | | | | | | | | | | | | |
\( \Gamma_0^v; \{ C_{2z}[000], \{ \sigma_y | \frac{1}{2}, \frac{1}{2} \} \}, T; \) Non-Centrosymmetric; with SOC

\[
\begin{array}{llll}
\Gamma & (000); & C_{2z}, \sigma_y, T; R_5; & 2; i \sigma_2, i \sigma_1, -i \sigma_2; \text{ P-WNL}_{\Gamma \Lambda/\Gamma X}; \\
X & \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); & C_{2z}, \sigma_y, T; R_5; & 2; i \sigma_2, i \sigma_1, -i \sigma_2; \text{ P-WNL}_{\Gamma G}; \\
R & \left( \frac{1}{2} 00 \right); & \sigma_y, T; \{ R_2, R_4 \}; 2; i \sigma_3, -i \sigma_2; \text{ P-WNL}; \\
S & \left( \frac{1}{2} 0 \frac{1}{2} \right); & \sigma_z, \bar{E}, T; \{ R_5, R_3 \}; 2; \sigma_0, -\sigma_0, -i \sigma_2; \text{ P-WNL}_{\Gamma X}; \\
& \quad \{ R_7, R_7 \}; 2; -\sigma_0, -\sigma_0, -i \sigma_2; \text{ P-WNL}_{\Gamma X}; \\
T & \left( \frac{1}{2} \frac{1}{2} 0 \right); & C_{2z}, T; \{ R_2, R_4 \}; 2; i \sigma_3, -i \sigma_2; \text{ C-1 WP}; 1 \\
W & \left( \frac{3}{4} \frac{3}{4} \frac{3}{4} \right); & C_{2z}, \sigma_x T; \{ R_2, R_4 \}; 2; i \sigma_3, -i \sigma_2; \text{ P-WNL}_{\Gamma X}; \\
\Lambda & \Gamma \Lambda/\Gamma X; & C_{2z}, \sigma_y; R_5; & 2; i \sigma_2, i \sigma_1; \text{ WNL}; \pi \\
G & XG; & C_{2z}, \sigma_y; R_5; & 2; i \sigma_2, i \sigma_1; \text{ WNL}; \pi \\
P & TW; & C_{2z}; R_2; & 1; i; \text{ P-WNL}; \\
& & R_4; & 1; -i; \\
\Sigma & \Gamma \Sigma/\Gamma X; & \sigma_y, T \sigma_x; R_2; & 1; i, 1; \text{ WNL}; \\
& & R_4; & 1; -i, 1; \\
F & XF; & \sigma_y, T \sigma_x; R_2; & 1; -i, 1; \text{ WNL}; \\
& & R_4; & 1; i, 1; \\
D & SW; & \bar{E}, T \sigma_x; \{ R_2, R_2 \}; 2; -\sigma_0, -i \sigma_2; \text{ WNL}; \pi \\
\Delta & \Gamma \Delta/\Gamma X; & \sigma_z, T C_{2z}; R_2; & 1; i, 1; \text{ WNL}; \\
& & R_4; & 1; -i, 1; \\
U & XU; & \sigma_z, T C_{2z}; R_2; & 1; i, 1; \text{ WNL}; \\
& & R_4; & 1; -i, 1; \\
Q & RW; & \bar{E}, T \sigma_y; R_2; & 1; -1, 1; \text{ WNL}; \\
\end{array}
\]
\[
\begin{align*}
\Gamma_0: \{C_{2z}[000], \{C_{2y}[000], \{I[000]\}, T; \text{Centrosymmetric; with SOC}
\end{align*}
\]

\[
\begin{align*}
\Gamma; \ (000); \ C_{2x}, C_{2y}, I, T; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
Y; \ \left( \frac{1}{2}00 \right); \ C_{2x},\ C_{2y}, I, T; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
X; \ (0\frac{1}{2}0); \ C_{2x}, C_{2y}, I, T; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
Z; \ (00\frac{1}{2}); \ C_{2x}, C_{2y}, I, T; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
U; \ (0\frac{1}{2}\frac{1}{2}); \ C_{2x}, C_{2y}, I, T; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
T; \ \left( \frac{1}{2}0\frac{1}{2} \right); \ C_{2x}, \ C_{2y}, I, T; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
S; \ \left( \frac{1}{2}\frac{1}{2}0 \right); \ C_{2x}, C_{2y}, I, T; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R; \ \left( \frac{1}{2}\frac{1}{2}\frac{1}{2} \right); \ C_{2x}, C_{2y}, I, T; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
\Delta; \ Y\Gamma; \ C_{2y}, \sigma_x, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
D; \ XS; \ C_{2y}, \sigma_x, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
P; \ UR; \ C_{2y}, \sigma_x, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
B; \ ZT; \ C_{2y}, \sigma_x, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
\Sigma; \ \Gamma X; \ C_{2x}, \sigma_z, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
C; \ YS; \ C_{2x}, \sigma_x, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
E; \ TR; \ C_{2x}, \sigma_z, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
A; \ ZU; \ C_{2x}, \sigma_z, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
\Lambda; \ \Gamma Z; \ C_{2x}, \sigma_y, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
H; \ YT; \ C_{2x}, \sigma_y, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
Q; \ SR; \ C_{2x}, \sigma_y, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
G; \ XU; \ C_{2x}, \sigma_y, IT; \ R_5: \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
\end{align*}
\]
\[ \Gamma_0; \{ C_{2z}(000), C_{2y}(000), \{ I, T \} \}; \ T; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; (000); \ C_{2z}C_{2y}I,T; \ \{ R_5 \}; \ 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]

\[ R_{10}; \ 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ Y; (\frac{1}{2}00); \ \sigma_z\sigma_y\sigma_zI,T; \ \{ R_{13}, R_{14} \}; \ 4; \Gamma_0,1, \Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \ \text{DP}; \ 0 \]

\[ X; (0\frac{1}{2}0); \ \sigma_y\sigma_z\sigma_zI,T; \ \{ R_{13}, R_{14} \}; \ 4; \Gamma_0,1, \Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \ \text{DP}; \ 0 \]

\[ Z; (00\frac{1}{2}); \ \sigma_z\sigma_z\sigma_zI,T; \ \{ R_{13}, R_{14} \}; \ 4; \Gamma_0,1, \Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \ \text{DP}; \ 0 \]

\[ U; (0\frac{1}{2}0); \ \sigma_z\sigma_y\sigma_zI,T; \ \{ R_{13}, R_{14} \}; \ 4; \Gamma_0,1, \Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \ \text{DP}; \ 0 \]

\[ T; (\frac{1}{2}0\frac{1}{2}); \ \sigma_y\sigma_y\sigma_yI,T; \ \{ R_{13}, R_{14} \}; \ 4; \Gamma_0,1, \Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \ \text{DP}; \ 0 \]

\[ S; (\frac{1}{2}\frac{1}{2}0); \ \sigma_z\sigma_z\sigma_zI,T; \ \{ R_{13}, R_{14} \}; \ 4; \Gamma_0,1, \Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \ \text{DP}; \ 0 \]

\[ R; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \ C_{2z}C_{2y}I,T; \ \{ R_5 \}; \ 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]

\[ R_{10}; \ 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ \Delta; \ \Gamma_Y; \ \ C_{2y}\sigma_z\sigma_zI,T; \ \{ R_5, R_6 \}; \ 2; \sigma_3, i\sigma_0, -i\sigma_2; \]

\[ D; \ \Gamma_X; \ \sigma_z\sigma_z\sigma_zI,T; \ \{ R_6, R_7 \}; \ 2; \sigma_3, -i\sigma_0, -i\sigma_2; \]

\[ P; \ \Gamma_U; \ \ C_{2y}\sigma_z\sigma_zI,T; \ \{ R_9 \}; \ 2; \sigma_3, -\sigma_1, -i\sigma_2; \]

\[ B; \ \Gamma_T; \ \sigma_z\sigma_z\sigma_zI,T; \ \{ R_9, R_8 \}; \ 2; \sigma_3, -i\sigma_0, -i\sigma_2; \]

\[ \Sigma; \ \Gamma_X; \ \ C_{2z}\sigma_y\sigma_yI,T; \ \{ R_5 \}; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ C; \ \Gamma_Y; \ \sigma_y\sigma_y\sigma_yI,T; \ \{ R_5, R_8 \}; \ 2; -i\sigma_3, i\sigma_0, -i\sigma_2; \]

\[ E; \ \Gamma_R; \ \ C_{2z}\sigma_y\sigma_yI,T; \ \{ R_9 \}; \ 2; \sigma_3, \sigma_1, -i\sigma_2; \]

\[ A; \ \Gamma_U; \ \sigma_z\sigma_y\sigma_yI,T; \ \{ R_9, R_7 \}; \ 2; \sigma_3, \sigma_3, -i\sigma_2; \]

\[ \Lambda; \ \Gamma_Z; \ \ C_{2z}\sigma_y\sigma_yI,T; \ \{ R_5 \}; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ H; \ \Gamma_Y; \ \sigma_y\sigma_y\sigma_yI,T; \ \{ R_5, R_8 \}; \ 2; -i\sigma_3, i\sigma_0, -i\sigma_2; \]

\[ Q; \ \Gamma_R; \ \ C_{2z}\sigma_y\sigma_yI,T; \ \{ R_9 \}; \ 2; i\sigma_3, \sigma_1, -i\sigma_2; \]

\[ G; \ \Gamma_U; \ \sigma_z\sigma_z\sigma_zI,T; \ \{ R_5, R_8 \}; \ 2; i\sigma_3, i\sigma_0, -i\sigma_2; \]

\[ \{ R_9, R_7 \}; \ 2; \sigma_3, -i\sigma_0, -i\sigma_2; \]
\[ \Gamma: (000); \ C_{2z},C_{2y},I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; \ 2; \ i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ Y: (\frac{1}{2}00); \ C_{2z},C_{2y},I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; \ 2; \ i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ X: (0\frac{1}{2}0); \ C_{2z},C_{2y},I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; \ 2; \ i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ Z: (00\frac{1}{2}); \ \sigma_x,\sigma_z,I,T; \ \{R_{13},R_{14}\}; \ 4; \ \Gamma_{0.1},i\Gamma_{3.0},\Gamma_{0.3},-i\Gamma_{2.0}; \ DP; \ 0 \]
\[ U: (0\frac{1}{2}0); \ \sigma_x,\sigma_z,I,T; \ \{R_{13},R_{14}\}; \ 4; \ \Gamma_{0.1},i\Gamma_{3.0},\Gamma_{0.3},-i\Gamma_{2.0}; \ DP; \ 0 \]
\[ T: (\frac{1}{2}0\frac{1}{2}); \ \sigma_x,\sigma_z,I,T; \ \{R_{13},R_{14}\}; \ 4; \ \Gamma_{0.1},i\Gamma_{3.0},\Gamma_{0.3},-i\Gamma_{2.0}; \ DP; \ 0 \]
\[ S: (\frac{1}{2}\frac{1}{2}0); \ C_{2z},C_{2y},I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; \ 2; \ i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R: (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \ \sigma_x,\sigma_z,I,T; \ \{R_{13},R_{14}\}; \ 4; \ \Gamma_{0.1},i\Gamma_{3.0},\Gamma_{0.3},-i\Gamma_{2.0}; \ DP; \ 0 \]
\[ \Delta; \ \Gamma Y; \ C_{2y},\sigma_x,I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ D; \ \Gamma X; \ C_{2z},\sigma_y,I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ P; \ \Gamma U; \ \sigma_x,C_{2y},I,T; \ \{R_5,R_6\}; \ 2; \ i\sigma_3, i\sigma_0, -i\sigma_2; \]
\[ \{R_6,R_7\}; \ 2; \ i\sigma_3, -i\sigma_0, -i\sigma_2; \]
\[ B; \ \Gamma T; \ \sigma_x,C_{2y},I,T; \ \{R_5,R_6\}; \ 2; \ i\sigma_3, i\sigma_0, -i\sigma_2; \]
\[ \{R_6,R_7\}; \ 2; \ i\sigma_3, -i\sigma_0, -i\sigma_2; \]
\[ \Sigma; \ \Gamma S; \ C_{2z},\sigma_y,I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ E; \ \Gamma R; \ \sigma_x,\sigma_y,I,T; \ \{R_5,R_7\}; \ 2; \ i\sigma_3, \sigma_3, -i\sigma_2; \]
\[ \{R_6,R_8\}; \ 2; \ i\sigma_3, -\sigma_3, -i\sigma_2; \]
\[ A; \ \Gamma R; \ \sigma_z,\sigma_y,I,T; \ \{R_5,R_7\}; \ 2; \ i\sigma_3, \sigma_3, -i\sigma_2; \]
\[ \{R_6,R_8\}; \ 2; \ i\sigma_3, -\sigma_3, -i\sigma_2; \]
\[ A; \ \Gamma Z; \ C_{2z},\sigma_y,I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ H; \ \Gamma Y; \ C_{2z},\sigma_y,I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ Q; \ \Gamma R; \ C_{2z},\sigma_y,I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ G; \ \Gamma U; \ C_{2z},\sigma_y,I,T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ \Gamma_0; \{C_2_x[000], C_{2_y}[000], (T^\frac{1}{2} \frac{1}{2} 0) \}; \text{Centrosymmetric; with SOC} \]

\[
\begin{array}{lll}
\Gamma; (000); & C_{2x}, C_{2y}, I, T; & R_5; \quad 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& & R_{10}; \quad 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
Y; (\frac{1}{2} 00); & \sigma_z, \sigma_y, I, T; & \{R_{13}, R_{14}\}; \quad 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{DP}; 0 \\
X; (0 0\frac{1}{2}); & \sigma_z, \sigma_x, I, T; & \{R_{13}, R_{14}\}; \quad 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{DP}; 0 \\
Z; (00\frac{1}{2}); & C_{2x}, C_{2y}, I, T; & R_5; \quad 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& & R_{10}; \quad 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
U; (0\frac{1}{2} \frac{1}{2}); & \sigma_z, \sigma_x, I, T; & \{R_{13}, R_{14}\}; \quad 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{DP}; 0 \\
T; (\frac{1}{2} 0\frac{1}{2}); & \sigma_z, \sigma_x, I, T; & \{R_{13}, R_{14}\}; \quad 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{DP}; 0 \\
S; (\frac{1}{2} \frac{1}{2} 0); & \sigma_z, \sigma_x, I, T; & \{R_{13}, R_{14}\}; \quad 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{DP}; 0 \\
R; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); & \sigma_z, \sigma_x, I, T; & \{R_{13}, R_{14}\}; \quad 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{DP}; 0 \\
\Delta; \Gamma_Y; & C_{2y}, \sigma_x, I, T; & R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
D; \Gamma_S; & \sigma_z, C_{2y}, I, T; & \{R_5, R_8\}; \quad 2; i\sigma_3, i\sigma_0, -i\sigma_2; \\
& & \{R_6, R_7\}; \quad 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \\
P; \Gamma_U; & \sigma_z, C_{2y}, I, T; & \{R_5, R_8\}; \quad 2; i\sigma_3, i\sigma_0, -i\sigma_2; \\
& & \{R_6, R_7\}; \quad 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \\
B; \Gamma_T; & C_{2y}, \sigma_x, I, T; & R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
\Sigma; \Gamma_X; & C_{2x}, \sigma_y, I, T; & R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
C; \Gamma_Y; & \sigma_y, C_{2x}, I, T; & \{R_5, R_8\}; \quad 2; -i\sigma_3, i\sigma_0, -i\sigma_2; \\
& & \{R_6, R_7\}; \quad 2; -i\sigma_3, -i\sigma_0, -i\sigma_2; \\
E; \Gamma_T; & \sigma_y, C_{2x}, I, T; & \{R_5, R_8\}; \quad 2; -i\sigma_3, i\sigma_0, -i\sigma_2; \\
& & \{R_6, R_7\}; \quad 2; -i\sigma_3, -i\sigma_0, -i\sigma_2; \\
A; \Gamma_Z; & C_{2x}, \sigma_y, I, T; & R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
A; \Gamma_Z; & C_{2x}, \sigma_y, I, T; & R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
H; \Gamma_T; & \sigma_y, C_{2x}, I, T; & \{R_5, R_8\}; \quad 2; -i\sigma_3, i\sigma_0, -i\sigma_2; \\
& & \{R_6, R_7\}; \quad 2; -i\sigma_3, -i\sigma_0, -i\sigma_2; \\
Q; \Gamma_Z; & C_{2x}, \sigma_z, I, T; & R_5; \quad 2; i\sigma_3, i\sigma_1, -i\sigma_2; \\
G; \Gamma_U; & \sigma_z, C_{2x}, I, T; & \{R_5, R_8\}; \quad 2; i\sigma_3, i\sigma_0, -i\sigma_2; \\
& & \{R_6, R_7\}; \quad 2; i\sigma_3, -i\sigma_0, -i\sigma_2; 
\end{array}
\]
7. SG 51-60

SG 51
Γ₀; \{C_{2z}|000\}, \{C_{2y}|000\}, \{I|000\}, \mathcal{T}; Centrosymmetric; with SOC

Γ; (000): \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad R_{10}; \\ & \quad 2; \ iσ₂, iσ₁, σ₀, −iσ₂; \end{align*}

\( \left( \frac{1}{2} \right) \); \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad R_{10}; \\ & \quad 2; \ iσ₂, iσ₁, −σ₀, −iσ₂; \end{align*}

Y; (010): \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad R_{10}; \\ & \quad 2; \ iσ₂, iσ₁, σ₀, −iσ₂; \end{align*}

\( \left( \frac{1}{2} \right) \); \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad R_{10}; \\ & \quad 2; \ iσ₂, iσ₁, −σ₀, −iσ₂; \end{align*}

X; (010): \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad R_{10}; \\ & \quad 2; \ iσ₂, iσ₁, σ₀, −iσ₂; \end{align*}

\( \left( \frac{1}{2} \right) \); \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad R_{10}; \\ & \quad 2; \ iσ₂, iσ₁, −σ₀, −iσ₂; \end{align*}

Z; (00\frac{1}{2}): \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad \{R_{13}, R_{14}\}; \\ & \quad 4; \ Γ₀₁, iΓ₁₂, Γ₁₃, −iΓ₂₀; \end{align*}

U; (0\frac{1}{2}1): \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad \{R_{13}, R_{14}\}; \\ & \quad 4; \ Γ₀₁, iΓ₁₂, Γ₁₃, −iΓ₂₀; \end{align*}

T; (\frac{1}{2}0\frac{1}{2}): \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad \{R_{13}, R_{14}\}; \\ & \quad 4; \ Γ₀₁, iΓ₁₂, Γ₁₃, −iΓ₂₀; \end{align*}

S; (\frac{1}{2}0\frac{1}{2}): \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad R_{10}; \\ & \quad 2; \ iσ₂, iσ₁, σ₀, −iσ₂; \end{align*}

\( \left( \frac{1}{2} \right) \); \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad R_{10}; \\ & \quad 2; \ iσ₂, iσ₁, −σ₀, −iσ₂; \end{align*}

R; (\frac{1}{2}1\frac{1}{2}): \quad \begin{align*} C_{2z}, C_{2y}, I, \mathcal{T}; & \quad \{R_{13}, R_{14}\}; \\ & \quad 4; \ Γ₀₁, iΓ₁₂, Γ₁₃, −iΓ₂₀; \end{align*}

Δ; ΓY: \quad \begin{align*} C_{2y}, σ₁, I, \mathcal{T}; & \quad R₅; \\ & \quad 2; \ iσ₂, iσ₁, −iσ₂; \end{align*}

D; XS: \quad \begin{align*} C_{2y}, σ₁, I, \mathcal{T}; & \quad R₅; \\ & \quad 2; \ iσ₂, iσ₁, −iσ₂; \end{align*}

P; UR: \quad \begin{align*} σ₅, C_{2y}, I, \mathcal{T}; & \quad \{R₅, R₆\}; \\ & \quad 2; \ iσ₀, iσ₃, −iσ₂; \\ & \quad \{R₇, R₈\}; \\ & \quad 2; \ −iσ₀, −iσ₃, −iσ₂; \end{align*}

B; ZT: \quad \begin{align*} σ₅, C_{2y}, I, \mathcal{T}; & \quad \{R₅, R₆\}; \\ & \quad 2; iσ₀, iσ₃, −iσ₂; \\ & \quad \{R₇, R₈\}; \\ & \quad 2; \ −iσ₀, −iσ₃, −iσ₂; \end{align*}

Σ; ΓX: \quad \begin{align*} C_{2z}, σ₉, I, \mathcal{T}; & \quad R₅; \\ & \quad 2; \ iσ₂, iσ₁, −iσ₂; \end{align*}

C; YS: \quad \begin{align*} C_{2z}, σ₉, I, \mathcal{T}; & \quad R₅; \\ & \quad 2; \ iσ₂, iσ₁, −iσ₂; \end{align*}

E; TR: \quad \begin{align*} σ₉, σ₃, I, \mathcal{T}; & \quad \{R₉, R₉\}; \\ & \quad 4; iΓ₀₀, −iΓ₀₁, −Γ₂₁; \end{align*}

A; ZU: \quad \begin{align*} σ₉, σ₉, I, \mathcal{T}; & \quad \{R₀, R₀\}; \\ & \quad 4; iΓ₀₀, −iΓ₀₁, −Γ₂₁; \end{align*}

Λ; ΓZ: \quad \begin{align*} C_{2z}, σ₉, I, \mathcal{T}; & \quad R₅; \\ & \quad 2; \ iσ₂, iσ₁, −iσ₂; \end{align*}

H; YT: \quad \begin{align*} C_{2z}, σ₉, I, \mathcal{T}; & \quad R₅; \\ & \quad 2; \ iσ₂, iσ₁, −iσ₂; \end{align*}

Q; SR: \quad \begin{align*} C_{2z}, σ₉, I, \mathcal{T}; & \quad R₅; \\ & \quad 2; \ iσ₂, iσ₁, −iσ₂; \end{align*}

G; XU: \quad \begin{align*} C_{2z}, σ₉, I, \mathcal{T}; & \quad R₅; \\ & \quad 2; \ iσ₂, iσ₁, −iσ₂; \end{align*}
Γ₀; \{C₂z|00\frac{1}{2}\}, \{C₂y|000\}, \{I|\frac{1}{2}\frac{1}{2}\frac{1}{2}\} \; T; \text{Centrosymmetric}; \text{with SOC}

\begin{align*}
\Gamma; (000); & \quad C₂z,C₂y,I,T; \; R₅; \quad 2; \quad iσ₂,iσ₁,σ₀,−iσ₂; \\
& \quad \quad \quad R₁₀; \quad 2; \quad iσ₂,iσ₁,σ₀,−iσ₂;

Y; (\frac{1}{2}00); & \quad σₙ,σ₀,I,T; \quad \{R₃₃,R₁₄\}; \quad 4; \quad Γ₀₁,Γ₃₀,Γ₀₃,−iΓ₂₀; \quad \text{DP}; \quad 0

X; (0\frac{1}{2}0); & \quad σₚ,σ₂,I,T; \quad \{R₃₃,R₁₄\}; \quad 4; \quad Γ₀₁,Γ₃₀,Γ₀₃,−iΓ₂₀; \quad \text{DP}; \quad 0

Z; (00\frac{1}{2}); & \quad σₙ,C₂y,I,T; \quad \{R₃₃,R₁₄\}; \quad 4; \quad Γ₀₁,Γ₃₀,Γ₀₃,−iΓ₂₀; \quad \text{P-DNL}_{\Sigma U};

U; (0\frac{1}{2}\frac{1}{2}); & \quad C₂y,σ₂,I,T; \quad \{R₀,R₉\}; \quad 4; \quad iΓ₀₂,Γ₀₃,Γ₀₃,iΓ₂₀; \quad \text{P-DNLs}; \\
& \quad \{R₁₀,R₁₀\}; \quad 4; \quad iΓ₀₂,Γ₀₃,Γ₀₃,−iΓ₂₀; \quad \text{P-DNLs};

T; (\frac{1}{2}0\frac{1}{2}); & \quad σₙ,σ₀,I,T; \quad \{R₅,R₆\}; \quad 2; \quad −σ₀,iσ₃,σ₀,−iσ₂; \\
& \quad \quad \quad \{R₇,R₈\}; \quad 2; \quad σ₀,−iσ₃,σ₀,−iσ₂; \\
& \quad \quad \quad \{R₁₅,R₁₆\}; \quad 2; \quad −σ₀,iσ₃,−σ₀,−iσ₂; \\
& \quad \quad \quad \{R₁₇,R₁₈\}; \quad 2; \quad σ₀,−iσ₃,−σ₀,−iσ₂;

S; (\frac{1}{2}\frac{1}{2}0); & \quad σₙ,σₙ,I,T; \quad \{R₃₃,R₁₄\}; \quad 4; \quad Γ₀₁,Γ₃₀,Γ₀₃,−iΓ₂₀; \quad \text{DP}; \quad 0

R; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & \quad σₚ,C₂z,I,T; \quad \{R₃₃,R₁₄\}; \quad 4; \quad Γ₀₁,Γ₃₀,Γ₀₃,−iΓ₂₀; \quad \text{P-DNL}_{\Sigma U R};

Δ; \Gamma Y; & \quad C₂y,σₙ,I,T; \quad \{R₅\}; \quad 2; \quad iσ₂,iσ₁,−iσ₂;

D; \Sigma X; & \quad σₙ,C₂y,I,T; \quad \{R₅,R₆\}; \quad 2; \quad iσ₃,iσ₀,−iσ₂; \\
& \quad \quad \quad \{R₆,R₇\}; \quad 2; \quad iσ₃,−iσ₀,−iσ₂;

P; \Sigma U R; & \quad C₂y,σₚ,I,T; \quad \{R₀,R₉\}; \quad 4; \quad iΓ₀₃,−iΓ₀₁,iΓ₂₀; \quad \text{DNL}; \quad 0

B; \Sigma Z T; & \quad σₚ,C₂z,I,T; \quad \{R₀,R₉\}; \quad 2; \quad iσ₀,iσ₃,−iσ₂; \\
& \quad \quad \quad \{R₇,R₈\}; \quad 2; \quad −iσ₀,−iσ₃,−iσ₂;

Σ; \Sigma Γ X; & \quad C₂z,σₙ,I,T; \quad \{R₅\}; \quad 2; \quad iσ₂,iσ₁,−iσ₂;

C; \Sigma Y S; & \quad σₚ,C₂z,I,T; \quad \{R₅,R₆\}; \quad 2; \quad −iσ₃,iσ₀,−iσ₂; \\
& \quad \quad \quad \{R₆,R₇\}; \quad 2; \quad −iσ₃,−iσ₀,−iσ₂;

E; \Sigma T R; & \quad σₙ,σ₂,Σ,E,I,T; \quad \{R₆,R₇\}; \quad 2; \quad iσ₃,σ₀,−σ₀,−iσ₂; \\
& \quad \quad \quad \{R₇,R₈\}; \quad 2; \quad iσ₃,−σ₀,−σ₀,−iσ₂;

A; Z U; & \quad σₙ,σ₂,I,T; \quad \{R₀,R₉\}; \quad 4; \quad iΓ₀₃,−iΓ₀₁,−Γ₂₁; \quad \text{DNL}; \quad 0

Λ; Γ Z; & \quad C₂z,σₙ,I,T; \quad \{R₅\}; \quad 2; \quad iσ₂,iσ₁,−iσ₂;

H; Σ T Y; & \quad σₚ,C₂z,I,T; \quad \{R₀,R₉\}; \quad 2; \quad −iσ₃,iσ₀,−iσ₂; \\
& \quad \quad \quad \{R₆,R₇\}; \quad 2; \quad −iσ₃,−iσ₀,−iσ₂;

Q; Σ R; & \quad C₂z,σ₂,I,T; \quad \{R₀\}; \quad 2; \quad iσ₃,σ₁,−iσ₂;

G; Σ X U; & \quad σₚ,C₂z,I,T; \quad \{R₀,R₉\}; \quad 2; \quad iσ₃,iσ₀,−iσ₂; \\
& \quad \quad \quad \{R₆,R₇\}; \quad 2; \quad iσ₃,−iσ₀,−iσ₂;
\( \Gamma_0 \): \( \{C_{2z}(000)\}, \{C_{2y}(000)\}, \{I_1(000)\}, T \); Centrosymmetric; with SOC

\[ \begin{align*}
\Gamma; \; (000); \; C_{2z},C_{2y},I,T; \; R_5; \; & 2: i\sigma_2,i\sigma_1,\sigma_0,-i\sigma_2; \\
& R_{10}; \; 2: i\sigma_2,i\sigma_1,-\sigma_0,-i\sigma_2; \\
Y; \; (\frac{1}{2}00); \; \sigma_z,\sigma_y,I,T; \; \{R_{13}, R_{14}\}; \; 4: \Gamma_0,1,\Gamma_3,0,\Gamma_2,0, -i\Gamma_2,0; \; \text{DP}; \; 0 \\
X; \; (0\frac{1}{2}0); \; C_{2z},C_{2y},I,T; \; R_5; \; & 2: i\sigma_2,i\sigma_1,\sigma_0,-i\sigma_2; \\
& R_{10}; \; 2: i\sigma_2,i\sigma_1,-\sigma_0,-i\sigma_2; \\
Z; \; (00\frac{1}{2}); \; C_{2z},C_{2y},I,T; \; \{R_{13}, R_{14}\}; \; 4: \Gamma_0,1,\Gamma_3,0,\Gamma_2,0, -i\Gamma_2,0; \; \text{P-DNL}; \; 0 \\
U; \; (0\frac{1}{2}\frac{1}{2}); \; C_{2z},C_{2y},I,T; \; \{R_{13}, R_{14}\}; \; 4: \Gamma_0,1,\Gamma_3,0,\Gamma_2,0, -i\Gamma_2,0; \; \text{P-DNL}; \; 0 \\
T; \; (\frac{1}{2}0\frac{1}{2}); \; C_{2z},\sigma_y,I,T; \; \{R_5, R_6\}; \; 2: -\sigma_0,i\sigma_3,\sigma_0,-i\sigma_2; \\
& \{R_7, R_8\}; \; 2: \sigma_0,-i\sigma_3,\sigma_0,-i\sigma_2; \\
& \{R_{15}, R_{16}\}; \; 2: -\sigma_0,i\sigma_3,-\sigma_0,-i\sigma_2; \\
& \{R_{17}, R_{18}\}; \; 2: \sigma_0,-i\sigma_3,-\sigma_0,-i\sigma_2; \\
S; \; (\frac{1}{2}\frac{1}{2}0); \; \sigma_z,\sigma_y,I,T; \; \{R_{13}, R_{14}\}; \; 4: \Gamma_0,1,\Gamma_3,0,\Gamma_2,0, -i\Gamma_2,0; \; \text{DP}; \; 0 \\
R; \; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \; C_{2z},\sigma_y,I,T; \; \{R_5, R_6\}; \; 2: -\sigma_0,i\sigma_3,\sigma_0,-i\sigma_2; \\
& \{R_7, R_8\}; \; 2: \sigma_0,-i\sigma_3,\sigma_0,-i\sigma_2; \\
& \{R_{15}, R_{16}\}; \; 2: -\sigma_0,i\sigma_3,-\sigma_0,-i\sigma_2; \\
& \{R_{17}, R_{18}\}; \; 2: \sigma_0,-i\sigma_3,-\sigma_0,-i\sigma_2; \\
\Delta; \; \Gamma_Y; \; \sigma_z,\sigma_x,IT; \; R_5; \; 2: i\sigma_2,i\sigma_1,-i\sigma_2; \\
D; \; \Gamma_S; \; \sigma_z,\sigma_x,IT; \; R_5; \; 2: i\sigma_2,i\sigma_1,-i\sigma_2; \\
P; \; \Gamma_U; \; \sigma_z,\sigma_y,IT; \; \{R_5, R_6\}; \; 2: i\sigma_0,i\sigma_3,-i\sigma_2; \\
& \{R_7, R_8\}; \; 2: -i\sigma_0,-i\sigma_3,-i\sigma_2; \\
B; \; \Gamma_T; \; \sigma_z,\sigma_y,IT; \; \{R_5, R_6\}; \; 2: i\sigma_0,i\sigma_3,-i\sigma_2; \\
& \{R_7, R_8\}; \; 2: -i\sigma_0,-i\sigma_3,-i\sigma_2; \\
\Sigma; \; \Gamma_X; \; \sigma_z,\sigma_x,IT; \; R_5; \; 2: i\sigma_2,i\sigma_1,-i\sigma_2; \\
C; \; \Gamma_Y; \; \sigma_z,\sigma_y,IT; \; \{R_5, R_8\}; \; 2: -i\sigma_3,i\sigma_0,-i\sigma_2; \\
& \{R_6, R_7\}; \; 2: -i\sigma_3,-i\sigma_0,-i\sigma_2; \\
E; \; \Gamma_T; \; \sigma_y,\sigma_z,\tilde{E},IT; \; \{R_6, R_9\}; \; 2: i\sigma_3,-i\sigma_3,-\sigma_0,-i\sigma_2; \\
& \{R_7, R_8\}; \; 2: i\sigma_3,i\sigma_3,-\sigma_0,-i\sigma_2; \\
A; \; \Gamma_U; \; \sigma_y,\sigma_z,IT; \; \{R_9, R_9\}; \; 4: i\Gamma_0,3,-i\Gamma_0,1,-\Gamma_2,1; \; \text{DNL}; \; 0 \\
\Lambda; \; \Gamma_Z; \; C_{2z},\sigma_y,IT; \; R_5; \; 2: i\sigma_2,i\sigma_1,-i\sigma_2; \\
H; \; \Gamma_T; \; \sigma_y,\sigma_z,IT; \; \{R_5, R_8\}; \; 2: -i\sigma_3,i\sigma_0,-i\sigma_2; \\
& \{R_6, R_7\}; \; 2: -i\sigma_3,-i\sigma_0,-i\sigma_2; \\
Q; \; \Gamma_S; \; \sigma_y,\sigma_z,IT; \; \{R_5, R_8\}; \; 2: -i\sigma_3,i\sigma_0,-i\sigma_2; \\
& \{R_6, R_7\}; \; 2: -i\sigma_3,-i\sigma_0,-i\sigma_2; \\
G; \; \Gamma_U; \; C_{2z},\sigma_y,IT; \; R_5; \; 2: i\sigma_2,i\sigma_1,-i\sigma_2; \end{align*} \]
\[ \Gamma_0; \{ C_2, |00\frac{1}{2} \}, \{ C_2y |000 \}, \{ I |0\frac{1}{2}0 \}, \mathcal{T}; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; (000); \quad C_{2x}, C_{2y}, I, \mathcal{T}; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]

\[ R_{10}; \quad 2; \quad i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ Y; (\frac{1}{2}00); \quad C_{2x}, C_{2y}, I, \mathcal{T}; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]

\[ R_{10}; \quad 2; \quad i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ X; (0\frac{1}{2}0); \quad \sigma_y, \sigma_x, I, \mathcal{T}; \quad \{ R_{13}, R_{14} \}; \quad 4; \quad \Gamma_{0,1}, \Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \quad \text{DP}; \quad 0 \]

\[ Z; (00\frac{1}{2}); \quad C_{2x}, C_{2y}, I, \mathcal{T}; \quad \{ R_{13}, R_{14} \}; \quad 4; \quad \Gamma_{0,1}, \Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \quad \text{P-DNLZU}; \]

\[ U; (0\frac{1}{2}\frac{1}{2}); \quad C_{2y}, \sigma_z, I, \mathcal{T}; \quad \{ R_9, R_9 \}; \quad 4; \quad i\Gamma_{0,2}, \Gamma_{0,3}, \Gamma_{0,3}, i\Gamma_{2,0}; \quad \text{P-DNLs}; \]

\[ \quad \{ R_{10}, R_{10} \}; \quad 4; \quad i\Gamma_{0,2}, \Gamma_{0,3}, -\Gamma_{0,3}, i\Gamma_{2,0}; \quad \text{P-DNLs}; \]

\[ T; (\frac{1}{2}0\frac{1}{2}); \quad C_{2x}, C_{2y}, I, \mathcal{T}; \quad \{ R_{13}, R_{14} \}; \quad 4; \quad \Gamma_{0,1}, \Gamma_{3,0}, \Gamma_{1,3}, -i\Gamma_{2,0}; \quad \text{P-DNLs}; \quad 0 \]

\[ S; (\frac{1}{2}\frac{1}{2}0); \quad \sigma_y, \sigma_x, I, \mathcal{T}; \quad \{ R_{13}, R_{14} \}; \quad 4; \quad \Gamma_{0,1}, \Gamma_{3,0}, \Gamma_{1,3}, -i\Gamma_{2,0}; \quad \text{DP}; \quad 0 \]

\[ R; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad C_{2y}, \sigma_z, I, \mathcal{T}; \quad \{ R_9, R_9 \}; \quad 4; \quad i\Gamma_{0,2}, \Gamma_{0,3}, \Gamma_{0,3}, i\Gamma_{2,0}; \quad \text{P-DNLs}; \]

\[ \quad \{ R_{10}, R_{10} \}; \quad 4; \quad i\Gamma_{0,2}, \Gamma_{0,3}, -\Gamma_{0,3}, i\Gamma_{2,0}; \quad \text{P-DNLs}; \]

\[ \Delta; \quad \Gamma_Y; \quad C_{2y}, \sigma_x, I, \mathcal{T}; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ D; \quad \Gamma_Y; \quad \sigma_z, C_{2y}, I, \mathcal{T}; \quad \{ R_5, R_5 \}; \quad 2; \quad i\sigma_3, i\sigma_0, -i\sigma_2; \]

\[ \quad \{ R_6, R_7 \}; \quad 2; \quad i\sigma_3, -i\sigma_0, -i\sigma_2; \]

\[ P; \quad \Gamma_Y; \quad C_{2y}, \sigma_z, I, \mathcal{T}; \quad \{ R_9, R_9 \}; \quad 4; \quad i\Gamma_{0,3}, -\Gamma_{0,1}, i\Gamma_{2,0}; \quad \text{DNL}; \quad 0 \]

\[ B; \quad \Gamma_Y; \quad \sigma_z, C_{2y}, I, \mathcal{T}; \quad \{ R_9, R_9 \}; \quad 2; \quad i\sigma_0, i\sigma_3, -i\sigma_2; \]

\[ \quad \{ R_7, R_8 \}; \quad 2; \quad -i\sigma_0, -i\sigma_3, -i\sigma_2; \]

\[ \Sigma; \quad \Gamma_X; \quad C_{2x}, \sigma_x, I, \mathcal{T}; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ C; \quad \Gamma_Y; \quad C_{2x}, \sigma_y, I, \mathcal{T}; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ E; \quad \Gamma_Y; \quad \sigma_y, \sigma_z, I, \mathcal{T}; \quad \{ R_9, R_9 \}; \quad 4; \quad i\Gamma_{0,3}, -i\Gamma_{0,1}, -\Gamma_{2,1}; \quad \text{DNL}; \quad 0 \]

\[ A; \quad \Gamma_Z; \quad C_{2x}, \sigma_y, I, \mathcal{T}; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ H; \quad \Gamma_Y; \quad C_{2x}, \sigma_y, I, \mathcal{T}; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ Q; \quad \Gamma_Y; \quad \sigma_z, C_{2x}, I, \mathcal{T}; \quad \{ R_9, R_9 \}; \quad 2; \quad i\sigma_3, i\sigma_0, -i\sigma_2; \]

\[ \quad \{ R_6, R_7 \}; \quad 2; \quad i\sigma_3, -i\sigma_0, -i\sigma_2; \]

\[ G; \quad \Gamma_Y; \quad \sigma_z, C_{2x}, I, \mathcal{T}; \quad \{ R_9, R_9 \}; \quad 2; \quad i\sigma_3, i\sigma_0, -i\sigma_2; \]

\[ \quad \{ R_6, R_7 \}; \quad 2; \quad i\sigma_3, -i\sigma_0, -i\sigma_2; \]
\[ \Gamma_0; \{ C_{2z}(000), \{ C_{2z}(000, \frac{1}{2} \frac{1}{2} 0), \{ I(000) \}, \mathcal{T}; \text{Centrosymmetric; with SOC} \}
\]

\[ \Gamma; (000); C_{2z}, C_{2y}, I; \mathcal{T}; R_5; \]
\[ R_{10}; \]
\[ 2; i\sigma_2, i\sigma_1, \sigma_0, i\sigma_2; \]

\[ Y; (\frac{3}{2} 0); \sigma_y, C_{2z}, I; \]
\[ \{R_{13}, R_{14}\}; 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, i\Gamma_{2,1}; \]
\[ \text{P-DNL}_{YS}; \]

\[ X; (0 0 \frac{1}{2}); \sigma_y, C_{2z}, I; \]
\[ \{R_{13}, R_{14}\}; 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, i\Gamma_{2,1}; \]
\[ \text{P-DNL}_{XS}; \]

\[ Z; (0 0 \frac{1}{2}); C_{2z}, C_{2y}, I; \mathcal{T}; R_5; \]
\[ 2; i\sigma_2, i\sigma_1, \sigma_0, i\sigma_2; \]
\[ R_{10}; \]
\[ 2; i\sigma_2, i\sigma_1, -\sigma_0, i\sigma_2; \]

\[ U; (0 \frac{1}{2} \frac{1}{2}); \sigma_y, C_{2z}, I; \]
\[ \{R_{13}, R_{14}\}; 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, i\Gamma_{2,1}; \]
\[ \text{P-DNL}_{UR}; \]

\[ T; (\frac{3}{2} 0 \frac{1}{2}); \sigma_y, C_{2z}, I; \]
\[ \{R_{13}, R_{14}\}; 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, i\Gamma_{2,1}; \]
\[ \text{P-DNL}_{TR}; \]

\[ S; (\frac{1}{2} \frac{1}{2} 0); C_{2z}, C_{2z}, I; \mathcal{T}; R_0, R_9; \]
\[ 4; i\Gamma_{0,3}, \Gamma_{0,1}, \Gamma_{0,0}, \Gamma_{2,1}; \]
\[ \text{P-DNL}s; \]
\[ \{R_{19}, R_{19}\}; 4; i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{0,0}, \Gamma_{2,1}; \]
\[ \text{P-DNL}s; \]

\[ R; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{2z}, C_{2z}, I; \mathcal{T}; R_0, R_9; \]
\[ 4; i\Gamma_{0,3}, \Gamma_{0,1}, \Gamma_{0,0}, \Gamma_{2,1}; \]
\[ \text{P-DNL}s; \]
\[ \{R_{19}, R_{19}\}; 4; i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{0,0}, \Gamma_{2,1}; \]
\[ \text{P-DNL}s; \]

\[ \Delta; \Gamma_Y; \]
\[ C_{2y}, \sigma_x, I; \mathcal{T}; R_5; \]
\[ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ D; XS; \]
\[ \sigma_z, \sigma_z, I; \mathcal{T}; R_0, R_9; \]
\[ 4; i\Gamma_{0,3}, -i\Gamma_{0,1}, \Gamma_{2,1}; \]
\[ \text{DNL}; 0 \]

\[ P; UR; \]
\[ \sigma_z, \sigma_z, I; \mathcal{T}; R_0, R_9; \]
\[ 4; i\Gamma_{0,3}, -i\Gamma_{0,1}, \Gamma_{2,1}; \]
\[ \text{DNL}; 0 \]

\[ B; \Gamma T; \]
\[ C_{2y}, \sigma_z, I; \mathcal{T}; R_5; \]
\[ 2; i\sigma_2, i\sigma_1, \sigma_2; \]

\[ \Sigma; \Gamma X; \]
\[ C_{2z}, \sigma_y, I; \mathcal{T}; R_5; \]
\[ 2; i\sigma_2, i\sigma_1, \sigma_2; \]

\[ C; \Gamma S; \]
\[ \sigma_z, C_{2z}, I; \mathcal{T}; R_0, R_9; \]
\[ 4; i\Gamma_{0,3}, i\Gamma_{0,1}, \Gamma_{2,1}; \]
\[ \text{DNL}; 0 \]

\[ E; \Gamma R; \]
\[ \sigma_z, C_{2z}, I; \mathcal{T}; R_0, R_9; \]
\[ 4; i\Gamma_{0,3}, i\Gamma_{0,1}, \Gamma_{2,1}; \]
\[ \text{DNL}; 0 \]

\[ A; \Gamma Z; \]
\[ C_{2z}, \sigma_y, I; \mathcal{T}; R_5; \]
\[ 2; i\sigma_2, i\sigma_1, \sigma_2; \]

\[ \Lambda; \Gamma Z; \]
\[ C_{2z}, \sigma_y, I; \mathcal{T}; R_5; \]
\[ 2; i\sigma_2, i\sigma_1, \sigma_2; \]

\[ H; \Gamma T; \]
\[ \sigma_y, C_{2z}, I; \mathcal{T}; R_5, R_6; \]
\[ 2; -i\sigma_0, i\sigma_3, \sigma_2; \]
\[ \{R_7, R_8\}; 2; -i\sigma_0, -i\sigma_3, \sigma_2; \]
\[ Q; \Sigma R; \]
\[ C_{2z}, \sigma_z, I; \mathcal{T}; R_0, R_9; \]
\[ 4; i\Gamma_{0,3}, \Gamma_{0,1}, \Gamma_{2,1}; \]
\[ \text{DNL}; 0 \]

\[ G; \Sigma X; \]
\[ \sigma_z, C_{2z}, I; \mathcal{T}; R_5, R_6; \]
\[ 2; i\sigma_0, i\sigma_3, \sigma_2; \]
\[ \{R_7, R_8\}; 2; -i\sigma_0, -i\sigma_3, \sigma_2; \]
\[ \Gamma_0; \{C_{2z}|000\}, \{C_{2y}|\frac{1}{2}0\}, \{I|\frac{1}{2}\frac{1}{2}\}, \mathcal{T}; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; \ (000): \ C_{2z}, C_{2y}, I, \mathcal{T}; \ \{R_5\}; \quad \text{2; } \sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]

\[ \ \{R_{10}\}; \quad \text{2; } \sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ \ \{Y; (\frac{5}{2}00)\}; \ C_{2z}, C_{2y}, I, \mathcal{T}; \ \{R_{13}, R_{14}\}; \quad \text{4; } \Gamma_0, i\Gamma_3, \Gamma_0, -i\Gamma_2; \quad \text{P-DNL}_{\mathcal{Y\mathcal{T}}}; \]

\[ \ \{X; (0\frac{1}{2}0)\}; \ C_{2z}, C_{2y}, I, \mathcal{T}; \ \{R_{13}, R_{14}\}; \quad \text{4; } \Gamma_0, i\Gamma_3, \Gamma_0, -i\Gamma_2; \quad \text{P-DNL}_{\mathcal{XU}}; \]

\[ \ \{Z; (00\frac{1}{2})\}; \ C_{2z}, C_{2y}, I, \mathcal{T}; \ \{R_{13}, R_{14}\}; \quad \text{4; } \Gamma_0, i\Gamma_3, \Gamma_0, -i\Gamma_2; \quad \text{DP}; \]

\[ \ \{U; (0\frac{1}{2}\frac{1}{2})\}; \ C_{2z}, C_{2y}, I, \mathcal{T}; \ \{R_9, R_9\}; \quad \text{4; } \Gamma_0, i\Gamma_3, \Gamma_0, i\Gamma_2; \quad \text{P-DNLs}; \]

\[ \ \{R_{10}, R_{10}\}; \quad \text{4; } \Gamma_0, i\Gamma_3, -\Gamma_0, i\Gamma_2; \quad \text{P-DNLs}; \]

\[ \ \{T; (\frac{5}{2}0\frac{1}{2})\}; \ C_{2z}, C_{2y}, I, \mathcal{T}; \ \{R_9, R_9\}; \quad \text{4; } \Gamma_0, i\Gamma_3, \Gamma_0, i\Gamma_2; \quad \text{P-DNLs}; \]

\[ \ \{R_{10}, R_{10}\}; \quad \text{4; } \Gamma_0, i\Gamma_3, -\Gamma_0, i\Gamma_2; \quad \text{P-DNLs}; \]

\[ \ \{S; (\frac{1}{2}\frac{1}{2}0)\}; \ C_{2z}, C_{2y}, I, \mathcal{T}; \ \{R_{13}, R_{14}\}; \quad \text{4; } \Gamma_0, i\Gamma_3, \Gamma_0, -i\Gamma_2; \quad \text{P-DNL}_{\mathcal{SR}}; \]

\[ \ \{R; (\frac{1}{2}\frac{1}{2}\frac{1}{2})\}; \ C_{2z}, C_{2y}, I, \mathcal{T}; \ \{R_9, R_9\}; \quad \text{4; } \Gamma_0, i\Gamma_3, \Gamma_0, -i\Gamma_2; \quad \text{P-DNLs}; \]

\[ \ \{R_{10}, R_{10}\}; \quad \text{4; } \Gamma_0, i\Gamma_3, -\Gamma_0, -i\Gamma_2; \quad \text{P-DNLs}; \]

\[ \ \Delta; \ \Gamma\mathcal{Y}; \ C_{2y}, \sigma_4, I, \mathcal{T}; \ \{R_5\}; \quad \text{2; } \sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \ \{R_5, R_5\}; \quad \text{2; } \sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \ \{R_6, R_7\}; \quad \text{2; } \sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \ \{P; \ \Gamma\mathcal{U}; \ \sigma_2, C_{2y}, I, \mathcal{T}; \ \{R_9, R_9\}; \quad \text{4; } \Gamma_0, -i\Gamma_1, i\Gamma_2; \quad \text{DNL}; \quad \text{0}; \]

\[ \ \{B; \ \Gamma\mathcal{Z}; \ \sigma_2, C_{2y}, I, \mathcal{T}; \ \{R_5, R_5\}; \quad \text{2; } \sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \ \{R_6, R_7\}; \quad \text{2; } \sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \ \{E; \ \Gamma\mathcal{T}; \ \sigma_2, C_{2y}, I, \mathcal{T}; \ \{R_5, R_5\}; \quad \text{4; } \Gamma_0, -i\Gamma_1, -\Gamma_2; \quad \text{DNL}; \quad \text{0}; \]

\[ \ \{A; \ \Gamma\mathcal{Z}; \ \sigma_2, C_{2y}, I, \mathcal{T}; \ \{R_5, R_5\}; \quad \text{2; } \sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \ \{R_6, R_7\}; \quad \text{2; } \sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \ \{H; \ \Gamma\mathcal{Y}; \ \sigma_2, C_{2y}, I, \mathcal{T}; \ \{R_5, R_5\}; \quad \text{4; } i\Gamma_0, i\Gamma_1, -i\Gamma_2; \quad \text{DNL}; \quad \text{0}; \]

\[ \ \{Q; \ \Gamma\mathcal{T}; \ \sigma_2, C_{2y}, I, \mathcal{T}; \ \{R_5, R_5\}; \quad \text{4; } i\Gamma_0, i\Gamma_1, i\Gamma_2; \quad \text{DNL}; \quad \text{0}; \]

\[ \ \{G; \ \Gamma\mathcal{U}; \ \sigma_2, C_{2y}, I, \mathcal{T}; \ \{R_5, R_5\}; \quad \text{4; } i\Gamma_0, i\Gamma_1, -i\Gamma_2; \quad \text{DNL}; \quad \text{0}; \]
\[ \Gamma_0; \{ C_{2z}|000\}, \{ C_{2y}|1\frac{1}{2}0\}, \{ I|0\frac{1}{2}0\}, T; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; \ (000); \ C_{2z}, C_{2y}, I, T; \ R_5; \ 2; \ i\sigma_2, i\sigma_3, \sigma_0, -i\sigma_2; \]

\[ R_{10}; \ 2; \ i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ Y; \ (\frac{1}{2}00); \ \sigma_x, C_{2z}, I, T; \ \{ R_{13}, R_{14} \}; \ 4; \ \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \ \text{P-DNLYS}; \]

\[ X; \ (0\frac{1}{2}0); \ \sigma_x, C_{2y}, I, T; \ \{ R_{13}, R_{14} \}; \ 4; \ \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \ \text{P-DNLXY}; \]

\[ Z; \ (00\frac{1}{2}); \ C_{2z}, C_{2y}, I, T; \ R_5; \ 2; \ i\sigma_2, i\sigma_3, \sigma_0, -i\sigma_2; \]

\[ R_{10}; \ 2; \ i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ U; \ (0\frac{1}{2}\frac{1}{2}); \ \sigma_x, C_{2y}, I, T; \ \{ R_{13}, R_{14} \}; \ 4; \ \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \ \text{P-DNLXY}; \]

\[ T; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \ \sigma_x, C_{2z}, I, T; \ \{ R_{13}, R_{14} \}; \ 4; \ \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \ \text{P-DNLTR}; \]

\[ S; \ (\frac{1}{2}1\frac{1}{2}); \ C_{2z}, C_{2y}, I, T; \ \{ R_0, R_9 \}; \ 4; \ i\Gamma_{0.2}, \Gamma_{0.3}, \Gamma_{0.3}, i\Gamma_{2.0}; \ \text{P-DNLYS}; \]

\[ R; \ (\frac{1}{2}1\frac{1}{2}); \ C_{2z}, C_{2y}, I, T; \ \{ R_0, R_9 \}; \ 4; \ i\Gamma_{0.2}, \Gamma_{0.3}, \Gamma_{0.3}, i\Gamma_{2.0}; \ \text{P-DNLTR}; \]

\[ \Delta; \ \Gamma Y; \ C_{2y}, \sigma_x, I, T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ D; \ \Gamma X; \ C_{2y}, \sigma_x, I, T; \ \{ R_0, R_9 \}; \ 2; \ i\sigma_3, i\sigma_0, -i\sigma_2; \]

\[ R_6, R_7; 2; \ i\sigma_4, -i\sigma_0, -i\sigma_2; \]

\[ \Sigma; \ \Gamma Y; \ C_{2y}, \sigma_x, I, T; \ \{ R_0, R_9 \}; \ 2; \ i\sigma_3, i\sigma_0, -i\sigma_2; \]

\[ R_6, R_7; 2; \ i\sigma_4, -i\sigma_0, -i\sigma_2; \]

\[ B; \ \Gamma Z; \ C_{2y}, \sigma_x, I, T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ C; \ \Gamma X; \ C_{2y}, \sigma_x, I, T; \ R_5; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ E; \ \Gamma Y; \ C_{2y}, \sigma_x, I, T; \ \{ R_0, R_9 \}; \ 4; \ i\Gamma_{0.3}, i\Gamma_{0.1}, -\Gamma_{2.1}; \ \text{DNL}; \ 0 \]

\[ F; \ \Gamma Z; \ C_{2y}, \sigma_x, I, T; \ \{ R_0, R_9 \}; \ 4; \ i\Gamma_{0.3}, i\Gamma_{0.1}, -\Gamma_{2.1}; \ \text{DNL}; \ 0 \]

\[ G; \ \Gamma Z; \ C_{2y}, \sigma_x, I, T; \ \{ R_0, R_9 \}; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ A; \ \Gamma Z; \ C_{2y}, \sigma_x, I, T; \ \{ R_0, R_9 \}; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \{ R_7, R_8 \}; 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ Q; \ \Gamma Z; \ C_{2y}, \sigma_x, I, T; \ \{ R_0, R_9 \}; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \{ R_7, R_8 \}; 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ G; \ \Gamma Z; \ C_{2y}, \sigma_x, I, T; \ \{ R_0, R_9 \}; \ 4; \ i\Gamma_{0.2}, i\Gamma_{0.1}, -\Gamma_{2.3}; \ \text{DNL}; \ 0 \]
Γ; (000): \( C_{2z}, C_{2y}, I; T \); \( R_5 \); 
2; \( i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \)
\( R_{10} \); 
2; \( i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \)
Y: (\( \frac{1}{2} 0 0 \)): \( \sigma_x, C_{2z}, I; T \); 
\{R_{13}, R_{14}\}; 
4; \( \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \) P-DNLYS;
X: (0\( \frac{1}{2} 0 \)): \( \sigma_y, C_{2z}, I; T \); 
\{R_{13}, R_{14}\}; 
4; \( \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \) P-DNLXS;
Z: (00\( \frac{1}{2} \)): \( \sigma_z, \sigma_y, I; T \); 
\{R_{13}, R_{14}\}; 
4; \( \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \) DP; 
0
U: (0\( \frac{1}{2} \frac{1}{2} \)): \( \sigma_z, C_{2z}, I; T \); 
\{R_5, R_6\}; 
2; \( -\sigma_0, i\sigma_1, \sigma_0, -i\sigma_2; \)
\{R_7, R_8\}; 
2; \( \sigma_0, -i\sigma_3, \sigma_0, -i\sigma_2; \)
\{R_{15}, R_{16}\}; 
2; \( -\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2; \)
\{R_{17}, R_{18}\}; 
2; \( \sigma_0, -i\sigma_3, -\sigma_0, -i\sigma_2; \)
T: (\( \frac{1}{2} \frac{1}{2} 0 \)): \( \sigma_y, C_{2z}, I; T \); 
\{R_5, R_6\}; 
2; \( -\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2; \)
\{R_7, R_8\}; 
2; \( \sigma_0, -i\sigma_3, \sigma_0, -i\sigma_2; \)
\{R_{15}, R_{16}\}; 
2; \( -\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2; \)
\{R_{17}, R_{18}\}; 
2; \( \sigma_0, -i\sigma_3, -\sigma_0, -i\sigma_2; \)
S: (\( \frac{1}{2} \frac{1}{2} \frac{1}{2} \)): \( C_{2z}, \sigma_x, I; T \); 
\{R_9, R_9\}; 
4; \( i\Gamma_{0.3}, \Gamma_{0.1}, \Gamma_{0.0}, -\Gamma_{2.1}; \) P-DNL;
\{R_{19}, R_{19}\}; 
4; \( \Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{0.0}, -\Gamma_{2.1}; \) P-DNL;
R: (\( \frac{1}{2} \frac{1}{2} \frac{1}{2} \)): \( C_{2y}, \sigma_z, I; T \); 
\{R_{13}, R_{14}\}; 
4; \( \Gamma_{1.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \) P-DNLsR;
Δ: \( \Gamma_Y \): \( C_{2y}, \sigma_z, I; T \); 
\{R_5\}; 
2; \( i\sigma_2, i\sigma_1, -i\sigma_2; \)
\( \Gamma_X \): \( \sigma_x, \sigma_z, I; T \); 
\{R_9, R_9\}; 
4; \( i\Gamma_{0.3}, -i\Gamma_{0.1}, -\Gamma_{2.1}; \) DNL; 
0
P: \( \Gamma_U \): \( C_{2y}, \sigma_x, E; IT \); 
\{R_6, R_6\}; 
2; \( -i\sigma_3, -\sigma_0, -\sigma_0, -i\sigma_2; \)
\{R_7, R_9\}; 
2; \( -i\sigma_3, \sigma_0, -\sigma_0, -i\sigma_2; \)
\{R_6, R_7\}; 
2; \( i\sigma_3, -i\sigma_0, -i\sigma_2; \)
\( \Sigma: \Gamma_X \): \( C_{2z}, \sigma_y, I; T \); 
\{R_5\}; 
2; \( i\sigma_2, i\sigma_1, -i\sigma_2; \)
\( \Gamma_Y \): \( \sigma_x, C_{2z}, I; T \); 
\{R_9, R_9\}; 
4; \( i\Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{2.1}; \) DNL; 
0
E: \( \Gamma_T \): \( C_{2z}, \sigma_y, E; IT \); 
\{R_6, R_6\}; 
2; \( i\sigma_3, -i\sigma_3, -\sigma_0, -i\sigma_2; \)
\{R_7, R_8\}; 
2; \( i\sigma_3, i\sigma_3, -\sigma_0, -i\sigma_2; \)
\{R_6, R_8\}; 
2; \( i\sigma_3, -\sigma_3, -i\sigma_2; \)
\{R_7, R_8\}; 
2; \( i\sigma_3, i\sigma_3, -\sigma_0, -i\sigma_2; \)
\{R_6, R_8\}; 
2; \( i\sigma_3, -\sigma_3, -i\sigma_2; \)
\{R_7, R_8\}; 
2; \( i\sigma_3, i\sigma_3, -\sigma_0, -i\sigma_2; \)
\{R_6, R_8\}; 
2; \( i\sigma_3, -\sigma_3, -i\sigma_2; \)
\{R_7, R_8\}; 
2; \( i\sigma_3, i\sigma_3, -\sigma_0, -i\sigma_2; \)
\{R_6, R_8\}; 
2; \( i\sigma_3, -\sigma_3, -i\sigma_2; \)
\[ \begin{align*}
\Gamma &= (000); \quad C_{2z}, C_{2y}, I, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{10}; \quad 2; \quad i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
Y &= (\frac{\pi}{2}00); \quad \sigma_z, C_{2y}, I, T; \quad \{R_{13}, R_{14}\}; \quad 4; \quad \Gamma_{0,1,0,1,0,0,0}, -i\Gamma_{2,0}; \quad P-DNL; \\
X &= (0\frac{\pi}{2}0); \quad \sigma_z, C_{2y}, I, T; \quad \{R_{13}, R_{14}\}; \quad 4; \quad \Gamma_{0,1,0,1,0,0,0}, -i\Gamma_{2,0}; \quad P-DNL; \\
Z &= (00\frac{\pi}{2}); \quad C_{2z}, C_{2y}, I, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{10}; \quad 2; \quad i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
U &= (0\frac{\pi}{2}2); \quad \sigma_z, C_{2y}, I, T; \quad \{R_{13}, R_{14}\}; \quad 4; \quad \Gamma_{0,1,0,1,0,0,0}, -i\Gamma_{2,0}; \quad P-DNL; \\
T &= (\frac{\pi}{2}0\frac{\pi}{2}); \quad \sigma_z, C_{2y}, I, T; \quad \{R_{13}, R_{14}\}; \quad 4; \quad \Gamma_{0,1,0,1,0,0,0}, -i\Gamma_{2,0}; \quad P-DNL; \\
S &= (\frac{\pi}{2}20); \quad C_{2z}, \sigma_z, I, T; \quad \{R_{13}, R_{14}\}; \quad 4; \quad \Gamma_{0,1,0,1,0,0,0}, -i\Gamma_{2,0}; \quad P-DNL; \\
R &= (\frac{\pi}{2}2\frac{\pi}{2}); \quad C_{2z}, \sigma_z, I, T; \quad \{R_{13}, R_{14}\}; \quad 4; \quad \Gamma_{0,1,0,1,0,0,0}, -i\Gamma_{2,0}; \quad P-DNL; \\
\Delta &= \Gamma Y; \quad C_{2y}, \sigma_x, I, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \\
D &= \Gamma X; \quad C_{2y}, \sigma_x, I, T; \quad \{R_5, R_8\}; \quad 2; \quad i\sigma_3, i\sigma_0, -i\sigma_2; \\
\Sigma &= \Gamma X; \quad C_{2y}, \sigma_x, I, T; \quad \{R_5, R_8\}; \quad 2; \quad i\sigma_3, i\sigma_0, -i\sigma_2; \\
P &= \Gamma X; \quad C_{2y}, \sigma_x, I, T; \quad \{R_5, R_8\}; \quad 2; \quad i\sigma_3, i\sigma_0, -i\sigma_2; \\
B &= \Gamma Z; \quad C_{2y}, \sigma_x, I, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \\
C &= \Gamma Z; \quad C_{2y}, \sigma_x, I, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \\
A &= \Gamma Z; \quad C_{2y}, \sigma_x, I, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \\
H &= \Gamma Y; \quad C_{2y}, \sigma_y, I, T; \quad \{R_5, R_8\}; \quad 4; \quad i\Gamma_{0,2,0,1,0,1,0,0}, -i\Gamma_{2,1}; \quad DNL; \quad 0 \\
Q &= \Gamma Z; \quad C_{2y}, \sigma_y, I, T; \quad \{R_5, R_8\}; \quad 4; \quad i\Gamma_{0,2,0,1,0,1,0,0}, -i\Gamma_{2,1}; \quad DNL; \quad 0 \\
G &= \Gamma X; \quad C_{2y}, \sigma_y, I, T; \quad \{R_5, R_8\}; \quad 4; \quad i\Gamma_{0,2,0,1,0,1,0,0}, -i\Gamma_{2,1}; \quad DNL; \quad 0 \\
\end{align*} \]
\( \Gamma_0; \{C_2z[000], C_{2y}[\frac{1}{2}0\frac{1}{2}], \{I\}[0\frac{1}{2}0]\}; \) Centrosymmetric; with SOC

\[ \begin{align*}
\Gamma; (000): & C_{2z}, C_{2y}, I, T; R_5; \quad 2: i\sigma_2, i\sigma_1, \sigma_0, i\sigma_2; \\
& R_{10}; \quad 2: i\sigma_2, i\sigma_1, -\sigma_0, i\sigma_2; \\
Y; (\frac{1}{2}00): & \sigma_z C_{2z}, I, T; \{R_{13}, R_{14}\}; 4: \Gamma_{0.1}, \Gamma_{3.3.0}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad P-DNL \text{YT}; \\
X; (0\frac{1}{2}0): & \sigma_y C_{2z}, I, T; \{R_{13}, R_{14}\}; 4: \Gamma_{0.1}, \Gamma_{3.3.0}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad P-DNL \text{XS}; \\
Z; (00\frac{1}{2}): & \sigma_z \sigma_z, I, T; \{R_{13}, R_{14}\}; 4: \Gamma_{0.1}, \Gamma_{3.3.0}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad DP; \quad 0 \\
U; (0\frac{1}{2} \frac{1}{2} \frac{1}{2}): & \sigma_z C_{2z}, I, T; \{R_5, R_6\}; 2: -\sigma_0, i\sigma_1, \sigma_0, i\sigma_2; \\
& \{R_7, R_8\}; 2: -\sigma_0, -i\sigma_3, \sigma_0, i\sigma_2; \\
& \{R_{15}, R_{16}\}; 2: -\sigma_0, i\sigma_1, -\sigma_0, i\sigma_2; \\
& \{R_{17}, R_{18}\}; 2: \sigma_0, -i\sigma_3, -\sigma_0, i\sigma_2; \\
T; (\frac{1}{4}0\frac{1}{2}): & C_{2z}, \sigma_y, I, T; \{R_0, R_0\}; 4: i\Gamma_{0.2}, \Gamma_{0.3}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad P-DNL \text{S}; \\
& \{R_{10}, R_{10}\}; 4: i\Gamma_{0.2}, \Gamma_{0.3}, -\Gamma_{0.3}, i\Gamma_{2.0}; \quad P-DNL \text{S}; \\
S; (\frac{1}{2} \frac{1}{2} 0): & C_{2z}, C_{2y}, I, T; \{R_0, R_0\}; 4: i\Gamma_{0.2}, \Gamma_{0.3}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad P-DNL \text{XS}; \\
& \{R_{10}, R_{10}\}; 4: i\Gamma_{0.2}, \Gamma_{0.3}, -\Gamma_{0.3}, i\Gamma_{2.0}; \quad P-DNL \text{XS}; \\
R; (\frac{1}{2} \frac{1}{2} \frac{1}{2}): & C_{2z}, C_{2z}, I, T; \{R_0, R_0\}; 4: i\Gamma_{0.2}, \Gamma_{0.3}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad P-DNL \text{TR}; \\
& \{R_{10}, R_{10}\}; 4: i\Gamma_{0.2}, \Gamma_{0.3}, -\Gamma_{0.3}, i\Gamma_{2.0}; \quad P-DNL \text{TR}; \\
\Delta; \Gamma Y; & C_{2y}, \sigma_x, I, T; \quad R_5; \quad 2: i\sigma_2, i\sigma_1, -i\sigma_2; \\
D; X S; & \sigma_x \sigma_z, I, T; \quad \{R_0, R_0\}; \quad 4: i\Gamma_{0.3}, -i\Gamma_{0.3}, \Gamma_{2.3}; \quad \text{DNL}; \quad 0 \\
P; U R; & C_{2y}, \sigma_x, \bar{E}, I, T; \quad \{R_0, R_0\}; \quad 2: -i\sigma_3, -i\sigma_0, -\sigma_0, -i\sigma_2; \\
& \{R_7, R_9\}; \quad 2: -i\sigma_3, \sigma_3, -\sigma_0, -i\sigma_2; \\
B; Z T; & \sigma_z C_{2y}, I, T; \quad \{R_0, R_0\}; \quad 2: i\sigma_3, i\sigma_0, -i\sigma_2; \\
& \{R_6, R_7\}; \quad 2: i\sigma_3, -i\sigma_0, -i\sigma_2; \\
\Sigma; \Gamma X; & C_{2z}, \sigma_y, I, T; \quad R_5; \quad 2: i\sigma_2, i\sigma_1, -i\sigma_2; \\
C; Y S; & C_{2z}, \sigma_z, I, T; \quad \{R_5, R_7\}; \quad 2: -i\sigma_3, -i\sigma_3, -i\sigma_2; \\
& \{R_6, R_8\}; \quad 2: -i\sigma_3, -i\sigma_3, -i\sigma_2; \\
\Xi; \Gamma R; & \sigma_y \sigma_z, I, T; \quad \{R_0, R_0\}; \quad 4: i\Gamma_{0.2}, \Gamma_{0.1}, -\Gamma_{2.3}; \quad \text{DNL}; \quad 0 \\
A; Z U; & \sigma_x \sigma_y, I, T; \quad \{R_5, R_7\}; \quad 2: i\sigma_3, -i\sigma_3, -i\sigma_2; \\
& \{R_6, R_8\}; \quad 2: i\sigma_3, -i\sigma_3, -i\sigma_2; \\
\Lambda; \Gamma Z; & C_{2z}, \sigma_y, I, T; \quad R_5; \quad 2: i\sigma_2, i\sigma_1, -i\sigma_2; \\
H; Y T; & C_{2z}, \sigma_y, I, T; \quad \{R_5, R_5\}; \quad 4: i\Gamma_{0.2}, i\Gamma_{0.1}, -\Gamma_{2.3}; \quad \text{DNL}; \quad 0 \\
Q; S R; & \sigma_z C_{2z}, I, T; \quad \{R_5, R_5\}; \quad 2: i\sigma_0, i\sigma_0, -i\sigma_2; \\
& \{R_6, R_6\}; \quad 2: i\sigma_0, -i\sigma_0, -i\sigma_2; \\
& \{R_7, R_7\}; \quad 2: -i\sigma_0, -i\sigma_0, -i\sigma_2; \\
& \{R_8, R_8\}; \quad 2: -i\sigma_0, i\sigma_0, -i\sigma_2; \\
G; X U; & \sigma_x, C_{2z}, I, T; \quad \{R_5, R_6\}; \quad 2: i\sigma_0, i\sigma_3, -i\sigma_2; \\
& \{R_7, R_8\}; \quad 2: -i\sigma_0, -i\sigma_3, -i\sigma_2; \end{align*} \]
8. SG 61-70

Γ: (000); $C_{2z} ; C_{2y}$, IT; $R_5$; 2; $i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2$;
$R_{10}$; 2; $i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2$;

Y: $(\frac{1}{2} 0 0)$; $\sigma_y, C_{2z}, IT$; $\{R_{13}, R_{14}\}$; 4; $\Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}$; P-DNL_Y$T$;

X: $(0 \frac{1}{2} 0)$; $\sigma_y, C_{2z}, IT$; $\{R_{13}, R_{14}\}$; 4; $\Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}$; P-DNL_X$S$;

Z: $(0 0 \frac{1}{2})$; $\sigma_z, C_{2y}$, IT; $\{R_{13}, R_{14}\}$; 4; $\Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}$; P-DNL_Z$U$;

U: $(0 \frac{1}{2} \frac{1}{2})$; $C_{2y}, C_{2z}$, IT; $\{R_9, R_9\}$; 4; $\Gamma_{0.2}, \Gamma_{0.3}, \Gamma_{0.3}, i\Gamma_{2.0}$; P-DNL_Z$U$;
$\{R_{10}, R_{10}\}$; 4; $i\Gamma_{0.2}, \Gamma_{0.3}, -\Gamma_{0.3}, i\Gamma_{2.0}$; P-DNL_Z$U$;

T: $(\frac{1}{2} \frac{1}{2} 0)$; $C_{2x}, C_{2z}$, IT; $\{R_9, R_9\}$; 4; $i\Gamma_{0.2}, \Gamma_{0.3}, \Gamma_{0.3}, i\Gamma_{2.0}$; P-DNL_Y$T$;
$\{R_{10}, R_{10}\}$; 4; $i\Gamma_{0.2}, \Gamma_{0.3}, -\Gamma_{0.3}, i\Gamma_{2.0}$; P-DNL_Y$T$;

S: $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$; $C_{2y}, C_{2z}$, IT; $\{R_9, R_9\}$; 4; $i\Gamma_{0.2}, \Gamma_{0.3}, \Gamma_{0.3}, i\Gamma_{2.0}$; P-DNL_X$S$;
$\{R_{10}, R_{10}\}$; 4; $i\Gamma_{0.2}, \Gamma_{0.3}, -\Gamma_{0.3}, i\Gamma_{2.0}$; P-DNL_X$S$;

R: $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$; $C_{2x}, C_{2y}$, IT; $\{R_6, R_6\}$; 2; $\sigma_0, \sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_7, R_7\}$; 2; $\sigma_0, -\sigma_0, \sigma_0, \sigma_0, -i\sigma_2$;
$\{R_8, R_8\}$; 2; $-\sigma_0, \sigma_0, -\sigma_0, \sigma_0, -i\sigma_2$;
$\{R_9, R_9\}$; 2; $-\sigma_0, -\sigma_0, -\sigma_0, \sigma_0, -i\sigma_2$;
$\{R_{16}, R_{16}\}$; 2; $\sigma_0, \sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_{17}, R_{17}\}$; 2; $\sigma_0, -\sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_{18}, R_{18}\}$; 2; $-\sigma_0, \sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_{19}, R_{19}\}$; 2; $-\sigma_0, -\sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;

$\Delta$: $\Delta_Y$; $C_{2y}, \sigma_x$, IT; $R_5$; 2; $i\sigma_2, i\sigma_1, -i\sigma_2$;

D: XS; $\sigma_x, \sigma_x$, IT; $\{R_6, R_6\}$; 4; $i\Gamma_{0.3}, -i\Gamma_{0.1}, -\Gamma_{2.1}$; DNL; 0

P: UR; $C_{2y}, \sigma_x$, IT; $\{R_6, R_6\}$; 2; $-i\sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_7, R_7\}$; 2; $-i\sigma_0, \sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_8, R_8\}$; 2; $i\sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_9, R_9\}$; 2; $i\sigma_0, \sigma_0, -\sigma_0, -i\sigma_2$;

B: ZT; $\sigma_z, C_{2y}$, IT; $\{R_5, R_5\}$; 2; $i\sigma_2, i\sigma_1, -i\sigma_2$;
$\{R_7, R_7\}$; 2; $-i\sigma_0, -i\sigma_3, -i\sigma_2$;

$\Sigma$: $\Gamma_X$; $C_{2x}, \sigma_y$, IT; $R_5$; 2; $i\sigma_2, i\sigma_1, -i\sigma_2$;

C: YS; $\sigma_y, C_{2z}$, IT; $\{R_5, R_5\}$; 2; $-i\sigma_0, i\sigma_3, -i\sigma_2$;
$\{R_7, R_7\}$; 2; $i\sigma_0, -i\sigma_3, -i\sigma_2$;

$\varepsilon$: TR; $C_{2x}, \sigma_z$, IT; $\{R_5, R_5\}$; 2; $-i\sigma_0, \sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_7, R_7\}$; 2; $-i\sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_8, R_8\}$; 2; $i\sigma_0, \sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_9, R_9\}$; 2; $i\sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;

$\Lambda$: ZU; $\sigma_y, \sigma_z$, IT; $\{R_9, R_9\}$; 4; $i\Gamma_{0.3}, -i\Gamma_{0.1}, -\Gamma_{2.1}$; DNL; 0

$\Lambda$: GF; $C_{2z}, \sigma_y$, IT; $R_5$; 2; $i\sigma_2, i\sigma_1, -i\sigma_2$;

H: YT; $\sigma_x, \sigma_y$, IT; $\{R_9, R_9\}$; 4; $i\Gamma_{0.3}, i\Gamma_{0.1}, -\Gamma_{2.1}$; DNL; 0

Q: SR; $C_{2z}, \sigma_y$, IT; $\{R_6, R_6\}$; 2; $\sigma_0, \sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_7, R_7\}$; 2; $\sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_8, R_8\}$; 2; $-i\sigma_0, \sigma_0, -\sigma_0, -i\sigma_2$;
$\{R_9, R_9\}$; 2; $-i\sigma_0, -\sigma_0, -\sigma_0, -i\sigma_2$;

G: XU; $\sigma_z, C_{2z}$, IT; $\{R_5, R_5\}$; 2; $i\sigma_0, i\sigma_3, -i\sigma_2$;
$\{R_7, R_7\}$; 2; $-i\sigma_0, -i\sigma_3, -i\sigma_2$;
Γ₀; \{C_{2z}|1 0 1\}; \{C_{2y}|1 1 0\}; \{I|1 1 0\}; T; Centrosymmetric; with SOC

\[ \Gamma; (000); \ C_{2z},C_{2y},I,T; \ \Gamma_0; \ 2; i\sigma_2,i\sigma_1,\sigma_0,-i\sigma_2; \]

\[ \Gamma_0; \ 2; i\sigma_2,i\sigma_1,-\sigma_0,-i\sigma_2; \]

\[ Y; (\frac{1}{2}00); \sigma_x,C_{2z},I,T; \ \Gamma_{13},\Gamma_{14}; \ 4; \Gamma_{01},i\Gamma_{30},\Gamma_{03},-i\Gamma_{20}; \ P-\text{DNLYS}; \]

\[ X; (0\frac{1}{2}0); \sigma_x,C_{2y},I,T; \ \Gamma_{13},\Gamma_{14}; \ 4; \Gamma_{01},i\Gamma_{30},\Gamma_{03},-i\Gamma_{20}; \ P-\text{DNLYS}; \]

\[ Z; (00\frac{1}{2}); \sigma_x,C_{2y},I,T; \ \Gamma_{13},\Gamma_{14}; \ 4; \Gamma_{01},i\Gamma_{30},\Gamma_{03},-i\Gamma_{20}; \ P-\text{DNLYS}; \]

\[ U; (0\frac{1}{2}\frac{1}{2}); C_{2z},C_{2y},I,T; \ \Gamma_{19},\Gamma_{19}; \ 4; \Gamma_{03},\Gamma_{01},-\Gamma_{00},-\Gamma_{21}; \ P-\text{DNLYS}; \]

\[ T; (\frac{1}{2}0\frac{1}{2}); C_{2y},\sigma_x,I,T; \ \Gamma_{13},\Gamma_{14}; \ 4; \Gamma_{01},i\Gamma_{30},\Gamma_{03},-i\Gamma_{20}; \ P-\text{DNLYS}; \]

\[ S; (\frac{1}{2}\frac{1}{2}0); \sigma_y,C_{2z},I,T; \ \Gamma_{10},\Gamma_{10}; \ 4; i\Gamma_{02},\Gamma_{03},\Gamma_{03},i\Gamma_{20}; \ P-\text{DNLYS}; \]

\[ R; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \sigma_y,\sigma_z,I,T; \ \Gamma_{10},\Gamma_{10}; \ 4; i\Gamma_{02},\Gamma_{03},\Gamma_{03},i\Gamma_{20}; \ P-\text{DNLYS}; \]

\[ \Delta; \Gamma Y; \ C_{2y},\sigma_x,I,T; \ \Gamma_{05}; \ 2; i\sigma_2,i\sigma_1,-i\sigma_2; \]

\[ D; \ X S; \ C_{2y},\sigma_y,I,T; \ \Gamma_{05},\Gamma_{05}; \ 2; i\sigma_2,i\sigma_1,-i\sigma_2; \]

\[ \{\Gamma_0,\Gamma_1\}; \ 2; i\sigma_3,-i\sigma_0,-i\sigma_2; \]

\[ P; \ \Gamma_{03},-\Gamma_{01},i\Gamma_{20}; \ DNL; \ 0 \]

\[ B; \ \Gamma Y T; \ \sigma_y,\sigma_z,I,T; \ \Gamma_{05},\Gamma_{05}; \ 2; i\sigma_0,-i\sigma_3,-i\sigma_2; \]

\[ \Delta; \ \Gamma Z; \ C_{2z},\sigma_y,I,T; \ \Gamma_{05}; \ 2; i\sigma_2,i\sigma_1,-i\sigma_2; \]

\[ C; \ \Gamma Z S; \ C_{2z},\sigma_y,I,T; \ \Gamma_{05},\Gamma_{05}; \ 4; i\Gamma_{02},i\Gamma_{03},-\Gamma_{21}; \ DNL; \ 0 \]

\[ E; \ \Gamma Y R; \ \sigma_y,\sigma_z,I,T; \ \Gamma_{05},\Gamma_{05}; \ 4; i\Gamma_{03},-i\Gamma_{01},i\Gamma_{20}; \ DNL; \ 0 \]

\[ A; \ \Gamma Z U; \ \sigma_y,\sigma_z,I,T; \ \Gamma_{05},\Gamma_{05}; \ 4; i\Gamma_{03},-i\Gamma_{01},-\Gamma_{21}; \ DNL; \ 0 \]

\[ \Lambda; \ \Gamma Z H; \ C_{2z},\sigma_y,I,T; \ \Gamma_{05}; \ 2; i\sigma_2,i\sigma_1,-i\sigma_2; \]

\[ H; \ \Gamma Z Y; \ C_{2z},\sigma_y,I,T; \ \Gamma_{05},\Gamma_{05}; \ 2; -i\sigma_3,i\sigma_0,-i\sigma_2; \]

\[ \{\Gamma_0,\Gamma_1\}; \ 2; -i\sigma_3,-i\sigma_0,-i\sigma_2; \]

\[ Q; \ \Gamma Z S; \ C_{2z},\sigma_y,I,T; \ \Gamma_{05},\Gamma_{05}; \ 2; -i\sigma_0,i\sigma_0,-i\sigma_2; \]

\[ \{\Gamma_0,\Gamma_1\}; \ 2; -i\sigma_0,-i\sigma_0,-i\sigma_2; \]

\[ G; \ \Gamma Z X; \ C_{2z},\sigma_y,I,T; \ \Gamma_{05},\Gamma_{05}; \ 4; i\Gamma_{02},i\Gamma_{03},-\Gamma_{23}; \ DNL; \ 0 \]
\( \Gamma^6; \{ C_{2x}[00\frac{1}{2}], C_{2y}[00\frac{1}{2}], I[000] \}, \mathcal{T}; \) Centrosymmetric; with SOC

\( \Gamma; \) (000); \( C_{2x}, C_{2y}, I, \mathcal{T}; R_5; \) 2; \( i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \) 
\( R_{10}; \) 2; \( i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \)

\( Y; \) (\( \frac{1}{2} \frac{1}{2} 0 \)); \( C_{2x}, C_{2y}, I, \mathcal{T}; R_5; \) 2; \( i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \) 
\( R_{10}; \) 2; \( i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \)

\( Z; \) (00\( \frac{1}{2} \)); \( C_{2x}, C_{2x}, I, \mathcal{T}; \{ R_{13}, R_{14} \}; \) 4; \( \Gamma_{0,1}, i\Gamma_{0,3}, \Gamma_{0,3}, -i\Gamma_{2,0}; \) P-DNL \( \mathbb{Z}_2; \)

\( T; \) (\( \frac{1}{2} \frac{1}{2} \)); \( C_{2x}, C_{2x}, I, \mathcal{T}; \{ R_{13}, R_{14} \}; \) 4; \( \Gamma_{0,1}, i\Gamma_{0,3}, \Gamma_{0,3}, -i\Gamma_{2,0}; \) P-DNL \( \mathcal{T}; \) 

\( S; \) (0\( \frac{1}{2} 0 \)); \( C_{2x}, I, \mathcal{T}; \{ R_2, R_4 \}; \) 2; \( i\sigma_3, \sigma_0, -i\sigma_2; \) 
\( \{ R_6, R_8 \}; \) 2; \( i\sigma_3, -\sigma_0, -i\sigma_2; \)

\( R; \) (0\( \frac{1}{2} \)); \( C_{2x}, E, I, \mathcal{T}; \{ R_0, R_9 \}; \) 4; \( \Gamma_{0,1}, -\Gamma_{0,0}, \Gamma_{0,3}, i\Gamma_{2,0}; \) P-DNL 

\( \Lambda; \) \( \Gamma \mathcal{Z}; \) \( C_{2x}, \sigma_y, I, \mathcal{T}; R_5; \) 2; \( i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( H; \) \( \Gamma \mathcal{T}; \) \( C_{2x}, \sigma_y, I, \mathcal{T}; R_5; \) 2; \( i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( D; \) \( \Gamma \mathcal{R}; \) \( C_{2x}, \sigma_y, I, \mathcal{T}; \{ R_2, R_4 \}; \) 2; \( i\sigma_3, -i\sigma_2; \)

\( A; \) \( \Gamma \mathcal{T}; \) \( \sigma_x, \sigma_y, I, \mathcal{T}; \{ R_5, R_6 \}; \) 2; \( i\sigma_0, \sigma_3, -i\sigma_2; \) 
\( \{ R_7, R_8 \}; \) 2; \( -i\sigma_0, -\sigma_3, -i\sigma_2; \)

\( \Sigma; \) \( \Gamma \mathcal{Y}; \) \( C_{2x}, \sigma_y, I, \mathcal{T}; R_5; \) 2; \( i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( \Delta; \) \( \Gamma \mathcal{D}; \) \( C_{2y}, \sigma_x, I, \mathcal{T}; R_5; \) 2; \( i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( B; \) \( \Gamma \mathcal{Z}; \) \( \sigma_x, \sigma_z, I, \mathcal{T}; \{ R_0, R_9 \}; \) 4; \( i\Gamma_{0,3}, -i\Gamma_{0,1}, -\Gamma_{2,1}; \) DNL; 0

\( G; \) \( \Gamma \mathcal{T}; \) \( \sigma_x, \sigma_z, I, \mathcal{T}; \{ R_9, R_9 \}; \) 4; \( i\Gamma_{0,3}, -i\Gamma_{0,1}, -\Gamma_{2,1}; \) DNL; 0

\( F; \) \( \Gamma \mathcal{F}; \) \( C_{2y}, \sigma_x, I, \mathcal{T}; R_5; \) 2; \( i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( E; \) \( \Gamma \mathcal{E}; \) \( \sigma_x, \sigma_y, I, \mathcal{T}; \{ R_5, R_6 \}; \) 2; \( i\sigma_0, \sigma_3, -i\sigma_2; \) 
\( \{ R_7, R_8 \}; \) 2; \( -i\sigma_0, -\sigma_3, -i\sigma_2; \)

\( C; \) \( \Gamma \mathcal{C}; \) \( C_{2x}, \sigma_y, I, \mathcal{T}; R_5; \) 2; \( i\sigma_2, i\sigma_1, -i\sigma_2; \)
$\Gamma_0^6$: \( \{C_{2z}|00\frac{1}{2}\}, \{C_{2y}|00\frac{1}{2}\}, \{I|\frac{1}{2}\frac{1}{2}\0\}, T \); Centrosymmetric; with SOC

\[ \begin{align*}
\Gamma: \ (000): \ & C_{2z}, C_{2y}, I, T; \ \{R_5\}; \ 2; \ \sigma_2, \sigma_3, \sigma_0, -\sigma_2; \\
& \quad \Gamma; \ (000): \ & C_{2z}, C_{2y}, I, T; \ \{R_{10}\}; \ 2; \ \sigma_2, \sigma_1, -\sigma_0, -\sigma_2; \\
Y: \ (\frac{1}{2}\frac{1}{2}0): \ & C_{2z}, C_{2y}, I, T; \ \{R_5\}; \ 2; \ \sigma_2, \sigma_1, \sigma_0, -\sigma_2; \\
& \quad \Gamma; \ (000): \ & C_{2z}, C_{2y}, I, T; \ \{R_{10}\}; \ 2; \ \sigma_2, \sigma_1, -\sigma_0, -\sigma_2; \\
Z: \ (00\frac{1}{2}): \ & C_{2z}, C_{2y}, I, T; \ \{R_{13}, R_{14}\}; \ 4; \ \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \ \text{P-DNL}_{2B}; \\
T: \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}): \ & C_{2z}, C_{2y}, I, T; \ \{R_{13}, R_{14}\}; \ 4; \ \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \ \text{P-DNL}_{TG}; \\
S: \ (0\frac{1}{2}0); \ & \sigma_x, E, I, T; \ \{R_9, R_9\}; \ 4; \ \Gamma_{0.1}, -\Gamma_{0.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \ \text{DP}; \ 0; \\
R: \ (0\frac{1}{2}\frac{1}{2}); \ & \sigma_x, I, T; \ \{R_1, R_1\}; \ 2; \ \sigma_0, \sigma_0, -i\sigma_2; \\
& \quad \Gamma; \ (000): \ & C_{2z}, C_{2y}, I, T; \ \{R_3, R_3\}; \ 2; \ -\sigma_0, \sigma_0, -i\sigma_2; \\
& \quad \Gamma; \ (000): \ & C_{2z}, C_{2y}, I, T; \ \{R_5, R_5\}; \ 2; \ \sigma_0, -\sigma_0, -i\sigma_2; \\
& \quad \Gamma; \ (000): \ & C_{2z}, C_{2y}, I, T; \ \{R_7, R_7\}; \ 2; \ -\sigma_0, -\sigma_0, -i\sigma_2; \\
A: \ \Gamma_Z; \ & C_{2z}, \sigma_y, I, T; \ \{R_5\}; \ 2; \ \sigma_2, \sigma_1, -i\sigma_2; \\
H: \ \Gamma_T; \ & C_{2z}, \sigma_y, I, T; \ \{R_5\}; \ 2; \ \sigma_2, -\sigma_1, -i\sigma_2; \\
D: \ \Gamma_R; \ & C_{2z}, \sigma_y, I, T; \ \{R_2, R_2\}; \ 2; \ \sigma_0, -i\sigma_2; \\
& \quad \Gamma; \ (000): \ & C_{2z}, \sigma_y, I, T; \ \{R_4, R_4\}; \ 2; \ -i\sigma_0, -i\sigma_2; \\
\Lambda: \ \Gamma_Z; \ & \sigma_x, \sigma_y, I, T; \ \{R_5, R_5\}; \ 2; \ i\sigma_0, \sigma_3, -i\sigma_2; \\
& \quad \Gamma; \ (000): \ & \sigma_x, \sigma_y, I, T; \ \{R_7, R_7\}; \ 2; \ -i\sigma_0, -\sigma_3, -i\sigma_2; \\
\Sigma: \ \Gamma_Y; \ & C_{2z}, \sigma_y, I, T; \ \{R_5\}; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
\Delta: \ \Gamma_D; \ & C_{2y}, \sigma_z, I, T; \ \{R_5\}; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
B: \ \Gamma_B; \ & \sigma_z, \sigma_z, I, T; \ \{R_9, R_9\}; \ 4; \ i\Gamma_{0.3}, -i\Gamma_{0.1}, -\Gamma_{2.1}; \ \text{DNL}; \ \text{DNL}; \ 0; \\
G: \ \Gamma_G; \ & \sigma_z, \sigma_z, I, T; \ \{R_9, R_9\}; \ 4; \ -i\Gamma_{0.3}, i\Gamma_{0.1}, -\Gamma_{2.1}; \ \text{DNL}; \ \text{DNL}; \ 0; \\
F: \ \Gamma_F; \ & C_{2y}, \sigma_y, I, T; \ \{R_5\}; \ 2; \ \sigma_2, -i\sigma_1, -i\sigma_2; \\
E: \ \Gamma_E; \ & \sigma_y, \sigma_y, I, T; \ \{R_5, R_5\}; \ 2; \ \sigma_0, \sigma_3, -i\sigma_2; \\
C: \ \Gamma_C; \ & C_{2z}, \sigma_y, I, T; \ \{R_5\}; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ \Gamma^6_0; \{C_{2x}, [000], (C_{2y}, [000], (T[000], T); Centrosymmetric; with SOC \]

\[ \Gamma; (000); C_{2x}, C_{2y}, I; T; R_5; 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ Y; (\frac{1}{2} \frac{1}{2} 0); C_{2x}, C_{2y}, I; T; R_5; 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ Z; (00 \frac{1}{2}); C_{2x}, C_{2y}, I; T; R_5; 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ T; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{2x}, C_{2y}, I; T; R_5; 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ S; (0 \frac{1}{2} 0); C_{2x}, I; T; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, -i\sigma_2; \]
\[ R; (0 \frac{1}{2} \frac{1}{2}); C_{2x}, I; T; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, -i\sigma_2; \]
\[ A; \Gamma Z; C_{2x}, \sigma_y IT; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ H; YT; C_{2x}, \sigma_y IT; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ D; SR; C_{2x}, IT; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \]
\[ A; \Gamma Z; C_{2x}, \sigma_y IT; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ \Sigma; \Gamma Y; C_{2x}, \sigma_y IT; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ \Delta; \Gamma \Delta; C_{2y}, \sigma_x IT; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ B; ZB; C_{2y}, \sigma_x IT; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ G; TG; C_{2y}, \sigma_x IT; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ F; YF; C_{2y}, \sigma_x IT; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ E; TE; C_{2x}, \sigma_y IT; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ C; YC; C_{2x}, \sigma_y IT; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ \Gamma \sigma; C_2z, C_2y, I; T; R_5; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ Y; (\frac{1}{2} \frac{1}{2} 0); C_2z, C_2y, I; T; R_5; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ Z; (00 \frac{1}{2}); \sigma_x, \sigma_z, I; \{ R_{13}, R_{14} \}; 4; \Gamma_{0.1}, \Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \text{DP; 0} \]
\[ T; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \sigma_x, \sigma_z, I; \{ R_{13}, R_{14} \}; 4; \Gamma_{0.1}, \Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \text{DP; 0} \]
\[ S; (0 \frac{1}{2} 0); C_2z, I; \{ R_2, R_4 \}; 2; i\sigma_3, -\sigma_0, i\sigma_2; \]
\[ \{ R_6, R_8 \}; 2; i\sigma_3, -\sigma_0, i\sigma_2; \]
\[ R; (0 \frac{1}{2} \frac{1}{2}); C_2z, I; \{ R_2, R_4 \}; 2; i\sigma_3, -\sigma_0, i\sigma_2; \]
\[ \{ R_6, R_8 \}; 2; i\sigma_3, -\sigma_0, i\sigma_2; \]
\[ \Lambda; \Gamma Z; C_2z, \sigma_y, I; T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ H; \Gamma T; C_2z, \sigma_y, I; T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ D; \Gamma R; C_2z, I; T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2; \]
\[ A; \Gamma T; \sigma_z, \sigma_y, I; T; \{ R_5, R_7 \}; 2; i\sigma_3, \sigma_3, -i\sigma_2; \]
\[ \{ R_6, R_8 \}; 2; i\sigma_3, -\sigma_3, -i\sigma_2; \]
\[ \Sigma; \Gamma Y; C_2z, \sigma_y, I; T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ \Delta; \Gamma \Delta; C_2z, \sigma_y, I; T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ B; \Gamma B; \sigma_z, C_2y, I; T; \{ R_5, R_7 \}; 2; i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \{ R_6, R_8 \}; 2; i\sigma_3, -\sigma_0, -i\sigma_2; \]
\[ G; \Gamma G; \sigma_z, C_2y, I; T; \{ R_5, R_7 \}; 2; i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \{ R_6, R_8 \}; 2; i\sigma_3, -\sigma_0, -i\sigma_2; \]
\[ F; \Gamma F; C_2y, \sigma_z, I; T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ E; \Gamma E; \sigma_z, \sigma_y, I; T; \{ R_5, R_7 \}; 2; i\sigma_3, \sigma_3, -i\sigma_2; \]
\[ \{ R_6, R_8 \}; 2; i\sigma_3, -\sigma_3, -i\sigma_2; \]
\[ C; \Gamma C; C_2z, \sigma_y, I; T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
Γ⁺: \{C_2z[000], C_2y[000], \{I|\frac{1}{2} \frac{1}{2} \frac{1}{2}\}\}, T; Centrosymmetric; with SOC

Γ; (000): C_{2z}, C_{2y}, I, T; \( R_5 \); 2; \( iσ_2, iσ_1, σ_0, -iσ_2; \)
\( R_{10} \); 2; \( iσ_2, iσ_1, -σ_0, -iσ_2; \)

Y; (\frac{1}{2} \frac{1}{2} 0): C_{2z}, C_{2y}, I, T; \( R_5 \); 2; \( iσ_2, iσ_1, σ_0, -iσ_2; \)
\( R_{10} \); 2; \( iσ_2, iσ_1, -σ_0, -iσ_2; \)

Z; (00 \frac{1}{2}): C_{2z}, C_{2y}, I, T; \( R_5 \); 2; \( iσ_2, iσ_1, σ_0, -iσ_2; \)
\( R_{10} \); 2; \( iσ_2, iσ_1, -σ_0, -iσ_2; \)

T; (\frac{1}{2} \frac{1}{2} \frac{1}{2}): C_{2z}, C_{2y}, I, T; \( R_5 \); 2; \( iσ_2, iσ_1, σ_0, -iσ_2; \)
\( R_{10} \); 2; \( iσ_2, iσ_1, -σ_0, -iσ_2; \)

S; (0 \frac{1}{2} 0): σ_x, E, I, T; \{R_0, R_9\}; 4; Γ₀, 1, -Γ₀, 0, Γ₀, 3, -iΓ₂, 0; DP; 0

R; (0 \frac{1}{2} \frac{1}{2}): σ_x, E, I, T; \{R_9, R_9\}; 4; Γ₀, 1, -Γ₀, 0, Γ₀, 3, -iΓ₂, 0; DP; 0

\[ A; \Gamma Z; C_{2z}, σ_y, I, T; \( R_5 \); 2; \( iσ_2, iσ_1, -iσ_2; \)
\{R_4, R_4\}; 2; \( -iσ_0, -iσ_2; \)

\[ Σ; \Gamma Y; C_{2z}, σ_y, I, T; \( R_5 \); 2; \( iσ_2, iσ_1, -iσ_2; \)

\[ Δ; \Gamma Δ; C_{2y}, σ_x, I, T; \( R_5 \); 2; \( iσ_2, iσ_1, -iσ_2; \)

\[ B; \Gamma Z; C_{2y}, σ_x, I, T; \( R_5 \); 2; \( iσ_2, iσ_1, -iσ_2; \)

\[ G; \Gamma G; C_{2y}, σ_x, I, T; \( R_5 \); 2; \( iσ_2, -iσ_1, -iσ_2; \)

\[ F; \Gamma F; C_{2y}, σ_x, I, T; \( R_5 \); 2; \( iσ_2, -iσ_1, -iσ_2; \)

\[ E; \Gamma E; C_{2z}, σ_y, I, T; \( R_5 \); 2; \( iσ_2, iσ_1, -iσ_2; \)

\[ C; \Gamma C; C_{2z}, σ_y, I, T; \( R_5 \); 2; \( iσ_2, iσ_1, -iσ_2; \)
\[ \Gamma^0_6 \{C_2z|000\}, \{C_2y|000\}, \{I|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}, T; Centrosymmetric; with SOC \]

| Location | Symmetry | Operations | Description |
|----------|-----------|------------|-------------|
| \( \Gamma; (000) \): | \( C_{2z}, C_{2y}, I, T; R_5 \) | 2; \( i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2 \) |  |
| \( R_{10} \) | 2; \( i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2 \) |  |
| \( Y; \left( \frac{1}{2}\frac{1}{2}\frac{1}{2} \right) \): | \( C_{2z}, C_{2y}, I, T; R_5 \) | 2; \( i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2 \) |  |
| \( R_{10} \) | 2; \( i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2 \) |  |
| \( Z; (00\frac{1}{2}) \): | \( \sigma_x, \sigma_z, I, T \) | \( \{R_{13}, R_{14}\} \) | 4; \( \Gamma_{0.1}, -\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; DP; 0 \) |
| \( T; \left( \frac{1}{2}\frac{1}{2}\frac{1}{2} \right) \): | \( \sigma_x, \sigma_z, I, T \) | \( \{R_{13}, R_{14}\} \) | 4; \( \Gamma_{0.1}, -\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; DP; 0 \) |
| \( S; (0\frac{1}{2}0) \): | \( \sigma_z, E, I, T \) | \( \{R_9, R_9\} \) | 4; \( \Gamma_{0.1}, -\Gamma_{0.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; DP; 0 \) |
| \( R; (0\frac{1}{2}\frac{1}{2}) \): | \( \sigma_z, E, I, T \) | \( \{R_9, R_9\} \) | 4; \( \Gamma_{0.1}, -\Gamma_{0.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; DP; 0 \) |
| \( \Lambda; \Gamma Z \): | \( C_{2z}, \sigma_y, I, T \) | \( R_5 \) | 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \) |
\( \Gamma_0^f \): \( \{C_{2z}[000]\}, \{C_{2y}[000]\}, \{T[000]\}; \) Centrosymmetric; with SOC

\( \Gamma; (000); C_{2z},C_{2y},I,T; R_5; \)
\( R_{10}; \)
\( 2: i_\sigma_2, i_\sigma_1, \sigma_0, -i_\sigma_2; \)

\( Y; (0\frac{1}{2}\frac{1}{2}); C_{2z},C_{2y},I,T; R_5; \)
\( R_{10}; \)
\( 2: i_\sigma_2, i_\sigma_1, \sigma_0, -i_\sigma_2; \)

\( X; (\frac{1}{2}0\frac{1}{2}); C_{2z},C_{2y},I,T; R_5; \)
\( R_{10}; \)
\( 2: i_\sigma_2, i_\sigma_1, \sigma_0, -i_\sigma_2; \)

\( Z; (\frac{1}{2}\frac{1}{2}0); C_{2z},C_{2y},I,T; R_5; \)
\( R_{10}; \)
\( 2: i_\sigma_2, i_\sigma_1, \sigma_0, -i_\sigma_2; \)

\( L; (\frac{1}{2}00); I,\bar{E},\bar{T}; \)
\( \{R_2, R_2\}; 2: \sigma_0, -\sigma_0, -i_\sigma_2; \)
\( \{R_4, R_4\}; 2: -\sigma_0, -\sigma_0, -i_\sigma_2; \)

\( \Lambda; \Gamma Z/\Gamma \Lambda; C_{2z},\sigma_y,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( \Gamma; \bar{X}G/\bar{X}Y; C_{2z},\sigma_y,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( H; \bar{Y}H/\bar{Y}X; C_{2z},\sigma_y,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( Q; \bar{Z}Q; C_{2z},\sigma_y,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( \Sigma; \Gamma X/\Gamma \Sigma; C_{2z},\sigma_2,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( \bar{C}; \bar{Y}C/\bar{Y}Z; C_{2z},\sigma_2,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( \bar{A}; \bar{Z}A/\bar{Z}Y; C_{2z},\sigma_2,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( \bar{U}; \bar{X}U; C_{2z},\sigma_2,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( \Delta; \Gamma Y/\Gamma \Delta; C_{2y},\sigma_2,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( D; \bar{X}D/\bar{X}Z; C_{2y},\sigma_2,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( B; \bar{Z}B/\bar{Z}X; C_{2y},\sigma_2,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)

\( R; \bar{Y}R; C_{2y},\sigma_2,IT; R_5; \)
\( 2: i_\sigma_2, i_\sigma_1, -i_\sigma_2; \)
$\Gamma_0^f$: $\{C_{2z}[000], \{C_{2y}[000], \{I[\frac{1}{2}, \frac{1}{2}, \frac{1}{2}], \}$; Centrosymmetric; with SOC

$\Gamma$: (000); $C_{2z}, C_{2y}, I, T$; $R_0$; $2; i\sigma_y, i\sigma_1, \sigma_0, -i\sigma_2$

$R_{10}$; $2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2$

$Y$: $(0 \frac{1}{2} \frac{1}{2})$; $\sigma_x, \sigma_y, I, T$; \{R_{13}, R_{14}\}; $4; \Gamma_0, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; D_P; 0

$X$: $(\frac{1}{2} 0 \frac{1}{2})$; $\sigma_x, \sigma_y, I, T$; \{R_{13}, R_{14}\}; $4; \Gamma_0, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; D_P; 0

$Z$: $(\frac{1}{2} \frac{1}{2} 0)$; $\sigma_y, \sigma_z, I, T$; \{R_{13}, R_{14}\}; $4; \Gamma_0, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; D_P; 0

$L$: $(\frac{1}{2} \frac{1}{2} 0)$; $\Gamma, E, T$; \{R_{2}, R_{2}\}; $2; \sigma_0, -\sigma_0, -i\sigma_2$

\{R_{4}, R_{4}\}; $2; -\sigma_0, -\sigma_0, -i\sigma_2$

$\Lambda$: $\Gamma, Z, \Gamma, \Lambda$; $C_{2z}, \sigma_y, IT$; $R_5$; $2; i\sigma_2, i\sigma_1, -i\sigma_2$

$G$: $X, G, X, Y$; $\sigma_x, C_{2z}, IT$; \{R_{6}, R_{8}\}; $2; \sigma_3, i\sigma_0, -i\sigma_2$

\{R_{6}, R_{7}\}; $2; i\sigma_3, -i\sigma_0, -i\sigma_2$

$H$: $Y, H, Y, X$; $\sigma_y, C_{2z}, IT$; \{R_{5}, R_{8}\}; $2; -i\sigma_3, i\sigma_0, -i\sigma_2$

\{R_{6}, R_{7}\}; $2; -i\sigma_3, -i\sigma_0, -i\sigma_2$

$Q$: $Z, Q$; $C_{2z}, \sigma_z, IT$; $R_0$; $2; i\sigma_3, \sigma_1, -i\sigma_2$

$\Sigma$: $\Gamma, X, \Gamma, \Sigma$; $C_{2z}, \sigma_z, IT$; $R_5$; $2; i\sigma_2, i\sigma_1, -i\sigma_2$

$C$: $Y, C, Y, Z$; $\sigma_y, C_{2z}, IT$; \{R_{5}, R_{8}\}; $2; -i\sigma_3, i\sigma_0, -i\sigma_2$

\{R_{6}, R_{7}\}; $2; -i\sigma_3, -i\sigma_0, -i\sigma_2$

$A$: $Z, A, Z, Y$; $\sigma_z, \sigma_y, IT$; \{R_{5}, R_{7}\}; $2; i\sigma_3, \sigma_3, -i\sigma_2$

\{R_{6}, R_{8}\}; $2; i\sigma_3, -\sigma_3, -i\sigma_2$

$U$: $X, U$; $C_{2z}, \sigma_y, IT$; $R_0$; $2; i\sigma_3, \sigma_1, -i\sigma_2$

$\Delta$: $\Gamma, Y, \Gamma, \Delta$; $C_{2y}, \sigma_z, IT$; $R_0$; $2; i\sigma_2, i\sigma_1, -i\sigma_2$

$D$: $X, D, X, Z$; $\sigma_x, C_{2y}, IT$; \{R_{5}, R_{8}\}; $2; i\sigma_3, \sigma_0, -i\sigma_2$

\{R_{6}, R_{7}\}; $2; i\sigma_3, -i\sigma_0, -i\sigma_2$

$B$: $Z, B, Z, X$; $\sigma_z, C_{2y}, IT$; \{R_{5}, R_{8}\}; $2; i\sigma_3, \sigma_0, -i\sigma_2$

\{R_{6}, R_{7}\}; $2; i\sigma_3, -i\sigma_0, -i\sigma_2$

$R$: $Y, R$; $C_{2y}, \sigma_z, IT$; $R_0$; $2; i\sigma_3, -\sigma_1, -i\sigma_2$
SG 71

\[ \Gamma_0; \{C_2z|000\}, \{C_2y|000\}, \{I|000\}, T; \text{Centrosymmetric; with SOC} \]

\begin{align*}
\Gamma: \ (000) & \quad C_{2z}, C_{2y}, I, T; R_5; \quad 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& \quad R_{10}; \quad 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
X: \ (\frac{1}{2} \frac{1}{2} \frac{1}{2}) & \quad C_{2z}, C_{2y}, I, T; R_5; \quad 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
& \quad R_{10}; \quad 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R: \ (\frac{1}{2} 0 0) & \quad C_{2y}, I, T; \quad \{R_2, R_4\}; \quad 2; i\sigma_1, \sigma_0, -i\sigma_2; \\
& \quad \{R_6, R_8\}; \quad 2; i\sigma_1, -\sigma_0, -i\sigma_2; \\
S: \ (\frac{1}{2} 0 1) & \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; i\sigma_1, \sigma_0, -i\sigma_2; \\
& \quad \{R_6, R_8\}; \quad 2; i\sigma_1, -\sigma_0, -i\sigma_2; \\
T: \ (\frac{1}{2} \frac{1}{2} 0) & \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; i\sigma_1, \sigma_0, -i\sigma_2; \\
& \quad \{R_6, R_8\}; \quad 2; i\sigma_1, -\sigma_0, -i\sigma_2; \\
W: \ (\frac{3}{4} \frac{1}{4} \frac{1}{4}) & \quad C_{2z}, C_{2y}, I, T; \quad R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
\Lambda: \ \Gamma \Lambda/TX; \quad C_{2z}, \sigma_y, I, T; \quad R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
G: \ XG; \quad C_{2z}, \sigma_y, I, T; \quad R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
P: \ TW; \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; i\sigma_1, -i\sigma_2; \\
\Sigma: \ \Gamma \Sigma/TX; \quad C_{2z}, \sigma_z, I, T; \quad R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
F: \ XF; \quad C_{2z}, \sigma_z, I, T; \quad R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
D: \ SW; \quad C_{2z}, I, T; \quad \{R_2, R_4\}; \quad 2; i\sigma_1, -i\sigma_2; \\
\Delta: \ \Gamma \Delta/TX; \quad C_{2y}, \sigma_z, I, T; \quad R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
U: \ XU; \quad C_{2y}, \sigma_z, I, T; \quad R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
Q: \ RW; \quad C_{2y}, I, T; \quad \{R_2, R_4\}; \quad 2; i\sigma_1, -i\sigma_2; \\
\end{align*}
\[ \Gamma^0_v; \{ C_2z|000\}, \{ C_2y|000\}, \{ I|1 \frac{1}{2} 0 \}, T; \text{Centrosymmetric; with SOC} \]

\( \Gamma; \) (000); \( C_{2z}, C_{2y}, I, T; R_5 \); 2; \( i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2 \);

\( R_{10} \); 2; \( i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2 \);

\( X; \) (1 \frac{1}{2} \frac{1}{2} \frac{1}{2} ); \( C_{2z}, C_{2y}, I, T; R_5 \); 2; \( i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2 \);

\( R_{10} \); 2; \( i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2 \);

\( R; \) (1 \frac{1}{2} 00); \( \sigma_y, E, I, T; \{ R_9, R_0 \} \); 4; \( \Gamma_{0.1}, -\Gamma_{0.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \) DP; 0

\( S; \) (1 \frac{1}{2} 0 \frac{1}{2} ); \( \sigma_z, E, I, T; \{ R_9, R_0 \} \); 4; \( \Gamma_{0.1}, -\Gamma_{0.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \) DP; 0

\( T; \) (1 \frac{1}{2} 2 0); \( C_{2z}, I, T; \{ R_2, R_4 \} \); 2; \( i\sigma_3, \sigma_0, -i\sigma_2 \);

\( \{ R_6, R_8 \} \); 2; \( i\sigma_3, -\sigma_0, -i\sigma_2 \);

\( W; \) (1 \frac{1}{4} \frac{1}{4} \frac{1}{4} ); \( C_{2y}, C_{2y}, I, T; \{ R_5, R_5 \} \); 4; \( i\Gamma_{0.2}, i\Gamma_{0.1}, i\Gamma_{2.0}; \) DP; 0

\( \Lambda; \) \( \Gamma, \Lambda/TX; C_{2z}, \sigma_y, I, T; R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \);

\( G; \) \( XG; C_{2z}, \sigma_y, I, T; R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \);

\( P; \) \( TW; C_{2z}, I, T; \{ R_2, R_4 \} \); 2; \( i\sigma_3, -i\sigma_2 \);

\( \Sigma; \) \( \Gamma, \Sigma/TX; C_{2z}, \sigma_z, I, T; R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \);

\( F; \) \( XF; C_{2z}, \sigma_z, I, T; R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \);

\( D; \) \( SW; C_{2z}, I, T; \{ R_2, R_2 \} \); 2; \( i\sigma_0, -i\sigma_2 \);

\( \{ R_4, R_4 \} \); 2; \( -i\sigma_0, -i\sigma_2 \);

\( \Delta; \) \( \Gamma, \Delta/TX; C_{2y}, \sigma_z, I, T; R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \);

\( U; \) \( XU; C_{2y}, \sigma_z, I, T; R_5 \); 2; \( i\sigma_2, i\sigma_1, -i\sigma_2 \);

\( Q; \) \( RW; C_{2y}, I, T; \{ R_2, R_2 \} \); 2; \( i\sigma_0, -i\sigma_2 \);

\( \{ R_4, R_4 \} \); 2; \( -i\sigma_0, -i\sigma_2 \);
$\Gamma^\circ \{C_{2z}\frac{1}{4}, C_{2y}\frac{1}{4}, \{I\{000\}, T\};$ Centrosymmetric; with SOC

$\Gamma$: (000); $C_{2z}, C_{2y}, I, T$; 
- $R_5$: 2; $i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2$;
- $R_{10}$: 2; $i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2$;

$X$: ($\frac{1}{2} \frac{1}{2} \frac{1}{2}$); $C_{2z}, C_{2y}, I, T$; 
- $R_5$: 2; $i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2$;
- $R_{10}$: 2; $i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2$;

$R$: ($\frac{1}{2} 0 0$); $\sigma_y, E, I, T$; 
- $R_9, R_9$: 4; $\Gamma_0, -\Gamma_0, \Gamma_0, 0, -i\Gamma_2, 0$; DP; 0

$S$: ($\frac{1}{2} 0 \frac{1}{2}$); $\sigma_z, E, I, T$; 
- $R_9, R_9$: 4; $\Gamma_0, -\Gamma_0, \Gamma_0, 0, -i\Gamma_2, 0$; DP; 0

$T$: ($\frac{1}{2} \frac{1}{2} \frac{1}{2}$); $\sigma_z, E, I, T$; 
- $R_9, R_9$: 4; $\Gamma_0, -\Gamma_0, \Gamma_0, 0, -i\Gamma_2, 0$; DP; 0

$W$: ($\frac{1}{2} \frac{1}{2} \frac{1}{2}$); $C_{2z}, C_{2y}, I, T$; 
- $R_1, R_1$: 2; $\sigma_0, \sigma_0, -i\sigma_2$;
- $R_2, R_2$: 2; $\sigma_0, -\sigma_0, -i\sigma_2$;
- $R_3, R_3$: 2; $-\sigma_0, \sigma_0, -i\sigma_2$;
- $R_4, R_4$: 2; $-\sigma_0, -\sigma_0, -i\sigma_2$;

$\Lambda$: $\Gamma\Lambda/\Gamma X$; $C_{2z}, \sigma_y, I, T$; 
- $R_5$: 2; $i\sigma_2, i\sigma_1, -i\sigma_2$;

$G$: $X G$; $C_{2z}, \sigma_y, I, T$; 
- $R_5$: 2; $-i\sigma_2, i\sigma_1, -i\sigma_2$;

$P$: $T W$; $C_{2z}, E, I, T$; 
- $R_5, R_5$: 2; $-i\sigma_0, -\sigma_0, -i\sigma_2$;
- $R_7, R_7$: 2; $i\sigma_0, -\sigma_0, -i\sigma_2$;

$\Sigma$: $\Gamma\Sigma/\Gamma X$; $C_{2z}, \sigma_z, I, T$; 
- $R_5$: 2; $i\sigma_2, i\sigma_1, -i\sigma_2$;

$F$: $X F$; $C_{2z}, \sigma_z, I, T$; 
- $R_5$: 2; $-i\sigma_2, i\sigma_1, -i\sigma_2$;

$D$: $S W$; $C_{2z}, E, I, T$; 
- $R_5, R_5$: 2; $i\sigma_0, -\sigma_0, -i\sigma_2$;
- $R_7, R_7$: 2; $-i\sigma_0, -\sigma_0, -i\sigma_2$;

$\Delta$: $\Gamma\Delta/\Gamma X$; $C_{2y}, \sigma_z, I, T$; 
- $R_5$: 2; $i\sigma_2, i\sigma_1, -i\sigma_2$;

$U$: $X U$; $C_{2y}, \sigma_z, I, T$; 
- $R_5$: 2; $i\sigma_2, i\sigma_1, -i\sigma_2$;

$Q$: $R W$; $C_{2y}, E, I, T$; 
- $R_5, R_5$: 2; $-i\sigma_0, -\sigma_0, -i\sigma_2$;
- $R_7, R_7$: 2; $i\sigma_0, -\sigma_0, -i\sigma_2$;
\[ \Gamma': \{ C_{2y} \mid \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ C_{2y} \mid \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ I \mid \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, T; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; \ (000); \ C_{2y}, C_{2y}, I, T; R_5; \ 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]

\[ R_10; \ 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ R; \ (\frac{1}{2}00); \ C_{2y}, I, T; \ \{ R_2, R_4 \}; \ 2; i\sigma_3, \sigma_0, -i\sigma_2; \]

\[ \{ R_6, R_8 \}; \ 2; i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ S; \ (\frac{1}{2}0\frac{1}{2}); \ C_{2y}, I, T; \ \{ R_2, R_4 \}; \ 2; i\sigma_3, \sigma_0, -i\sigma_2; \]

\[ \{ R_6, R_8 \}; \ 2; i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ T; \ (\frac{1}{2}0\frac{3}{2}); \ \sigma_x, E, I, T; \ \{ R_9, R_9 \}; \ 4; \Gamma_0, 1, -\Gamma_0, 0, \Gamma_0, 3, -i\Gamma_2, 0; \text{DP}; 0 \]

\[ W; \ (\frac{3}{4}\frac{3}{4}\frac{1}{4}); \ C_{2y}, C_{2y}, I, T; \ \{ R_1, R_4 \}; \ 2; \sigma_3, \sigma_3, -i\sigma_2; \]

\[ \{ R_2, R_3 \}; \ 2; \sigma_3, -\sigma_3, -i\sigma_2; \]

\[ \Lambda; \ \Gamma\Lambda/TX; \ C_{2y}, \sigma_x, I, T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ G; \ \chi G; \ C_{2y}, \sigma_y, I, T; \ R_5; \ 2; -i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ P; \ \text{TW}; \ C_{2y}, E, I, T; \ \{ R_5, R_5 \}; \ 2; -i\sigma_0, -\sigma_0, -i\sigma_2; \]

\[ \{ R_7, R_7 \}; \ 2; i\sigma_0, -\sigma_0, -i\sigma_2; \]

\[ \Sigma; \ \Gamma\Sigma/TX; \ C_{2y}, \sigma_z, I, T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ F; \ \text{XF}; \ C_{2y}, \sigma_z, I, T; \ R_5; \ 2; -i\sigma_2, -i\sigma_1, -i\sigma_2; \]

\[ D; \ \text{SW}; \ C_{2y}, E, I, T; \ \{ R_5, R_7 \}; \ 2; i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ \Delta; \ \Gamma\Delta/TX; \ C_{2y}, \sigma_x, I, T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ U; \ \text{XU}; \ C_{2y}, \sigma_z, I, T; \ R_5; \ 2; i\sigma_2, -i\sigma_1, -i\sigma_2; \]

\[ Q; \ \text{RW}; \ C_{2y}, E, I, T; \ \{ R_5, R_7 \}; \ 2; -i\sigma_3, -\sigma_0, -i\sigma_2; \]
\( \Gamma_q \); \( \{C_{4v}^\dagger|000\}, T \); Non-Centrosymmetric; with SOC

\( \Gamma \); \( (000) \): \( C_{4v}^\dagger, T \); \( \{R_2, R_8\}; 2; \frac{a_n + \iota a_n}{\sqrt{2}}, -\iota \sigma_2 \); C-1 WP; 1

\( M; (\frac{1}{2}\frac{1}{2}0) \); \( C_{4v}^\dagger, T \); \( \{R_2, R_8\}; 2; \frac{a_n + \iota a_n}{\sqrt{2}}, -\iota \sigma_2 \); C-1 WP; 1

\( Z; (00\frac{1}{2}) \); \( C_{4v}^\dagger, T \); \( \{R_2, R_8\}; 2; \frac{a_n + \iota a_n}{\sqrt{2}}, -\iota \sigma_2 \); C-1 WP; 1

\( A; (\frac{1}{2}\frac{1}{2}\frac{1}{2}) \); \( C_{4v}^\dagger, T \); \( \{R_2, R_8\}; 2; \frac{a_n + \iota a_n}{\sqrt{2}}, -\iota \sigma_2 \); C-1 WP; 1

\( R; (0\frac{1}{2}\frac{1}{2}) \); \( C_{2v}, T \); \( \{R_2, R_4\}; 2; \iota \sigma_3, -\iota \sigma_2 \); C-1 WP; 1

\( X; (0\frac{1}{2}0) \); \( C_{2v}, T \); \( \{R_2, R_4\}; 2; \iota \sigma_3, -\iota \sigma_2 \); C-1 WP; 1

\( \Delta; \Gamma X \); \( \bar{E}, TC_{2z}; R_2 \); 1; -1, 1;

\( U; Z R \); \( \bar{E}, TC_{2z}; R_2 \); 1; -1, 1;

\( \Lambda; \Gamma Z \); \( C_{4z}^\dagger \); \( R_2 \); 1; \sqrt{-1};

\( R_4 \); 1; \((-1)^{3/4};

\( R_6 \); 1; \sqrt{-1};

\( R_8 \); 1; \((-1)^{3/4};

\( V; MA \); \( C_{4z}^\dagger \); \( R_2 \); 1; \sqrt{-1};

\( R_4 \); 1; \((-1)^{3/4};

\( R_6 \); 1; \sqrt{-1};

\( R_8 \); 1; \((-1)^{3/4};

\( \Sigma; \Gamma M \); \( \bar{E}, TC_{2z}; R_2 \); 1; -1, 1;

\( S; Z A \); \( \bar{E}, TC_{2z}; R_2 \); 1; -1, 1;

\( Y; XM \); \( \bar{E}, TC_{2z}; R_2 \); 1; -1, 1;

\( T; RA \); \( \bar{E}, TC_{2z}; R_2 \); 1; -1, 1;

\( W; XR \); \( C_{2z} \); \( R_2 \); 1; \iota;

\( R_4 \); 1; -\iota;
Γ: (000); \( C_{4v}^+ \), \( T \); \( \{ R_2, R_6 \} \); 2; \( \frac{a_0 + i\sigma_2}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1
\{ R_4, R_6 \}; 2; \( \frac{a_0 - i\sigma_2}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1

M: \( \left( \frac{1}{2} \frac{1}{2} 0 \right) \); \( C_{4v}^+ \), \( T \); \( \{ R_2, R_6 \} \); 2; \( \frac{a_0 + i\sigma_2}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1
\{ R_4, R_6 \}; 2; \( \frac{a_0 - i\sigma_2}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1

Z: \( (00 \frac{1}{2}) \); \( C_{4v}^+ \), \( T \); \( \{ R_1, R_1 \} \); 2; \( \sigma_0, -i\sigma_2 \); P-NS\( _{ZAR} \);
\{ R_3, R_7 \}; 2; \( i\sigma_3, -i\sigma_2 \); P-NS\( _{ZAR} \);
\{ R_5, R_5 \}; 2; \(-\sigma_0, -i\sigma_2 \); P-NS\( _{ZAR} \);

A: \( \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right) \); \( C_{4v}^+ \), \( T \); \( \{ R_1, R_1 \} \); 2; \( \sigma_0, -i\sigma_2 \); P-NS\( _{ZAR} \);
\{ R_3, R_7 \}; 2; \( i\sigma_3, -i\sigma_2 \); P-NS\( _{ZAR} \);
\{ R_5, R_5 \}; 2; \(-\sigma_0, -i\sigma_2 \); P-NS\( _{ZAR} \);

R: \( (0 \frac{1}{2} \frac{1}{2}) \); \( C_{2x} \), \( T \); \( \{ R_1, R_1 \} \); 2; \( \sigma_0, -i\sigma_2 \); P-NS\( _{ZAR} \);
\{ R_3, R_3 \}; 2; \(-\sigma_0, -i\sigma_2 \); P-NS\( _{ZAR} \);

X: \( (0 \frac{1}{2} 0) \); \( C_{2x} \), \( T \); \( \{ R_2, R_2 \} \); 2; \( i\sigma_3, -i\sigma_2 \); C-1 WP; 1

Δ: \( \Gamma_X \); \( \bar{E}, TC_{2z} \); \( R_2 \); 1; \(-1, 1\);

U: \( ZR \); \( \bar{E}, TC_{2z} \); \( \{ R_2, R_2 \} \); 2; \(-\sigma_0, -i\sigma_2 \); L-NS\( _{ZAR} \);

Λ: \( \Gamma_Z \); \( C_{4v}^+ \); \( R_2 \); 1; \( \sqrt{-1} \);
\( R_4 \); 1; \((-1)^{3/4} \);
\( R_6 \); 1; \(-\sqrt{-1} \);
\( R_8 \); 1; \(-(-1)^{3/4} \);

V: \( MA \); \( C_{4v}^+ \); \( R_2 \); 1; \( \sqrt{-1} \);
\( R_4 \); 1; \((-1)^{3/4} \);
\( R_6 \); 1; \(-\sqrt{-1} \);
\( R_8 \); 1; \(-(-1)^{3/4} \);

Σ: \( \Gamma_M \); \( \bar{E}, TC_{2z} \); \( R_2 \); 1; \(-1, 1\);

Σ: \( \Gamma_M \); \( \bar{E}, TC_{2z} \); \( R_2 \); 1; \(-1, 1\);

S: \( \Gamma_A \); \( \bar{E}, TC_{2z} \); \( \{ R_2, R_2 \} \); 2; \(-\sigma_0, -i\sigma_2 \); L-NS\( _{ZAR} \);

Y: \( \Gamma_X \); \( \bar{E}, TC_{2z} \); \( R_2 \); 1; \(-1, 1\);

T: \( RA \); \( \bar{E}, TC_{2z} \); \( \{ R_2, R_2 \} \); 2; \(-\sigma_0, -i\sigma_2 \); L-NS\( _{ZAR} \);

W: \( XR \); \( C_{2z} \); \( R_2 \); 1; \( i \);
\( R_4 \); 1; \(-i \);
Γ; (000): \( C_{4x}^+; T \); \{\( R_2, R_8 \); 2; \( \frac{a_0 + i a_1}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1
\{\( R_4, R_6 \); 2; \( \frac{a_0 - i a_1}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1
\}
M; (\( \frac{1}{2} \frac{1}{2} 0 \)): \( C_{4x}^+; T \); \{\( R_2, R_8 \); 2; \( \frac{a_0 + i a_1}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1
\{\( R_4, R_6 \); 2; \( \frac{a_0 - i a_1}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1
\}
Z; (00\( \frac{1}{2} \)): \( C_{4z}^+; T \); \{\( R_2, R_8 \); 2; \( \frac{a_0 + i a_1}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1
\{\( R_4, R_6 \); 2; \( \frac{a_0 - i a_1}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1
\}
A; (\( \frac{1}{2} \frac{1}{2} \frac{1}{2} \)): \( C_{4z}^+; T \); \{\( R_2, R_8 \); 2; \( \frac{a_0 + i a_1}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1
\{\( R_4, R_6 \); 2; \( \frac{a_0 - i a_1}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1
\}
R; (0\( \frac{1}{2} \)): \( C_{2z}; T \); \{\( R_2, R_4 \); 2; \( i\sigma_3, -i\sigma_2\); C-1 WP; 1
\}
X; (0\( \frac{1}{2} \)): \( C_{2z}; T \); \{\( R_2, R_4 \); 2; \( i\sigma_3, -i\sigma_2\); C-1 WP; 1
\}
Δ; ΓX; \( \bar{E}, TC_{2z}; R_2; 1; -1,1; \)
Λ; ΓZ; \( C_{4z}^+; R_2; 1; \sqrt{-1}; \)
R₄; 1; \((-1)^{3/4}; \)
R₆; 1; \(-\sqrt{-1}; \)
R₈; 1; \((-1)^{3/4}; \)
V; MA; \( C_{4z}^+; R_2; 1; \sqrt{-1}; \)
R₄; 1; \((-1)^{3/4}; \)
R₆; 1; \(-\sqrt{-1}; \)
R₈; 1; \((-1)^{3/4}; \)
Σ; ΓM; \( \bar{E}, TC_{2z}; R_2; 1; -1,1; \)
S; ZΛ; \( \bar{E}, TC_{2z}; R_2; 1; -1,1; \)
Y; XM; \( \bar{E}, TC_{2z}; R_2; 1; -1,1; \)
T; RA; \( \bar{E}, TC_{2z}; R_2; 1; -1,1; \)
W; XR; \( C_{2z}; R_2; 1; i; \)
R₄; 1; \(-i; \)
\( \Gamma \); \{\( C_{4z}^+ \{000\} \), \( T \); Non-Centrosymmetric; with SOC

\[ \Gamma \); (000); \( C_{4z}^+\), \( T \); \{\( R_2\), \( R_8\)\}; 2; \( \frac{\sigma_0 + i\sigma_2}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1

\[ \{R_4\), \( R_6\)\}; 2; \( \frac{\sigma_0 - i\sigma_2}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1

\[ M \); (1\( \frac{1}{2} \)0); \( C_{4z}^+\), \( T \); \{\( R_2\), \( R_8\)\}; 2; \( \frac{\sigma_0 + i\sigma_2}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1

\[ \{R_4\), \( R_6\)\}; 2; \( \frac{\sigma_0 - i\sigma_2}{\sqrt{2}} \), \(-i\sigma_2\); C-1 WP; 1

\[ Z \); (00\( \frac{1}{2} \)); \( C_{4z}^+\), \( T \); \{\( R_1\), \( R_1\)\}; 2; \( \sigma_0\), \(-i\sigma_2\); P-NS\_ZAR

\[ \{R_3\), \( R_7\)\}; 2; \( \sigma_3\), \(-i\sigma_2\); P-NS\_ZAR

\[ \{R_5\), \( R_5\)\}; 2; \(-\sigma_0\), \(-i\sigma_2\); P-NS\_ZAR

\[ A \); (1\( \frac{1}{2} \)\( \frac{1}{2} \)); \( C_{4z}^+\), \( T \); \{\( R_1\), \( R_1\)\}; 2; \( \sigma_0\), \(-i\sigma_2\); P-NS\_ZAR

\[ \{R_3\), \( R_7\)\}; 2; \( \sigma_3\), \(-i\sigma_2\); P-NS\_ZAR

\[ \{R_5\), \( R_5\)\}; 2; \(-\sigma_0\), \(-i\sigma_2\); P-NS\_ZAR

\[ R \); (0\( \frac{1}{2} \)\( \frac{1}{2} \)); \( C_{2z}\), \( T \); \{\( R_1\), \( R_1\)\}; 2; \( \sigma_0\), \(-i\sigma_2\); P-NS\_ZAR

\[ \{R_3\), \( R_3\)\}; 2; \(-\sigma_0\), \(-i\sigma_2\); P-NS\_ZAR

\[ X \); (0\( \frac{1}{2} \)0); \( C_{2z}\), \( T \); \{\( R_2\), \( R_4\)\}; 2; \( i\sigma_3\), \(-i\sigma_2\); C-1 WP; 1

\[ \Delta \); \( \Gamma X \); \( E,TC_{2z}\); \( R_2\); 1; \(-1,1\);

\[ U \); \( ZR \); \( E,TC_{2z}\); \{\( R_2\), \( R_2\)\}; 2; \(-\sigma_0\), \(-i\sigma_2\); L-NS\_ZAR

\[ \Lambda \); \( \Gamma Z \); \( C_{4z}^+\); \( R_2\); 1; \( \sqrt{-1}\);

\[ R_4\); 1; \((-1)^{3/4}\);

\[ R_6\); 1; \(-\sqrt{-1}\);

\[ R_8\); 1; \((-1)^{3/4}\);

\[ V \); \( MA \); \( C_{4z}^+\); \( R_2\); 1; \( \sqrt{-1}\);

\[ R_4\); 1; \((-1)^{3/4}\);

\[ R_6\); 1; \(-\sqrt{-1}\);

\[ R_8\); 1; \((-1)^{3/4}\);

\[ \Sigma \); \( \Gamma M \); \( E,TC_{2z}\); \( R_2\); 1; \(-1,1\);

\[ S \); \( ZA \); \( E,TC_{2z}\); \{\( R_2\), \( R_2\)\}; 2; \(-\sigma_0\), \(-i\sigma_2\); L-NS\_ZAR

\[ Y \); \( XM \); \( E,TC_{2z}\); \( R_2\); 1; \(-1,1\);

\[ T \); \( RA \); \( E,TC_{2z}\); \{\( R_2\), \( R_2\)\}; 2; \(-\sigma_0\), \(-i\sigma_2\); L-NS\_ZAR

\[ W \); \( XR \); \( C_{2z}\); \( R_2\); 1; \( i\);

\[ R_4\); 1; \(-i\);
\( \Gamma; (000); \{ C_{4v}^+[000], T; Non-Centrosymmetric; with SOC \}

\[
\begin{align*}
\Gamma &; (000); \quad C_{4v}^+T; \quad \{ R_2, R_6 \}; 2; \frac{\sigma_0 + i \sigma_3}{\sqrt{2} 0}, -i \sigma_2; \quad C-1 WP; 1 \\
&; \quad \{ R_4, R_6 \}; 2; -\frac{\sigma_0 - i \sigma_3}{\sqrt{2}}, -i \sigma_2; \quad C-1 WP; 1 \\
N &; (0\frac{1}{2}0); \quad \bar{E}, T; \quad \{ R_2, R_2 \}; 2; -\sigma_0, -i \sigma_2; \quad C-1 WP; 1 \\
X &; (00\frac{1}{2}); \quad C_{2z}, T; \quad \{ R_2, R_4 \}; 2; i \sigma_3, -i \sigma_2; \quad C-1 WP; 1 \\
Z &; (\frac{1}{2}\frac{1}{2} \frac{1}{2}); \quad C_{4x}^+T; \quad \{ R_2, R_6 \}; 2; \frac{\sigma_0 + i \sigma_3}{\sqrt{2}}, -i \sigma_2; \quad C-1 WP; 1 \\
&; \quad \{ R_4, R_6 \}; 2; -\frac{\sigma_0 - i \sigma_3}{\sqrt{2}}, -i \sigma_2; \quad C-1 WP; 1 \\
P &; (\frac{1}{4}\frac{1}{4} \frac{1}{4}); \quad C_{2z}; C_{4x}^+T; \quad \{ R_2, R_4 \}; 2; i \sigma_3, \sigma = \frac{\sqrt{2}(\sigma_0 - \sigma_2)}{\sqrt{2} 0}; \quad C-1 WP; 1 \\
\Lambda &; \Gamma \Lambda/\Gamma Z; \quad C_{4z}^+; \quad R_4; \quad 1; \sqrt{-1}; \\
&; \quad R_4; \quad 1; (-1)^{3/4}; \\
&; \quad R_6; \quad 1; -\sqrt{-1}; \\
&; \quad R_6; \quad 1; -(-1)^{3/4}; \\
V &; \bar{Z}V; \quad C_{4z}^+; \quad R_2; \quad 1; \sqrt{-1}; \\
&; \quad R_4; \quad 1; (-1)^{3/4}; \\
&; \quad R_6; \quad 1; \sqrt{-1}; \\
&; \quad R_6; \quad 1; -(-1)^{3/4}; \\
W &; \bar{X}P; \quad C_{2z}; \quad R_2; \quad 1; i; \\
&; \quad R_4; \quad 1; -i; \\
\Sigma &; \Gamma Z/\Sigma; \quad \bar{E}, T C_{2z}; \quad R_2; \quad 1; -1,1; \\
F &; \bar{Z}F; \quad \bar{E}, T C_{2z}; \quad R_2; \quad 1; -1,1; \\
Q &; \bar{N}P; \quad \bar{E}; \quad R_2; \quad 1; -1; \\
\Delta &; \Gamma X; \quad \bar{E}, T C_{2z}; \quad R_2; \quad 1; -1,1; \\
U &; \bar{Z}U; \quad \bar{E}, T C_{2z}; \quad R_2; \quad 1; -1,1; \\
Y &; XZ/XY; \quad \bar{E}, T C_{2z}; \quad R_2; \quad 1; -1,1; 
\end{align*}
\]
\( \Gamma_0; \{ C_{4z}^+; \frac{3}{4} \frac{1}{4} \frac{1}{4} \}; T; \text{Non-Centrosymmetric; with SOC} \)

\begin{align*}
\Gamma; \ (000); \ C_{4z}^+; T; & \quad \{ R_2, R_6 \}; 2; \frac{\sigma_0 + i \sigma_3}{\sqrt{2}}, -i \sigma_2; \ C-1 \ WP; 1 \\
& \quad \{ R_4, R_6 \}; 2; \frac{\sigma_0 - i \sigma_3}{\sqrt{2}}, -i \sigma_2; \ C-1 \ WP; 1 \\
N; \ (0 \frac{1}{2} 0); \ E; T; & \quad \{ R_2, R_2 \}; 2; -\sigma_0, -i \sigma_2; \ C-1 \ WP; 1 \\
X; \ (00 \frac{1}{2}); \ C_{2z}; T; & \quad \{ R_2, R_4 \}; 2; i \sigma_3, -i \sigma_2; \ C-1 \ WP; 1 \\
Z; \ (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ C_{4z}^+; T; & \quad \{ R_2, R_6 \}; 2; \frac{\sigma_0 + i \sigma_3}{\sqrt{2}}, -i \sigma_2; \ C-1 \ WP; 1 \\
& \quad \{ R_4, R_6 \}; 2; \frac{\sigma_0 - i \sigma_3}{\sqrt{2}}, -i \sigma_2; \ C-1 \ WP; 1 \\
P; \ (\frac{1}{4} \frac{1}{4} \frac{1}{4}); \ C_{2z}; C_{4z}^+; T; & \quad \{ R_2 \}; 1; i, 1; \\
& \quad \{ R_4, R_4 \}; 2; -i \sigma_0, -i \sigma_2; \ C-2 \ WP; 2 \\
\Lambda; \ \Gamma \Lambda/\Gamma Z; \ C_{4z}^+; & \quad \{ R_2 \}; 1; \sqrt{-1}; \quad R_4; 1; (-1)^{3/4}; \\
& \quad \{ R_6 \}; 1; -\sqrt{-1}; \quad R_8; 1; -(-1)^{3/4}; \\
V; \ ZV; \ C_{4z}^+; \ E; & \quad \{ R_2 \}; 1; \sqrt{-1}, -1; \quad R_4; 1; (-1)^{3/4}, -1; \\
& \quad \{ R_6 \}; 1; -\sqrt{-1}, -1; \quad R_8; 1; -(-1)^{3/4}, -1; \\
W; \ XP; \ C_{2z}; & \quad \{ R_2 \}; 1; i; \quad R_4; 1; -i; \\
\Sigma; \ \Gamma Z/\Gamma \Sigma; \ \bar{E}; TC_{2z}; & \quad \{ R_2 \}; 1; -1, 1; \\
F; \ ZF; \ \bar{E}; TC_{2z}; & \quad \{ R_2 \}; 1; -1, 1; \\
Q; \ NP; \ E; & \quad \{ R_2 \}; 1; -1; \\
\Delta; \ \Gamma X; \ \bar{E}; TC_{2z}; & \quad \{ R_2 \}; 1; -1, 1; \\
U; \ ZU; \ \bar{E}; TC_{2z}; & \quad \{ R_2 \}; 1; -1, 1; \\
Y; \ XZ/XY; \ \bar{E}; TC_{2z}; & \quad \{ R_2 \}; 1; -1, 1; \\
\end{align*}
\( \Gamma; \{ S_{4z}^+ | 000 \}, T; \) Non-Centrosymmetric; with SOC

\\begin{align*}
\Gamma; \ (000); \ & S_{4z}^+; \ T; \ \{ R_2, R_6 \}; \ 2; \ \frac{a_0 + i a_3}{\sqrt{2}}, -i\sigma_2; \ \text{P-WNL}_Z; \\
& \{ R_4, R_6 \}; \ 2; \ \frac{a_0 - i a_3}{\sqrt{2}}, -i\sigma_2; \ \text{P-WNL}_Z; \\
M; \ (\frac{1}{2} \frac{1}{2} 0); \ & S_{4z}^+; \ T; \ \{ R_2, R_6 \}; \ 2; \ \frac{a_0 + i a_3}{\sqrt{2}}, -i\sigma_2; \ \text{P-WNL}_{MA}; \\
& \{ R_4, R_6 \}; \ 2; \ \frac{a_0 - i a_3}{\sqrt{2}}, -i\sigma_2; \ \text{P-WNL}_{MA}; \\
Z; \ (00 \frac{1}{2}); \ & S_{4z}^+; \ T; \ \{ R_2, R_6 \}; \ 2; \ \frac{a_0 + i a_3}{\sqrt{2}}, -i\sigma_2; \ \text{P-WNL}_Z; \\
& \{ R_4, R_6 \}; \ 2; \ \frac{a_0 - i a_3}{\sqrt{2}}, -i\sigma_2; \ \text{P-WNL}_Z; \\
A; \ (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ & S_{4z}^+; \ T; \ \{ R_2, R_6 \}; \ 2; \ \frac{a_0 + i a_3}{\sqrt{2}}, -i\sigma_2; \ \text{P-WNL}_{MA}; \\
& \{ R_4, R_6 \}; \ 2; \ \frac{a_0 - i a_3}{\sqrt{2}}, -i\sigma_2; \ \text{P-WNL}_{MA}; \\
R; \ (0 \frac{1}{2} \frac{1}{2}); \ & C_{2z}; \ T; \ \{ R_2, R_4 \}; \ 2; \ i\sigma_3, -i\sigma_2; \ \text{C-1 WP}; \ 1 \\
X; \ (0 \frac{1}{2} 0); \ & C_{2z}; \ T; \ \{ R_2, R_4 \}; \ 2; \ i\sigma_3, -i\sigma_2; \ \text{C-1 WP}; \ 1 \\
\Delta; \ \Gamma X; \ & E, T C_{2z}; \ R_2; \ 1; -1, 1; \\
U; \ \Gamma Z; \ & E, T C_{2z}; \ R_2; \ 1; -1, 1; \\
\Lambda; \ \Gamma Z; \ & C_{2z}, S_{4z}^+ T; \ \{ R_2, R_4 \}; \ 2; \ i\sigma_3, \frac{e^{-i\pi/4}(a_1 + a_2)}{\sqrt{2}}; \ \text{WNL}; \ \pi \\
V; \ \Lambda A; \ & C_{2z}, S_{4z}^+ T; \ \{ R_2, R_4 \}; \ 2; \ i\sigma_3, \frac{e^{-i\pi/4}(a_1 + a_2)}{\sqrt{2}}; \ \text{WNL}; \ \pi \\
\Sigma; \ \Gamma M; \ & E, T C_{2z}; \ R_2; \ 1; -1, 1; \\
S; \ \Gamma A; \ & E, T C_{2z}; \ R_2; \ 1; -1, 1; \\
Y; \ \Sigma M; \ & E, T C_{2z}; \ R_2; \ 1; -1, 1; \\
T; \ \Lambda A; \ & E, T C_{2z}; \ R_2; \ 1; -1, 1; \\
W; \ \Sigma R; \ & C_{2z}; \ R_2; \ 1; i; \\
& \ R_4; \ 1; -i; \\
\end{align*}
\[ \Gamma^0; \{ S^+_4[000], T; \text{Non-Centrosymmetric; with SOC} \} \]

| Γ | (000) | \( S^+_4, T \) | \( \{ R_2, R_6 \}; 2; \frac{a_0 + i a_3}{\sqrt{2}}, -i a_2 \); P-WNL \( \Gamma Z \) |
|---|---|---|---|
| \( N \) | (0\( \frac{1}{2} \)) | \( E, T \) | \( \{ R_2, R_2 \}; 2; -\sigma_0, -i \sigma_2 \); C-1 WP; 1 |
| \( X \) | (00\( \frac{1}{2} \)) | \( C_2z, T \) | \( \{ R_2, R_4 \}; 2; i \sigma_3, -i \sigma_2 \); C-1 WP; 1 |
| \( Z \) | (\( \frac{1}{2} \frac{1}{2} \)) | \( S^+_4, T \) | \( \{ R_2, R_8 \}; 2; \frac{a_0 + i a_3}{\sqrt{2}}, -i a_2 \); P-WNL \( \Gamma Z \) |
| \( P \) | (\( \frac{1}{4} \frac{1}{2} \)) | \( S^+_4 \) | \( R_2; 1; \sqrt{-1}; \)
| | | | \( R_4; 1; (-1)^{3/4}; \)
| | | | \( R_6; 1; -\sqrt{-1}; \)
| | | | \( R_8; 1; -(-1)^{3/4}; \)
| \( \Lambda \) | \( \Gamma\Lambda/\Gamma Z \) | \( C_{2z}, S^+_4, T \) | \( \{ R_2, R_4 \}; 2; i \sigma_3, \frac{-e^{-i/4}(\sigma_1 + \sigma_2)}{\sqrt{2}} \); WNL; \( \pi \) |
| \( V \) | \( \Gamma V \) | \( C_{2z}, S^+_4, T \) | \( \{ R_2, R_4 \}; 2; i \sigma_3, \frac{-e^{-i/4}(\sigma_1 + \sigma_2)}{\sqrt{2}} \); WNL; \( \pi \) |
| \( W \) | \( \Gamma X \) | \( C_{2z} \) | \( R_2; 1; i; \)
| | | | \( R_4; 1; -i; \)
| \( \Sigma \) | \( \Gamma Z/\Sigma \) | \( \bar{E}, T C_{2z} \) | \( R_2; 1; -1,1; \)
| \( F \) | \( \Gamma Z \) | \( E, T C_{2z} \) | \( R_2; 1; -1,1; \)
| \( Q \) | \( \Sigma P \) | \( \bar{E} \) | \( R_2; 1; -1; \)
| \( \Delta \) | \( \Gamma X \) | \( \bar{E}, T C_{2z} \) | \( R_2; 1; -1,1; \)
| \( U \) | \( \Sigma Z \) | \( \bar{E}, T C_{2z} \) | \( R_2; 1; -1,1; \)
| \( Y \) | \( \Gamma X \) | \( \bar{E}, T C_{2z} \) | \( R_2; 1; -1,1; \)
\[ \Gamma; \{ C^+_{4v}[000], \{ I[000], T; Centrosymmetric; with SOC \} \]

\[ \Gamma: (000); C^+_{4v}, I, T; \{ R_2, R_8 \}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2 \]
[\[ R_4, R_6 \]; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2 \]
[\[ R_{10}, R_{16} \]; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2 \]
[\[ R_{12}, R_{14} \]; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2 \]

\[ M; (1\frac{1}{2}, 0); C^+_{4v}, I, T; \{ R_2, R_8 \}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2 \]
[\[ R_4, R_6 \]; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2 \]
[\[ R_{10}, R_{16} \]; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2 \]
[\[ R_{12}, R_{14} \]; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2 \]

\[ Z; (00\frac{1}{2}); C^+_{4v}, I, T; \{ R_2, R_8 \}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2 \]
[\[ R_4, R_6 \]; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2 \]
[\[ R_{10}, R_{16} \]; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2 \]
[\[ R_{12}, R_{14} \]; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2 \]

\[ A; (1\frac{1}{2}, \frac{1}{2}); C^+_{4v}, I, T; \{ R_2, R_8 \}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2 \]
[\[ R_4, R_6 \]; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2 \]
[\[ R_{10}, R_{16} \]; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2 \]
[\[ R_{12}, R_{14} \]; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2 \]

\[ R; (0\frac{1}{2}, \frac{1}{2}); C_{2s}, I, T; \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_0, -i\sigma_2 \]
[\[ R_6, R_8 \]; 2; \sigma_0, -\sigma_0, -i\sigma_2 \]

\[ X; (0\frac{1}{2}, 0); C_{2s}, I, T; \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_0, -i\sigma_2 \]
[\[ R_6, R_8 \]; 2; \sigma_0, -\sigma_0, -i\sigma_2 \]

\[ \Delta; \Gamma X; \sigma_2, I, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2 \]

\[ U; \Gamma Z; \sigma_2, I, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2 \]

\[ \Lambda; \Gamma Z^+; C^+_{4v}, I, T; \{ R_2, R_8 \}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, -i\sigma_2 \]
[\[ R_4, R_6 \]; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, -i\sigma_2 \]

\[ V; \Gamma A; C^+_{4v}, I, T; \{ R_2, R_8 \}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, -i\sigma_2 \]
[\[ R_4, R_6 \]; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, -i\sigma_2 \]

\[ \Sigma; \Gamma M; \sigma_2, I, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2 \]

\[ S; \Gamma A; \sigma_2, I, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2 \]

\[ Y; \Gamma M; \sigma_2, I, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2 \]

\[ T; \Gamma A; \sigma_2, I, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2 \]

\[ W; \Gamma R; C_{2s}, I, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2 \]
Γ; \( \{C^+_{4z}\{00\frac{1}{2}\}\} \), \( \{I\{00\frac{1}{2}\}\} \), \( T \); Centrosymmetric; with SOC

\[ \Gamma; \{C^+_{4z}\{00\frac{1}{2}\}, I, T; \{R^2, R^4\}; 2; \sigma_2, -i\sigma_2; \]
\[ \{R_4, R_6\}; 2; -\frac{a_0 + i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2; \]
\[ \{R_{10}, R_{16}\}; 2; \frac{a_0 + i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2; \]
\[ \{R_{12}, R_{14}\}; 2; -\frac{a_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2; \]

\[ M; \{C^+_{4z}\{1\frac{1}{2}\}; \{R^2, R^4\}; 2; \sigma_2, -i\sigma_2; \]
\[ \{R_4, R_6\}; 2; -\frac{a_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2; \]
\[ \{R_{10}, R_{16}\}; 2; \frac{a_0 + i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2; \]
\[ \{R_{12}, R_{14}\}; 2; -\frac{a_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2; \]

\[ Z; \{00\frac{1}{2}\}; \{C^+_{4z}\{E,I,T\}; \{R^2, R^4\}; 4; \frac{\Gamma_{0.1} + i\Gamma_{3.1}}{\sqrt{2}}, -\Gamma_{0.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; DP: 0 \]

\[ A; \{1\frac{1}{2}\}; \{C^+_{4z}\{E,I,T\}; \{R^2, R^4\}; 4; \frac{\Gamma_{0.1} + i\Gamma_{3.1}}{\sqrt{2}}, -\Gamma_{0.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; DP: 0 \]

\[ R; \{0\frac{1}{2}\}; \{C^+_{2z}\{I,T\}; \{R^2, R^4\}; 2; i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ X; \{0\frac{1}{2}\}; \{C^+_{2z}\{I,T\}; \{R^2, R^4\}; 2; i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \{R_6, R_8\}; 2; i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ \Delta; \{R^2, R^4\}; \{\sigma_2, I, T\}; 2; i\sigma_3, -i\sigma_2; \]

\[ U; \{R^2, R^4\}; \{\sigma_2, E, I, T\}; 2; -i\sigma_3, \sigma_0, -i\sigma_2; \]

\[ \Lambda; \{R^2, R^4\}; \{C^+_{4z}\{I,T\}; \{R^2, R^4\}; \{R^4, R_6\}; \{R_4, R_6\}; 2; -\frac{a_0 - i\sigma_3}{\sqrt{2}}, -i\sigma_2; \]

\[ V; \{R_4, R_6\}; 2; -\frac{a_0 + i\sigma_3}{\sqrt{2}}, -i\sigma_2; \]
\[ \{R_4, R_6\}; 2; -\frac{a_0 - i\sigma_3}{\sqrt{2}}, -i\sigma_2; \]

\[ \Sigma; \{R^2, R^4\}; \{\sigma_2, I, T\}; \{R_5, R_7\}; 2; i\sigma_3, -i\sigma_2; \]

\[ S; \{R^2, R^4\}; \{\sigma_2, E, I, T\}; \{R_5, R_7\}; 2; -i\sigma_3, \sigma_0, -i\sigma_2; \]

\[ Y; \{R^2, R^4\}; \{\sigma_2, I, T\}; \{R_5, R_7\}; 2; i\sigma_3, -i\sigma_2; \]

\[ T; \{R_5, R_7\}; \{\sigma_2, E, I, T\}; \{R_5, R_7\}; 2; -i\sigma_3, \sigma_0, -i\sigma_2; \]

\[ W; \{R_5, R_7\}; \{\sigma_2, E, I, T\}; \{R_5, R_7\}; 2; i\sigma_3, -i\sigma_2; \]
\[ \Gamma; \{ C_{4v}^+ | \frac{1}{2}, \frac{1}{2}, 0 \}, \{ I | \frac{1}{2}, \frac{1}{2}, 0 \}, T; \text{Centrosymmetric; with SOC} \]

\[ \{ R_2, R_8 \}; 2; \frac{a_0 + i a_1}{\sqrt{2}}, \sigma_0, -i \sigma_2; \]
\[ \{ R_4, R_6 \}; 2; \frac{-a_0 - i a_1}{\sqrt{2}}, \sigma_0, -i \sigma_2; \]
\[ \{ R_{10}, R_{16} \}; 2; \frac{a_0 + i a_3}{\sqrt{2}}, -\sigma_0, -i \sigma_2; \]
\[ \{ R_{12}, R_{14} \}; 2; \frac{-a_0 - i a_3}{\sqrt{2}}, -\sigma_0, -i \sigma_2; \]

\[ M; \{ \frac{1}{2}, \frac{1}{2} \}; \{ R_{19}, R_{20} \}; 4; \frac{\Gamma_{0,1} + \Gamma_{0,3}}{\sqrt{2}}, -\Gamma_{0,0}, \Gamma_{0,3}, -i \Gamma_{2,0}; \text{DP; 0} \]

\[ Z; \{ 0, \frac{1}{2} \}; \{ R_{2}, R_{8} \}; 2; \frac{a_0 + i a_3}{\sqrt{2}}, \sigma_0, -i \sigma_2; \]
\[ \{ R_{4}, R_{6} \}; 2; \frac{-a_0 - i a_3}{\sqrt{2}}, \sigma_0, -i \sigma_2; \]
\[ \{ R_{10}, R_{16} \}; 2; \frac{a_0 + i a_3}{\sqrt{2}}, -\sigma_0, -i \sigma_2; \]
\[ \{ R_{12}, R_{14} \}; 2; \frac{-a_0 - i a_3}{\sqrt{2}}, -\sigma_0, -i \sigma_2; \]

\[ A; \{ \frac{1}{2}, \frac{1}{2} \}; \{ R_{19}, R_{20} \}; 4; \frac{\Gamma_{0,1} + \Gamma_{0,3}}{\sqrt{2}}, -\Gamma_{0,0}, \Gamma_{0,3}, -i \Gamma_{2,0}; \text{DP; 0} \]

\[ R; \{ 0, \frac{1}{2} \}; \{ R_{9}, R_{9} \}; 4; \Gamma_{0,1}, -\Gamma_{0,0}, \Gamma_{0,3}, -i \Gamma_{2,0}; \text{DP; 0} \]

\[ X; \{ 0 \}; \{ R_{9}, R_{9} \}; 4; \Gamma_{0,1}, -\Gamma_{0,0}, \Gamma_{0,3}, -i \Gamma_{2,0}; \text{DP; 0} \]

\[ \Delta; \{ G_{X} \}; \{ R_{2}, R_{4} \}; 2; i \sigma_3, -i \sigma_2; \]

\[ U; \{ Z_{R} \}; \{ R_{2}, R_{4} \}; 2; i \sigma_3, -i \sigma_2; \]

\[ \Lambda; \{ G_{Z} \}; \{ R_{2}, R_{8} \}; 2; \frac{a_0 + i a_3}{\sqrt{2}}, -i \sigma_2; \]
\[ \{ R_{4}, R_{6} \}; 2; \frac{-a_0 - i a_3}{\sqrt{2}}, -i \sigma_2; \]

\[ V; \{ M_{A} \}; \{ R_{10}, R_{12} \}; 2; \frac{-a_0 - i a_3}{\sqrt{2}}, \sigma_0, -i \sigma_2; \]
\[ \{ R_{14}, R_{16} \}; 2; \frac{a_0 + i a_3}{\sqrt{2}}, \sigma_0, -i \sigma_2; \]

\[ \Sigma; \{ G_{M} \}; \{ R_{2}, R_{4} \}; 2; i \sigma_3, -i \sigma_2; \]

\[ S; \{ Z_{A} \}; \{ R_{2}, R_{4} \}; 2; i \sigma_3, -i \sigma_2; \]

\[ Y; \{ X_{M} \}; \{ R_{2}, R_{4} \}; 2; \sigma_3, -i \sigma_2; \]

\[ T; \{ R_{2}, R_{4} \}; 2; \sigma_3, -i \sigma_2; \]

\[ W; \{ X_{R} \}; \{ R_{2}, R_{4} \}; 2; -i \sigma_3, -i \sigma_2; \]

\[ \{ R_{4}, R_{4} \}; 2; -i \sigma_3, -i \sigma_2; \]
\[
\Gamma; (000); C_{4v}^+, I, T; \{R_2, R_8\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2; \\
\quad \{R_4, R_6\}; 2; \frac{-\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2; \\
\quad \{R_{10}, R_{16}\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2; \\
\quad \{R_{12}, R_{14}\}; 2; \frac{-\sigma_0 - i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2; \\
\]

\[
M; (\frac{1}{2}, 0); C_{4v}^+, E, I, T; \{R_{19}, R_{20}\}; 4; \frac{\Gamma_{0,0} + i\Gamma_{0,3}}{\sqrt{2}}, -\Gamma_{0,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{DP}; 0 \\
\]

\[
Z; (00\frac{1}{2}); C_{4v}^+, E, I, T; \{R_{19}, R_{20}\}; 4; \frac{\Gamma_{0,0} + i\Gamma_{0,3}}{\sqrt{2}}, -\Gamma_{0,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{DP}; 0 \\
\]

\[
A; (\frac{1}{2}, \frac{1}{2}, \frac{1}{2}); C_{4v}^+, I, T; \{R_2, R_8\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2; \\
\quad \{R_4, R_6\}; 2; \frac{-\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2; \\
\quad \{R_{10}, R_{16}\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2; \\
\quad \{R_{12}, R_{14}\}; 2; \frac{-\sigma_0 - i\sigma_3}{\sqrt{2}}, -\sigma_0, -i\sigma_2; \\
\]

\[
R; (0, 0, \frac{1}{2}); \sigma_x, E, I, T; \{R_9, R_{10}\}; 4; \Gamma_{0,1}, -\Gamma_{0,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{DP}; 0 \\
\]

\[
X; (0, \frac{1}{2}, 0); \sigma_x, E, I, T; \{R_9, R_{10}\}; 4; \Gamma_{0,1}, -\Gamma_{0,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{DP}; 0 \\
\]

\[
\Delta; \Gamma X; \sigma_z, I, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \\
\]

\[
U; ZR; \sigma_z, E, I, T; \{R_5, R_7\}; 2; -i\sigma_3, \sigma_0, -i\sigma_2; \\
\]

\[
\Lambda; \Gamma Z; C_{4v}^+, I, T; \{R_2, R_8\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, -i\sigma_2; \\
\quad \{R_4, R_6\}; 2; \frac{-\sigma_0 - i\sigma_3}{\sqrt{2}}, -i\sigma_2; \\
\]

\[
V; MA; C_{4v}^+, E, I, T; \{R_{10}, R_{12}\}; 2; \frac{-\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2; \\
\quad \{R_{14}, R_{16}\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0, -i\sigma_2; \\
\]

\[
\Sigma; \Gamma M; \sigma_z, I, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \\
\]

\[
S; ZA; \sigma_z, E, I, T; \{R_5, R_7\}; 2; -i\sigma_3, \sigma_0, -i\sigma_2; \\
\]

\[
Y; XM; \sigma_z, I, T; \{R_2, R_4\}; 2; \sigma_3, -i\sigma_2; \\
\]

\[
T; RA; \sigma_z, E, I, T; \{R_5, R_7\}; 2; -\sigma_3, \sigma_0, -i\sigma_2; \\
\]

\[
W; XR; C_{2v}, I, T; \{R_2, R_4\}; 2; i\sigma_0, -i\sigma_2; \\
\quad \{R_4, R_6\}; 2; -i\sigma_0, -i\sigma_2; \\
\]
Γ': (000); $C_{4v}^+\{000\}, \{I\{000\}, T\};$ Centrosymmetric; with SOC

Γ: (000); $C_{4v}^+ I, T; \{R_2, R_6\}; 2; \frac{\alpha_0+i\alpha_3}{\sqrt{2}}, \sigma_0, -i\sigma_2;$

{R_4, R_6}; 2; -\frac{\alpha_0-i\alpha_3}{\sqrt{2}}, \sigma_0, -\sigma_2;

{R_{10}, R_{16}}; 2; \frac{\alpha_0+i\alpha_3}{\sqrt{2}}, \sigma_0, -i\sigma_2;

{R_{12}, R_{14}}; 2; -\frac{\alpha_0-i\alpha_3}{\sqrt{2}}, \sigma_0, -i\sigma_2;

N: (0\frac{1}{2}0); \{I, \tilde{E}, \tilde{T}\}; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, -i\sigma_2);

{R_4, R_5}; 2; -\sigma_0, -\sigma_0, -i\sigma_2;

X: (00\frac{1}{2}); $C_{2z} I, T; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0, -i\sigma_2;$

{R_4, R_6}; 2; i\sigma_3, -\sigma_0, -i\sigma_2;

Z: (\frac{1}{2} 1 1); $C_{4v}^+ I, T; \{R_2, R_4\}; 2; \frac{\alpha_0+i\alpha_3}{\sqrt{2}}, \sigma_0, -i\sigma_2;$

{R_6, R_6}; 2; -\frac{\alpha_0-i\alpha_3}{\sqrt{2}}, \sigma_0, -i\sigma_2;

{R_{10}, R_{16}}; 2; \frac{\alpha_0+i\alpha_3}{\sqrt{2}}, \sigma_0, -i\sigma_2;

{R_{12}, R_{14}}; 2; -\frac{\alpha_0-i\alpha_3}{\sqrt{2}}, \sigma_0, -i\sigma_2;

P: (\frac{1}{2} 1 1 1); S_{4z}^+ I, T; \{R_2, R_4\}; 2; \frac{\alpha_0+i\alpha_3}{\sqrt{2}}, -i\sigma_2;

{R_4, R_6}; 2; -\frac{\alpha_0-i\alpha_3}{\sqrt{2}}, -i\sigma_2;

Λ; Γ/ΔZ; C_{4z}^+ I, T; \{R_2, R_4\}; 2; \frac{\alpha_0+i\alpha_3}{\sqrt{2}}, -i\sigma_2;

{R_4, R_6}; 2; -\frac{\alpha_0-i\alpha_3}{\sqrt{2}}, -i\sigma_2;

V; ZV; C_{4z}^+ I, T; \{R_2, R_4\}; 2; \frac{\alpha_0+i\alpha_3}{\sqrt{2}}, -i\sigma_2;

{R_4, R_6}; 2; -\frac{\alpha_0-i\alpha_3}{\sqrt{2}}, -i\sigma_2;

W; XP; C_{2z} I, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2;

Σ; ΓZ/TΣ; σ_z I, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2;

F; ZF; σ_z I, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2;

Q; NP; $\tilde{E} I, T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2;

Δ; ΓX; σ_z I, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2;

U; ZU; σ_z I, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2;

Y; XZ/XY; σ_z I, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2;
$\Gamma^v_v; \{C^{\frac{4}{4}}_{4z} \}, \{I_{4z} \}, T_v$; Centrosymmetric; with SOC

$\Gamma$: (000); $C^v_{4z}, I, T_v$;
  \{R_2, R_4\}: 2; $\frac{e_{\frac{4}{4}}}{\sqrt{2}}, \sigma_0, -i\sigma_2$
  \{R_4, R_9\}: 2; $-\frac{e_{\frac{4}{4}}}{\sqrt{2}}, \sigma_0, -i\sigma_2$
  \{R_{10}, R_{16}\}: 2; $\frac{e_{\frac{4}{4}}}{\sqrt{2}}, \sigma_0, -i\sigma_2$
  \{R_{12}, R_{14}\}: 2; $-\frac{e_{\frac{4}{4}}}{\sqrt{2}}, -\sigma_0, -i\sigma_2$

$N$: (0$^1/4$0); $I, \bar{E}, T_v$;
  \{R_2, R_4\}: 2; $\sigma_0, -\sigma_0, -i\sigma_2$
  \{R_4, R_4\}: 2; $-\sigma_0, -\sigma_0, -i\sigma_2$

$X$: (001$^1$2$^1$); $\sigma_z, E, I, T_v$;
  \{R_9, R_9\}: 4; $\Gamma_{0,1}, -\Gamma_{0,0}, \Gamma_{0,3}, -i\Gamma_{2,0};$ DP: 0

$Z$: (1$^1$1$^2$3$^1$); $C^{\frac{4}{4}}_{4z}, E, I, T_v$;
  \{R_9, R_20\}: 4; $\frac{\sigma_{\frac{4}{4}, \frac{4}{4}}}{\sqrt{2}}, -\Gamma_{0,0}, \Gamma_{0,3}, -i\Gamma_{2,0};$ DP: 0

$P$: (1 $^1$1 $^1$2 $^2$3); $S^{\frac{4}{4}}_{4z}, I, T_v$;
  \{R_2, R_6\}: 2; $\sqrt{3}, \sigma_3, -i\sigma_2$
  \{R_4, R_4\}: 2; $(-1)^{1/4} \sigma_0, -i\sigma_2$
  \{R_8, R_8\}: 2; $(-1)^{3/4} \sigma_0, -i\sigma_2$

$\Lambda$: $\Gamma \Lambda / T \Gamma Z_v$; $C^{\frac{4}{4}}_{4z}, E, I, T_v$;
  \{R_2, R_8\}: 2; $\frac{e_{\frac{4}{4}}}{\sqrt{2}}, -i\sigma_2$
  \{R_4, R_6\}: 2; $-\frac{e_{\frac{4}{4}}}{\sqrt{2}}, -i\sigma_2$

$V$: $Z \bar{V}$; $C^{\frac{4}{4}}_{4z}, E, I, T_v$;
  \{R_9, R_12\}: 2; $\frac{e_{\frac{4}{4}, \frac{4}{4}}}{\sqrt{2}}, \sigma_0, -i\sigma_2$
  \{R_{14}, R_{16}\}: 2; $-\frac{\sigma_{\frac{4}{4}, \frac{4}{4}}}{\sqrt{2}}, \sigma_0, -i\sigma_2$

$W$: $X \bar{P}$; $C_{2z}, I, T_v$;
  \{R_2, R_2\}: 2; $i\sigma_0, -i\sigma_2$
  \{R_4, R_4\}: 2; $-i\sigma_0, -i\sigma_2$

$\Sigma$: $\Gamma Z / \Sigma Z_v$; $\sigma_z, I, T_v$;
  \{R_2, R_4\}: 2; $i\sigma_3, -i\sigma_2$

$F$: $Z \bar{F}$; $\sigma_z, E, I, T_v$;
  \{R_6, R_7\}: 2; $-i\sigma_3, \sigma_0, -i\sigma_2$

$Q$: $N \bar{P}$; $\bar{E}, I, T_v$;
  \{R_2, R_2\}: 2; $-\sigma_0, -i\sigma_2$

$\Delta$: $\Gamma X$; $\sigma_z, I, T_v$;
  \{R_2, R_4\}: 2; $i\sigma_3, -i\sigma_2$

$U$: $Z \bar{U}$; $\sigma_z, E, I, T_v$;
  \{R_5, R_5\}: 2; $-i\sigma_3, \sigma_0, -i\sigma_2$

$Y$: $X \bar{Z}/X Y$; $\sigma_z, I, T_v$;
  \{R_2, R_2\}: 2; $\sigma_5, -i\sigma_2$
$\Gamma$; (000); $C_{4v}^+; C_{2v}; T$; $R_6; 2; \sigma_{0+}^{i\sigma_2}, i\sigma_1, -i\sigma_2$; C-1 WP; 1
$R_7; 2; \sigma_{0-}^{i\sigma_2}, i\sigma_1, -i\sigma_2$; C-1 WP; 1

$M; (1\frac{1}{2}0); C_{4v}^+; C_{2v}; T$; $R_6; 2; \sigma_{0+}^{i\sigma_2}, i\sigma_1, -i\sigma_2$; C-1 WP; 1
$R_7; 2; \sigma_{0-}^{i\sigma_2}, i\sigma_1, -i\sigma_2$; C-1 WP; 1

$Z; (00\frac{1}{2}); C_{4v}^+; C_{2v}; T$; $R_6; 2; \sigma_{0+}^{i\sigma_2}, i\sigma_1, -i\sigma_2$; C-1 WP; 1
$R_7; 2; \sigma_{0-}^{i\sigma_2}, i\sigma_1, -i\sigma_2$; C-1 WP; 1

$A; (1\frac{1}{2}2\frac{1}{2}); C_{4v}^+; C_{2v}; T$; $R_6; 2; \sigma_{0+}^{i\sigma_2}, i\sigma_1, -i\sigma_2$; C-1 WP; 1
$R_7; 2; \sigma_{0-}^{i\sigma_2}, i\sigma_1, -i\sigma_2$; C-1 WP; 1

$R; (0\frac{1}{2}\frac{1}{2}); C_{4v}^+; C_{2v}; T$; $R_5; 2; is_2, is_1, -i\sigma_2$; C-1 WP; 1

$X; (0\frac{1}{2}0); C_{4v}^+; C_{2v}; T$; $R_5; 2; is_2, is_1, -i\sigma_2$; C-1 WP; 1

$\Delta; \Gamma X; C_{2v}; T C_{2v}; R_2; 1; i, 1$
$R_4; 1; -i, 1$

$U; Z R; C_{2v}; T C_{2v}; R_2; 1; i, 1$
$R_4; 1; -i, 1$

$\Lambda; \Gamma Z; C_{4v}^+; C_{2v} T; R_2; 1; \sqrt{-1}, 1$
$R_4; 1; (-1)^{3/4}, 1$
$R_6; 1; -\sqrt{-1}, 1$
$R_8; 1; -(-1)^{3/4}, 1$

$V; MA; C_{4v}^+; C_{2v} T; R_2; 1; \sqrt{-1}, 1$
$R_4; 1; (-1)^{3/4}, 1$
$R_6; 1; -\sqrt{-1}, 1$
$R_8; 1; -(-1)^{3/4}, 1$

$\Sigma; \Gamma M; C_{2v}; C_{2h} T; R_2; 1; i, 1$
$R_4; 1; -i, 1$

$S; Z A; C_{2v}; C_{2h} T; R_2; 1; i, 1$
$R_4; 1; -i, 1$

$Y; XM; C_{2v}; T C_{2h}; R_2; 1; i, 1$
$R_4; 1; -i, 1$

$T; RA; C_{2v}; T C_{2h}; R_2; 1; i, 1$
$R_4; 1; -i, 1$

$W; XR; C_{2v}; T C_{2y}; R_2; 1; i, 1$
$R_4; 1; -i, 1$
\( \Gamma_q; \{C_{4v}^{+}\langle 000 \rangle, \{C_{2h} \frac{1}{2} \frac{1}{2} 0 \}, T \}; \text{Non-Centrosymmetric; with SOC} \)

\(\Gamma; (000); \quad C_{4v}^{+}, C_{2h}, T; \quad R_6; \quad 2; \frac{\alpha + i\gamma}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{C-1 WP}; \quad 1 \)

\(R_7; \quad 2; \frac{\alpha - i\gamma}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{C-1 WP}; \quad 1 \)

\(\Gamma; \left( \frac{1}{2} \frac{1}{2} 0 \right); \quad C_{4v}^{+}, C_{2h}, T; \quad \{R_6, R_7\}; \quad 4; \quad \frac{\Gamma_0.1 + i\Gamma_0.3, -i\Gamma_2.0}{\sqrt{2}}; \quad \text{C-2 DP}; \quad 2 \)

\(Z; (00\frac{1}{2}); \quad C_{4v}^{+}, C_{2h}, T; \quad R_6; \quad 2; \frac{\alpha + i\gamma}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{C-1 WP}; \quad 1 \)

\(R_7; \quad 2; \frac{\alpha - i\gamma}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{C-1 WP}; \quad 1 \)

\(A; \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); \quad C_{4v}^{+}, C_{2h}, T; \quad \{R_6, R_7\}; \quad 4; \quad \frac{\Gamma_0.1 + i\Gamma_0.3, -i\Gamma_2.0}{\sqrt{2}}; \quad \text{C-2 DP}; \quad 2 \)

\(R; (01\frac{1}{2}); \quad C_{2y}, C_{2z}, T; \quad \{R_5, R_6\}; \quad 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-NS}_{\text{MARX}}; \quad \{R_7, R_8\}; \quad 2; \sigma_0, -i\sigma_3, -i\sigma_2; \quad \text{P-NS}_{\text{MARX}}; \)

\(X; (0\frac{1}{2} 0); \quad C_{2y}, C_{2z}, T; \quad \{R_5, R_6\}; \quad 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-NS}_{\text{MARX}}; \quad \{R_7, R_8\}; \quad 2; \sigma_0, -i\sigma_3, -i\sigma_2; \quad \text{P-NS}_{\text{MARX}}; \)

\(\Delta; \quad \Gamma X; \quad C_{2y}, T C_{2z}; \quad R_2; \quad 1; i, 1; \quad R_4; \quad 1; -i, 1; \)

\(U; \quad Z R; \quad C_{2y}, T C_{2z}; \quad R_2; \quad 1; i, 1; \quad R_4; \quad 1; -i, 1; \)

\(\Lambda; \quad \Gamma Z; \quad C_{4v}^{+}, C_{2h} T; \quad R_2; \quad 1; \left(-1\right)^{1/4}, 1; \quad R_4; \quad 1; \left(-1\right)^{3/4}, 1; \quad R_6; \quad 1; \left(-1\right)^{1/4}, 1; \quad R_8; \quad 1; \left(-1\right)^{3/4}, 1; \)

\(V; \quad \text{MA}; \quad C_{4v}^{+}, C_{2h} T; \quad \{R_2, R_6\}; \quad 2; \left(-1\right)^{1/4} \sigma_3, \sigma_1; \quad \text{L-NS}; \quad \{R_4, R_8\}; \quad 2; \left(-1\right)^{3/4} \sigma_3, \sigma_1; \quad \text{L-NS}; \)

\(\Sigma; \quad \Gamma M; \quad C_{2h}, C_{2h} T; \quad R_2; \quad 1; i, 1; \quad R_4; \quad 1; -i, 1; \)

\(S; \quad Z A; \quad C_{2h}, C_{2h} T; \quad R_2; \quad 1; i, 1; \quad R_4; \quad 1; -i, 1; \)

\(Y; \quad \text{XM}; \quad C_{2h}, E, T C_{2h}; \quad \{R_3, R_7\}; \quad 2; -i\sigma_3, \sigma_0, -i\sigma_2; \quad \text{L-NS}_{\text{MARX}}; \)

\(T; \quad \text{RA}; \quad C_{2h}, E, T C_{2h}; \quad \{R_3, R_7\}; \quad 2; -i\sigma_3, \sigma_0, -i\sigma_2; \quad \text{L-NS}_{\text{MARX}}; \)

\(W; \quad \text{XR}; \quad C_{2h}, T C_{2h}; \quad \{R_2, R_4\}; \quad 2; i\sigma_3, -i\sigma_2; \quad \text{L-NS}_{\text{MARX}}; \)
SG 91

\( \Gamma_q; \{ C_{4z}^+ | 001 \}, \{ C_{2z} | 000 \}, \mathcal{T} \); Non-Centrosymmetric; with SOC

- **\( \Gamma \): (000); \( C_{4z}^+; C_{2z}; \mathcal{T}; \)
  - \( R_6; 2; \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) C-1 WP; 1
  - \( R_7; 2; \frac{\alpha_0 - i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) C-1 WP; 1

- **\( M \): (1\( \frac{1}{2} \) 0); \( C_{4z}^+; C_{2z}; \mathcal{T}; \)
  - \( R_6; 2; \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) C-1 WP; 1
  - \( R_7; 2; \frac{\alpha_0 - i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) C-1 WP; 1

- **\( Z \): (00\( \frac{1}{2} \)); \( C_{4z}^+; C_{2z}; \mathcal{T}; \)
  - \( \{ R_8, R_{10} \}; 2; \sigma_0, i\sigma_3, -i\sigma_2; \) P-NS\( _{ZAR} \);
  - \( \{ R_9, R_{11} \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \) P-NS\( _{ZAR} \);
  - \( R_{14}; 2; i\sigma_3, i\sigma_2, -i\sigma_2; \) P-NS\( _{ZAR} \);

- **\( A \): (1\( \frac{1}{2} \) \( \frac{1}{2} \)); \( C_{4z}^+; C_{2z}; \mathcal{T}; \)
  - \( \{ R_8, R_{10} \}; 2; \sigma_0, i\sigma_3, -i\sigma_2; \) P-NS\( _{ZAR} \);
  - \( \{ R_9, R_{11} \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \) P-NS\( _{ZAR} \);
  - \( R_{14}; 2; i\sigma_3, i\sigma_2, -i\sigma_2; \) P-NS\( _{ZAR} \);

- **\( R \): (01\( \frac{1}{2} \)); \( C_{2z}; C_{2y}; T; \)
  - \( \{ R_5, R_6 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \) P-NS\( _{ZAR} \);
  - \( \{ R_7, R_8 \}; 2; \sigma_0, -i\sigma_3, -i\sigma_2; \) P-NS\( _{ZAR} \);

- **\( X \): (01\( \frac{1}{2} \)); \( C_{2z}; C_{2y}; T; \)
  - \( R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \) C-1 WP; 1

- **\( \Delta \): \( \Gamma X; \)
  - \( C_{2y}; \mathcal{T} C_{2z}; \)
  - \( R_2; 1; i, 1 \);
  - \( R_4; 1; -i, 1 \);

- **\( U \): \( Z R; \)
  - \( C_{2y}; E; \mathcal{T} C_{2z}; \)
  - \( \{ R_5, R_7 \}; 2; -i\sigma_3, \sigma_0, -i\sigma_2; \) L-NS\( _{ZAR} \);

- **\( \Lambda \): \( \Gamma Z; \)
  - \( C_{4z}^+; C_{2z} T; \)
  - \( R_2; 1; \sqrt{-1}, 1 \);
  - \( R_4; 1; (-1)^{3/4}, 1 \);
  - \( R_6; 1; -\sqrt{-1}, 1 \);
  - \( R_8; 1; -(-1)^{3/4}, 1 \);

- **\( V \): \( M A; \)
  - \( C_{4z}^+; C_{2z} T; \)
  - \( R_2; 1; \sqrt{-1}, 1 \);
  - \( R_4; 1; (-1)^{3/4}, 1 \);
  - \( R_6; 1; -\sqrt{-1}, 1 \);
  - \( R_8; 1; -(-1)^{3/4}, 1 \);

- **\( \Sigma \): \( \Gamma M; \)
  - \( C_{2z}; C_{2z} T; \)
  - \( R_2; 1; i, 1 \);
  - \( R_4; 1; -i, 1 \);

- **\( S \): \( Z A; \)
  - \( C_{2z}; E; C_{2z} T; \)
  - \( \{ R_{12}, R_{16} \}; 2; i\sigma_3, -\sigma_0, \sigma_1; \) L-NS\( _{ZAR} \);

- **\( Y \): \( X M; \)
  - \( C_{2z}; \mathcal{T} C_{2z}; \)
  - \( R_2; 1; i, 1 \);
  - \( R_4; 1; -i, 1 \);

- **\( T \): \( R A; \)
  - \( C_{2z}; \mathcal{T} C_{2z}; \)
  - \( \{ R_2, R_4 \}; 2; i\sigma_3, \sigma_1; \) L-NS\( _{ZAR} \);

- **\( W \): \( X R; \)
  - \( C_{2z}; \mathcal{T} C_{2z}; \)
  - \( R_2; 1; i, 1 \);
  - \( R_4; 1; -i, 1 \);
Γ; (000); $C_{4v}^+, C_{2v}, T$; $R_6$: 2; $\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}$, $i\sigma_3$, $-i\sigma_2$; C-1 WP; 1

$R_7$: 2; $\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}$, $i\sigma_3$, $-i\sigma_2$; C-1 WP; 1

$M; (\frac{1}{2} \frac{1}{2} 0)$; $C_{4v}^+, C_{2v}, T$; \{$R_6, R_7\}$; 4; $\frac{\Gamma_0 + i\Gamma_{1,2}}{\sqrt{2}}$, $\Gamma_{0,3}$, $-i\Gamma_{2,0}$; C-2 DP; 2

$Z; (00 \frac{1}{2})$; $C_{4v}^+, C_{2v}, T$; \{$R_8, R_{10}\}$; 2; $\sigma_0, i\sigma_3, -i\sigma_2$; P-NS$_{ZAR}$;

\{$R_9, R_{11}\}$; 2; $-\sigma_0, i\sigma_3, -i\sigma_2$; P-NS$_{ZAR}$;

$R_{14}$; 2; $i\sigma_3, i\sigma_3, -i\sigma_2$; P-NS$_{ZAR}$;

$A; (\frac{1}{2} \frac{1}{2} 1)$; $C_{4v}^+, C_{2v}, T$; \{$R_8, R_{11}\}$; 2; $i\sigma_3, i\sigma_3, -i\sigma_2$; P-NS;

\{$R_9, R_{10}\}$; 2; $i\sigma_3, -i\sigma_3, -i\sigma_2$; P-NS;

\{$R_{12}, R_{12}\}$; 4; $-\Gamma_{0,2}, i\Gamma_{0,3}, -\Gamma_{2,1}$; C-4 QDP; 4

$R; (0 \frac{1}{2} \frac{1}{2})$; $C_{2v}, C_{2y}, T$; \{$R_5, R_9\}$; 4; $i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1}$; C-2 DP; 2

$X; (0 \frac{1}{2} 0)$; $C_{2y}, C_{2z}, T$; \{$R_5, R_6\}$; 2; $-\sigma_0, i\sigma_3, -i\sigma_2$; P-NS$_{MARX}$;

\{$R_7, R_8\}$; 2; $\sigma_0, -i\sigma_3, -i\sigma_2$; P-NS$_{MARX}$;

$\Delta; \Gamma X$; $C_{2y}, TC_{2z}$; $R_2$: 1; $i, 1$; $R_3$: 1; $-i, 1$;

$U; ZR$; $C_{2y}, E, TC_{2z}$; \{$R_5, R_7\}$; 2; $-i\sigma_3, \sigma_0, -i\sigma_2$; L-NS$_{ZAR}$;

$\Lambda; \Gamma Z$; $C_{4v}, C_{2b}, T$; $R_2$: 1; $\sqrt{-1}, 1$;

$R_3$: 1; $(-1)^{3/4}, 1$;

$R_6$: 1; $\frac{\sqrt{-1}}{2}, 1$;

$R_8$: 1; $(-1)^{3/4}, 1$;

$V; MA$; $C_{4v}^+, C_{2b}, T$; \{$R_2, R_6\}$; 2; $\sqrt{-1}\Gamma_3, \sigma_1$; L-NS;

\{$R_4, R_8\}$; 2; $(-1)^{3/4}\sigma_3, \sigma_1$; L-NS;

$\Sigma; \Gamma M$; $C_{2a}, C_{2b}, T$; $R_2$: 1; $i, 1$;

$R_3$: 1; $-i, 1$;

$S; ZA$; $C_{2a}, E, C_{2b}, T$; \{$R_{12}, R_{16}\}$; 2; $i\sigma_3, -\sigma_0, \sigma_1$; L-NS$_{ZAR}$;

$Y; XM$; $C_{2a}, E, TC_{2y}$; \{$R_5, R_7\}$; 2; $-i\sigma_3, \sigma_0, -i\sigma_2$; L-NS$_{MARX}$;

$T; RA$; $C_{2a}, E, TC_{2y}$; \{$R_5, R_5\}$; 2; $-i\sigma_0, \sigma_0, -i\sigma_2$; L-NS;

\{$R_7, R_7\}$; 2; $\sigma_0, \sigma_0, -i\sigma_2$; L-NS;

$W; XR$; $C_{2a}, TC_{2y}$; \{$R_2, R_4\}$; 2; $i\sigma_3, -i\sigma_2$; L-NS$_{MARX}$;
SG 93

Γ; \{C_{4v}^+|001\}, \{C_{2v}|000\}, T; Non-Centrosymmetric; with SOC

Γ: (000); \ C_{4v}^+; C_{2v}; T;
R_0; 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; C-1 WP; 1
R_1; 2; \frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; C-1 WP; 1

M; (1\frac{1}{2}0); \ C_{4v}^+; C_{2v}; T;
R_0; 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; C-1 WP; 1
R_1; 2; \frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; C-1 WP; 1

Z; (00\frac{1}{2}); \ C_{4v}^+; C_{2v}; T;
R_0; 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; C-1 WP; 1
R_1; 2; \frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; C-1 WP; 1

A; (1\frac{1}{2}2); \ C_{4v}^+; C_{2v}; T;
R_0; 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; C-1 WP; 1
R_1; 2; \frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; C-1 WP; 1

R; (0\frac{1}{2}); \ C_{2v}, C_{2y}; T;
R_0; 2; i\sigma_2, i\sigma_1, -i\sigma_2; C-1 WP; 1

X; (0\frac{1}{2}0); \ C_{2v}, C_{2y}; T;
R_0; 2; i\sigma_2, i\sigma_1, -i\sigma_2; C-1 WP; 1

Δ; ΓX; \ C_{2y}, TC_{2z};
R_0; 2; i, 1;
R_4; 1; -i, 1;

U; ZR; \ C_{2y}, TC_{2z};
R_0; 2; i, 1;
R_4; 1; -i, 1;

Λ; ΓZ; \ C_{4v}^+; C_{2z}; T;
R_2; 1; \sqrt{-1}, 1;
R_4; 1; (-1)^{3/4}, 1;
R_6; 1; -\sqrt{-1}, 1;
R_8; 1; -(-1)^{3/4}, 1;

V; MA; \ C_{4v}^+; C_{2z}; T;
R_2; 1; \sqrt{-1}, 1;
R_4; 1; (-1)^{3/4}, 1;
R_6; 1; -\sqrt{-1}, 1;
R_8; 1; -(-1)^{3/4}, 1;

Σ; ΓM; \ C_{2z}, C_{2z}; T;
R_0; 2; i, 1;
R_4; 1; -i, 1;

S; ZA; \ C_{2z}, E; C_{2z}; T;
R_0; 2; i, 1, 1,
R_7; 1; i, 1, 1;

Y; XM; \ C_{2z}, TC_{2y};
R_2; 1; i, 1;
R_4; 1; -i, 1;

T; RA; \ C_{2z}, TC_{2y};
R_2; 1; i, 1;
R_4; 1; -i, 1;

W; XR; \ C_{2z}, TC_{2y};
R_2; 1; i, 1;
R_4; 1; -i, 1;
Γ; (000); $C^+_{4v}, C_{2v}, T$; $R_6$: 2: $\frac{a_0 + i a_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2$; C-1 WP; 1

$R_7$: 2: $\frac{a_0 - i a_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2$; C-1 WP; 1

$M$: (1/2 1 0); $C^+_{4v}, C_{2v}, T$; $\{R_6, R_7\}$: 4: $\frac{1}{2} \Gamma_{0,3}, -i\Gamma_{2,0}$; C-2 DP; 2

$Z$: (00 1); $C^+_{4v}, C_{2v}, T$; $R_6$: 2: $\frac{a_0 + i a_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2$; C-1 WP; 1

$R_7$: 2: $\frac{a_0 - i a_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2$; C-1 WP; 1

$A$: (1/2 1 1/2); $C^+_{4v}, C_{2v}, T$; $\{R_6, R_7\}$: 4: $\frac{1}{2} \Gamma_{0,3}, -i\Gamma_{2,0}$; C-2 DP; 2

$R$: (0 1 1/2); $C_{2y}, C_{2z}, T$; $\{R_5, R_6\}$: 2: $-\sigma_0, i\sigma_3, -i\sigma_2$; P-NSMARX;
$\{R_7, R_8\}$: 2: $\sigma_0, -i\sigma_3, -i\sigma_2$; P-NSMARX;

$X$: (0 1/2 0); $C_{2y}, C_{2z}, T$; $\{R_5, R_6\}$: 2: $-\sigma_0, i\sigma_3, -i\sigma_2$; P-NSMARX;
$\{R_7, R_8\}$: 2: $\sigma_0, -i\sigma_3, -i\sigma_2$; P-NSMARX;

$\Delta$: $\Delta X$; $C_{2y}, T C_{2z}$; $R_2$: 1; i, i, 1;
$R_4$: 1; -i, 1, 1;

$U$: $\Delta Z$; $C_{2y}, T C_{2z}$; $R_2$: 1; i, i, 1;
$R_4$: 1; -i, 1, 1;

$\Lambda$: $\Gamma Z$; $C^+_{4v}, C_{2b}, T$; $R_2$: 1: $\sqrt{-1}, 1$;
$R_4$: 1: $(-1)^{3/4}, 1$;
$R_6$: 1: $-\sqrt{-1}, 1$;
$R_8$: 1: $(-1)^{3/4}, 1$;

$V$: $\Delta A$; $C^+_{4v}, C_{2b}, T$; $\{R_2, R_6\}$: 2: $\sqrt{-1}\sigma_3, \sigma_1$; L-NSs;
$\{R_4, R_8\}$: 2: $(-1)^{3/4}\sigma_3, \sigma_1$; L-NSs;

$\Sigma$: $\Gamma M$; $C_{2a}, C_{2b}, T$; $R_2$: 1; i, i, 1;
$R_4$: 1; -i, 1, 1;

$S$: $\Delta A$; $C_{2a}, C_{2b}, T$; $R_5$: 1; -i, 1, 1;
$R_7$: 1; i, i, 1;

$Y$: $\Delta M$; $C_{2a}, E, T C_{2b}$; $\{R_3, R_7\}$: 2: $-i\sigma_3, \sigma_0, -i\sigma_2$; L-NSMARX;

$T$: $\Delta A$; $C_{2a}, E, T C_{2b}$; $\{R_3, R_7\}$: 2: $-i\sigma_3, \sigma_0, -i\sigma_2$; L-NSMARX;

$W$: $\Delta X$; $C_{2a}, T C_{2b}$; $\{R_2, R_4\}$: 2: $i\sigma_3, -i\sigma_2$; L-NSMARX;
\[ \Gamma; (000); C_{4h}^+; 2; \frac{\alpha_0+\alpha_2}{\sqrt{2}}; \sigma_1, -\sigma_2; C-1 \text{ WP}; 1 \]

\[ R_\gamma; 2; \frac{\alpha_0-\alpha_2}{\sqrt{2}}; \sigma_1, -\sigma_2; C-1 \text{ WP}; 1 \]

\[ M; (\frac{1}{2} 0 0); C_{4h}^+; 2; \frac{\alpha_0+\alpha_2}{\sqrt{2}}; \sigma_1, -\sigma_2; C-1 \text{ WP}; 1 \]

\[ R_\gamma; 2; \frac{\alpha_0-\alpha_2}{\sqrt{2}}; \sigma_1, -\sigma_2; C-1 \text{ WP}; 1 \]

\[ Z; (00\frac{1}{2}); C_{4h}^+; \{R_6, R_{10}\}; 2; \sigma_0, i\sigma_3, -i\sigma_2; \text{ P-NSZAR}; \]

\[ \{R_9, R_{11}\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \text{ P-NSZAR}; \]

\[ R_{14}; 2; i\sigma_3, i\sigma_2, -i\sigma_2; \text{ P-NSZAR}; \]

\[ A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{4h}^+; \{R_6, R_{10}\}; 2; \sigma_0, i\sigma_3, -i\sigma_2; \text{ P-NSZAR}; \]

\[ \{R_9, R_{11}\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \text{ P-NSZAR}; \]

\[ R_{14}; 2; i\sigma_3, i\sigma_2, -i\sigma_2; \text{ P-NSZAR}; \]

\[ X; (0\frac{1}{2} 0); C_{2h}; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{ C-1 WP}; 1 \]

\[ \Delta; \Gamma X; C_{2h}; 2; 1; i, 1; \]

\[ R_4; 1; -i, 1; \]

\[ U; ZR; C_{2h}; 2; -i\sigma_3, \sigma_0, -i\sigma_2; \text{ L-NSZAR}; \]

\[ \Lambda; \Gamma Z; C_{4h}^+; 2; 1; \sqrt{-1}, 1; \]

\[ R_4; 1; (-1)^{3/4}, 1; \]

\[ R_6; 1; -\sqrt{-1}, 1; \]

\[ R_8; 1; -(-1)^{3/4}, 1; \]

\[ V; MA; C_{4h}^+; 2; 1; \sqrt{-1}, 1; \]

\[ R_4; 1; (-1)^{3/4}, 1; \]

\[ R_6; 1; -\sqrt{-1}, 1; \]

\[ R_8; 1; -(-1)^{3/4}, 1; \]

\[ \Sigma; \Gamma M; C_{2h}; 2; 1; i, 1; \]

\[ R_4; 1; -i, 1; \]

\[ S; ZA; C_{2h}; 2; -i\sigma_3, -\sigma_0, \sigma_1; \text{ L-NSZAR}; \]

\[ Y; XM; C_{2h}; 2; 1; i, 1; \]

\[ R_4; 1; -i, 1; \]

\[ T; RA; C_{2h}; 2; i\sigma_3, \sigma_1; \text{ L-NSZAR}; \]

\[ W; XR; C_{2h}; 2; 1; i, 1; \]

\[ R_4; 1; -i, 1; \]
Γ; (000); $C_{4v}^+; \{C_{2v}\}; T$; Non-Centrosymmetric; with SOC

$R_6; \Gamma_{4}; 2; \frac{\alpha_0+\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; C-1$ WP; 1

$R_7; \Gamma_{4}; 2; \frac{\alpha_0-i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; C-1$ WP; 1

$Z; (00\frac{1}{2}); C_{4v}^+; \{R_8, R_{10}\}; 2; \sigma_0, i\sigma_3, -i\sigma_2; P-NSZAR;
\{R_9, R_{11}\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; P-NSZAR;
\{R_9, R_{10}\}; 2; i\sigma_3, -i\sigma_3, -i\sigma_2; P-NSZAR;
\{R_{12}, R_{13}\}; 4; -\Gamma_{0,2}, i\Gamma_{0,3}, -\Gamma_{2,1}; C-2$ DP; 2

$A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{4v}^+; \{R_8, R_{11}\}; 2; i\sigma_3, i\sigma_3, -i\sigma_2; P-NSZAR;
\{R_9, R_{10}\}; 2; i\sigma_3, -i\sigma_3, -i\sigma_2; P-NSZAR;
\{R_{12}, R_{13}\}; 4; -\Gamma_{0,2}, i\Gamma_{0,3}, -\Gamma_{2,1}; C-4$ QDP; 4

$R; (0\frac{1}{2} \frac{1}{2}); C_{2v}; \{R_9, R_{10}\}; 4; i\Gamma_{0,2}, \Gamma_{0,3}, -\Gamma_{2,1}; C-2$ DP; 2

$X; (0\frac{1}{2} \frac{1}{2}); C_{2v}; \{R_9, R_{10}\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; P-NSM;ARX;
\{R_9, R_{10}\}; 2; \sigma_0, -i\sigma_3, -i\sigma_2; P-NSM;ARX;
\{R_{12}, R_{13}\}; 4; -\Gamma_{0,2}, i\Gamma_{0,3}, -\Gamma_{2,1}; C-4$ QDP; 4

$\Delta; \Gamma X; C_{2v},\mathcal{T}C_{2v}; \{R_2\}; 1; i, 1;
\{R_4\}; 1; -i, 1;

U; ZR; C_{2v},E,\mathcal{T}C_{2v}; \{R_9, R_{10}\}; 2; -i\sigma_3, \sigma_0, -i\sigma_2; L-NSZAR;

\Lambda; \Gamma E; C_{4v},C_{2v}; \{R_2\}; 1; \sqrt{-1}, 1;
\{R_4\}; 1; (-1)^{3/4}, 1;
\{R_6\}; 1; \sqrt{-1}, 1;
\{R_8\}; 1; (-1)^{3/4}, 1;

V; MA; C_{4v}^+; \{R_2, R_{10}\}; 2; \sqrt{-1}, 1, \sigma_3, \sigma_1; L-NSZAR;
\{R_4, R_{10}\}; 2; (-1)^{3/4}, \sigma_3, \sigma_1; L-NSZAR;

\Sigma; \Gamma M; C_{2v},C_{2v}; \{R_2\}; 1; i, 1;
\{R_4\}; 1; -i, 1;

S; ZA; C_{2v},\mathcal{E},C_{2v}; \{R_{12}, R_{16}\}; 2; -i\sigma_3, -\sigma_0, \sigma_1; L-NSZAR;

Y; XM; C_{2v},E,\mathcal{T}C_{2v}; \{R_9, R_{10}\}; 2; -i\sigma_3, \sigma_0, -i\sigma_2; L-NSM;ARX;

T; RA; C_{2v},E,\mathcal{T}C_{2v}; \{R_9, R_{10}\}; 2; -i\sigma_0, \sigma_0, -i\sigma_2; L-NSZAR;
\{R_7, R_8\}; 2; i\sigma_3, -i\sigma_2; L-NSZAR;

W; XR; C_{2v},\mathcal{T}C_{2v}; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; L-NSM;ARX;
\[
\begin{array}{cccc}
\Gamma; & (000); & C_{14}^+.C_{2x}.T; & R_6; \\
& & & 2: \frac{a_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \ C-1 \ WP; \ 1 \\
& & & R_7; \ 2: \frac{a_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \ C-1 \ WP; \ 1 \\
N; & (0\frac{1}{2}0); & C_{2y}.T; & \{R_2, R_4\}; \ 2: i\sigma_3, -i\sigma_2; \ C-1 \ WP; \ 1 \\
X; & (00\frac{1}{2}); & C_{2x}.C_{26}.T; & R_5; \ 2: i\sigma_2, i\sigma_1, -i\sigma_2; \ C-1 \ WP; \ 1 \\
Z; & (\frac{1}{2} \frac{1}{2} \frac{1}{2}); & C_{4z}^+.C_{2x}.T; & R_6; \ 2: \frac{a_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \ C-1 \ WP; \ 1 \\
& & & R_7; \ 2: \frac{a_0-i\sigma_2}{-\sqrt{2}}, i\sigma_1, -i\sigma_2; \ C-1 \ WP; \ 1 \\
P; & (\frac{1}{2} \frac{1}{2} \frac{1}{2}); & C_{22}, C_{2y}, C_{26}.T; & R_5; \ 2: i\sigma_2, i\sigma_1, \frac{i(\sigma_1+i\sigma_3)}{\sqrt{2}}; \ C-1 \ WP; \ 1 \\
\Lambda; & \Gamma\Lambda/TZ; & C_{14}^+.C_{26}.T; & R_2; \ 1: \sqrt{-1}, 1; \\
& & & R_4; \ 1: (-1)^{3/4}, 1; \\
& & & R_6; \ 1: \sqrt{-1}, 1; \\
& & & R_8; \ 1: -(-1)^{3/4}, 1; \\
V; & ZV; & C_{4z}^+.C_{26}.T; & R_2; \ 1: \sqrt{-1}, 1; \\
& & & R_4; \ 1: (-1)^{3/4}, 1; \\
& & & R_6; \ 1: \sqrt{-1}, 1; \\
& & & R_8; \ 1: -(-1)^{3/4}, 1; \\
W; & XP; & C_{2x}, C_{26}.T; & R_2; \ 1: i, 1; \\
& & & R_4; \ 1: -i, 1; \\
\Sigma; & \Gamma\Sigma/T\Sigma; & C_{2x}.TC_{2y}; & R_2; \ 1: i, 1; \\
& & & R_4; \ 1: -i, 1; \\
F; & ZF; & C_{2x}.TC_{2y}; & R_2; \ 1: i, 1; \\
& & & R_4; \ 1: -i, 1; \\
Q; & NP; & C_{2y}; & R_2; \ 1: i; \\
& & & R_4; \ 1: -i; \\
\Delta; & \Gamma\Sigma_X; & C_{2a}.C_{26}.T; & R_2; \ 1: i, 1; \\
& & & R_4; \ 1: -i, 1; \\
U; & ZU; & C_{2a}.C_{26}.T; & R_2; \ 1: i, 1; \\
& & & R_4; \ 1: -i, 1; \\
Y; & XZ/XY; & C_{2a}.TC_{2z}; & R_2; \ 1: i, 1; \\
& & & R_4; \ 1: -i, 1; \\
\end{array}
\]
Non-Centrosymmetric with SOC

| Point in Brillouin Zone | Symmetry | Wavefunctions |
|-------------------------|----------|---------------|
| \( \Gamma \) (000)     | \( C_{4v} \), \( C_{2v} \), TR | \( R_6 \): 2; \( \frac{a_0^{-i}a_2}{\sqrt{3}} \), \( i\sigma_1 \), \( i\sigma_2 \); C-1 WP: 1 |
| \( N \) (0\( \frac{1}{2} \)0) | \( C_{2v} \), TR | \( R_7 \): 2; \( \frac{a_0+i}{\sqrt{3}} \), \( \sigma_1 \), \( \sigma_2 \); C-1 WP: 1 |
| \( X \) (00\( \frac{1}{2} \))     | \( C_{2v} \), \( C_{2v} \), TR | \( R_5 \): 2; \( i\sigma_2 \), \( i\sigma_1 \), \( i\sigma_2 \); C-1 WP: 1 |
| \( Z \) (\( \frac{1}{2} \)\( \frac{1}{2} \)\( \frac{1}{2} \)) | \( C_{4v} \), \( C_{4v} \), TR | \( R_6 \): 2; \( \frac{a_0+i}{\sqrt{3}} \), \( \sigma_1 \), \( \sigma_2 \); C-1 WP: 1 |
| \( P \) (\( \frac{1}{2} \)\( \frac{1}{2} \)\( \frac{1}{2} \)) | \( C_{2v} \), \( C_{2v} \), \( C_{2v} \), TR | \( R_7 \): 2; \( \frac{a_0-i}{\sqrt{3}} \), \( \sigma_1 \), \( \sigma_2 \); C-1 WP: 1 |

\( \Lambda \): \( \Gamma \Lambda / T \Lambda Z \) | \( C_{4v} \), \( C_{2v} \), TR | \( R_2 \): 1; \( \sqrt{-1} \), 1; |
| | | \( R_4 \): 1; \( -1 \)\(^{3/4} \), 1; |
| | | \( R_6 \): 1; \( -\sqrt{-1} \), 1; |
| | | \( R_8 \): 1; \( -(-1)^{3/4} \), 1; |

\( V \): \( Z \Lambda / T \Lambda Z \) | \( C_{4v} \), \( E \), \( C_{2v} \), TR | \( R_{10} \): 1; \( \sqrt{-1} \), 1, 1; |
| | | \( R_{12} \): 1; \( -(-1)^{3/4} \), 1, 1; |
| | | \( R_{14} \): 1; \( -\sqrt{-1} \), 1, 1; |
| | | \( R_{16} \): 1; \( -(1)^{3/4} \), 1, 1; |

\( W \): \( X \Lambda / T \Lambda P \) | \( C_{2v} \), \( C_{2v} \), TR | \( R_5 \): 1; \( i \), 1; |
| | | \( R_4 \): 1; \( -i \), 1; |

\( \Sigma \): \( \Gamma \Sigma / T \Sigma \) | \( C_{2v} \), \( T \) \( C_{2v} \) | \( R_2 \): 1; \( i \), 1; |
| | | \( R_4 \): 1; \( -i \), 1; |

\( F \): \( Z \Sigma / T \Sigma F \) | \( C_{2v} \), \( T \) \( C_{2v} \) | \( R_2 \): 1; \( i \), 1; |
| | | \( R_4 \): 1; \( -i \), 1; |

\( Q \): \( N \) \( P \) | \( C_{2v} \), \( E \) | \( R_5 \): 1; \( -i \), 1; |
| | | \( R_7 \): 1; \( i \), 1; |

\( \Delta \): \( \Gamma \Delta / T \Delta \) | \( C_{2v} \), \( C_{2v} \), TR | \( R_2 \): 1; \( i \), 1; |
| | | \( R_4 \): 1; \( -i \), 1; |

\( U \): \( Z \Delta / T \Delta U \) | \( C_{2v} \), \( E \), \( C_{2v} \), TR | \( R_5 \): 1; \( -i \), 1, 1; |
| | | \( R_7 \): 1; \( i \), 1, 1; |

\( Y \): \( X \Delta / T \Delta Y \) | \( C_{2v} \), \( T \) \( C_{2v} \) | \( R_5 \): 1; \( i \), 1; |
| | | \( R_4 \): 1; \( -i \), 1; |
\[ \Gamma_q; \{ C^+_{4z}[000], \{ \sigma_y[000] \}, T \}; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \ (000); \ C^+_{4z}, \sigma_y, T; R_6; 2; \frac{a_0+i\sigma_2}{\sqrt{2}}, \ -i\sigma_1, -i\sigma_2; \text{P-WNL}_{\Gamma_Z}; \]

\[ R_7; 2; \frac{a_0-i\sigma_2}{\sqrt{2}}, \ i\sigma_1, -i\sigma_2; \text{P-WNL}_{\Gamma_Z}; \]

\[ M; \ (\frac{1}{2}\frac{1}{2}0); \ C^+_{4z}, \sigma_y, T; R_6; 2; \frac{a_0+i\sigma_2}{\sqrt{2}}, \ i\sigma_1, -i\sigma_2; \text{P-WNL}_{MA}; \]

\[ R_7; 2; \frac{a_0-i\sigma_2}{\sqrt{2}}, \ i\sigma_1, -i\sigma_2; \text{P-WNL}_{MA}; \]

\[ Z; \ (00\frac{1}{2}); \ C^+_{4z}, \sigma_y, T; R_6; 2; \frac{a_0+i\sigma_2}{\sqrt{2}}, \ i\sigma_1, -i\sigma_2; \text{P-WNL}_{\Gamma_Z}; \]

\[ R_7; 2; \frac{a_0-i\sigma_2}{\sqrt{2}}, \ i\sigma_1, -i\sigma_2; \text{P-WNL}_{\Gamma_Z}; \]

\[ A; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \ C^+_{4z}, \sigma_y, T; R_6; 2; \frac{a_0+i\sigma_2}{\sqrt{2}}, \ i\sigma_1, -i\sigma_2; \text{P-WNL}_{MA}; \]

\[ R_7; 2; \frac{a_0-i\sigma_2}{\sqrt{2}}, \ i\sigma_1, -i\sigma_2; \text{P-WNL}_{MA}; \]

\[ R; \ (0\frac{1}{2}\frac{1}{2}); \ C_{2z}, \sigma_y, T; R_5; 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{XR}; \]

\[ X; \ (0\frac{1}{2}0); \ C_{2z}, \sigma_y, T; R_5; 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{XR}; \]

\[ \Delta; \ \Gamma X; \ \sigma_x, T C_{2z}; R_2; 1; i, 1; \]

\[ R_4; 1; -i, 1; \]

\[ U; \ ZR; \ \sigma_x, T C_{2z}; R_2; 1; i, 1; \]

\[ R_4; 1; -i, 1; \]

\[ \Lambda; \ \Gamma Z; \ C^+_{4z}, \sigma_y; \ R_6; 2; \frac{a_0+i\sigma_2}{\sqrt{2}}, \ i\sigma_1; \ WNL; \ \pi \]

\[ R_7; 2; \frac{a_0-i\sigma_2}{\sqrt{2}}, \ i\sigma_1; \ WNL; \ \pi \]

\[ V; \ MA; \ C^+_{4z}, \sigma_y; \ R_6; 2; \frac{a_0+i\sigma_2}{\sqrt{2}}, \ i\sigma_1; \ WNL; \ \pi \]

\[ R_7; 2; \frac{a_0-i\sigma_2}{\sqrt{2}}, \ i\sigma_1; \ WNL; \ \pi \]

\[ \Sigma; \ \Gamma M; \ \sigma_{db}, T \sigma_{da}; R_2; 1; i, 1; \]

\[ R_4; 1; -i, 1; \]

\[ S; \ \Gamma A; \ \sigma_{db}, T \sigma_{da}; R_2; 1; i, 1; \]

\[ R_4; 1; -i, 1; \]

\[ Y; \ \Gamma M; \ \sigma_y, T \sigma_z; R_2; 1; i, 1; \]

\[ R_4; 1; -i, 1; \]

\[ T; \ \Gamma A; \ \sigma_y, T \sigma_z; R_2; 1; i, 1; \]

\[ R_4; 1; -i, 1; \]

\[ W; \ \Gamma R; \ C_{2z}, \sigma_y; R_5; 2; i\sigma_2, i\sigma_1; \ WNL; \ \pi \]
\[ \Gamma; \{ C^+_4 \{000\}, \{ \sigma_y |^{1+} \{000\} \}, T; \text{Non-Centrosymmetric with SOC} \]

\[ \Gamma; \{000\}; \quad C^+_4, \sigma_y, T; \quad R_6; \quad 2; \quad \frac{a_{y} + i a_{z}}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_P Z; \]

\[ R_7; \quad 2; \quad \frac{a_{y} - i a_{z}}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_P Z; \]

\[ M; \{ \frac{1}{2} \{000\} \}; \quad C^+_4, \sigma_y, T; \quad \{ R_6, R_7 \}; \quad 4; \quad \frac{\Gamma_{0.1} + \Gamma_{3.0}}{\sqrt{2}}, \Gamma_{0.3}, -i \Gamma_{2.0}; \quad \text{DP}; \quad 0 \]

\[ Z; \{000 \}; \quad C^+_4, \sigma_y, T; \quad R_6; \quad 2; \quad \frac{a_{y} + i a_{z}}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_P Z; \]

\[ R_7; \quad 2; \quad \frac{a_{y} - i a_{z}}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_P Z; \]

\[ A; \{ \frac{1}{2} \{3/2\} \}; \quad C^+_4, \sigma_y, T; \quad \{ R_6, R_7 \}; \quad 4; \quad \frac{\Gamma_{0.1} + \Gamma_{3.0}}{\sqrt{2}}, \Gamma_{0.3}, -i \Gamma_{2.0}; \quad \text{DP}; \quad 0 \]

\[ R; \{000 \}; \quad \sigma_z, C_2, T; \quad \{ R_5, R_6 \}; \quad 2; \quad -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{RA}; \]

\[ \{ R_7, R_8 \}; \quad 2; \quad \sigma_0, -i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{RA}; \]

\[ X; \{000 \}; \quad \sigma_z, C_2, T; \quad \{ R_5, R_6 \}; \quad 2; \quad -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{XM}; \]

\[ \{ R_7, R_8 \}; \quad 2; \quad \sigma_0, -i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{XM}; \]

\[ \Delta; \quad \Gamma X; \quad \sigma_z, T C_2; \quad R_2; \quad 1; \quad i, 1; \]

\[ R_4; \quad 1; \quad -i, 1; \]

\[ U; \quad Z R; \quad \sigma_z, T C_2; \quad R_2; \quad 1; \quad i, 1; \]

\[ R_4; \quad 1; \quad -i, 1; \]

\[ \Lambda; \quad \Gamma Z; \quad C^+_4, \sigma_y; \quad R_6; \quad 2; \quad \frac{a_{y} + i a_{z}}{\sqrt{2}}, i \sigma_1; \quad \text{WNL}; \quad \pi \]

\[ R_7; \quad 2; \quad \frac{a_{y} - i a_{z}}{\sqrt{2}}, i \sigma_1; \quad \text{WNL}; \quad \pi \]

\[ V; \quad M A; \quad C^+_4, \sigma_z; \quad R_6; \quad 2; \quad \frac{a_{z} + i a_{y}}{\sqrt{2}}, -\sigma_3; \quad \text{WNL}; \quad \pi \]

\[ R_7; \quad 2; \quad \frac{a_{z} - i a_{y}}{\sqrt{2}}, -\sigma_3; \quad \text{WNL}; \quad \pi \]

\[ \Sigma; \quad \Gamma M; \quad \sigma_{db}, T \sigma_{da}; \quad R_2; \quad 1; \quad i, 1; \]

\[ R_4; \quad 1; \quad -i, 1; \]

\[ S; \quad \Gamma A; \quad \sigma_{db}, T \sigma_{da}; \quad R_2; \quad 1; \quad i, 1; \]

\[ R_4; \quad 1; \quad -i, 1; \]

\[ Y; \quad X M; \quad \sigma_y, E, T \sigma_{s}; \quad \{ R_5, R_7 \}; \quad 2; \quad -i \sigma_3, \sigma_0, -i \sigma_2; \quad \text{WNL}; \quad \pi \]

\[ T; \quad R A; \quad \sigma_y, E, T \sigma_{s}; \quad \{ R_5, R_7 \}; \quad 2; \quad -i \sigma_3, \sigma_0, -i \sigma_2; \quad \text{WNL}; \quad \pi \]

\[ W; \quad X R; \quad \sigma_y, C_2; \quad R_5; \quad 1; \quad i, i; \]

\[ R_6; \quad 1; \quad i, -i; \]

\[ R_7; \quad 1; \quad -i, i; \]

\[ R_8; \quad 1; \quad -i, i; \]
SG 101

\[ \Gamma_q; \{ C_{4z}^{+}|00 \frac{1}{2} \}, \{ \sigma_y|00 \frac{1}{2} \}, T; \text{Non-Centrosymmetric; with SOC} \]

\[
\begin{align*}
\Gamma: & \quad (000); \quad C_{4z}^{+}, \sigma_y,T; \quad R_0; \quad 2; \quad \frac{\sigma_6 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{\Gamma Z}; \\
& \quad R_7; \quad 2; \quad \frac{\sigma_6 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{\Gamma Z}; \\
M: & \quad (\frac{1}{2} \frac{1}{2} 0); \quad C_{4z}^{+}, \sigma_y,T; \quad R_0; \quad 2; \quad \frac{\sigma_6 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{M y}; \\
& \quad R_7; \quad 2; \quad \frac{\sigma_6 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{M y}; \\
Z: & \quad (00 \frac{1}{2}); \quad C_{2z}, \sigma_z,T; \quad \{ R_0, R_7 \}; \quad 4; \quad \frac{\Gamma_0 + i\Gamma_0}{\sqrt{2}}, i\Gamma_0, -i\Gamma_0, -i\Gamma_0; \quad \text{DP}; \quad 0 \\
A: & \quad (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad C_{4z}^{+}, \sigma_y,T; \quad \{ R_0, R_7 \}; \quad 4; \quad \frac{\Gamma_0 + i\Gamma_0}{\sqrt{2}}, i\Gamma_0, -i\Gamma_0, -i\Gamma_0; \quad \text{DP}; \quad 0 \\
R: & \quad (0 \frac{1}{2} \frac{1}{2}); \quad C_{2z}, \sigma_z,T; \quad \{ R_0, R_7 \}; \quad 4; \quad i\Gamma_0, -i\Gamma_0, -i\Gamma_0; \quad \text{DP}; \quad 0 \\
X: & \quad (0 \frac{1}{2} 0); \quad C_{2z}, \sigma_y,T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{X R}; \\
\Delta: & \quad \Gamma X; \quad \sigma_z, T C_{2z}; \quad R_2; \quad 1; \ i, 1; \\
& \quad R_4; \quad 1; \ -i, 1; \\
U: & \quad \Gamma Z; \quad \sigma_z, T C_{2z}; \quad \{ R_2, R_4 \}; \quad 2; \quad \sigma_3, \sigma_1; \quad \text{WNL}; \quad \pi \\
A: & \quad \Gamma Z; \quad C_{4z}^{+}, \sigma_y; \quad R_6; \quad 2; \quad \frac{\sigma_6 + i\sigma_2}{\sqrt{2}}, i\sigma_1; \quad \text{WNL}; \quad \pi \\
& \quad R_7; \quad 2; \quad -\frac{\sigma_6 - i\sigma_2}{\sqrt{2}}, i\sigma_1; \quad \text{WNL}; \quad \pi \\
V: & \quad \Gamma A; \quad C_{4z}^{+}, \sigma_y; \quad R_6; \quad 2; \quad \frac{\sigma_6 + i\sigma_2}{\sqrt{2}}, i\sigma_1; \quad \text{WNL}; \quad \pi \\
& \quad R_7; \quad 2; \quad -\frac{\sigma_6 - i\sigma_2}{\sqrt{2}}, i\sigma_1; \quad \text{WNL}; \quad \pi \\
\Sigma: & \quad \Gamma M; \quad \sigma_{db}, T \sigma_{da}; \quad R_2; \quad 1; \ i, 1; \\
& \quad R_4; \quad 1; \ -i, 1; \\
S: & \quad \Gamma A; \quad \sigma_{db}, T \sigma_{da}; \quad R_2; \quad 1; \ i, 1; \\
& \quad R_4; \quad 1; \ -i, 1; \\
Y: & \quad \Gamma M; \quad \sigma_y, T \sigma_z; \quad R_2; \quad 1; \ i, 1; \\
& \quad R_4; \quad 1; \ -i, 1; \\
T: & \quad \Gamma A; \quad \sigma_y, T \sigma_z; \quad \{ R_2, R_4 \}; \quad 2; \quad \sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \\
W: & \quad \Gamma R; \quad C_{2z}, \sigma_y; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi \]
\[
\Gamma; \qquad \{(C^+_4)^2 \Gamma_0 \}, \{ \sigma_y | \frac{\sqrt{2}}{2} \}, T ; \text{Non-Centrosymmetric; with SOC} \\
\Gamma; \ (000); \ C^+_4 \sigma_y, T; \ R_6; \quad 2: \ \frac{a_0 + i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_{P.2} ; \\
\Gamma; \ (000); \ C^+_4 \sigma_y, T; \ R_7; \quad 2: \ \frac{a_0 - i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_{P.2} ; \\
M; \ (\frac{1}{2} \frac{1}{2} 0); \ C^+_4 \sigma_x, T; \ \{ R_6, R_7 \}; \quad 4: \ \frac{\Gamma_0 + i \Gamma_0}{\sqrt{2}}, \Gamma_0, -i \Gamma_0, \text{DP}; \quad 0 \\
Z; \ (00 \frac{1}{2}); \ C^+_4 \sigma_x, T; \ \{ R_6, R_7 \}; \quad 4: \ \frac{\Gamma_0 + i \Gamma_0}{\sqrt{2}}, \Gamma_0, -i \Gamma_0, \text{DP}; \quad 0 \\
A; \ (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ C^+_4 \sigma_x, T; \ \{ R_6, R_7 \}; \quad 2: \ \frac{a_0 + i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_{M.A} ; \\
R; \ (00 \frac{1}{2} \frac{1}{2}); \ \sigma_y, C_2z, T; \ \{ R_5, R_6 \}; \quad 2: \ -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{Z.R} ; \\
X; \ (0 \frac{1}{2} \frac{1}{2}); \ \sigma_y, C_2z, T; \ \{ R_5, R_6 \}; \quad 2: \ -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{X.M} ; \\
\Delta; \ \Gamma X; \ \sigma_x, T C_2z; \ \{ R_2, R_4 \}; \quad 1: \ i, 1; \quad \text{WNL}; \quad \pi \\
U; \ \Gamma Z; \ \sigma_x, T C_2z; \ \{ R_2, R_4 \}; \quad 2: \ \sigma_3, \sigma_1; \quad \text{WNL}; \quad \pi \\
A; \ \Gamma Z; \ \sigma_y; \ \{ R_6 \}; \quad 2: \ \frac{a_0 + i \sigma_2}{\sqrt{2}}, i \sigma_1 ; \quad \text{WNL}; \quad \pi \\
V; \ \Gamma A; \ \sigma_x; \ \{ R_6 \}; \quad 2: \ \frac{a_1 + i \sigma_2}{\sqrt{2}}, -\sigma_3 ; \quad \text{WNL}; \quad \pi \\
\Sigma; \ \Gamma M; \ \sigma_{db}, T \sigma_{da}; \ \{ R_2, R_4 \}; \quad 1: \ i, 1; \quad \text{WNL}; \quad \pi \\
S; \ \Gamma A; \ \sigma_{db}, T \sigma_{da}; \ \{ R_2, R_4 \}; \quad 1: \ i, 1; \quad \text{WNL}; \quad \pi \\
Y; \ \Gamma M; \ \sigma_y, E, T \sigma_{da}; \ \{ R_5, R_7 \}; \quad 2: \ -i \sigma_3, \sigma_0, -i \sigma_2; \quad \text{WNL}; \quad \pi \\
T; \ \Gamma A; \ \sigma_y, E, T \sigma_{da}; \ \{ R_5, R_7 \}; \quad 1: \ -1, 1, 1; \quad \text{WNL}; \quad \pi \\
W; \ \Gamma A; \ \sigma_y, E, T \sigma_{da}; \ \{ R_6, R_8 \}; \quad 1: \ i, i; \quad \text{WNL}; \quad \pi \\
R; \ \Gamma A; \ \sigma_y, E, T \sigma_{da}; \ \{ R_6, R_8 \}; \quad 1: \ i, i; \quad \text{WNL}; \quad \pi \\
\]
| Point | Notation | Matrix Elements | Symmetry | Details |
|-------|----------|-----------------|----------|---------|
| \( \Gamma \); \( (000) \) | \( C_{4z}^+ \sigma_y, T \); \( R_0 \); \( R_7 \) | 2; \( \frac{a_0 + i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 \), \(-i\sigma_2 \); | P-WNL \( \Gamma \); | \( Z \); \( M \); \( Z \); \( M \); |
| \( Z \); \( (00\frac{1}{2}) \) | \( C_{4z}^+ \sigma_y, T \); \( \{R_0, R_6\} \); \( R_7 \); | 2; \( \frac{a_0 + i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 \), \(-i\sigma_2 \); | P-WNL \( \Gamma \); | \( Z \); \( M \); \( Z \); \( M \); |
| \( \Delta \); \( \Gamma \); \( \sigma_x, T \); \( 2; \) | i\( \sigma_2 \), \( i\sigma_1 \), \(-i\sigma_2 \); | | P-WNL \( \pi \); | \( Z \); \( M \); \( Z \); \( M \); |
| \( U \); \( Z \); \( \sigma_x, T \); \( 2; \) | 2; \( \sigma_3, \sigma_1 \); | P-WNL \( \pi \); | \( Z \); \( M \); \( Z \); \( M \); |
| \( \Lambda \); \( \Gamma \); \( \sigma_y \); \( 2; \) | \( \frac{a_0 + i\sigma_2}{\sqrt{2}} \), \( i\sigma_3 \); | | P-WNL \( \pi \); | \( Z \); \( M \); \( Z \); \( M \); |
| \( \Sigma \); \( \Gamma \); \( \sigma_{db}, \sigma_{da} \); \( 2; \) | \( 1 \), \( i \), \(-i \), \(-i \); | | P-WNL \( \pi \); | \( Z \); \( M \); \( Z \); \( M \); |
| \( S \); \( Z \); \( \sigma_{db}, \sigma_{da} \); \( 2; \) | \( \sigma_3 \), \(-i\sigma_2 \); | | P-WNL \( \pi \); | \( Z \); \( M \); \( Z \); \( M \); |
| \( T \); \( R \); \( \sigma_y, T \); \( 2; \) | \( i\sigma_2 \), \( i\sigma_1 \); | | P-WNL \( \pi \); | \( Z \); \( M \); \( Z \); \( M \); |
\( \Gamma \); \( \Gamma_{y} \); \( C^{+}_{4z}[000] \), \( \sigma_{y}[111] \), \( T \); Non-Centrosymmetric; with SOC

\( \Gamma_{y} \): 

- \( (000) \): \( C^{+}_{4z}, \sigma_{y}, T \); 
  - \( R_{6} \): 2; \( \frac{a_{0}+i a_{2}}{\sqrt{2}} \), \( i \sigma_{3}, -i \sigma_{2} \); P-WNL; 
  - \( R_{7} \): 2; \( \frac{a_{0}+i a_{2}}{\sqrt{2}} \), \( i \sigma_{3}, -i \sigma_{2} \); P-WNL; 

- \( M \); \( \left( \frac{1}{2}, \frac{1}{2}, 0 \right) \): \( C^{+}_{4z}, \sigma_{x}, T \); 
  - \( \{ R_{6}, R_{7} \} \): 4; \( \frac{\Gamma_{0,0}+i \Gamma_{2,0}}{\sqrt{2}} \), \( \Gamma_{0,3}, -i \Gamma_{2,0} \); DP; 0 

- \( Z \); \( \left( 0, \frac{1}{2}, \frac{1}{2} \right) \): \( C^{+}_{4z}, \sigma_{dy}, T \); 
  - \( \{ R_{6}, R_{8} \} \): 4; \( \frac{\Gamma_{0,0}+i \Gamma_{2,0}}{\sqrt{2}} \), \( \Gamma_{0,3}, i \Gamma_{2,0} \); DP; 0 
  - \( \{ R_{7}, R_{8} \} \): 4; \( \frac{\Gamma_{0,0}+i \Gamma_{3,0}}{\sqrt{2}} \), \( \Gamma_{0,3}, -i \Gamma_{2,0} \); DP; 0 

- \( A \); \( \left( \frac{1}{2}, \frac{1}{2}, \frac{1}{2} \right) \): \( C^{+}_{4z}, \sigma_{dy}, T \); 
  - \( \{ R_{6}, R_{7} \} \): 4; \( \frac{\Gamma_{0,0}+i \Gamma_{3,0}}{\sqrt{2}} \), \( \Gamma_{0,3}, -i \Gamma_{2,0} \); DP; 0 

- \( R \); \( \left( 0, \frac{1}{2}, \frac{1}{2} \right) \): \( \sigma_{y}, C_{2z}, T \); 
  - \( \{ R_{5}, R_{8} \} \): 2; \( -\sigma_{0}, i \sigma_{3}, -i \sigma_{2} \); P-WNL; WNL; 
  - \( \{ R_{7}, R_{8} \} \): 2; \( \sigma_{0}, -i \sigma_{3}, -i \sigma_{2} \); P-WNL; WNL; 

- \( \Delta \); \( \Gamma \); \( \sigma_{x}, T C_{2z} \); 
  - \( R_{2} \): 1; i, i; 
  - \( R_{4} \): 1; -i, i; 

- \( U \); \( Z \); \( \sigma_{x}, T C_{2z} \); 
  - \( \{ R_{2}, R_{4} \} \): 2; \( \sigma_{3}, \sigma_{1} \); WNL; \( \pi \) 

- \( \Lambda \); \( \Gamma \); \( C^{+}_{4z}, \sigma_{y} \); 
  - \( R_{6} \): 2; \( \frac{a_{0}+i a_{2}}{\sqrt{2}} \), \( i \sigma_{3} \); WNL; \( \pi \) 
  - \( R_{7} \): 2; \( \frac{a_{0}+i a_{2}}{\sqrt{2}} \), \( i \sigma_{3} \); WNL; \( \pi \) 

- \( V \); \( MA \); \( C^{+}_{4z}, \sigma_{x} \); 
  - \( R_{6} \): 2; \( \frac{a_{0}+i a_{2}}{\sqrt{2}} \), \( \sigma_{3} \); WNL; \( \pi \) 
  - \( R_{7} \): 2; \( \frac{a_{0}+i a_{2}}{\sqrt{2}} \), \( -\sigma_{3} \); WNL; \( \pi \) 
  - \( R_{8} \): 2; \( \frac{a_{0}+i a_{2}}{\sqrt{2}} \), \( -\sigma_{3} \); WNL; \( \pi \) 

- \( \Sigma \); \( \Gamma \); \( \sigma_{dy}, T \sigma_{da} \); 
  - \( R_{2} \): 1; i, i; 
  - \( R_{4} \): 1; -i, i; 

- \( S \); \( Z \); \( \sigma_{dy}, T \sigma_{da} \); 
  - \( \{ R_{2}, R_{4} \} \): 2; \( \sigma_{3}, -i \sigma_{2} \); WNL; \( \pi \) 

- \( Y \); \( X \); \( \sigma_{y}, E, T \sigma_{x} \); 
  - \( \{ R_{5}, R_{7} \} \): 2; \( -i \sigma_{3}, \sigma_{0}, -i \sigma_{2} \); WNL; \( \pi \) 

- \( T \); \( RA \); \( \sigma_{y}, E, T \sigma_{x} \); 
  - \( R_{5} \): 1; -1, 1, 1; 
  - \( R_{7} \): 1; -i, i, i; 
  - \( R_{8} \): 1; -i, i, i; 

- \( W \); \( XR \); \( \sigma_{y}, C_{2z} \); 
  - \( R_{5} \): 1; i, i; 
  - \( R_{6} \): 1; i, -i; 
  - \( R_{7} \): 1; -i, i; 
  - \( R_{8} \): 1; -i, i;
$\Gamma_q; \{C^+_4(00\frac{1}{2}), \{\sigma_y|000\}, T; \text{Non-Centrosymmetric; with SOC}\}$

$\Gamma; \ (000); \ C^+_4; \sigma_y, T; \ R_4; \ 2; \frac{a_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \ \text{P-WNL}_{\Gamma_1};$

$R_7; \ 2; \frac{a_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \ \text{P-WNL}_{\Gamma_2};$

$M; \ (\frac{1}{2} \frac{1}{2} 0); \ C^+_4; \sigma_y, T; \ R_6; \ 2; \frac{a_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \ \text{P-WNL}_{\Gamma_1};$

$R_7; \ 2; \frac{a_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \ \text{P-WNL}_{\Gamma_2};$

$Z; \ (00 \frac{1}{2}); \ C^+_4; \sigma_d, T; \ \{R_6, R_7\}; \ 4; \frac{\Gamma_0.1+i\Gamma_3.3}{\sqrt{2}}, \Gamma_{0.3}, -i\Gamma_{2.0}; \ \text{DP}; \ 0$

$A; \ (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ C^+_4; \sigma_d, T; \ \{R_6, R_7\}; \ 4; \frac{\Gamma_0.1+i\Gamma_3.3}{\sqrt{2}}, \Gamma_{0.3}, -i\Gamma_{2.0}; \ \text{DP}; \ 0$

$R; \ (0 \frac{1}{2} \frac{1}{2}); \ \ C^+_2; \sigma_y, T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \ \text{P-WNL}_{XR}$

$X; \ (0 \frac{1}{2} 0); \ C^+_2; \sigma_y, T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \ \text{P-WNL}_{XR}$

$\Delta; \ \Gamma X; \ \sigma_z, TC_2z; \ R_2; \ 1; i, 1$

$R_4; \ 1; -i, 1$

$U; \ Z R; \ \sigma_z, TC_2z; \ R_2; \ 1; i, 1$

$R_4; \ 1; -i, 1$

$\Lambda; \ \Gamma Z; \ C^+_4; \sigma_y; \ R_6; \ 2; \frac{a_0+i\sigma_2}{\sqrt{2}}, i\sigma_1; \ \text{WNL}; \ \pi$

$R_7; \ 2; \frac{a_0-i\sigma_2}{\sqrt{2}}, i\sigma_1; \ \text{WNL}; \ \pi$

$V; \ \MA; \ C^+_4; \sigma_y; \ R_6; \ 2; \frac{a_0+i\sigma_2}{\sqrt{2}}, i\sigma_1; \ \text{WNL}; \ \pi$

$R_7; \ 2; \frac{a_0-i\sigma_2}{\sqrt{2}}, i\sigma_1; \ \text{WNL}; \ \pi$

$\Sigma; \ \Gamma M; \ \sigma_d; \ \sigma_{da}, \ \{R_2, R_4\}; \ 2; \sigma_3, -i\sigma_2; \ \text{WNL}; \ \pi$

$S; \ \ZA; \ \sigma_d; \ \sigma_{da}, \ \{R_2, R_4\}; \ 2; \sigma_3, -i\sigma_2; \ \text{WNL}; \ \pi$

$Y; \ \XM; \ \sigma_y, T \sigma_z; \ R_2; \ 1; i, 1$

$R_4; \ 1; -i, 1$

$T; \ \RA; \ \sigma_y, T \sigma_z; \ R_2; \ 1; i, 1$

$R_4; \ 1; -i, 1$

$W; \ \XR; \ C^+_2; \sigma_y; \ R_5; \ 2; i\sigma_2, i\sigma_1; \ \text{WNL}; \ \pi$
\[\Gamma; (000); \Gamma_4^+; \sigma_y; \mathcal{T}; \]  
\[R_6; \quad 2; \quad \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_\Gamma \mathcal{T}; \]  
\[R_7; \quad 2; \quad \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_\Gamma \mathcal{T}; \]  
\[M; (\frac{1}{2} \frac{1}{2} 0); \quad \Gamma_4^+; \sigma_x; \mathcal{T}; \quad \{R_6, R_7\}; \quad 4; \quad \frac{\Gamma_{0.1} + i\Gamma_{3.0}}{\sqrt{2}}, \Gamma_{0.3}, -i\Gamma_{2.0}; \quad \text{DP}; \quad 0; \]  
\[Z; (00\frac{1}{2}); \quad \Gamma_4^+; \sigma_{db}; \mathcal{T}; \quad \{R_6, R_7\}; \quad 4; \quad \frac{\Gamma_{0.0} + i\Gamma_{3.0}}{\sqrt{2}}, \Gamma_{0.3}, -i\Gamma_{2.0}; \quad \text{DP}; \quad 0; \]  
\[A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad \Gamma_4^+; \sigma_{db}; \mathcal{T}; \quad \{R_6, R_7\}; \quad 4; \quad \frac{\Gamma_{0.0} + i\Gamma_{3.0}}{\sqrt{2}}, \Gamma_{0.3}, -i\Gamma_{2.0}; \quad \text{DP}; \quad 0; \]  
\[R; (01\frac{1}{2}); \quad \sigma_z, C_{2z}, \mathcal{T}; \quad \{R_6, R_7\}; \quad 2; \quad -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{RA}; \]  
\[\Delta; \quad \Gamma X; \quad \sigma_z, T C_{2z}; \quad R_2; \quad 1; \quad i, 1; \]  
\[U; \quad Z R; \quad \sigma_z, T C_{2z}; \quad R_2; \quad 1; \quad i, 1; \]  
\[A; \quad \Gamma Z; \quad C_{4z}^+; \sigma_y; \quad R_6; \quad 2; \quad \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1; \quad \text{WNL}; \quad \pi; \]  
\[V; \quad M A; \quad C_{4z}^+; \sigma_x; \quad R_6; \quad 2; \quad \frac{\sigma_1 + i\sigma_0}{\sqrt{2}}, -\sigma_3; \quad \text{WNL}; \quad \pi; \]  
\[\Sigma; \quad \Gamma M; \quad \sigma_{db}, T \sigma_{da}; \quad R_2; \quad 1; \quad i, 1; \]  
\[S; \quad Z A; \quad \sigma_{db}, T \sigma_{da}; \quad \{R_2, R_4\}; \quad 2; \quad \sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi; \]  
\[Y; \quad X M; \quad \sigma_y, E, T \sigma_z; \quad \{R_5, R_7\}; \quad 2; \quad -i\sigma_3, \sigma_0, -i\sigma_2; \quad \text{WNL}; \quad \pi; \]  
\[T; \quad R A; \quad \sigma_y, E, T \sigma_z; \quad \{R_5, R_7\}; \quad 2; \quad -i\sigma_3, \sigma_0, -i\sigma_2; \quad \text{WNL}; \quad \pi; \]  
\[W; \quad X R; \quad \sigma_y, C_{2z}; \quad R_5; \quad 1; \quad i, i; \]  
\[R_6; \quad 1; \quad i, -i; \]  
\[R_7; \quad 1; \quad -i, -i; \]  
\[R_8; \quad 1; \quad -i, i; \]
SG 107

\[ \Gamma; \{ C_{4v}^+|000\}, \{\sigma_y|000\}, T \; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \; (000); \; C_{4v}^+\sigma_y,T; \quad R_6; \quad 2; \quad \sigma_0 + i\sigma_2 \frac{\sqrt{2}}{2}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{\Gamma Z}; \]

\[ \Gamma; \; (0\frac{1}{2}\frac{1}{2}) \; \sigma_y,T; \quad \{ R_2, R_4 \}; \quad 2; \quad i\sigma_3, -i\sigma_2; \quad \text{P-WNL}; \]

\[ X; \; (00\frac{1}{2}) \; C_{2z}\sigma, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{XP}; \]

\[ Z; \; (\frac{1}{2}\frac{1}{2}\frac{1}{2}) \; C_{4z}^+\sigma_y,T; \quad R_6; \quad 2; \quad \sigma_0 + i\sigma_2 \frac{\sqrt{2}}{2}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{\Gamma Z}; \]

\[ P; \; (\frac{3}{4}\frac{3}{4}\frac{1}{2}) \; C_{2z}\sigma_{db}, C_{4z}^+ T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -\sigma_0 + i\sigma_2 \frac{\sqrt{2}}{2}; \quad \text{P-WNL}_{XP}; \]

\[ \Lambda; \; \Gamma\Lambda/TZ; \; C_{4z}^+\sigma_y; \quad R_6; \quad 2; \quad \sigma_0 + i\sigma_2 \frac{\sqrt{2}}{2}, i\sigma_1; \quad \text{WNL}; \quad \pi \]

\[ V; \; ZV; \; C_{4z}^+\sigma_y; \quad R_6; \quad 2; \quad \sigma_0 + i\sigma_2 \frac{\sqrt{2}}{2}, i\sigma_1; \quad \text{WNL}; \quad \pi \]

\[ W; \; XP; \; C_{2z}\sigma_{db}; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi \]

\[ \Sigma; \; \Gamma\Sigma/T\Sigma; \; \sigma_y,T\sigma_x; \quad R_2; \quad 1; \quad i, 1; \]

\[ \; R_4; \quad 1; \quad -i, 1; \]

\[ F; \; ZF; \; \sigma_y,T\sigma_x; \quad R_2; \quad 1; \quad i, 1; \]

\[ \; R_4; \quad 1; \quad -i, 1; \]

\[ Q; \; NP; \; E,T\sigma_y; \quad R_2; \quad 1; \quad -i, 1; \]

\[ \Delta; \; \Gamma\Delta; \; \sigma_{db}, T\sigma_{da}; \quad R_2; \quad 1; \quad i, 1; \]

\[ \; R_4; \quad 1; \quad -i, 1; \]

\[ U; \; ZU; \; \sigma_{db}, T\sigma_{da}; \quad R_2; \quad 1; \quad i, 1; \]

\[ \; R_4; \quad 1; \quad -i, 1; \]

\[ Y; \; XZ/XY; \; \sigma_{da}, T\sigma_{2z}; \quad R_2; \quad 1; \quad i, 1; \]

\[ \; R_4; \quad 1; \quad -i, 1; \]
\( \Gamma' \): \( \{C_{4z}^+|000\}, \{(\sigma_y|_{1\frac{1}{2}}|0)\} \), \( \mathcal{T} \); Non-Centrosymmetric; with SOC

- \( \Gamma \): (000); \( C_{4z}^+\sigma_y, \mathcal{T} \)
  - \( R_6 \): \( \frac{\sigma_0 + i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2 \); P-WNL_{FZ};
  - \( R_7 \): \( \frac{\sigma_0 - i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2 \); P-WNL_{FZ};

- \( N \): (0\( \frac{1}{2} \)0); \( \sigma_y, \mathcal{E}, \mathcal{T} \)
  - \( \{R_5, R_6\} \): \( \sigma_0, -\sigma_0, -i \sigma_2 \); P-WNL_{NP};
  - \( \{R_7, R_7\} \): \( -\sigma_0, -\sigma_0, -i \sigma_2 \); P-WNL_{NP};

- \( X \): (00\( \frac{1}{2} \)); \( C_{2z}, \sigma_{db}, \mathcal{T} \)
  - \( R_5 \): \( i \sigma_2, i \sigma_1, -i \sigma_2 \); P-WNL_{XP};

- \( Z \): (1\( \frac{1}{2} \)\( \frac{1}{2} \)\( \frac{1}{2} \)); \( C_{4z}^+\sigma_y, \mathcal{T} \)
  - \( R_6 \): \( \frac{\sigma_0 + i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2 \); P-WNL_{FZ};
  - \( R_7 \): \( \frac{\sigma_0 - i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2 \); P-WNL_{FZ};

- \( P \): (1\( \frac{1}{4} \)\( \frac{1}{4} \)\( \frac{1}{4} \)); \( C_{2z}, \sigma_{db}, C_{4z}^+ \mathcal{T} \)
  - \( \{R_5, R_5\} \): \( \Gamma_{0,2}, i \Gamma_{0,1} \); P-WNL; \( \pi \)

- \( \Lambda \): \( \Gamma \Lambda, \mathcal{T} \Z ; C_{4z}^+\sigma_y \)
  - \( R_6 \): \( \frac{\sigma_0 + i \sigma_2}{\sqrt{2}}, i \sigma_1 \); WNL; \( \pi \)
  - \( R_7 \): \( \frac{\sigma_0 - i \sigma_2}{\sqrt{2}}, i \sigma_1 \); WNL; \( \pi \)

- \( V \): \( \mathcal{Z} \Lambda \); \( C_{4z}^+\sigma_y \)
  - \( R_6 \): \( \frac{\sigma_0 + i \sigma_2}{\sqrt{2}}, i \sigma_1 \); WNL; \( \pi \)
  - \( R_7 \): \( \frac{\sigma_0 - i \sigma_2}{\sqrt{2}}, i \sigma_1 \); WNL; \( \pi \)

- \( W \): \( \mathcal{X} \Lambda \); \( C_{2z}, \sigma_{db} \)
  - \( R_5 \): \( i \sigma_2, i \sigma_1 \); WNL; \( \pi \)

- \( \Sigma \): \( \Gamma \Lambda, \mathcal{T} \Sigma \); \( \sigma_y, \mathcal{T} \sigma_2 \)
  - \( R_2 \): \( 1, i, 1 \);
  - \( R_4 \): \( 1, -i, 1 \);
  - \( R_5 \): \( 1, i, 1 \);

- \( F \): \( \mathcal{Z} \Lambda \); \( \sigma_y, \mathcal{T} \sigma_2 \)
  - \( R_2 \): \( 1, -i, 1 \);
  - \( R_4 \): \( 1, i, 1 \);

- \( Q \): \( \mathcal{N} \Lambda \); \( \mathcal{E}, \mathcal{T} \sigma_2 \)
  - \( \{R_2, R_2\} \): \( -\sigma_0, -i \sigma_2 \); WNL; \( \pi \)

- \( \Delta \): \( \Gamma \mathcal{X} \); \( \sigma_{db}, \mathcal{T} \sigma_{da} \)
  - \( R_2 \): \( 1, i, 1 \);
  - \( R_4 \): \( 1, -i, 1 \);

- \( U \): \( \mathcal{Z} \mathcal{U} \); \( \sigma_{db}, \mathcal{T} \sigma_{da} \)
  - \( R_2 \): \( 1, -i, 1 \);
  - \( R_4 \): \( 1, i, 1 \);

- \( Y \): \( \mathcal{X} \mathcal{Z} \mathcal{X} \); \( \sigma_{da}, \mathcal{T} C_{2z} \)
  - \( R_2 \): \( 1, i, 1 \);
  - \( R_4 \): \( 1, -i, 1 \);
\( \Gamma^0; \{ C_{4h}^{+}\{3 \ 0 \ 0 \}, \{ \sigma_y \{000 \}, T; \text{Non-Centrosymmetric with SOC} \} \)

| \( \Gamma \) | (000) | \( C_{4h}^{+} \sigma_y, T \) | \( R_6 \) | \( \frac{a_0 + i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2 \) | P-WNL \( \Gamma^0 \) |
|---|---|---|---|---|---|
| \( R_T \) | \( \frac{a_0 - i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2 \) | P-WNL \( \Gamma^0 \) |

| \( N \) | (0 1 0) | \( \sigma_y, T \) | \( \{ R_2, R_4 \} \) | \( i \sigma_1, -i \sigma_2 \) | P-WNL |

| \( X \) | (00 0 0) | \( \sigma_{db}, C_{2x}, T \) | \( \{ R_5, R_6 \} \) | \( -\sigma_0, i \sigma_3, -i \sigma_2 \) | P-WNL \( XZ \) |

| \( R_7, R_8 \) | \( \sigma_0, -i \sigma_3, -i \sigma_2 \) | P-WNL \( XZ \) |

| \( Z \) | (1 1 1 1) | \( C_{4v}^{+} \sigma_{db}, T \) | \( \{ R_6, R_7 \} \) | \( \frac{\Gamma_0 + i \sigma_0 + \sigma_3}{\sqrt{2}}, \Gamma_{0,3}, -i \Gamma_{2,0}; \text{DP}; 0 \) |

| \( P \) | (1 1 1 1) | \( \sigma_{db}, C_{2x}, C_{4v}^{+} T \) | \( R_{13} \) | \(-1)^{3/4}, i, 1 \) |

| \( R_{14} \) | \(-1)^{3/4}, i, 1 \) |

| \( \Lambda \) | \( \Gamma A/TZ \) | \( C_{4v}^{+} \sigma_y \) | \( R_6 \) | \( \frac{a_0 + i \sigma_2}{\sqrt{2}}, i \sigma_1 \) | WNL; \( \pi \)

| \( R_7 \) | \( \frac{a_0 - i \sigma_2}{\sqrt{2}}, i \sigma_1 \) | WNL; \( \pi \)

| \( V \) | \( \sigma_{db} \) | \( C_{4v}^{+} \sigma_{db} \) | \( R_6 \) | \( \frac{a_0 + i \sigma_2}{\sqrt{2}}, i \sigma_1 \) | WNL; \( \pi \)

| \( R_7 \) | \( \frac{a_0 - i \sigma_2}{\sqrt{2}}, i \sigma_1 \) | WNL; \( \pi \)

| \( W \) | \( \sigma_{da}, C_{2x} \) | \( R_5 \) | \( i, i \) |

| \( R_6 \) | \( i, -i \) |

| \( R_7 \) | \( i, -i \) |

| \( R_8 \) | \( i, -i \) |

| \( \Sigma \) | \( \Gamma Z/T \Sigma \) | \( \sigma_y, T \sigma_x \) | \( R_2 \) | \( i, 1 \) |

| \( R_4 \) | \(-i, 1 \) |

| \( F \) | \( \sigma_y, T \sigma_x \) | \( R_2 \) | \( i, 1 \) |

| \( R_4 \) | \(-i, 1 \) |

| \( Q \) | \( E, T \sigma_y \) | \( R_2 \) | \(-1, -i \) |

| \( \Delta \) | \( \Gamma X \) | \( \sigma_{db}, T \sigma_{da} \) | \( R_2 \) | \( i, 1 \) |

| \( R_4 \) | \(-1, -i \) |

| \( U \) | \( \sigma_{db}, T \sigma_{da} \) | \( \{ R_2, R_4 \} \) | \( 2; \sigma_3, -i \sigma_2 \) | WNL; \( \pi \)

| \( Y \) | \( \sigma_{da}, E, T C_{2x} \) | \( \{ R_5, R_7 \} \) | \( -i \sigma_3, \sigma_0, \sigma_1 \) | WNL; \( \pi \)
865
SG 110
+ 3 1 1
Γvq ; {C4z
| 4 4 2 }, {σy | 12 21 0}, T ; Non-Centrosymmetric; with SOC

Γ; (000);

+
C4z
,σy ,T ;

N ; (0 12 0);

σy ,Ē,T ;

X;

(00 21 );

Z; ( 21̄ 12 12 );
P;

( 41 14 14 );

2;

R7 ;

2;

{R5 , R5 };

2; σ0 , −σ0 , −iσ2 ;

P-WNLN P ;

σdb ,C2z ,T ;

{R5 , R6 };

2; −σ0 , iσ3 , −iσ2 ;

P-WNLXZ ;

+
C4z
,σdb ,T ;

{R6 , R7 };

4;

+
σdb ,C2z ,C4z
T

Λ; ΓΛ/ΓZ;

+
C4z
,σy ;

V ; ZV;

+
C4z
,σdb ;

W ; XP;

σda ,C2z ;

{R7 , R7 };

{R7 , R8 };

R6 ;

Ē,T σy ;

∆; ΓX;

σdb ,T σda ;

U ; ZU;

σdb ,T σda ;

Y ; XZ/XY; σda ,E,T C2z ;

2;

R7 ;

2;

R6 ;

2;

3/4

σ1√
−iσ0
, −σ3 ;
2

2;

R5 ;

1; i, i;

R6 ;

1; i, −i;

R2 ;
R2 ;
{R2 , R2 };

P-WNLN P ;
P-WNLXZ ;
DP;

0

P-WNLs;
P-WNLs;

WNL;

π

WNL;

π

WNL;

π

WNL;

π

WNL;

π

WNL;

π

WNL;

π

1; −i, i;
1; i, 1;

1; −i, 1;
1; −i, 1;
1; i, 1;

2; −σ0 , −iσ2 ;

1; i, 1;

R4 ;

1; −i, 1;

{R5 , R7 };

P-WNLΓZ ;

1; −i, −i;

R2 ;

{R2 , R4 };

P-WNLΓZ ;

σ0 , −iσ0 , −iσ2 ; P-WNLs;

σ0√
+iσ2
, iσ1 ;
2
σ0√
−iσ2
−
, iσ1 ;
2
σ1√
+iσ0
,
−σ
3;
2

R7 ;

R4 ;
Q; NP;

Γ0,1 +iΓ3,0
√
, Γ0,3 , −iΓ2,0 ;
2
3/4
−(−1) σ3 , iσ0 , σ1 ;

{R18 , R18 }; 2; (−1)3/4 σ0 , −iσ0 , −iσ2 ;

R4 ;
σy ,T σx ;

2; σ0 , −iσ3 , −iσ2 ;

{R17 , R17 }; 2; −(−1)

R8 ;
Σ; ΓZ/ΓΣ; σy ,T σx ;

2; −σ0 , −σ0 , −iσ2 ;

; {R13 , R14 }; 2;

R7 ;

F ; ZF;

σ0√
+iσ2
, iσ1 , −iσ2 ;
2
σ0 −iσ
2
√
, iσ1 , −iσ2 ;
− 2

R6 ;

2; σ3 , −iσ2 ;

2; −iσ3 , σ0 , σ1 ;


| Point | Group | Symmetry Elements | Representative Matrix Elements | Band Structure |
|-------|-------|-------------------|-------------------------------|----------------|
| Γ; (000) | $S^+_4, C_{2x}, T$ | $R_6$: $\frac{2}{2 \sqrt{2}} i \sigma_1, -i \sigma_2$; P-WNL $\Gamma_2$; $R_7$: $\frac{-2}{2 \sqrt{2}} i \sigma_1, -i \sigma_2$; P-WNL $\Gamma_2$; | $\sigma_0 \pm i \sigma_2$; $\sqrt{2}$ |
| $M$: (111) | $S^+_4, C_{2x}, T$ | $R_6$: $\frac{-2}{2 \sqrt{2}} i \sigma_1, -i \sigma_2$; P-WNL $\Gamma_{MA}$; $R_7$: $\frac{2}{2 \sqrt{2}} i \sigma_1, -i \sigma_2$; P-WNL $\Gamma_{MA}$; | $\sigma_0 \pm i \sigma_2$; $\sqrt{2}$ |
| Z; (0012) | $S^+_4, C_{2x}, T$ | $R_6$: $\frac{2}{2 \sqrt{2}} i \sigma_1, -i \sigma_2$; P-WNL $\Gamma_2$; $R_7$: $\frac{-2}{2 \sqrt{2}} i \sigma_1, -i \sigma_2$; P-WNL $\Gamma_2$; | $\sigma_0 \pm i \sigma_2$; $\sqrt{2}$ |
| A; (1112) | $S^+_4, C_{2x}, T$ | $R_6$: $\frac{-2}{2 \sqrt{2}} i \sigma_1, -i \sigma_2$; P-WNL $\Gamma_{MA}$; $R_7$: $\frac{2}{2 \sqrt{2}} i \sigma_1, -i \sigma_2$; P-WNL $\Gamma_{MA}$; | $\sigma_0 \pm i \sigma_2$; $\sqrt{2}$ |
| R; (012) | $C_{2x}, C_{2y}, T$ | $R_5$: $i \sigma_2, i \sigma_1, -i \sigma_2$; C-1 WP; 1 | |
| X; (013) | $C_{2x}, C_{2y}, T$ | $R_5$: $i \sigma_2, i \sigma_1, -i \sigma_2$; C-1 WP; 1 | |
| Δ; ΓX | $C_{2y}, TC_{2z}$ | $R_2$: 1; i, 1; | |
| U; ZR | $C_{2y}, TC_{2z}$ | $R_2$: 1; i, 1; $R_4$: 1; -i, 1; | |
| Λ; ΓZ | $C_{2x}, \sigma_{db}, S^+_4, T$ | $R_5$: $2 i \sigma_2, i \sigma_1, \frac{-2}{2 \sqrt{2}}$; WNL; $\pi$ | |
| V; MA | $C_{2x}, \sigma_{db}, S^+_4, T$ | $R_5$: $2 i \sigma_2, i \sigma_1, \frac{-2}{2 \sqrt{2}}$; WNL; $\pi$ | |
| Σ; ΓM | $\sigma_{db}, TC_{da}$ | $R_2$: 1; i, 1; $R_4$: 1; -i, 1; | |
| S; ZA | $\sigma_{db}, TC_{da}$ | $R_2$: 1; i, 1; $R_4$: 1; -i, 1; | |
| Y; XM | $C_{2x}, TC_{2y}$ | $R_2$: 1; i, 1; $R_4$: 1; -i, 1; | |
| T; RA | $C_{2x}, TC_{2y}$ | $R_2$: 1; i, 1; $R_4$: 1; -i, 1; | |
| W; XR | $C_{2x}, TC_{2y}$ | $R_2$: 1; i, 1; $R_4$: 1; -i, 1; | |
SG 112

Γ: (000); \(S^+_{4z}, C_{2x}, T; \) \(R_6; \) 2; \(\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) P-WNL\(_{1/2}; \)

\(R_7; \) 2; \(\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) P-WNL\(_{1/2}; \)

\(M; (\frac{1}{2} \frac{1}{2} 0); \) \(S^+_{4z}, C_{2x}, T; \) \(R_6; \) 2; \(\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) P-WNL\(_{MA}; \)

\(R_7; \) 2; \(\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) P-WNL\(_{MA}; \)

\(Z; (00 \frac{1}{2}); \) \(S^+_{4z}, \sigma_{db}, T; \) \(\{R_6, R_7\}; 4; \) \(\frac{\Gamma_0 + i\Gamma_3}{\sqrt{2}}, \Gamma_{0,3}, -i\Gamma_{2,0}; \) DP; 0

\(A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \) \(S^+_{4z}, \sigma_{db}, T; \) \(\{R_6, R_7\}; 4; \) \(\frac{\Gamma_0 + i\Gamma_3}{\sqrt{2}}, \Gamma_{0,3}, -i\Gamma_{2,0}; \) DP; 0

\(R; (0 \frac{1}{2} \frac{1}{2}); \) \(C_{2x}, C_{2y}, T; \) \(R_5; \) 2; \(i\sigma_2, i\sigma_1, -i\sigma_2; \) C-1 WP; 1

\(X; (0 \frac{1}{2} 0); \) \(C_{2x}, C_{2y}, T; \) \(R_5; \) 2; \(i\sigma_2, i\sigma_1, -i\sigma_2; \) C-1 WP; 1

\(\Delta; \Gamma X; \) \(C_{2y}, TC_{2x}; \) \(R_2; \) 1; \(i, 1; \)

\(R_4; \) 1; \(-i, 1; \)

\(U; Z R; \) \(C_{2y}, E, TC_{2x}; \) \(R_5; \) 1; \(-i, 1, 1; \)

\(R_7; \) 1; \(i, 1, 1; \)

\(A; \Gamma Z; \) \(C_{2x}, \sigma_{db}, S^+_{4z}, T; \) \(R_5; \) 2; \(i\sigma_2, i\sigma_1, \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}; \) WNL; \(\pi; \)

\(V; MA; \) \(C_{2x}, \sigma_{db}, S^+_{4z}, T; \) \(R_5; \) 2; \(i\sigma_2, i\sigma_1, \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}; \) WNL; \(\pi; \)

\(\Sigma; \Gamma M; \) \(\sigma_{db}, T_{\sigma_{da}}; \) \(R_2; \) 1; \(i, 1; \)

\(R_4; \) 1; \(-i, 1; \)

\(S; Z A; \) \(\sigma_{db}, T_{\sigma_{da}}; \) \(\{R_2, R_4\}; 2; \sigma_3, -i\sigma_2; \) WNL; \(\pi; \)

\(Y; XM; \) \(C_{2x}, TC_{2y}; \) \(R_2; \) 1; \(i, 1; \)

\(R_4; \) 1; \(-i, 1; \)

\(T; RA; \) \(C_{2x}, E, TC_{2y}; \) \(R_5; \) 1; \(-i, 1, 1; \)

\(R_7; \) 1; \(i, 1, 1; \)

\(W; XR; \) \(C_{2x}, TC_{2y}; \) \(R_2; \) 1; \(i, 1; \)

\(R_4; \) 1; \(-i, 1; \)
\[ \Gamma_\nu; \{ S_4^+; 000 \}, \{ C_{2z}^+; \frac{1}{2} \}; T; \text{Non-Centrosymmetric; with SOC} \]

- **\Gamma:** (000); \( S_{4z}^+; C_{2z}; T; R_6 \); \( \frac{\sigma_0 + i \sigma_2}{\sqrt{2}} \), \( i \sigma_1, -i \sigma_2 \); P-WNL_{\text{FS}}
- **M:** (1 1 0); \( S_{4z}^+; C_{2z}; T; \{ R_6, R_7 \}; 4; \frac{\sigma_0 + i \sigma_2}{\sqrt{2}}, \sigma_1, -i \sigma_2 \); P-WNL_{\text{FS}}
- **Z:** (001); \( S_{4z}^+; C_{2z}; T; R_6 \); \( \frac{\sigma_0 + i \sigma_2}{\sqrt{2}}, \sigma_1, -i \sigma_2 \); P-WNL_{\text{FS}}
- **A:** (1 1_1 1); \( S_{4z}^+; C_{2z}; T; \{ R_6, R_7 \}; 4; \frac{\sigma_0 + i \sigma_2}{\sqrt{2}}, \sigma_1, -i \sigma_2 \); P-WNL_{\text{FS}}
- **R:** (0 1 1_1); \( C_{2y}; \{ R_5, R_6 \}; 2; -\sigma_0, i \sigma_3, -i \sigma_2 \); P-NS_{\text{FS}}
- **X:** (0 1_1 1); \( C_{2y}; \{ R_5, R_6 \}; 2; -\sigma_0, i \sigma_3, -i \sigma_2 \); P-NS_{\text{FS}}

- **\Delta:** \( \Gamma X; C_{2y}, T C_{2z}; R_2; 1, 1, 1; R_4; 1, -i, 1 \)
- **U:** \( Z R; C_{2y}, T C_{2z}; R_2; 1, 1, 1; R_4; 1, -i, 1 \)
- **\Lambda:** \( \Gamma Z; C_{2z}, \sigma_{db}, S_{4z}^+; T; R_5; 2; \sigma_2, i \sigma_1, \frac{\sigma_0 + i \sigma_2}{\sqrt{2}} \); WNL; \( \pi \)
- **V:** \( \text{MA}; C_{2z}, \sigma_{db}, S_{4z}^+; T; \{ R_5, R_6 \}; 4; i \Gamma_{0.2}, -i \Gamma_{0.1}, \frac{\sigma_0 + i \sigma_2}{\sqrt{2}} \); DNL; \( 0 \)
- **\Sigma:** \( \text{GM}; \sigma_{db}, T \sigma_{da}; R_2; 1, 1, 1; R_4; 1, -i, 1 \)
- **S:** \( \text{ZA}; \sigma_{db}, T \sigma_{da}; R_2; 1, 1, 1; R_4; 1, -i, 1 \)
- **Y:** \( \text{XM}; C_{2z}, E, T C_{2y}; \{ R_5, R_7 \}; 2; -i \sigma_3, \sigma_0, -i \sigma_2 \); L-NS_{\text{FS}}
- **T:** \( \text{RA}; C_{2z}, E, T C_{2y}; \{ R_5, R_7 \}; 2; -i \sigma_3, \sigma_0, -i \sigma_2 \); L-NS_{\text{FS}}
- **W:** \( \text{XR}; C_{2z}, T C_{2y}; \{ R_2, R_4 \}; 2; i \sigma_3, -i \sigma_2 \); L-NS_{\text{FS}}
\[ \Gamma_q; \{ S^+_{100} | 000 \}, \{ C_{2z} | 1 \frac{1}{2} 1 \}; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; (000); S^+_{4z}, C_{2z}, T; \]
\[ R_6; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ \text{P-WNL}_{\Gamma^2}; \]
\[ R_7; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ \text{P-WNL}_{\Gamma^2}; \]
\[ M; (0 1 \frac{1}{2} 0); S^+_{4z}, C_{2z}, T; \]
\[ \{ R_6, R_7 \}, 4; \frac{\Gamma_0, + i\Gamma_3}{\sqrt{2}}, \Gamma_0, 3, -i\Gamma_2, 0; \]
\[ \text{P-DNL}_{\Gamma A}; \]
\[ Z; (00 \frac{1}{2}); S^+_{4z}, \sigma_{db}, T; \]
\[ \{ R_6, R_7 \}, 4; \frac{\Gamma_0, 0, + i\Gamma_0, 2}{\sqrt{2}}, \Gamma_0, 3, -i\Gamma_2, 0; \]
\[ \text{DP}; 0 \]
\[ A; (0 1 \frac{1}{2} 0); S^+_{4z}, \sigma_{db}, T; \]
\[ \{ R_6, R_7 \}, 4; \frac{-\Gamma_0, 0, + i\Gamma_0, 2}{\sqrt{2}}, \Gamma_0, 3, i\Gamma_2, 0; \]
\[ \text{P-DNL}_{\Gamma A}; \]
\[ R; (0 \frac{1}{2} 0); C_{2y}, C_{2z}, T; \]
\[ \{ R_5, R_6 \}, 2; -\sigma_0, i\sigma_3, -i\sigma_2; \]
\[ \text{P-NS}_{\text{MARX}}; \]
\[ \{ R_7, R_8 \}, 2; \sigma_0, -i\sigma_3, -i\sigma_2; \]
\[ \text{P-NS}_{\text{MARX}}; \]
\[ X; (0 \frac{1}{2} 0); C_{2y}, C_{2z}, T; \]
\[ \{ R_5, R_6 \}, 2; -\sigma_0, i\sigma_3, -i\sigma_2; \]
\[ \text{P-NS}_{\text{MARX}}; \]
\[ \{ R_7, R_8 \}, 2; \sigma_0, -i\sigma_3, -i\sigma_2; \]
\[ \text{P-NS}_{\text{MARX}}; \]
\[ \Delta; \Gamma X; C_{2y}, T C_{2z}; \]
\[ R_2; 1, 1, 1; \]
\[ R_4; 1, -i, 1; \]
\[ R_5; 1, -i, 1; \]
\[ \text{U; ZR; } C_{2y}, E, T C_{2z}; \]
\[ R_5; 1, -i, 1, 1; \]
\[ R_7; 1, 1, 1; \]
\[ \Lambda; \Gamma Z; C_{2z}, \sigma_{db}, S^+_{4z}, T; \]
\[ R_5; 2; i\sigma_2, i\sigma_1, \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}; \]
\[ \text{WNL}; \pi \]
\[ V; \text{MA; } C_{2z}, \sigma_{db}, S^+_{4z}, T; \]
\[ \{ R_5, R_5 \}, 4; i\Gamma_0, 2, -i\Gamma_0, 1, \frac{1}{\sqrt{2}}, \Gamma_2, 0, + i\Gamma_2, 0; \]
\[ \text{DNL}; 0 \]
\[ \Sigma; \Gamma M; \sigma_{db}, T \sigma_{da}; \]
\[ R_2; 1, 1, 1; \]
\[ R_4; 1, -i, 1; \]
\[ \text{S; ZA; } \sigma_{db}, T \sigma_{da}; \]
\[ \{ R_2, R_3 \}, 2; \sigma_3, -i\sigma_2; \]
\[ \text{WNL}; \pi \]
\[ Y; \text{XM; } C_{2z}, E, T C_{2y}; \]
\[ \{ R_5, R_7 \}, 2; -i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \text{L-NS}_{\text{MARX}}; \]
\[ T; \text{RA; } C_{2z}, T C_{2y}; \]
\[ \{ R_2, R_4 \}, 2; -i\sigma_3, -i\sigma_2; \]
\[ \text{L-NS}_{\text{MARX}}; \]
\[ W; \text{XR; } C_{2z}, T C_{2y}; \]
\[ \{ R_2, R_4 \}, 2; i\sigma_3, -i\sigma_2; \]
\[ \text{L-NS}_{\text{MARX}}; \]
\( \Gamma \); \( \{S_{4h}^{+}|000\}, \{C_{2h}|000\} \); Non-Centrosymmetric; with SOC

\[ \Gamma; (000); S_{4z}^{+}, C_{2a}, T; \]
\[ R_6; 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \text{P-WNL}_{\Gamma Z}; \]
\[ R_7; 2; \frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \text{P-WNL}_{\Gamma Z}; \]

\[ M; (\frac{1}{2}, \frac{1}{2}, 0); S_{4z}^{+}, C_{2a}, T; \]
\[ R_6; 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \text{P-WNL}_{MA}; \]
\[ R_7; 2; \frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \text{P-WNL}_{MA}; \]

\[ Z; (00\frac{1}{2}); S_{4z}^{+}, C_{2a}, T; \]
\[ R_6; 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \text{P-WNL}_{FZ}; \]
\[ R_7; 2; \frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \text{P-WNL}_{FZ}; \]

\[ A; (\frac{1}{2}, \frac{1}{2}, \frac{1}{2}); S_{4z}^{+}, C_{2a}, T; \]
\[ R_6; 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \text{P-WNL}_{MA}; \]
\[ R_7; 2; \frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \text{P-WNL}_{MA}; \]

\[ R; (0\frac{1}{2}, \frac{1}{2}); C_{2z}, \sigma_y, T; \]
\[ R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{XR}; \]

\[ X; (0\frac{1}{2}, 0); C_{2z}, \sigma_y, T; \]
\[ R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{XR}; \]

\[ \Delta; \Gamma X; \]
\[ \sigma_x, T \sigma_y; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ U; \]
\[ Z R; \]
\[ \sigma_x, T \sigma_y; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ \Lambda; \Gamma Z; \]
\[ C_{2z}, \sigma_y, S_{4h}^{+}, T; \]
\[ R_5; 2; i\sigma_2, i\sigma_1, \frac{\sigma_0-i\sigma_2}{\sqrt{2}} \]; \text{WNL}; \pi \]

\[ V; \]
\[ M A; \]
\[ C_{2z}, \sigma_y, S_{4h}^{+}, T; \]
\[ R_5; 2; i\sigma_2, i\sigma_1, \frac{\sigma_0-i\sigma_2}{\sqrt{2}} \]; \text{WNL}; \pi \]

\[ \Sigma; \Gamma M; \]
\[ C_{2h}, C_{2h} T; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ S; \]
\[ Z A; \]
\[ C_{2h}, C_{2h} T; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ Y; \]
\[ X M; \]
\[ \sigma_y, T C_{2z}; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ T; \]
\[ R A; \]
\[ \sigma_y, T C_{2z}; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ W; \]
\[ X R; \]
\[ C_{2z}, \sigma_y; \]
\[ R_5; 2; i\sigma_2, i\sigma_1; \text{WNL}; \pi \]
\( \Gamma; \) (000): \( S^+_{4z}, C_{2z}, T; \) 
\[
R_6; 2; \frac{a_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{T^2};
\]
\[
R_7; 2; \frac{a_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{T^2};
\]
\( M; \) (\( \frac{1}{2} \frac{1}{2} 0 \)): \( S^+_{4z}, C_{2z}, T; \) 
\[
R_6; 2; \frac{a_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{MA};
\]
\[
R_7; 2; \frac{a_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{MA};
\]
\( Z; \) (00\( \frac{1}{2} \)): \( S^+_{4z}, \sigma_z, T; \) 
\[
\{ R_6, R_7 \}; 4; \Gamma_{0.1 + i\sigma_0}, \Gamma_{0.3}, \Gamma_{0.3}, \Gamma_{2.0}; \quad \text{P-WNL}; \quad \pi
\]
\( A; \) (\( \frac{1}{2} \frac{1}{2} \frac{1}{2} \)): \( S^+_{4z}, \sigma_z, T; \) 
\[
\{ R_6, R_7 \}; 4; \Gamma_{0.1 + i\sigma_0}, \Gamma_{0.3}, \Gamma_{2.0}, \Gamma_{2.0}; \quad \text{P-WNL}; \quad \pi
\]
\( R; \) (0\( \frac{1}{2} \frac{1}{2} \)): \( C_{2z}, \sigma_z, T; \) 
\[
\{ R_6, R_7 \}; 4; \Gamma_{0.3}, \Gamma_{1.1}, \Gamma_{2.1}; \quad \text{P-WNL}; \quad \pi
\]
\( X; \) (0\( \frac{1}{2} \frac{1}{2} \)): \( C_{2z}, \sigma_y, T; \) 
\[
R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{XR};
\]
\( \Delta; \) \( \Gamma \chi; \) \( \sigma_z, T \sigma_y; \) 
\[
\{ R_2, R_4 \}; 2; \sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi
\]
\( \Lambda; \) \( \Gamma \zeta; \) \( C_{2z}, \sigma_y, S^+_{4z} T; \) 
\[
R_5; 2; i\sigma_2, i\sigma_1, \frac{a_0 - i\sigma_2}{\sqrt{2}}; \quad \text{WNL}; \quad \pi
\]
\( V; \) \( \Gamma \alpha; \) \( C_{2z}, \sigma_y, S^+_{4z} T; \) 
\[
R_5; 2; i\sigma_2, i\sigma_1, \frac{a_0 + i\sigma_2}{\sqrt{2}}; \quad \text{WNL}; \quad \pi
\]
\( \Sigma; \) \( \Gamma \mu; \) \( C_{2z}, C_{2z} T; \) 
\[
R_2; 2; i, 1, 1; \quad \text{P-WNL}; \quad \pi
\]
\[
R_4; 2; -i, 1, 1; \quad \text{P-WNL}; \quad \pi
\]
\( S; \) \( \Gamma \alpha; \) \( C_{2z}, E, C_{2z} T; \) 
\[
R_5; 2; -i, 1, 1; \quad \text{P-WNL}; \quad \pi
\]
\[
R_7; 2; -i, 1, 1; \quad \text{P-WNL}; \quad \pi
\]
\( Y; \) \( \Gamma \nu; \) \( \sigma_y, T C_{2z}; \) 
\[
R_2; 2; i, 1, 1; \quad \text{P-WNL}; \quad \pi
\]
\[
R_4; 2; -i, 1, 1; \quad \text{P-WNL}; \quad \pi
\]
\( T; \) \( \Gamma \rho; \) \( \sigma_y, T C_{2z}; \) 
\[
\{ R_2, R_4 \}; 2; \sigma_3, \sigma_1; \quad \text{WNL}; \quad \pi
\]
\( W; \) \( \Gamma \sigma; \) \( C_{2z}, \sigma_y; \) 
\[
R_5; 2; i\sigma_2, i\sigma_1; \quad \text{WNL}; \quad \pi
\]
\[ \Gamma_q; \{ S_4^+ \{000\}, \{ C_{2v} \{1^{1/2}0\}\}, T \}; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; (000); S_{4v}^+ C_{2v}, T; \]
\[ R_0; 2: \frac{a_0+i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_T \]
\[ R_{\tau}; 2: \frac{a_0-i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_T \]

\[ M; (1^{1/2}0); S_{4v}^+ \sigma_5, T; \{ R_6, R_7 \}; 4: \frac{\Gamma_{0,1}+i \Gamma_{3,0}}{\sqrt{2}}, \Gamma_{0,3,} -i \Gamma_{2,0}; \quad \text{DP}; 0 \]

\[ Z; (00\frac{1}{2}); S_{4v}^+ C_{2v}, T; \]
\[ R_6; 2: \frac{a_0+i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_T \]
\[ R_{\tau}; 2: \frac{a_0-i \sigma_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \quad \text{P-WNL}_T \]

\[ A; (1^{1/2}0); S_{4v}^+ \sigma_5, T; \{ R_6, R_7 \}; 4: \frac{\Gamma_{0,1}+i \Gamma_{3,0}}{\sqrt{2}}, \Gamma_{0,3}, -i \Gamma_{2,0}; \quad \text{DP}; 0 \]

\[ R; (0\frac{1}{2}); \sigma_x C_{2v}, T; \]
\[ \{ R_5, R_6 \}; 2: -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{RA} \]
\[ \{ R_7, R_8 \}; 2: \sigma_0, -i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{RA} \]

\[ X; (0\frac{1}{2}); \sigma_z C_{2v}, T; \]
\[ \{ R_5, R_6 \}; 2: -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{XM} \]
\[ \{ R_7, R_8 \}; 2: \sigma_0, -i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{XM} \]

\[ \Delta; \Gamma X; \quad \sigma_z T \sigma_y; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ U; \Gamma R; \quad \sigma_x T \sigma_y; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ \Lambda; \gamma Z; \quad C_{2v}, \sigma_9 S_{4v}^+_T; \]
\[ R_5; 2: i \sigma_2, i \sigma_1, \frac{\sigma_0-i \sigma_2}{\sqrt{2}}; \quad \text{WNL}; \quad \pi \]

\[ V; \Gamma A; \quad C_{2v}, \sigma_9 S_{4v}^+_T; \]
\[ R_0; 2: i \sigma_3, -\sigma_1, \frac{i(\sigma_0+i \sigma_2)}{\sqrt{2}}; \quad \text{WNL}; \quad \pi \]

\[ \Sigma; \Gamma M; \quad C_{2v}, C_{2b} T; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ S; \Gamma A; \quad C_{2v}, C_{2b} T; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ Y; \Gamma M; \quad \sigma_y E T C_{2v}; \]
\[ \{ R_5, R_7 \}; 2: -i \sigma_3, \sigma_0, \sigma_1; \quad \text{WNL}; \quad \pi \]

\[ T; \Gamma A; \quad \sigma_y E T C_{2v}; \]
\[ \{ R_5, R_7 \}; 2: -i \sigma_3, \sigma_0, \sigma_1; \quad \text{WNL}; \quad \pi \]

\[ W; \Gamma R; \quad \sigma_y C_{2v}; \]
\[ R_5; 1; i, i; \]
\[ R_6; 1; i, -i; \]
\[ R_7; 1; -i, -i; \]
\[ R_8; 1; -i, i; \]
\[ \Gamma; \{ S_{4z}^+ \}^{(000)}, \{ C_{2a}\}^{\frac{1}{2} \frac{1}{2} \frac{1}{2}}, T; \text{Non-Centrosymmetric; with SOC} \]

\[
\begin{align*}
\Gamma; (000); & S_{4z}^+, C_{2a}, T; \quad R_6; \quad 2: \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\Gamma, 2}; \\
& R_7; \quad 2: \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\Gamma, 2}; \\
M; (\frac{1}{2} \frac{1}{2} 0); & S_{4z}^+, \sigma_x, T; \quad \{ R_6, R_7 \}; \quad 4: \frac{\Gamma_{0,1} + i\Gamma_{3,0}}{\sqrt{2}}, \Gamma_{0,3}, -i\Gamma_{2,0}; \quad \text{DP}; \quad 0 \\
Z; (00 \frac{1}{2}); & S_{4z}^+, \sigma_z, T; \quad \{ R_6, R_7 \}; \quad 4: \frac{\Gamma_{0,1} + i\Gamma_{3,0}}{\sqrt{2}}, \Gamma_{0,3}, -i\Gamma_{2,0}; \quad \text{DP}; \quad 0 \\
A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); & S_{4z}^+, C_{2a}, T; \quad R_6; \quad 2: \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\Gamma, A}; \\
& R_7; \quad 2: \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\Gamma, A}; \\
R; (0 \frac{1}{2} \frac{1}{2}); & \sigma_y, C_{2a}, T; \quad \{ R_5, R_6 \}; \quad 2: -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\Gamma, R}; \\
& \{ R_7, R_8 \}; \quad 2: \sigma_0, -i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\Gamma, R}; \\
X; (0 \frac{1}{2} 0); & \sigma_z, C_{2a}, T; \quad \{ R_5, R_6 \}; \quad 2: -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\Gamma, X}; \\
& \{ R_7, R_8 \}; \quad 2: \sigma_0, -i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\Gamma, X}; \\
\Delta; \Gamma X; & \sigma_z, T \sigma_y; \quad R_2; \quad 1; i, 1; \\
& R_4; \quad 1; -i, 1; \\
U; \Gamma Z; & \sigma_z, T \sigma_y; \quad \{ R_2, R_4 \}; \quad 2: \sigma_3, -i\sigma_2; \quad \text{WNL}; \quad \pi \\
A; \Gamma Z; & C_{2a}, \sigma_y, S_{4z}^+ T; \quad R_5; \quad 2: i\sigma_3, i\sigma_1, -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}; \quad \text{WNL}; \quad \pi \\
V; \Gamma A; & C_{2a}, \sigma_z, S_{4z}^+ T; \quad R_9; \quad 2: i\sigma_3, -\sigma_1, -\frac{i(\sigma_0 + i\sigma_2)}{\sqrt{2}}; \quad \text{WNL}; \quad \pi \\
\Sigma; \Gamma M; & C_{2a}, C_{2b} T; \quad R_2; \quad 1; i, 1; \\
& R_4; \quad 1; -i, 1; \\
S; \Gamma Z; & C_{2a}, E, C_{2b} T; \quad R_5; \quad 1; -i, 1, 1; \\
& R_7; \quad 1; i, 1, 1; \\
Y; \Gamma M; & \sigma_y, E, T C_{2z}; \quad \{ R_5, R_7 \}; \quad 2: -i\sigma_3, \sigma_0, \sigma_1; \quad \text{WNL}; \quad \pi \\
T; \Gamma A; & \sigma_y, E, T C_{2z}; \quad R_5; \quad 1; -1, 1, 1; \\
& R_7; \quad 1; 1, 1, 1; \\
W; \Gamma R; & \sigma_y, C_{2z}; \quad R_5; \quad 1; i, i; \\
& R_6; \quad 1; i, -i; \\
& R_7; \quad 1; -i, -i; \\
& R_8; \quad 1; -i, i; \]
\( \Gamma_v: \{S_{4z}^+|000\}, \{C_{2a}|000\}, T; Non-Centrosymmetric; with SOC \)

\( \Gamma; (000); S_{4z}^+, C_{2a}, T; R_6; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; P-WNL_{\Gamma Z}; \)

\( R_2; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; P-WNL_{\Gamma Z}; \)

\( N; (0\frac{1}{2}0); \sigma_y, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; P-WNL; \)

\( X; (00\frac{1}{2}); C_{2z}, C_{2b}, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; C-1 WP; 1 \)

\( Z; \left(\frac{1}{2}\frac{1}{2}\frac{1}{2}\right); S_{4z}^+, C_{2a}, T; R_6; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; P-WNL_{\Gamma Z}; \)

\( R_2; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; P-WNL_{\Gamma Z}; \)

\( P; \left(\frac{1}{4}\frac{1}{4}\frac{1}{4}\right); S_{4z}^+, T\sigma_y; R_2; 1; \sqrt{-1}, 1; \)

\( R_4; 1; (-1)^{3/4}, 1; \)

\( R_6; 1; -\sqrt{-1}, 1; \)

\( R_8; 1; -(-1)^{3/4}, 1; \)

\( \Lambda; \Gamma\Lambda/\Gamma Z; C_{2z}, \sigma_y; S_{4z}^+, T; R_5; 2; i\sigma_2, i\sigma_1, -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}; WNL; \pi \)

\( V; \Gamma V; C_{2z}, \sigma_y; S_{4z}^+, T; R_5; 2; i\sigma_2, i\sigma_1, -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}; WNL; \pi \)

\( W; \Gamma W; C_{2z}, C_{2b}, T; R_5; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( \Sigma; \Gamma\Sigma/\Gamma\Sigma; \sigma_y, T C_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( F; \Gamma F; \sigma_y, T C_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( Q; \Gamma Q; \tilde{E}, T \sigma_y; R_2; 1; -1, 1; \)

\( \Delta; \Gamma \Delta; C_{2z}, C_{2b}, T; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( U; \Gamma U; C_{2z}, C_{2b}, T; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( Y; \Gamma Y; C_{2z}, T C_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)
$\Gamma$; \( \{S^+_4|000\} \), \( \{C_2a|\frac{1}{2} \frac{1}{2} 0\} \). \( \mathcal{T} \); Non-Centrosymmetric; with SOC

\( \Gamma \): (000); \( S^+_4, C_2a, \mathcal{T} \); \( R_6 \); 2; \( \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2 \); P-WNL\(_{\Gamma Z}\); \( R_7 \); 2; \( \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2 \); P-WNL\(_{\Gamma Z}\);

\( N \): (000); \( \sigma_y, \mathcal{E}, \mathcal{T} \); \( \{R_5, R_6\} \); 2; \( \sigma_0, -\sigma_0, -i\sigma_2 \); P-WNL\(_N\); \( \{R_7, R_8\} \); 2; \( -\sigma_0, -\sigma_0, -i\sigma_2 \); P-WNL\(_N\);

\( X \): (000); \( C_2a, C_2b, \mathcal{T} \); \( R_5 \); 2; \( \sigma_2, i\sigma_1, -i\sigma_2 \); C-1 WP; \( \pi \);

\( Z \): (000); \( S^+_4, C_2a, \mathcal{T} \); \( R_6 \); 2; \( \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2 \); P-WNL\(_{\Gamma Z}\); \( R_7 \); 2; \( \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2 \); P-WNL\(_{\Gamma Z}\);

\( P \): (000); \( S^+_4, \mathcal{T}, \sigma_y \); \( \{R_2, R_6\} \); 2; \( \sqrt{-1}\sigma_3, -i\sigma_2 \); P-WNL\(_S\); \( \{R_4, R_8\} \); 2; \( -1\frac{3}{4}\sigma_3, -i\sigma_2 \); P-WNL\(_S\);

\( \Lambda \); \( \Gamma\Gamma/T\Sigma \); \( C_2a, \sigma_y, S^+_4, \mathcal{T} \); \( R_5 \); 2; \( \sigma_2, i\sigma_1, -\frac{\sigma_0 + i\sigma_2}{\sqrt{2}} \); WNL; \( \pi \);

\( V \); \( \Sigma\mathcal{Z}/\Sigma\Sigma \); \( C_2a, \sigma_y, S^+_4, \mathcal{T} \); \( R_5 \); 2; \( \sigma_2, i\sigma_1, -\frac{\sigma_0 + i\sigma_2}{\sqrt{2}} \); WNL; \( \pi \);

\( W \); \( \Sigma\mathcal{P} \); \( C_2a, C_2b, \mathcal{T} \); \( R_2 \); 1; \( i, 1 \);

\( R_4 \); 1; \( -i, 1 \);

\( \Sigma \); \( \Gamma\Sigma/T\Sigma \); \( \sigma_y, \mathcal{T}, C_2a \); \( R_2 \); 1; \( i, 1 \);

\( R_4 \); 1; \( -i, 1 \);

\( F \); \( \Sigma\mathcal{F} \); \( \sigma_y, \mathcal{T}, C_2a \); \( R_2 \); 1; \( -i, 1 \);

\( R_4 \); 1; \( i, 1 \);

\( Q \); \( \Sigma\mathcal{P} \); \( \mathcal{E}, \mathcal{T}, \sigma_y \); \( \{R_2, R_7\} \); 2; \( -\sigma_0, -i\sigma_2 \); WNL; \( \pi \);

\( \Delta \); \( \Gamma\Delta \); \( C_2a, C_2b, \mathcal{T} \); \( R_2 \); 1; \( i, 1 \);

\( R_4 \); 1; \( -i, 1 \);

\( U \); \( \Sigma\mathcal{U} \); \( C_2a, C_2b, \mathcal{T} \); \( R_2 \); 1; \( -i, 1 \);

\( R_4 \); 1; \( i, 1 \);

\( Y \); \( \Sigma\mathcal{Y}/\Sigma\mathcal{Y} \); \( C_2a, \mathcal{T}, C_2a \); \( R_2 \); 1; \( i, 1 \);

\( R_4 \); 1; \( -i, 1 \);
Γ: (000); \( S_{4z}^1, C_{2x}, T \); 
- \( R_6 \): \( \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) P-WNL\( \Gamma_Z \);
- \( R_7 \): \( \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) P-WNL\( \Gamma_Z \);

\( N; (0 \frac{1}{2} 0) \); \( C_{2y}, T \); 
- \( R_2, R_4 \): \( 2; i\sigma_3, -i\sigma_2; \) C-1 WP; 1

\( X; (00 \frac{1}{2}) \); \( C_{2z}, \sigma_{db}, T \); 
- \( R_5 \): \( 2; i\sigma_2, i\sigma_1, -i\sigma_2; \) P-WNL\( \Gamma_Z \);

\( Z; (\frac{1}{2} \frac{1}{2} \frac{1}{2}) \); \( S_{4z}^1, C_{2x}, T \); 
- \( R_6 \): \( 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) P-WNL\( \Gamma_Z \);

\( P; (\frac{1}{4} \frac{1}{4} \frac{1}{4}) \); \( S_{4z}^1, C_{2z} \); 
- \( R_6 \): \( 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \) P-WNL\( \Gamma_Z \);

\( \Lambda; \Gamma\Lambda/\Gamma\Sigma \); \( C_{2z}, \sigma_{db}, S_{4z}^1, T \); 
- \( R_5 \): \( 2; i\sigma_2, i\sigma_1, \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}; \) WNL; \( \pi \)

\( V; \Gamma V \); \( C_{2z}, \sigma_{db}, S_{4z}^1, T \); 
- \( R_5 \): \( 2; i\sigma_2, i\sigma_1, \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}; \) WNL; \( \pi \)

\( W; \Gamma W \); \( C_{2z}, \sigma_{db} \); 
- \( R_5 \): \( 2; i\sigma_2, i\sigma_1; \) WNL; \( \pi \)

\( \Sigma; \Gamma\Sigma/\Gamma\Sigma \); \( C_{2z}, TC_{2y} \); 
- \( R_2 \): \( 1; i, 1; \)

\( F; \Gamma F \); \( C_{2z}, TC_{2y} \); 
- \( R_2 \): \( 1; i, 1; \)

\( Q; \Gamma P \); \( C_{2y} \); 
- \( R_4 \): \( 1; -i, 1; \)

\( \Delta; \Gamma X \); \( \sigma_{db}, T \sigma_{da} \); 
- \( R_2 \): \( 1; i, 1; \)

\( U; \Gamma U \); \( \sigma_{db}, T \sigma_{da} \); 
- \( R_4 \): \( 1; -i, 1; \)

\( Y; \Gamma Y \); \( \sigma_{da}, TC_{2z} \); 
- \( R_4 \): \( 1; -i, 1; \)
SG 122

Γ; \(\{S^+_1,000\},\{C_2,\frac{1}{4}\}\), \(T\); Non-Centrosymmetric; with SOC

\[
\begin{array}{llll}
\Gamma; & (000); & S^+_1, C_2, T; & R_6; \\
\Gamma; & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & \sigma_{db}, C_2, T; & R_{13}\end{array}
\]

\[\begin{array}{ll}
1; & \frac{\sqrt{3}}{3}; -\frac{\sqrt{3}}{3}; \\
1; & \frac{\sqrt{3}}{3}; -\frac{\sqrt{3}}{3}; \\
1; & \frac{\sqrt{3}}{3}; -\frac{\sqrt{3}}{3}; \\
1; & \frac{\sqrt{3}}{3}; -\frac{\sqrt{3}}{3}; \\
\end{array}\]

\[\begin{array}{ll}
R_6; & 2; \frac{\sqrt{3}}{\sqrt{2}}; -\frac{\sqrt{3}}{\sqrt{2}}; \\
R_7; & 2; \frac{\sqrt{3}}{\sqrt{2}}; -\frac{\sqrt{3}}{\sqrt{2}}; \\
\end{array}\]

\[\begin{array}{llll}
N; & (0\frac{1}{2}\frac{1}{2}); & C_2, T; & \{R_2, R_4\}; \\
X; & (00\frac{1}{2}); & \sigma_{db}, C_2, T; & \{R_5, R_6\}; \\
Z; & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & S^+_1, \sigma_{db}, T; & \{R_6, R_7\}; \\
\end{array}\]

\[
\begin{array}{llll}
R_6; & 2; \frac{\sqrt{3}}{\sqrt{2}}; -\frac{\sqrt{3}}{\sqrt{2}}; \\
R_7; & 2; \frac{\sqrt{3}}{\sqrt{2}}; -\frac{\sqrt{3}}{\sqrt{2}}; \\
\end{array}\]

\[\begin{array}{llll}
P; & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & S^+_1, \sigma_{da}; & \{R_5, R_6\}; \\
\end{array}\]

\[\begin{array}{llll}
R_8; & 1; i, i; \\
R_9; & 1; i, -i; \\
R_{10}; & 1; -i, -i; \\
R_{11}; & 1; -i, i; \\
\end{array}\]

\[\begin{array}{llll}
\Sigma; & \Gamma T \Sigma; & C_2, TC_2, T; & R_4; \\
A; & \Gamma A \Gamma T \Sigma; & C_2, \sigma_{db}, S^+_1, T; & R_5; \\
V; & Z V; & C_2, \sigma_{db}, S^+_1, T; & R_5; \\
W; & \sigma_{da}, C_2; & R_5; \\
\end{array}\]

\[\begin{array}{llll}
R_6; & 1; i, i; \\
R_7; & 1; i, -i; \\
R_8; & 1; -i, -i; \\
R_9; & 1; -i, i; \\
\end{array}\]

\[\begin{array}{llll}
\Delta; & \Gamma X; & \sigma, T, \sigma_{da}; & R_2; \\
\end{array}\]

\[\begin{array}{llll}
R_3; & 1; i, i; \\
R_4; & 1; -i, -i; \\
\end{array}\]

\[\begin{array}{llll}
U; & Z U; & \sigma_{db}, T, \sigma_{da}; & \{R_2, R_4\}; \\
Y; & X Z / X Y; & \sigma_{da}, E, TC_2; & \{R_5, R_7\}; \\
\end{array}\]

\[\begin{array}{llll}
R_3; & 2; \sigma_3, -i\sigma_2; \\
R_4; & 2; \sigma_3, -i\sigma_2; \\
\end{array}\]

\[\begin{array}{llll}
WNL; & \pi; \\
WNL; & \pi; \\
\end{array}\]
Γ; (000): $C_{4z}^+, C_{2z}, I, T$; $R_6$: $2: \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_1, \sigma_0, -i\sigma_2$;
$R_7$: $2: -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_1, \sigma_0, -i\sigma_2$;
$R_{13}$: $2: \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$;
$R_{14}$: $2: -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$

M; (110): $C_{4z}^+, C_{2z}, I, T$; $R_6$: $2: \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_1, \sigma_0, -i\sigma_2$;
$R_7$: $2: -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_1, \sigma_0, -i\sigma_2$;
$R_{13}$: $2: \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$;
$R_{14}$: $2: -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$

Z; (00½): $C_{4z}^+, C_{2z}, I, T$; $R_6$: $2: \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_1, \sigma_0, -i\sigma_2$;
$R_7$: $2: -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_1, \sigma_0, -i\sigma_2$;
$R_{13}$: $2: \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$;
$R_{14}$: $2: -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$
\( \Gamma \); \( (000) \): \( C_{4z}^+ \), \( C_{2x}^+ \), \( I ; T \); \( R_6 \):  
2; \( \frac{\sigma_0+i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , \sigma_0 , -i\sigma_2 ; \)
\( R_7 \):  
2; \( -\frac{\sigma_0-i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , \sigma_0 , -i\sigma_2 ; \)
\( R_{13} \):  
2; \( \frac{\sigma_0+i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , -\sigma_0 , -i\sigma_2 ; \)
\( R_{14} \):  
2; \( -\frac{\sigma_0-i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , -\sigma_0 , -i\sigma_2 ; \)
\( M \); \( (\frac{1}{2} \frac{1}{2} 0) \): \( C_{4z}^+ \), \( C_{2x}^+ \), \( I ; T \); \( R_6 \):  
2; \( \frac{\sigma_0+i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , \sigma_0 , -i\sigma_2 ; \)
\( R_7 \):  
2; \( -\frac{\sigma_0-i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , \sigma_0 , -i\sigma_2 ; \)
\( R_{13} \):  
2; \( \frac{\sigma_0+i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , -\sigma_0 , -i\sigma_2 ; \)
\( R_{14} \):  
2; \( -\frac{\sigma_0-i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , -\sigma_0 , -i\sigma_2 ; \)
\( Z \); \( (00 \frac{1}{2}) \): \( I , \sigma_{dh} , C_{4z}^+ ; T \); \( \{R_{19}, R_{20}\} \):  
4; \( \Gamma_3, \Gamma_0, \frac{\Gamma_{0,0,0,0,0}}{\sqrt{2}} \), \( -i\Gamma_{2,0} ; \) \( DP ; 0 \)
\( \{R_{21}, R_{22}\} \):  
4; \( \Gamma_3, \Gamma_0, \frac{\Gamma_{0,0,0,0,0}}{\sqrt{2}} \), \( -i\Gamma_{2,0} ; \) \( DP ; 0 \)
\( A \); \( (1 \frac{1}{2} \frac{1}{2} \frac{1}{2}) \): \( I , \sigma_{dh} , C_{4z}^+ ; T \); \( \{R_{19}, R_{20}\} \):  
4; \( \Gamma_3, \Gamma_0, \frac{\Gamma_{0,0,0,0,0}}{\sqrt{2}} \), \( -i\Gamma_{2,0} ; \) \( DP ; 0 \)
\( \{R_{21}, R_{22}\} \):  
4; \( \Gamma_3, \Gamma_0, \frac{\Gamma_{0,0,0,0,0}}{\sqrt{2}} \), \( -i\Gamma_{2,0} ; \) \( DP ; 0 \)
\( R \); \( (0 \frac{1}{2} \frac{1}{2}) \): \( \sigma_x, \sigma_y ; I , T \); \( \{R_{13}, R_{14}\} \):  
4; \( \Gamma_{0,1} , \frac{i\Gamma_{3,0}}{\sqrt{2}}, \frac{i\Gamma_{3,0}}{\sqrt{2}} \), \( -i\Gamma_{2,0} ; \) \( DP ; 0 \)
\( X \); \( (0 \frac{1}{2} 0) \): \( C_{2z}, C_{2y}, I , T \); \( R_5 \):  
2; \( i\sigma_2 , i\sigma_1 , \sigma_0 , -i\sigma_2 ; \)
\( R_{10} \):  
2; \( i\sigma_2 , i\sigma_1 , -\sigma_0 , -i\sigma_2 ; \)
\( \Delta \); \( \Gamma_X \): \( C_{2y}, \sigma_x, I , T \); \( R_5 \):  
2; \( i\sigma_2 , i\sigma_1 , -i\sigma_2 ; \)
\( U \); \( \sigma_x, C_{2y}, I , T \); \( \{R_5, R_8\} \):  
2; \( i\sigma_3 , i\sigma_0 , -i\sigma_2 ; \)
\( \{R_6, R_7\} \):  
2; \( i\sigma_3 , -i\sigma_0 , -i\sigma_2 ; \)
\( \Lambda \); \( \Gamma_Z \): \( C_{4z}, \sigma_y, I , T \); \( R_6 \):  
2; \( \frac{\sigma_0+i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , -i\sigma_2 ; \)
\( R_7 \):  
2; \( -\frac{\sigma_0-i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , -i\sigma_2 ; \)
\( V \); \( \sigma_x, C_{2z}, I , T \); \( R_5 \):  
2; \( \frac{\sigma_0+i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , -i\sigma_2 ; \)
\( R_7 \):  
2; \( -\frac{\sigma_0-i\sigma_2}{\sqrt{2}} \), \( i\sigma_1 , -i\sigma_2 ; \)
\( \Sigma \); \( \Gamma_M \): \( C_{2z}, \sigma_z, I , T \); \( R_5 \):  
2; \( i\sigma_2 , i\sigma_1 , -i\sigma_2 ; \)
\( \{R_6, R_7\} \):  
2; \( i\sigma_3 , i\sigma_0 , -i\sigma_2 ; \)
\( \{R_6, R_7\} \):  
2; \( i\sigma_3 , -i\sigma_0 , -i\sigma_2 ; \)
\( Y \); \( \sigma_x, C_{2z}, I , T \); \( R_5 \):  
2; \( i\sigma_2 , i\sigma_1 , -i\sigma_2 ; \)
\( T \); \( \sigma_x, C_{2z}, I , T \); \( \{R_6, R_7\} \):  
2; \( i\sigma_3 , i\sigma_0 , -i\sigma_2 ; \)
\( \{R_6, R_7\} \):  
2; \( i\sigma_3 , -i\sigma_0 , -i\sigma_2 ; \)
\( W \); \( \sigma_x, C_{2z}, I , T \); \( R_5 \):  
2; \( i\sigma_2 , i\sigma_1 , -i\sigma_2 ; \)
\( \Gamma \); \( (000) \); \( C_{4v}^+; C_{2v}; I; T \); \( R_6; \quad 2; \ \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \)
\( R_7; \quad 2; -\frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \)
\( R_{13}; \quad 2; \ \frac{2\sigma_0+i\sigma_2}{\sqrt{2}}, \sigma_1, -\sigma_0, -i\sigma_2; \)
\( R_{14}; \quad 2; -\frac{2\sigma_0-i\sigma_2}{\sqrt{2}}, \sigma_1, -\sigma_0, -i\sigma_2; \)

\( M; \ (1\ \frac{1}{2} 0) \); \( C_{4v}^+; \sigma_z; C_{2v}; T \); \( R_{19}; \quad 4; -\frac{\Gamma_{1,0}^3-\Gamma_{1,1}^3}{\sqrt{2}}, \Gamma_{1,2}^3, i\Gamma_{0,3}^3, -i\Gamma_{3,2}^3; \) DP; 0

\( Z; \ (00\ \frac{1}{2}) \); \( C_{4v}^+; C_{2v}; I; T \); \( R_6; \quad 2; \ \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \)
\( R_7; \quad 2; -\frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \)
\( R_{13}; \quad 2; \ \frac{2\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \)
\( R_{14}; \quad 2; -\frac{2\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \)

\( A; \ (1\ \frac{1}{2} \ \frac{1}{2}) \); \( C_{4v}^+; \sigma_z; C_{2v}; T \); \( R_{19}; \quad 4; -\frac{\Gamma_{1,0}^3-\Gamma_{1,1}^3}{\sqrt{2}}, \Gamma_{1,2}^3, i\Gamma_{0,3}^3, -i\Gamma_{3,2}^3; \) DP; 0

\( R; \ (0\ \frac{1}{2} \ \frac{1}{2}) \); \( \sigma_z; \sigma_y; I; T \); \( \{R_{13}, R_{14}\}; \quad 4; \ \Gamma_{0,1}^3, i\Gamma_{3,0}^3, \Gamma_{0,3}^3, -i\Gamma_{2,0}^3; \) DP; 0

\( X; \ (0\ \frac{1}{2} 0) \); \( \sigma_z; \sigma_y; I; T \); \( \{R_{13}, R_{14}\}; \quad 4; \ \Gamma_{0,1}^3, i\Gamma_{3,0}^3, \Gamma_{0,3}^3, -i\Gamma_{2,0}^3; \) DP; 0

\( \Delta; \ \Gamma\chi \); \( 2y; \sigma_z; I; T \); \( R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( U; \ \Gamma\chi \); \( 2y; \sigma_z; I; T \); \( R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( \Lambda; \ \Gamma\chi \); \( C_{4v}^+; \sigma_y; I; T \); \( R_6; \quad 2; \ \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \)
\( R_7; \quad 2; -\frac{\sigma_0-i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \)

\( V; \ \Gamma\alpha \); \( C_{4v}^+; \sigma_z; I; T \); \( R_6; \quad 2; -\frac{\sigma_0-i\sigma_2}{\sqrt{2}}, -\sigma_3, -i\sigma_2; \)
\( R_7; \quad 2; \ i\frac{\sigma_0+i\sigma_2}{\sqrt{2}}, -\sigma_3, -i\sigma_2; \)

\( \Sigma; \ \Gamma\chi \); \( 2y; \sigma_z; I; T \); \( R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( S; \ \Gamma\chi \); \( 2y; \sigma_z; I; T \); \( R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( Y; \ \Gamma\chi \); \( \sigma_y; C_{2v}; I; T \); \( \{R_5, R_8\}; \quad 2; i\sigma_3, i\sigma_0, -i\sigma_2; \)
\( \{R_6, R_7\}; \quad 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \)

\( T; \ \Gamma\chi \); \( \sigma_y; C_{2v}; I; T \); \( \{R_5, R_8\}; \quad 2; i\sigma_3, i\sigma_0, -i\sigma_2; \)
\( \{R_6, R_7\}; \quad 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \)

\( W; \ \Gamma\chi \); \( \sigma_y; C_{2v}; I; T \); \( \{R_5, R_8\}; \quad 2; i\sigma_3, i\sigma_0, -i\sigma_2; \)
\( \{R_6, R_7\}; \quad 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \)
\( \Gamma_4: \{ C_{4v}^+| \frac{1}{2} \frac{1}{2} 0 \}, \{ C_{2v}|000 \}, \{ I| \frac{1}{2} \frac{1}{2} \frac{1}{2} \} \); Centrosymmetric; with SOC

\( \Gamma \); (000); \( C_{4v}^+, C_{2v}, I, T; \)

\( R_6; \) 2; \( \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \)

\( R_7; \) 2; \( \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \)

\( R_{13}; \) 2; \( \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \)

\( R_{14}; \) 2; \( \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \)

\( M; (\frac{1}{2} \frac{1}{2} 0); \) \( C_{4v}^+, \sigma_x, C_{2v}, T; \)

\( R_{19}; \) 4; \( \frac{\Gamma_{0,0} - i\Gamma_{3,1}}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3}, -i\Gamma_{3,2}; \) DP; 0

\( Z; (00 \frac{1}{2}); I, \sigma_{0b}, C_{4v}^+, T; \)

\( \{ R_{19}, R_{20}; \} 4; \Gamma_{3,2}, \Gamma_{0,3}, \frac{\Gamma_{0,0} + i\Gamma_{3,2}}{\sqrt{2}}, -i\Gamma_{2,0}; \) DP; 0

\( \{ R_{21}, R_{22}; \} 4; \Gamma_{3,2}, \Gamma_{0,3}, \frac{\Gamma_{0,0} - i\Gamma_{3,2}}{\sqrt{2}}, -i\Gamma_{2,0}; \) DP; 0

\( A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \) \( C_{4v}^+, \sigma_{0d}, C_{2v}, T; \)

\( R_{19}; \) 4; \( \frac{\Gamma_{0,0} - i\Gamma_{3,1}}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3}, -i\Gamma_{3,2}; \) DP; 0

\( R; (0 \frac{1}{2}); \sigma_y, \sigma_z, I, T; \)

\( \{ R_{13}, R_{14}; \} 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \) DP; 0

\( X; (0 \frac{1}{2} 0); \sigma_x, \sigma_y, I, T; \)

\( \{ R_{13}, R_{14}; \} 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \) DP; 0

\( \Delta; \Gamma \chi; C_{2y}, \sigma_z, I, T; \)

\( R_5; \) 2; \( i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( \{ R_5, R_8; \} 2; i\sigma_3, i\sigma_0, -i\sigma_2; \)

\( \{ R_6, R_7; \} 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \)

\( \Lambda; \Gamma \zeta; C_{4v}^+, \sigma_y, I, T; \)

\( R_6; \) 2; \( \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \)

\( R_7; \) 2; \( \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \)

\( V; \) MA; \( C_{4v}^+, \sigma_x, I, T; \)

\( R_6; \) 2; \( \frac{i\sigma_0 + i\sigma_2}{\sqrt{2}}, -\sigma_3, -i\sigma_2; \)

\( R_7; \) 2; \( \frac{i\sigma_0 - i\sigma_2}{\sqrt{2}}, -\sigma_3, -i\sigma_2; \)

\( \Sigma; \Gamma \mu; C_{2a}, \sigma_z, I, T; \)

\( R_5; \) 2; \( i\sigma_2, i\sigma_1, -i\sigma_2; \)

\( \{ R_5, R_8; \} 2; i\sigma_3, i\sigma_0, -i\sigma_2; \)

\( \{ R_6, R_7; \} 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \)

\( \psi; \) XM; \( \sigma_y, C_{2x}, I, T; \)

\( \{ R_5, R_8; \} 2; i\sigma_3, i\sigma_0, -i\sigma_2; \)

\( \{ R_6, R_7; \} 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \)

\( T; \) RA; \( C_{2x}, \sigma_z, I, T; \)

\( R_5; \) 2; \( i\sigma_3, -i\sigma_1, -i\sigma_2; \)

\( \{ R_5, R_8; \} 2; i\sigma_3, i\sigma_0, -i\sigma_2; \)

\( \{ R_6, R_7; \} 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \)
\[ \Gamma; \{ \Omega_{4,1}^+|\frac{1}{2},0 \}, \{ \Omega_{2x}^+|\frac{1}{2},0 \}, \{ I|000 \}; T; \text{Centrosymmetric with SOC} \]

\[ \Gamma; (000); \; \Omega_{4x}^+, \Omega_{2x}, I, T; \quad R_6; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_7; \quad \frac{-i\alpha_0 - i\alpha_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{13}; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{14}; \quad \frac{-i\alpha_0 - i\alpha_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ M; (\frac{1}{2}, 0, 0); \; \Omega_{4x}^+, \Omega_{2x}, I, T; \quad \{ R_6, R_7 \}; \quad \frac{\Gamma_0, 3, 0, 0, -i\Gamma_2, 0, 0, 0, 0; \text{P-DNLs}}{\Gamma_0, 3, 0, 0, -i\Gamma_2, 0, 0, 0, 0; \text{P-DNLs}}; \]

\[ Z; (00\frac{1}{2}); \; \Omega_{4x}^+, \Omega_{2x}, I, T; \quad R_6; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_7; \quad \frac{-i\alpha_0 - i\alpha_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{13}; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{14}; \quad \frac{-i\alpha_0 - i\alpha_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ A; (\frac{1}{2}, \frac{1}{2}, \frac{1}{2}); \; \Omega_{4x}^+, \Omega_{2x}, I, T; \quad \{ R_6, R_7 \}; \quad \frac{\Gamma_0, 3, 0, 0, -i\Gamma_2, 0, 0, 0, 0; \text{P-DNLs}}{\Gamma_0, 3, 0, 0, -i\Gamma_2, 0, 0, 0, 0; \text{P-DNLs}}; \]

\[ R; (0\frac{1}{2}, \frac{1}{2}); \; \sigma_z, \Omega_{2x}, I, T; \quad \{ R_{13}, R_{14} \}; \quad \frac{\Gamma_0, 3, 0, 0, -i\Gamma_2, 0, 0, 0, 0; \text{P-DNLs}}{\Gamma_0, 3, 0, 0, -i\Gamma_2, 0, 0, 0, 0; \text{P-DNLs}}; \]

\[ \Delta; \; \Omega_{4y}^+, \sigma_x, I, T; \quad R_5; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ U; \; \Omega_{4y}^+, \sigma_x, I, T; \quad R_5; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]

\[ V; \; \Omega_{4z}^+, \sigma_y, I, T; \quad R_6; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ W; \; \Omega_{4z}^+, \sigma_y, I, T; \quad R_6; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]

\[ \Sigma; \; \Omega_{4x}^+, \sigma_z, I, T; \quad R_5; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ S; \; \Omega_{4x}^+, \sigma_z, I, T; \quad R_5; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]

\[ Y; \; \Omega_{4x}^+, \sigma_z, I, T; \quad R_5; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ T; \; \Omega_{4x}^+, \sigma_z, I, T; \quad R_5; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]

\[ W; \; \Omega_{4x}^+, \sigma_z, I, T; \quad R_5; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]

\[ \{ R_7, R_8 \}; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]

\[ \{ R_7, R_8 \}; \quad \frac{\alpha_0 + i\alpha_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\(\Gamma; \{C_{4x}^{+}\frac{1}{2} \frac{1}{2} 0\}, \{C_{2z}\frac{1}{2} \frac{1}{2} 0\}, \{I[00\frac{1}{2}]\}, T; \text{Centrosymmetric; with SOC}\)

\(\Gamma; (000): C_{4x}^{+}, C_{2z}, I, T; \quad R_6; \quad 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2;\)

\(R_7; \quad 2; -\frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2;\)

\(R_{13}; \quad 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2;\)

\(R_{14}; \quad 2; -\frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2;\)

\(M; (1 \frac{1}{2} 0): C_{4x}^{+}, C_{2z}, I, T; \quad \{R_6, R_7\}; \quad 4; \frac{\Gamma_{0,0}+i\Gamma_{0,2}}{\sqrt{2}}, \Gamma_{0,3}, \Gamma_{0,0}, -i\Gamma_{2,0}; \quad \text{P-DNLs;}\)

\(\{R_{20}, R_{21}\}; \quad 4; \frac{\Gamma_{0,0}+i\Gamma_{0,2}}{\sqrt{2}}, \Gamma_{0,3}, -\Gamma_{0,0}, -i\Gamma_{2,0}; \quad \text{P-DNLs;}\)

\(Z; (00\frac{1}{2}): I, \sigma_{0z}, C_{4x}^{+}, T; \quad \{R_{19}, R_{20}\}; \quad 4; \frac{\Gamma_{3,2}, \Gamma_{0,3}}{\sqrt{2}}, \frac{\Gamma_{2,0}+i\Gamma_{0,2}}{\sqrt{2}}, -i\Gamma_{2,0}; \quad \text{DP; 0}\)

\(\{R_{21}, R_{22}\}; \quad 4; \frac{\Gamma_{3,2}, \Gamma_{0,3}}{\sqrt{2}}, -\frac{\Gamma_{2,0}+i\Gamma_{0,2}}{\sqrt{2}}, -i\Gamma_{2,0}; \quad \text{DP; 0}\)

\(A; (1 \frac{1}{2} 2): I, \sigma_{0z}, S_{4z}^{+}, T; \quad \{R_{19}, R_{20}\}; \quad 4; \frac{\Gamma_{3,2}, \Gamma_{0,3}}{\sqrt{2}}, \frac{\Gamma_{2,0}+i\Gamma_{0,2}}{\sqrt{2}}, -i\Gamma_{2,0}; \quad \text{P-DNL}_{MA};\)

\(\{R_{21}, R_{22}\}; \quad 4; \frac{\Gamma_{3,2}, \Gamma_{0,3}}{\sqrt{2}}, -\frac{\Gamma_{2,0}+i\Gamma_{0,2}}{\sqrt{2}}, -i\Gamma_{2,0}; \quad \text{P-DNL}_{MA};\)

\(R; (0 \frac{1}{2} \frac{1}{2}): C_{2y}, C_{2z}, I, T; \quad \{R_5, R_6\}; \quad 2; -\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2;\)

\(\{R_7, R_8\}; \quad 2; \sigma_0, -i\sigma_3, \sigma_0, -i\sigma_2;\)

\(\{R_{15}, R_{16}\}; \quad 2; -\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2;\)

\(\{R_{17}, R_{18}\}; \quad 2; \sigma_0, -i\sigma_3, -\sigma_0, -i\sigma_2;\)

\(X; (0 \frac{1}{2} 0): \sigma x, C_{2z}, I, T; \quad \{R_{13}, R_{14}\}; \quad 4; \frac{\Gamma_{0,1}, \Gamma_{3,0}, \Gamma_{0,3}}{\sqrt{2}}, -i\Gamma_{2,0}; \quad \text{P-DNL}_{X_M};\)

\(\Delta; \Gamma X; \quad C_{2y}, \sigma x, I; \quad R_5; \quad 2; \sigma_2, \sigma_3, -\sigma_2;\)

\(U; \Gamma R; \quad \sigma x, C_{2y}, I; \quad \{R_5, R_6\}; \quad 2; i\sigma_3, \sigma_0, -i\sigma_2;\)

\(\{R_6, R_7\}; \quad 2; i\sigma_3, -i\sigma_0, -i\sigma_2;\)

\(A; \Gamma Z; \quad C_{4x}^{+}, \sigma y, I; \quad R_6; \quad 2; \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2;\)

\(R_7; \quad 2; -\frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2;\)

\(V; \text{MA}; \quad C_{4x}^{+}, \sigma y, I; \quad \{R_6, R_7\}; \quad 4; -\frac{\Gamma_{0,1}+i\Gamma_{0,2}}{\sqrt{2}}, -\Gamma_{0,3}, -i\Gamma_{2,0}; \quad \text{DNL; 0}\)

\(\Sigma; \Gamma M; \quad C_{2z}, \sigma z, I; \quad R_5; \quad 2; i\sigma_2, \sigma_3, -i\sigma_2;\)

\(S; \Gamma A; \quad \sigma z, C_{2z}, I; \quad \{R_5, R_8\}; \quad 2; i\sigma_3, \sigma_0, -i\sigma_2;\)

\(\{R_6, R_7\}; \quad 2; i\sigma_3, -i\sigma_0, -i\sigma_2;\)

\(Y; \text{XM}; \quad \sigma z, C_{2z}, I; \quad \{R_9, R_0\}; \quad 4; i\Gamma_{0,3}, -i\Gamma_{0,1}, -\Gamma_{2,1}; \quad \text{DNL; 0}\)

\(T; \text{RA}; \quad C_{2x}, \sigma y, E, I; \quad \{R_6, R_8\}; \quad 2; -i\sigma_3, -\sigma_0, \sigma_0, -i\sigma_2;\)

\(\{R_7, R_0\}; \quad 2; -i\sigma_3, \sigma_0, \sigma_0, -i\sigma_2;\)

\(W; \text{XR}; \quad \sigma y, C_{2z}, I; \quad \{R_5, R_6\}; \quad 2; i\sigma_0, i\sigma_3, -i\sigma_2;\)

\(\{R_7, R_8\}; \quad 2; -i\sigma_0, -i\sigma_3, -i\sigma_2;\)
$\Gamma_q; \{C_4^+, \frac{1}{2} \{000\} \}, \{I\{\frac{1}{2} \{0\}\}, T\};$ Centrosymmetric; with SOC

\begin{align*}
\Gamma; \ (000); & \quad C_{4v}^+, C_{2v}, \ I, \ T; \quad R_6; \quad \begin{cases} a_0 + i \sigma_2 \sqrt{2}, i \sigma_1, \sigma_0, -i \sigma_2; \\ R_7; \quad -a_0 - i \sigma_2 \sqrt{2}, i \sigma_1, \sigma_0, -i \sigma_2; \\ R_{13}; \quad 2 a_0 + i \sigma_2 \sqrt{2}, i \sigma_1, -\sigma_0, -i \sigma_2; \\ R_{14}; \quad -2 a_0 - i \sigma_2 \sqrt{2}, i \sigma_1, -\sigma_0, -i \sigma_2; \end{cases} \\
M; \ (\frac{1}{2} \{0\}); & \quad C_{4v}^+, C_{2v}, \sigma_x, \ T; \quad R_{19}; \quad \begin{cases} \Gamma_1^0, i \Gamma_3, i \Gamma_1^0, -i \Gamma_3; \quad \text{P-DNL}\(_{MA}\); \\ \end{cases} \\
Z; \ (00\frac{1}{2}); & \quad C_{4v}^+, C_{2v}, \ I, \ T; \quad R_6; \quad \begin{cases} a_0 + i \sigma_2 \sqrt{2}, i \sigma_1, \sigma_0, -i \sigma_2; \\ R_7; \quad -a_0 - i \sigma_2 \sqrt{2}, i \sigma_1, \sigma_0, -i \sigma_2; \\ R_{13}; \quad 2 a_0 + i \sigma_2 \sqrt{2}, i \sigma_1, -\sigma_0, -i \sigma_2; \\ R_{14}; \quad -2 a_0 - i \sigma_2 \sqrt{2}, i \sigma_1, -\sigma_0, -i \sigma_2; \end{cases} \\
A; \ (\frac{1}{2} \{0\}); & \quad C_{4v}^+, C_{2v}, \sigma_x, \ T; \quad R_{19}; \quad \begin{cases} \Gamma_1^0, i \Gamma_3, i \Gamma_1^0, -i \Gamma_3; \quad \text{P-DNL}\(_{MA}\); \\ \end{cases} \\
R; \ (00\frac{1}{2}); & \quad C_{2h}, C_{2v}, \ I, \ T; \quad \{R_{13}, R_{14}\}; \quad 4; \quad \Gamma_0^1, i \Gamma_3, i \Gamma_0^1, -i \Gamma_2; \quad \text{P-DNL}\(_{XR}\); \\
X; \ (00\frac{1}{2}); & \quad C_{2h}, C_{2v}, \ I, \ T; \quad \{R_{13}, R_{14}\}; \quad 4; \quad \Gamma_0^1, i \Gamma_3, i \Gamma_0^1, -i \Gamma_2; \quad \text{P-DNL}\(_{XR}\); \\
\Delta; \ \Gamma X; & \quad C_{2h}, \sigma_x, IT; \quad R_5; \quad \begin{cases} \Gamma_1^0, i \Gamma_3, \Gamma_0^1, -i \Gamma_2; \quad \text{P-DNL}\(_{XR}\); \\ \end{cases} \\
U; \ \Gamma Z; & \quad C_{2h}, \sigma_x, IT; \quad R_5; \quad \begin{cases} \Gamma_1^0, i \Gamma_3, \Gamma_0^1, -i \Gamma_2; \quad \text{P-DNL}\(_{XR}\); \\ \end{cases} \\
\Lambda; \ \Gamma Z; & \quad C_{4v}^+, \sigma_y, IT; \quad R_6; \quad \begin{cases} a_0 + i \sigma_2 \sqrt{2}, i \sigma_1, -i \sigma_2; \\ R_7; \quad -a_0 - i \sigma_2 \sqrt{2}, i \sigma_1, -i \sigma_2; \end{cases} \\
V; \ \Gamma A; & \quad C_{4v}^+, \sigma_y, IT; \quad \{R_6, R_7\}; \quad \begin{cases} \Gamma_0^1, i \Gamma_3, \Gamma_0^1, -i \Gamma_2; \quad \text{DNL}; \quad 0 \\ \end{cases} \\
\Sigma; \ \Gamma M; & \quad C_{2h}, \sigma_x, IT; \quad R_5; \quad \begin{cases} \Gamma_1^0, i \Gamma_3, \Gamma_0^1, -i \Gamma_2; \quad \text{P-DNL}\(_{XR}\); \\ \end{cases} \\
S; \ \Gamma A; & \quad C_{2h}, \sigma_x, IT; \quad R_5; \quad \begin{cases} \Gamma_1^0, i \Gamma_3, \Gamma_0^1, -i \Gamma_2; \quad \text{P-DNL}\(_{XR}\); \\ \end{cases} \\
Y; \ \Gamma M; & \quad C_{2h}, \sigma_y, IT; \quad \{R_5, R_8\}; \quad \begin{cases} \Gamma_1^0, i \Gamma_3, \Gamma_0^1, -i \Gamma_2; \quad \text{P-DNL}\(_{XR}\); \\ \end{cases} \\
T; \ \Gamma A; & \quad C_{2h}, \sigma_y, IT; \quad \{R_5, R_8\}; \quad \begin{cases} \Gamma_1^0, i \Gamma_3, \Gamma_0^1, -i \Gamma_2; \quad \text{P-DNL}\(_{XR}\); \\ \end{cases} \\
W; \ \Gamma R; & \quad C_{2h}, \sigma_y, IT; \quad \{R_5, R_8\}; \quad \begin{cases} \Gamma_1^0, i \Gamma_3, \Gamma_0^1, -i \Gamma_2; \quad \text{P-DNL}\(_{XR}\); \\ \end{cases} \\
\end{align*}
SG 130

\[ \{ C_{4z}^+ | 000 \}, \{ C_{2z} | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ I | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, T \}; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; (000); \]

\[ C_{4z}^+, C_{2z}, I, T; \]

\[
R_6; \quad 2; \quad \frac{q_0 + i q_2}{\sqrt{2}}, i \sigma_1, \sigma_0, -i \sigma_2; \]

\[
R_7; \quad 2; \quad -\frac{q_0 + i q_2}{\sqrt{2}}, i \sigma_1, \sigma_0, -i \sigma_2; \]

\[
R_{13}; \quad 2; \quad \frac{2q_0 + i q_2}{\sqrt{2}}, i \sigma_1, -\sigma_0, -i \sigma_2; \]

\[
R_{14}; \quad 2; \quad -\frac{2q_0 + i q_2}{\sqrt{2}}, i \sigma_1, -\sigma_0, -i \sigma_2; \]

\[ M; (\frac{1}{2} \frac{1}{2} 0); \]

\[ C_{4z}^+, C_{2z}, \sigma_z, T; \]

\[
R_{19}; \quad 4; \quad -\frac{\Gamma_0 + i \Gamma_3}{\sqrt{2}}, \Gamma_{1,2}, i \Gamma_{0,3}, -i \Gamma_{3,2}; \]

\[ P-\text{DNL}_{MA}; \]

\[ Z; (00 \frac{1}{2}); \]

\[ I, \sigma_z, C_{4z}^+, T; \]

\[
\{ R_{19}, R_{20} \}; \quad 4; \quad \Gamma_{3,2}, \Gamma_{0,3}, \frac{\Gamma_0 + i \Delta_2}{\sqrt{2}}, i \Gamma_{2,0}; \]

\[
\{ R_{21}, R_{22} \}; \quad 4; \quad \Gamma_{3,2}, \Gamma_{0,3}, -\frac{\Gamma_0 + i \Delta_2}{\sqrt{2}}, -i \Gamma_{2,0}; \]

\[ \text{DP}; \quad 0 \]

\[ A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \]

\[ C_{4z}^+, \sigma_z, I, T; \]

\[
\{ R_{19}, R_{19} \}; \quad 8; \quad \frac{Q_{0,3} + i Q_{0,3}}{\sqrt{2}}, \frac{Q_{0,2,1} + Q_{0,2,3}}{\sqrt{2}}, Q_{0,1,0}, i Q_{2,1,0}; \]

\[ \text{OP}; \quad 0 \]

\[ R; (0 \frac{1}{2} \frac{1}{2}); \]

\[ C_{2z}, \sigma_y, I, T; \]

\[
\{ R_{9}, R_{9} \}; \quad 4; \quad i \Gamma_{0,2}, \Gamma_{0,3}, \Gamma_{0,3}, \Gamma_{2,0}; \]

\[
\{ R_{10}, R_{10} \}; \quad 4; \quad i \Gamma_{0,2}, \Gamma_{0,3}, -\Gamma_{0,3}, i \Gamma_{2,0}; \]

\[ \text{P-DNL}_{S}; \]

\[ X; (0 \frac{1}{2} 0); \]

\[ C_{2y}, C_{2z}, I, T; \]

\[
\{ R_{13}, R_{14} \}; \quad 4; \quad \Gamma_{0,1}, i \Gamma_{3,0}, \Gamma_{0,3}, -i \Gamma_{2,0}; \]

\[ \text{P-DNL}_{XR}; \]

\[ \Delta; \quad \Gamma_X; \]

\[ C_{2y}, \sigma_x, I, T; \]

\[
R_{5}; \quad 2; \quad i \sigma_2, i \sigma_1, -i \sigma_2; \]

\[ \Upsilon; \quad \Gamma_Z; \]

\[ \sigma_z, C_{2y}, I, T; \]

\[
\{ R_{5}, R_{8} \}; \quad 2; \quad i \sigma_3, i \sigma_0, -i \sigma_2; \]

\[
\{ R_{6}, R_{7} \}; \quad 2; \quad i \sigma_3, -i \sigma_0, -i \sigma_2; \]

\[ \Lambda; \quad \Gamma_Z; \]

\[ C_{4z}^+, \sigma_y, I, T; \]

\[
R_6; \quad 2; \quad \frac{q_0 + i q_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \]

\[
R_7; \quad 2; \quad -\frac{2q_0 + i q_2}{\sqrt{2}}, i \sigma_1, -i \sigma_2; \]

\[ \nu; \quad \eta; \]

\[ C_{2y}, \sigma_z, I, T; \]

\[
R_6, R_7; \quad 4; \quad \frac{\Gamma_0 + i \Gamma_3}{\sqrt{2}}, i \Gamma_{0,1}, -i \Gamma_{2,0}; \]

\[ \text{DNL}; \quad 0 \]

\[ \Sigma; \quad \Gamma_M; \]

\[ C_{2z}, \sigma_z, I, T; \]

\[
R_5; \quad 2; \quad i \sigma_2, i \sigma_1, -i \sigma_2; \]

\[ S; \quad \eta; \]

\[ \sigma_z, C_{2y}, I, T; \]

\[
\{ R_5, R_8 \}; \quad 2; \quad i \sigma_3, i \sigma_0, -i \sigma_2; \]

\[
\{ R_6, R_7 \}; \quad 2; \quad i \sigma_3, -i \sigma_0, -i \sigma_2; \]

\[ \Upsilon; \quad \eta; \]

\[ C_{2z}, \sigma_y, I, T; \]

\[
\{ R_5, R_8 \}; \quad 2; \quad i \sigma_3, i \sigma_0, -i \sigma_2; \]

\[
\{ R_6, R_7 \}; \quad 2; \quad i \sigma_3, -i \sigma_0, -i \sigma_2; \]

\[ T; \quad \varphi; \]

\[ \sigma_y, \sigma_z, I, T; \]

\[
\{ R_9, R_9 \}; \quad 4; \quad \Gamma_{0,3}, -\Gamma_{0,1}, -\Gamma_{2,3}; \]

\[ \text{DNL}; \quad 0 \]

\[ W; \quad \eta; \]

\[ C_{2z}, \sigma_y, I, T; \]

\[
\{ R_5, R_5 \}; \quad 4; \quad i \Gamma_{0,2}, i \Gamma_{0,1}, -i \Gamma_{2,1}; \]

\[ \text{DNL}; \quad 0 \]
SG 131

$\Gamma_q; \{C_{4z}^+|000\}, \{C_{2x}|000\}, \{I|000\}, T; \text{Centrosymmetric; with SOC}$

$\Gamma; (000); C_{4z}^+, C_{2x}, I, T; \quad R_6; 2; \frac{\alpha_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2$;
$R_7; 2; -\frac{\alpha_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2$;
$R_{13}; 2; \frac{\alpha_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$;
$R_{14}; 2; -\frac{\alpha_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$;

$M; (\frac{1}{2} \frac{1}{2} 0); C_{4z}^+, C_{2x}, I, T; \quad R_6; 2; \frac{\alpha_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2$;
$R_7; 2; -\frac{\alpha_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2$;
$R_{13}; 2; \frac{\alpha_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$;
$R_{14}; 2; -\frac{\alpha_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$;

$Z; (00 \frac{1}{2}); C_{4z}^+, \sigma_{y6}, C_{2b}, T; \quad R_{19}; 4; \frac{\Gamma_{1,2,3,4}}{-\sqrt{2}}, \Gamma_{1,2,3,4}, -i\Gamma_{1,2,3,4}; \text{DP}; 0$

$A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{4z}^+, \sigma_{y6}, C_{2b}, T; \quad R_{19}; 4; \frac{\Gamma_{1,2,3,4}}{-\sqrt{2}}, \Gamma_{1,2,3,4}, -i\Gamma_{1,2,3,4}; \text{DP}; 0$

$R; (0 \frac{1}{2} \frac{1}{2}); C_{2x}, C_{2y}, I, T; \quad R_5; 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2$;
$R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2$;

$X; (0 \frac{1}{2} 0); C_{2x}, C_{2y}, I, T; \quad R_5; 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2$;
$R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2$;

$\Delta; \Gamma X; \quad C_{2y}, \sigma_x, IT; \quad R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2$;

$U; \Gamma Z; \quad C_{2y}, \sigma_x, IT; \quad R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2$;

$\Lambda; \Gamma Z; \quad C_{4z}^+, \sigma_y, IT; \quad R_6; 2; \frac{\alpha_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2$;
$R_7; 2; -\frac{\alpha_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2$;

$V; \Gamma A; \quad C_{4z}^+, \sigma_y, IT; \quad R_6; 2; \frac{\alpha_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2$;
$R_7; 2; -\frac{\alpha_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2$;

$\Upsilon; \Gamma M; \quad C_{2x}, \sigma_z, IT; \quad R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2$;

$S; \Gamma A; \quad C_{2x}, \sigma_z, IT; \quad \{R_5, R_6\}; 2; i\sigma_0, i\sigma_3, -i\sigma_2$;
$\{R_7, R_8\}; 2; -i\sigma_0, -i\sigma_3, -i\sigma_2$;

$Y; \Gamma M; \quad C_{2x}, \sigma_z, IT; \quad R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2$;

$T; \Gamma A; \quad C_{2x}, \sigma_z, IT; \quad R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2$;

$W; \Gamma R; \quad C_{2x}, \sigma_y, IT; \quad R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2$;
Centrosymmetric; with SOC

\[ \Gamma; (000); C_{4v}^+, C_{2v}, I, T; \]
\[ \begin{align*}
R_6; & 2; \gamma_{0+\bar{0}2}, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_7; & 2; -\gamma_{0-\bar{0}2}, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{13}; & 2; 2\gamma_{0+\bar{0}2}, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_{14}; & 2; -2\gamma_{0-\bar{0}2}, i\sigma_1, -\sigma_0, -i\sigma_2;
\end{align*} \]

\[ M; (110); C_{4v}^+, C_{2v}, I, T; \]
\[ \begin{align*}
R_6; & 2; \gamma_{0+\bar{0}2}, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_7; & 2; -\gamma_{0-\bar{0}2}, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{13}; & 2; 2\gamma_{0+\bar{0}2}, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_{14}; & 2; -2\gamma_{0-\bar{0}2}, i\sigma_1, -\sigma_0, -i\sigma_2;
\end{align*} \]

\[ Z; (00\frac{1}{2}); C_{4v}^+, \sigma_z, C_{2v}, T; \]
\[ R_{19}; 4; -\frac{\Gamma_{3,0} - i\Gamma_{3,1}}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3}, -i\Gamma_{3,2}; \text{ DP; 0} \]

\[ A; (\frac{1}{2}, \frac{1}{2}); C_{4v}^+, \sigma_z, C_{2v}, T; \]
\[ R_{19}; 4; -\frac{\Gamma_{3,0} - i\Gamma_{3,1}}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3}, -i\Gamma_{3,2}; \text{ DP; 0} \]

\[ R; (0\frac{1}{2})_2; \sigma_z, \sigma_z, I, T; \]
\[ \{R_{13}, R_{14}\}; 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \text{ DP; 0} \]

\[ X; (0\frac{1}{2})_0; C_{2v}, C_{2v}, I, T; \]
\[ R_5; 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_6; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
\]
Γ; \{C_{4z}^{+}[\frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}], \{C_{2x}[000], \{I\frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}\} \}, T; Centrosymmetric; with SOC

Γ; (000); \quad C_{4z}^{+}, C_{2x}, I, T; \quad \begin{align*}
R_6 &; \quad 2; \quad \frac{\gamma_{0.4+i\sigma_2}}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_7 &; \quad 2; \quad -\frac{\gamma_{0.4-i\sigma_2}}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_13 &; \quad 2; \quad \frac{\gamma_{0.4+i\sigma_2}}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_14 &; \quad 2; \quad -\frac{\gamma_{0.4-i\sigma_2}}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \\
M; (\frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad C_{4z}^{+}, \sigma_x, C_{2x}, T; \quad \begin{align*}
R_{19} &; \quad 4; \quad \frac{\Gamma_{1.0-i\Gamma_3.1}}{\sqrt{2}}, \Gamma_{1.2}, \Gamma_{0.3}, -i\Gamma_{3.2}; \quad \text{DP; 0} \\
R_{19} &; \quad 4; \quad \frac{\Gamma_{1.0-i\Gamma_3.1}}{\sqrt{2}}, \Gamma_{1.2}, \Gamma_{0.3}, -i\Gamma_{3.2}; \quad \text{DP; 0} \\
Z; (00 \frac{1}{2}); \quad C_{4z}^{+}, \sigma_{db}, C_{2b}, T; \quad \begin{align*}
R_{19} &; \quad 4; \quad \frac{\Gamma_{1.0-i\Gamma_3.1}}{\sqrt{2}}, \Gamma_{1.2}, \Gamma_{0.3}, -i\Gamma_{3.2}; \quad \text{DP; 0} \\
R_{19} &; \quad 4; \quad \frac{\Gamma_{1.0-i\Gamma_3.1}}{\sqrt{2}}, \Gamma_{1.2}, \Gamma_{0.3}, -i\Gamma_{3.2}; \quad \text{DP; 0} \\
A; (\frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad I, \sigma_x, C_{4z}^{+}, T; \quad \begin{align*}
\{R_{19}, R_{20}\} &; \quad 4; \quad \Gamma_{1.2}, \Gamma_{0.3}, \frac{\Gamma_{0.4+i\Gamma_2.0}}{\sqrt{2}}, -i\Gamma_{2.0}; \quad \text{DP; 0} \\
\{R_{21}, R_{22}\} &; \quad 4; \quad \Gamma_{1.2}, \Gamma_{0.3}, \frac{\Gamma_{0.4+i\Gamma_2.0}}{\sqrt{2}}, -i\Gamma_{2.0}; \quad \text{DP; 0} \\
R; (0 \frac{1}{2} \frac{1}{2}); \quad \sigma_x, \sigma_y, I, T; \quad \begin{align*}
\{R_{13}, R_{14}\} &; \quad 4; \quad \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \quad \text{DP; 0} \\
\{R_{13}, R_{14}\} &; \quad 4; \quad \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \quad \text{DP; 0} \\
X; (0 \frac{1}{2} 0); \quad \sigma_x, \sigma_y, I, T; \quad \begin{align*}
\{R_{13}, R_{14}\} &; \quad 4; \quad \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \quad \text{DP; 0} \\
\{R_{13}, R_{14}\} &; \quad 4; \quad \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \quad \text{DP; 0} \\
\Delta; \quad \Gamma_X; \quad C_{2y}, \sigma_x, I, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \\
U; \quad \Gamma_Z; \quad C_{2y}, \sigma_x, I, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \\
\Lambda; \quad \Gamma_Z; \quad C_{4z}^{+}, \sigma_y, I, T; \quad R_6; \quad 2; \quad \frac{\gamma_{0.4+i\sigma_2}}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \\
\Lambda; \quad \Gamma_Z; \quad C_{4z}^{+}, \sigma_y, I, T; \quad R_6; \quad 2; \quad \frac{\gamma_{0.4+i\sigma_2}}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \\
V; \quad \Gamma_A; \quad C_{4z}^{+}, \sigma_x, I, T; \quad R_6; \quad 2; \quad -\frac{\gamma_{0.4-i\sigma_2}}{\sqrt{2}}, -\sigma_3, -i\sigma_2; \\
R_7; \quad 2; \quad -\frac{\gamma_{0.4-i\sigma_2}}{\sqrt{2}}, -\sigma_3, -i\sigma_2; \\
\Sigma; \quad \Gamma_M; \quad C_{2x}, \sigma_z, I, T; \quad R_5; \quad 2; \quad i\sigma_2, i\sigma_1, -i\sigma_2; \\
S; \quad \Gamma_A; \quad C_{2x}, \sigma_z, I, T; \quad \{R_5, R_6\} \quad 2; \quad i\sigma_0, i\sigma_3, -i\sigma_2; \\
\{R_7, R_8\} \quad 2; \quad -i\sigma_0, -i\sigma_3, -i\sigma_2; \\
Y; \quad \Gamma_X; \quad \sigma_y, C_{2x}, IT; \quad \{R_5, R_8\} \quad 2; \quad i\sigma_3, i\sigma_0, -i\sigma_2; \\
\{R_6, R_7\} \quad 2; \quad i\sigma_3, -i\sigma_0, -i\sigma_2; \\
T; \quad \Gamma_A; \quad \sigma_y, C_{2z}, IT; \quad \{R_5, R_8\} \quad 2; \quad i\sigma_3, i\sigma_0, -i\sigma_2; \\
\{R_6, R_7\} \quad 2; \quad i\sigma_3, -i\sigma_0, -i\sigma_2; \\
W; \quad \Gamma_X; \quad \sigma_y, C_{2z}, IT; \quad \{R_5, R_8\} \quad 2; \quad i\sigma_3, i\sigma_0, -i\sigma_2; \\
\{R_6, R_7\} \quad 2; \quad i\sigma_3, -i\sigma_0, -i\sigma_2; \\

\(\Gamma_q; \{C_{4z}^+|\frac{1}{2} \frac{1}{2} \frac{1}{2}\}, \{C_{2z}|000\}, \{I|\frac{1}{2} \frac{1}{2} \frac{1}{2}\}\); Centrosymmetric; with SOC

\[\Gamma; (000); C_{4z}^+, C_{2z}, I, T; R_6; 2; \frac{a_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2;\]

\[R_7; 2; -\frac{a_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2;\]

\[R_{13}; 2; \frac{a_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2;\]

\[R_{14}; 2; -\frac{a_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2;\]

\[M; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{4z}^+, \sigma_x, C_{2z}, T; R_{19}; 4; \frac{\Gamma_1 + \Gamma_3}{\sqrt{2}}, \Gamma_1, 2, \Gamma_0, 3, -i\Gamma_3, 2; DP; 0\]

\[Z; (00\frac{1}{2}); C_{4z}^+, \sigma_x, C_{2z}, T; R_{19}; 4; \frac{\Gamma_1 + \Gamma_3}{\sqrt{2}}, \Gamma_1, 2, \Gamma_0, 3, -i\Gamma_3, 2; DP; 0\]

\[A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{4z}^+, C_{2z}, I, T; R_6; 2; \frac{a_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2;\]

\[R_7; 2; -\frac{a_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2;\]

\[R_{13}; 2; \frac{a_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2;\]

\[R_{14}; 2; -\frac{a_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2;\]

\[R; (0 \frac{1}{2} \frac{1}{2}); \sigma_y, \sigma_x, I, T; \{R_{13}, R_{14}\}; 4; \Gamma_0, 1, i\Gamma_3, 0, \Gamma_0, 3, -i\Gamma_2, 0; DP; 0\]

\[X; (0 \frac{1}{2} \frac{1}{2}); \sigma_x, \sigma_y, I, T; \{R_{13}, R_{14}\}; 4; \Gamma_0, 1, i\Gamma_3, 0, \Gamma_0, 3, -i\Gamma_2, 0; DP; 0\]

\[\Delta; \Gamma X; C_{2y}, \sigma_x, I, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2;\]

\[U; \Gamma Z; \sigma_x, C_{2y}, I, T; \{R_5, R_8\}; 2; i\sigma_3, i\sigma_0, -i\sigma_2;\]

\[\{R_6, R_7\}; 2; i\sigma_3, -i\sigma_0, -i\sigma_2;\]

\[\Lambda; \Gamma Z; C_{4z}^+, \sigma_y, I, T; R_6; 2; \frac{a_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2;\]

\[R_7; 2; -\frac{a_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2;\]

\[V; \Gamma A; C_{4z}^+, \sigma_x, I, T; R_6; 2; \frac{a_0 + i\sigma_2}{\sqrt{2}}, -\sigma_3, -i\sigma_2;\]

\[R_7; 2; \frac{a_0 - i\sigma_2}{\sqrt{2}}, -\sigma_3, -i\sigma_2;\]

\[\Sigma; \Gamma M; \sigma_{2z}, \sigma_z, I, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2;\]

\[S; \Gamma A; \sigma_{4z}, \sigma_{2z}, I, T; R_5; 2; i\sigma_3, -i\sigma_1, -i\sigma_2;\]

\[Y; \Gamma M; \sigma_y, C_{2z}, I, T; \{R_5, R_8\}; 2; i\sigma_3, i\sigma_0, -i\sigma_2;\]

\[\{R_6, R_7\}; 2; i\sigma_3, -i\sigma_0, -i\sigma_2;\]

\[T; \Gamma A; C_{2z}, \sigma_{2z}, I, T; R_5; 2; i\sigma_3, i\sigma_0, -i\sigma_2;\]

\[W; \Gamma M; \sigma_y, C_{2z}, I, T; \{R_5, R_8\}; 2; i\sigma_3, i\sigma_0, -i\sigma_2;\]

\[\{R_6, R_7\}; 2; i\sigma_3, -i\sigma_0, -i\sigma_2;\]
\[ \Gamma; \{ C_{4v}^+ (1 1 1), \{ C_{2v}^+ (1 1 1)\}, \{ I[000]\}, \mathcal{T}; \text{Centrosymmetric with SOC} \]

\[ \Gamma; (000); \quad C_{4v}^+, C_{2v}, I, \mathcal{T}; \quad R_6; \quad 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \Gamma_0, \sigma_0, -i\sigma_2; \]

\[ R_7; \quad 2; \frac{-\sigma_0 + i\sigma_2}{\sqrt{2}}, \Gamma_0, \sigma_0, -i\sigma_2; \]

\[ R_{13}; \quad 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \Gamma_1, -\sigma_0, -i\sigma_2; \]

\[ R_{14}; \quad 2; \frac{-\sigma_0 + i\sigma_2}{\sqrt{2}}, \Gamma_1, -\sigma_0, -i\sigma_2; \]

\[ M; (1 1 1 0); \quad C_{4v}^+, C_{2v}, I, \mathcal{T}; \quad \{ R_6, R_7 \}; \quad 4; \frac{\Gamma_{0,1} + i\Gamma_{0,3}}{\sqrt{2}}, \Gamma_0, -\Gamma_0, -i\Gamma_2, i\Gamma_0; \quad \text{P-DNLs}; \]

\[ \{ R_{20}, R_{21} \}; \quad 4; \frac{\Gamma_{0,1} + i\Gamma_{0,3}}{\sqrt{2}}, \Gamma_0, -\Gamma_0, -i\Gamma_2, -i\Gamma_0; \quad \text{P-DNLs}; \]

\[ Z; (0 0 \frac{1}{2}); \quad C_{4v}^+, \sigma_{d_2}, C_{2v}, \mathcal{T}; \quad R_{19}; \quad 4; \frac{\Gamma_{0,1} - i\Gamma_{0,3}}{\sqrt{2}}, \Gamma_1, i\Gamma_0, -i\Gamma_2, 2; \quad \text{DP}; \quad 0 \]

\[ A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \quad C_{4v}^+, \sigma_{d_2}, I, \mathcal{T}; \quad \{ R_{19}, R_{19} \}; \quad 8; \frac{\Gamma_{0,1} - i\Gamma_{0,3}}{\sqrt{2}}, \Gamma_1, i\Gamma_0, -i\Gamma_2, -i\Gamma_0; \quad \text{OP}; \quad 0 \]

\[ R; (0 \frac{1}{2} \frac{1}{2}); \quad \sigma_{x}, C_{2v}, I, \mathcal{T}; \quad \{ R_{13}, R_{14} \}; \quad 4; \Gamma_{0,1}, i\Gamma_{0,3}, -i\Gamma_2, 0; \quad \text{P-DNL}_{\text{RA}}; \]

\[ X; (0 \frac{1}{2} 0); \quad \sigma_{x}, C_{2v}, I, \mathcal{T}; \quad \{ R_{13}, R_{14} \}; \quad 4; \Gamma_{0,1}, i\Gamma_{0,3}, -i\Gamma_2, 0; \quad \text{P-DNL}_{\text{XM}}; \]

\[ \Delta; \quad \Gamma_{X}; \quad C_{2y}, \sigma_{x, I}; \quad R_5; \quad 2; \sigma_2, \sigma_1, -i\sigma_2; \]

\[ U; \quad ZR; \quad C_{2y}, \sigma_{x, IT}; \quad R_5; \quad 2; \sigma_2, \sigma_1, -i\sigma_2; \]

\[ \Lambda; \quad \Gamma_{Z}; \quad C_{4v}^+, \sigma_{y}, I, \mathcal{T}; \quad R_6; \quad 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \Gamma_1, -\sigma_0, -i\sigma_2; \]

\[ R_7; \quad 2; \frac{-\sigma_0 + i\sigma_2}{\sqrt{2}}, \Gamma_1, -\sigma_0, -i\sigma_2; \]

\[ V; \quad MA; \quad C_{4v}^+, \sigma_{x, IT}; \quad \{ R_6, R_7 \}; \quad 4; \frac{\Gamma_{0,1} - i\Gamma_{0,3}}{\sqrt{2}}, -\Gamma_0, -i\Gamma_2, 0; \quad \text{DNL}; \quad 0 \]

\[ \Sigma; \quad \Gamma_{M}; \quad C_{2y}, \sigma_{z, IT}; \quad R_5; \quad 2; \sigma_2, \sigma_1, -i\sigma_2; \]

\[ S; \quad ZA; \quad C_{2y}, \sigma_{z, IT}; \quad \{ R_5, R_0 \}; \quad 2; \sigma_0, \sigma_3, -i\sigma_2; \]

\[ \{ R_7, R_8 \}; \quad 2; -\sigma_0, -\sigma_3, -i\sigma_2; \]

\[ Y; \quad XM; \quad \sigma_{x}, C_{2v}, I, \mathcal{T}; \quad \{ R_9, R_0 \}; \quad 4; \Gamma_0, -\Gamma_0, -i\Gamma_2; \quad \text{DNL}; \quad 0 \]

\[ T; \quad RA; \quad \sigma_{x}, C_{2v}, I, \mathcal{T}; \quad \{ R_9, R_0 \}; \quad 4; \Gamma_0, -\Gamma_0, -i\Gamma_2; \quad \text{DNL}; \quad 0 \]

\[ W; \quad XR; \quad \sigma_{y}, C_{2v}, I, \mathcal{T}; \quad \{ R_5, R_6 \}; \quad 2; \sigma_0, i\sigma_3, -i\sigma_2; \]

\[ \{ R_7, R_8 \}; \quad 2; -\sigma_0, -i\sigma_3, -i\sigma_2; \]
\[ \Gamma; \{ C_{4s}^+ \}, \{ C_{2s} \}, \{ 000 \}, \mathcal{T}; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; (000): C_{4s}^+ C_{2s}, \mathcal{T}; \]
\[
\begin{align*}
R_6; & \quad 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_7; & \quad 2; \frac{-\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{13}; & \quad 2; \frac{2\sigma_1 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_{14}; & \quad 2; \frac{-2\sigma_1 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \\
\end{align*}
\]

\[ M; \{ \frac{1}{2} \}; C_{4s}^+ C_{2s}, \mathcal{T}; \]
\[
\{ R_6, R_7 \}; \quad 4; \frac{\Gamma_{0,3} + i\Gamma_{2,0}}{\sqrt{2}}, \Gamma_{0,3}, \Gamma_{0,0}, -i\Gamma_{2,0}; \quad \text{P-DNLs}; \\
\{ R_{20}, R_{21} \}; \quad 4; \frac{\Gamma_{0,3} + i\Gamma_{2,0}}{\sqrt{2}}, \Gamma_{0,3}, -\Gamma_{0,0}, -i\Gamma_{2,0}; \quad \text{P-DNLs}; \\
\]

\[ Z; (00\frac{1}{2}): C_{4s}^+ \sigma_2, \mathcal{T}; \]
\[
\{ R_{19} \}; \quad 4; \frac{\Gamma_{1,2} - i\Gamma_{3,0}}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3}, -i\Gamma_{3,2}; \quad \text{DP}; \quad 0 \\
\]

\[ A; \{ \frac{1}{2} \}; C_{4s}^+ C_{2s}, \mathcal{T}; \]
\[
\{ R_{19}; R_{20} \}; \quad 4; \frac{\Gamma_{1,2} - i\Gamma_{3,0}}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3}, -i\Gamma_{3,2}; \quad \text{P-DNL}_{MA}; \\
\]

\[ R; (0\frac{1}{2})_0: C_{2y}, \mathcal{T}; \]
\[
\{ R_5, R_6 \}; \quad 2; -\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2; \\
\{ R_7, R_8 \}; \quad 2; \sigma_0, -i\sigma_3, \sigma_0, -i\sigma_2; \\
\{ R_{15}, R_{16} \}; \quad 2; -\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2; \\
\{ R_{17}, R_{18} \}; \quad 2; \sigma_0, -i\sigma_3, -\sigma_0, -i\sigma_2; \\
\]

\[ X; (0\frac{1}{2}); \sigma_2, \mathcal{T}; \]
\[
\{ R_{13}, R_{14} \}; \quad 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \quad \text{P-DNL}_{XM}; \\
\]

\[ \Delta; \Gamma X; \]
\[
\{ R_5 \}; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
\]

\[ U; \Gamma R; \]
\[
\{ R_5, R_8 \}; \quad 2; i\sigma_3, i\sigma_0, -i\sigma_2; \\
\]

\[ \Lambda; \Gamma Z; \]
\[
\{ R_6, R_7 \}; \quad 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \\
\]

\[ V; \Gamma A; \]
\[
\{ R_6, R_7 \}; \quad 4; \frac{\Gamma_{0,1} + i\Gamma_{3,0}}{\sqrt{2}}, \Gamma_{0,3}, -i\Gamma_{2,0}; \quad \text{DNL}; \quad 0 \\
\]

\[ \Sigma; \Gamma M; \]
\[
\{ R_5 \}; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
\]

\[ S; \Gamma A; \]
\[
\{ R_6, R_7 \}; \quad 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \\
\]

\[ Y; \Gamma X; \]
\[
\{ R_5, R_6 \}; \quad 4; i\Gamma_{0,3}, -i\Gamma_{0,1}, -i\Gamma_{2,1}; \quad \text{DNL}; \quad 0 \\
\]

\[ T; \Gamma A; \]
\[
\{ R_6, R_9 \}; \quad 2; -i\sigma_3, -i\sigma_3, -\sigma_0, -i\sigma_2; \\
\{ R_7, R_8 \}; \quad 2; -i\sigma_3, i\sigma_3, -\sigma_0, -i\sigma_2; \\
\]

\[ W; \Gamma R; \]
\[
\{ R_5, R_6 \}; \quad 2; i\sigma_0, i\sigma_3, -i\sigma_2; \\
\{ R_7, R_8 \}; \quad 2; -i\sigma_0, -i\sigma_3, -i\sigma_2; \\
\]
$\Gamma_q; \{C^{+}_{4v}[000]\}, \{C_{2v}[\frac{1}{2} \frac{1}{2} 0]\}, \{I[\frac{1}{2} \frac{1}{2} 0]\}, T;$ Centrosymmetric; with SOC

$\Gamma; (000); \\{ C^{+}_{4v}, C_{2v}, I, T; \}:
\begin{align*}
R_6 & : 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_1, \sigma_0, -i\sigma_2; \\
R_7 & : 2; \frac{-\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_1, \sigma_0, -i\sigma_2; \\
R_{13} & : 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_1, -\sigma_0, -i\sigma_2; \\
R_{14} & : 2; \frac{-\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_1, -\sigma_0, -i\sigma_2; \\
\end{align*}$

$M; (\frac{1}{2} \frac{1}{2} 0); \\{ C^{+}_{4v}, C_{2v}, \sigma_z, T; \}:
\begin{align*}
R_{19} & : 4; \frac{\Gamma_3, \sigma_z - \Gamma_3}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3} , -i\Gamma_{3,2}; \ P-DNL_{MA}; \\
\end{align*}$

$Z; (00 \frac{1}{2}); \\{ C^{+}_{4v}, \sigma_{db}, C_{2v}, T; \}:
\begin{align*}
R_{19} & : 4; \frac{\Gamma_3, \sigma_z - \Gamma_3}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3} , -i\Gamma_{3,2}; \ P-DNL_{MA}; \\
\end{align*}$

$A; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); I, \sigma_{db}, S^{+}_{4v}, T; \{ R_{19}, R_{20} \}:
\begin{align*}
R_{19} & : 4; \frac{\Gamma_3, \sigma_z - \Gamma_3}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3} , -i\Gamma_{3,2}; \ P-DNL_{MA}; \\
\end{align*}$

$R; (0 \frac{1}{2} \frac{1}{2}); \\{ C_{2y}, C_{2x}, I, T; \}:
\begin{align*}
R_{13} & : 4; \Gamma_{0,1}, i\Gamma_{3,0} , \Gamma_{0,3} , -i\Gamma_{2,0}; \ P-DNL_{XR}; \\
\end{align*}$

$X; (0 \frac{1}{2} 0); \\{ C_{2y}, C_{2x}, I, T; \}:
\begin{align*}
R_{13} & : 4; \Gamma_{0,1}, i\Gamma_{3,0} , \Gamma_{0,3} , -i\Gamma_{2,0}; \ P-DNL_{XR}; \\
\end{align*}$

$\Delta; \Gamma X; \\{ C_{2y}, \sigma_z, I, T; \}:
\begin{align*}
R_5 & : 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
\end{align*}$

$U; \ ZR; \\{ C_{2y}, \sigma_z, I, T; \}:
\begin{align*}
R_5 & : 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
\end{align*}$

$\Lambda; \ \Gamma Z; \\{ C^{+}_{4v}, \sigma_y, I, T; \}:
\begin{align*}
R_6 & : 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \\
R_7 & : 2; \frac{-\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \\
\end{align*}$

$V; \ MA; \\{ C^{+}_{4v}, \sigma_y, I, T; \}:
\begin{align*}
R_6, R_7 & : 4; \frac{\Gamma_3, \sigma_z + \Gamma_3}{\sqrt{2}}, i\Gamma_{0,1} , -i\Gamma_{2,0}; \ DNL; \ 0 \\
\end{align*}$

$\Sigma; \ \Gamma M; \\{ C_{2a}, \sigma_z, I, T; \}:
\begin{align*}
R_5 & : 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
\end{align*}$

$S; \ ZA; \\{ C_{2a}, \sigma_z, I, T; \}:
\begin{align*}
R_5, R_6 & : 2; i\sigma_0, i\sigma_3, -i\sigma_2; \\
R_7, R_8 & : 2; -i\sigma_0, -i\sigma_3, -i\sigma_2; \\
\end{align*}$

$Y; \ XM; \\{ C_{2x}, \sigma_z, I, T; \}:
\begin{align*}
R_5, R_7 & : 2; i\sigma_3, \sigma_3, -i\sigma_2; \\
R_6, R_8 & : 2; i\sigma_3, -\sigma_3, -i\sigma_2; \\
\end{align*}$

$T; \ RA; \\{ C_{2x}, \sigma_z, I, T; \}:
\begin{align*}
R_5, R_7 & : 2; i\sigma_3, \sigma_3, -i\sigma_2; \\
R_6, R_8 & : 2; i\sigma_3, -\sigma_3, -i\sigma_2; \\
\end{align*}$

$W; \ X R; \\{ C_{2x}, \sigma_y, I, T; \}:
\begin{align*}
R_5, R_6 & : 4; i\Gamma_{0,2}, i\Gamma_{0,1}, -\Gamma_{2,1}; \ DNL; \ 0 \\
\end{align*}$
$\Gamma$: (000); $C_{4z}^+|00\rangle_2$, $C_{2z}|\frac{1}{2}\rangle_2$, $\{I|\frac{1}{2}\frac{1}{2}\}$, $\mathcal{T}$; Centrosymmetric; with SOC

$\Gamma$: (000); $C_{4z}^+C_{2z}.I,\mathcal{T}$; $R_6$; 2: $\frac{a_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2$;
$R_7$; 2: $-\frac{a_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2$;
$R_{13}$; 2: $\frac{2a_1+i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$;
$R_{14}$; 2: $-\frac{2a_1+i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2$;

$M$: (110); $C_{4z}^+C_{2z}.\sigma_x,\mathcal{T}$; $R_{19}$; 4: $\Gamma_{0.0}+i\Gamma_{3.3}$, $\Gamma_{1.2}, i\Gamma_{0.3}, -i\Gamma_{3.2}$; P-DNLMA ;

$A$: (111); $C_{4z}^+C_{2z}.I,\mathcal{T}$; $\{R_6, R_7\}$; 4: $\Gamma_{0.0}+i\Gamma_{3.3}$, $\Gamma_{1.2}, i\Gamma_{0.3}, -i\Gamma_{3.2}; DP$; 0

$R$: (012); $C_{2z}.\sigma_y,\mathcal{T}$; $\{R_9, R_9\}$; 4: $i\Gamma_{0.2}, \Gamma_{0.3}, \Gamma_{0.3}, i\Gamma_{0.2}$; P-DNLs;
$\{R_{20}, R_{21}\}$; 4: $i\Gamma_{0.1}+i\Gamma_{3.3}$, $\Gamma_{0.3}, \Gamma_{0.3}, -i\Gamma_{2.0}$; P-DNLs;

$X$: (010); $C_{2y}C_{2z}.I,\mathcal{T}$; $\{R_{13}, R_{14}\}$; 4: $\Gamma_{0.1}, i\Gamma_{3.3}, \Gamma_{0.3}, -i\Gamma_{2.0}$; P-DNLXR ;

$\Delta$: $\mathcal{G}X$; $C_{2y}.\sigma_x,\mathcal{I}$; $R_5$; 2: $i\sigma_2, i\sigma_1, -i\sigma_2$;

$V$: $\mathcal{M}A$; $C_{4z}^+\sigma_y,\mathcal{T}$; $\{R_6, R_7\}$; 4: $\Gamma_{0.0}+i\Gamma_{3.3}, i\Gamma_{0.1}, -i\Gamma_{2.0}$; DNL; 0

$\Sigma$: $\mathcal{G}M$; $C_{2a}.\sigma_z,\mathcal{I}$; $R_5$; 2: $i\sigma_2, i\sigma_1, -i\sigma_2$;

$T$: $\mathcal{R}A$; $\sigma_y,\sigma_z,\mathcal{I}$; $\{R_9, R_9\}$; 4: $\Gamma_{0.3}, -\Gamma_{0.1}, -\Gamma_{2.3}$; DNL; 0

$W$: $\mathcal{X}R$; $C_{2z}.\sigma_y,\mathcal{T}$; $\{R_5, R_5\}$; 4: $i\Gamma_{0.2}, i\Gamma_{0.1}, -\Gamma_{2.1}$; DNL; 0
Γ': \{C_{4h}^{1}{000}\}, \{C_{2v}{000}\}, \{I{000}\}, \mathcal{T}; Centrosymmetric; with SOC

\Gamma; (000); \ C_{4h}^{1}, C_{2v}, I, \mathcal{T} \ R_{6}; \ 2; \ \frac{\zeta_{1}}{\sqrt{2}}, \ i \sigma_{1}, \sigma_{0}, -i \sigma_{2}; \\
\ R_{7}; \ 2; \ -\frac{u_{1}}{\sqrt{2}}, \ i \sigma_{1}, \sigma_{0}, -i \sigma_{2}; \\
\ R_{13}; \ 2; \ \frac{u_{1}}{\sqrt{2}}, \ i \sigma_{1}, -\sigma_{0}, -i \sigma_{2}; \\
\ R_{14}; \ 2; \ -\frac{u_{1}}{\sqrt{2}}, \ i \sigma_{1}, -\sigma_{0}, -i \sigma_{2}; \\
N; (0\frac{1}{2}0); \ C_{2v}, I, \mathcal{T} \ \{R_{2}, R_{4}\}; \ 2; \ i \sigma_{3}, \sigma_{0}, -i \sigma_{2}; \\
\ \{R_{6}, R_{8}\}; \ 2; \ i \sigma_{3}, -\sigma_{0}, -i \sigma_{2}; \\
X; (00\frac{1}{2}); \ C_{2v}, C_{2u}, I, \mathcal{T} \ R_{5}; \ 2; \ i \sigma_{2}, i \sigma_{1}, \sigma_{0}, -i \sigma_{2}; \\
\ R_{10}; \ 2; \ i \sigma_{2}, i \sigma_{1}, -\sigma_{0}, -i \sigma_{2}; \\
Z; (\frac{1}{2}1\frac{1}{2}) \ C_{4h}^{1}, C_{2v}, I, \mathcal{T} \ R_{6}; \ 2; \ \frac{\zeta_{1}}{\sqrt{2}}, \ i \sigma_{1}, \sigma_{0}, -i \sigma_{2}; \\
\ R_{7}; \ 2; \ -\frac{u_{1}}{\sqrt{2}}, \ i \sigma_{1}, \sigma_{0}, -i \sigma_{2}; \\
\ R_{13}; \ 2; \ \frac{u_{1}}{\sqrt{2}}, \ i \sigma_{1}, -\sigma_{0}, -i \sigma_{2}; \\
\ R_{14}; \ 2; \ -\frac{u_{1}}{\sqrt{2}}, \ i \sigma_{1}, -\sigma_{0}, -i \sigma_{2}; \\
P; (\frac{1}{4}1\frac{1}{4}) \ S_{1z}^{1}, C_{2v}, I, \mathcal{T} \ R_{6}; \ 2; \ \frac{\zeta_{1}}{\sqrt{2}}, \ i \sigma_{1}, -i \sigma_{2}; \\
\ R_{7}; \ 2; \ -\frac{u_{1}}{\sqrt{2}}, \ i \sigma_{1}, -i \sigma_{2}; \\
\Lambda; \Gamma \ A / TZ; \ C_{4h}^{1}, \sigma_{y}, I, \mathcal{T} \ R_{6}; \ 2; \ \frac{\zeta_{1}}{\sqrt{2}}, \ i \sigma_{1}, -i \sigma_{2}; \\
\ R_{7}; \ 2; \ -\frac{u_{1}}{\sqrt{2}}, \ i \sigma_{1}, -i \sigma_{2}; \\
V; \ Z \ V; \ C_{4h}^{1}, \sigma_{y}, I, \mathcal{T} \ R_{6}; \ 2; \ \frac{\zeta_{1}}{\sqrt{2}}, \ i \sigma_{1}, -i \sigma_{2}; \\
\ R_{7}; \ 2; \ -\frac{u_{1}}{\sqrt{2}}, \ i \sigma_{1}, -i \sigma_{2}; \\
W; \ X \ P; \ C_{2v}, \sigma_{db}, I, \mathcal{T} \ R_{5}; \ 2; \ i \sigma_{2}, i \sigma_{1}, -i \sigma_{2}; \\
\Sigma; \Gamma \ Z / T \ Z; \ C_{2v}, \sigma_{z}, I, \mathcal{T} \ R_{5}; \ 2; \ i \sigma_{2}, i \sigma_{1}, -i \sigma_{2}; \\
F; \ Z \ F; \ C_{2v}, \sigma_{z}, I, \mathcal{T} \ R_{5}; \ 2; \ i \sigma_{2}, i \sigma_{1}, -i \sigma_{2}; \\
Q; \ N \ P; \ C_{2v}, I, \mathcal{T} \ \{R_{2}, R_{4}\}; \ 2; \ i \sigma_{3}, -i \sigma_{2}; \\
\Delta; \Gamma \ X; \ C_{2v}, \sigma_{z}, I, \mathcal{T} \ R_{5}; \ 2; \ i \sigma_{2}, i \sigma_{1}, -i \sigma_{2}; \\
U; \ Z \ U; \ C_{2v}, \sigma_{z}, I, \mathcal{T} \ R_{5}; \ 2; \ i \sigma_{2}, i \sigma_{1}, -i \sigma_{2}; \\
Y; \ X \ Z / X \ Y; \ C_{2v}, \sigma_{dz}, I, \mathcal{T} \ R_{5}; \ 2; \ i \sigma_{2}, i \sigma_{1}, -i \sigma_{2};
\[ \Gamma_v: \{C_4^v, \Gamma_{\frac{1}{2} \frac{1}{2} 0} \}, \{C_2v, 000 \}, \{I_{\frac{1}{2} \frac{1}{2} 0} \}; T; \text{Centrosymmetric with SOC} \]

\[ \Gamma; (000); C_{4v}^v, C_{2v}, I, T; R_6; 2; \frac{\sigma_{0, \alpha 0 2}}{\sqrt{2}}, \sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_7; 2; -\frac{\sigma_{0, \alpha 0 2}}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{13}; 2; \frac{\sigma_{0, \alpha 0 2}}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{14}; 2; -\frac{\sigma_{0, \alpha 0 2}}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ N; (0\frac{1}{2} 0); \sigma_y, E, I, T; \{R_9, R_0\}; 4; \Gamma_{0, 1}, -\Gamma_{0, 0}, \Gamma_{0, 3}, i\Gamma_{2, 0}; \text{DP}; 0 \]

\[ X; (00 \frac{1}{2}); C_{2x}, C_{2v}, I, T; R_5; 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ Z; (\frac{1}{2} \frac{1}{2} \frac{1}{2}) C_{4z}^z, C_{2z}, I, T; R_6; 2; \frac{\sigma_{0, \alpha 0 2}}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_7; 2; -\frac{\sigma_{0, \alpha 0 2}}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{13}; 2; \frac{\sigma_{0, \alpha 0 2}}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{14}; 2; -\frac{\sigma_{0, \alpha 0 2}}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \]

\[ P; (\frac{1}{1} \frac{1}{2}); \sigma_{x}, C_{2x}, I, T; \{R_6, R_7\}; 4; \Gamma_{1, 0} + i\Gamma_{3, 2}, i\Gamma_{0, 1}, -i\Gamma_{2, 0}; \text{DP}; 0 \]

\[ \Lambda; \Gamma A / \Gamma Z; C_{4z}^z, \sigma_y, I, T; R_6; 2; \frac{\sigma_{0, \alpha 0 2}}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ R_7; 2; -\frac{\sigma_{0, \alpha 0 2}}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]

\[ \Sigma; \Lambda / \Gamma Z; C_{2z}, \sigma_z, I, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ F; \Lambda / \Sigma; C_{2z}, \sigma_z, I, T; R_5; 2; i\sigma_2, -i\sigma_1, -i\sigma_2; \]

\[ Q; \Lambda / \Sigma; C_{2y}, I, T; \{R_2, R_2\}; 2; i\sigma_0, -i\sigma_2; \]
\[ \{R_4, R_4\}; 2; -i\sigma_0, -i\sigma_2; \]

\[ \Delta; \Lambda / \Sigma; C_{2x}, \sigma_z, I, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ U; \Lambda / \Sigma; C_{2x}, \sigma_z, I, T; R_5; 2; -i\sigma_2, -i\sigma_1, -i\sigma_2; \]

\[ Y; \Lambda / \Sigma; C_{2z}, \sigma_z, I, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]
### SG 141

Γ: \{C_{4z}^+, 0 \frac{1}{2} 0\}, \{C_{2z} \frac{1}{2} \frac{1}{2} 0\}, \{I \frac{1}{2} \frac{1}{2} 0\}, T; Centrosymmetric; with SOC

| Γ | (000); C_{4z} \cdot C_{2z} \cdot I \cdot T; 2 \frac{1}{2} | R_6; \frac{\sqrt{2}}{2} i \sigma_1, \sigma_0, -i \sigma_2; |
|---|---|---|
| | | R_7; \frac{\sqrt{2}}{2} -i \sigma_1, \sigma_0, -i \sigma_2; |
| | | R_{13}; \frac{\sqrt{2}}{2} i \sigma_1, -\sigma_0, -i \sigma_2; |
| | | R_{14}; \frac{\sqrt{2}}{2} -i \sigma_1, -\sigma_0, -i \sigma_2; |

N: \{(0 \frac{1}{2})\}; C_{2y} \cdot I \cdot T; \{R_2, R_4\}; 2 i \sigma_3, \sigma_0, -i \sigma_2; |
| | | \{R_6, R_8\}; 2 i \sigma_3, -\sigma_0, -i \sigma_2; |

X: \{(00 \frac{1}{2})\}; \sigma_{db} \cdot \sigma_{da} \cdot I \cdot T; \{R_{13}, R_{14}\}; 4 \Gamma_{0,1}, i \Gamma_{3,0}, \Gamma_{0,3}, -i \Gamma_{2,0}; DP; 0 |

Z: \{(\frac{1}{2} \frac{1}{2} \frac{1}{2})\}; C_{4z}^+ \cdot \sigma_{db} \cdot C_{2z} \cdot T; 4 \frac{1}{2} \Gamma_{0,0}, -i \Gamma_{3,3}, \Gamma_{1,2}, i \Gamma_{0,3}, -i \Gamma_{3,2}; DP; 0 |

P: \{(\frac{1}{2} \frac{1}{2} \frac{1}{2})\}; S^+_4 \cdot \sigma_{db} \cdot IT; \{R_9, R_{10}\}; 2 (-1)^{3/4} \sigma_0, (-1)^{3/4} \sigma_3, -i \sigma_2; |
| | | \{R_{11}, R_{12}\}; 2 (-1)^{3/4} \sigma_0, (-1)^{3/4} \sigma_3, -i \sigma_2; |
| | | R_{19}; \sqrt{2} i \sigma_3, -(-1)^{3/4} \sigma_2, -i \sigma_2; |

Λ: ΓΛ/ΓZ; C_{4z}^- \cdot \sigma_y \cdot IT; 2 \frac{\sqrt{2}}{2} i \sigma_1, -i \sigma_2; |
| | | \frac{\sqrt{2}}{2} -i \sigma_1, i \sigma_2; |

V: ZV; C_{4z}^- \cdot \sigma_x \cdot E \cdot IT; 2 \frac{\sqrt{2}}{2} i \sigma_1, \sigma_0, -i \sigma_2; |
| | | \frac{\sqrt{2}}{2} -i \sigma_1, \sigma_0, -i \sigma_2; |

W: XP; C_{2z} \cdot \sigma_{db} \cdot IT; \{R_6, R_8\}; 2 i \sigma_0, -\sigma_3, -i \sigma_2; |
| | | \{R_7, R_8\}; 2 -i \sigma_0, -\sigma_3, -i \sigma_2; |

Σ: ΓZ/ΓΣ; C_{2z} \cdot \sigma_z \cdot IT; \{R_5\}; 2 i \sigma_2, i \sigma_1, -i \sigma_2; |

F: ZF; C_{2z} \cdot \sigma_s \cdot IT; \{R_5\}; 2 -i \sigma_2, i \sigma_1, -i \sigma_2; |

Q: NP; C_{2z} \cdot E \cdot IT; \{R_5, R_7\}; 2 -i \sigma_3, \sigma_0, -i \sigma_2; |

Δ: ΓX; C_{2z} \cdot \sigma_z \cdot IT; \{R_5\}; 2 i \sigma_2, i \sigma_1, -i \sigma_2; |

U: ZU; C_{2z} \cdot \sigma_s \cdot IT; \{R_5, R_8\}; 2 i \sigma_0, i \sigma_3, -i \sigma_2; |
| | | \{R_7, R_8\}; 2 -i \sigma_0, -i \sigma_3, -i \sigma_2; |

Y: XZ/XY; C_{2z} \cdot \sigma_{db} \cdot IT; \{R_6, R_8\}; 2 i \sigma_0, i \sigma_3, -i \sigma_2; |
| | | \{R_7, R_8\}; 2 -i \sigma_0, -i \sigma_3, -i \sigma_2; |
\(\Gamma_v^0; \{C_{4z}^+\}$\{140\}, \{C_{2x}\}$\{140\}; \{I\}$\{00\}, \mathcal{T}; \text{Centrosymmetric with SOC}

\(\Gamma; (000); \quad C_{4z}^+; C_{2x}; I; \mathcal{T}; \quad R_{6}; \quad 2; \)^{\sigma_1+\sigma_2}/\sqrt{2}, \sigma_1, \sigma_0, -i\sigma_2;
\quad R_{7}; \quad 2; -^{\sigma_1-\sigma_2}/\sqrt{2}, \sigma_1, \sigma_0, -i\sigma_2;
\quad R_{13}; \quad 2; \)\quad \sigma_1, -\sigma_0, -i\sigma_2;
\quad R_{14}; \quad 2; -\sigma_1 -i\sigma_2, \sigma_1, -\sigma_0, -i\sigma_2;

\(N; (012); \quad C_{2y}, E, I, \mathcal{T}; \quad \{R_{10}, R_{10}\}; 4; i\Gamma_{0.2}, -\Gamma_{0.0}, \Gamma_{0.3}, i\Gamma_{2.0}; \quad \text{DP; 0}
\quad X; (00\frac{1}{2}); \quad \sigma_z, \sigma_{da}, I, \mathcal{T}; \quad \{R_{13}, R_{14}\}; 4; \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \quad \text{DP; 0}
\quad Z; (\frac{1}{2}2\frac{1}{2}); \quad C_{4z}^+, \sigma_{db}, C_{2b}, \mathcal{T}; \quad \{R_{19}\}; 4; \Gamma_{0.0} - i\Gamma_{3.1}, \Gamma_{1.2}, i\Gamma_{0.3}, -i\Gamma_{3.2}; \quad \text{DP; 0}
\quad P; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad S_{14}^+, \sigma_{db}, I, \mathcal{T}; \quad \{R_{0}, R_{12}\}; 2; (-1)^{3/4}\sigma_3, (-1)^{3/4}\sigma_3, -i\sigma_2;
\quad \{R_{10}, R_{11}\}; 2; (-1)^{3/4}\sigma_3, (-1)^{3/4}\sigma_3, -i\sigma_2;
\quad \{R_{19}, R_{19}\}; 4; \sqrt{-\Gamma_{0.3}}, (-1)^{3/4}\Gamma_{0.2}, i\Gamma_{2.0}; \quad \text{QDP; 0}
\quad \Lambda; \quad \Gamma \Lambda/\Gamma Z; \quad C_{4z}^+, \sigma_y, I, \mathcal{T}; \quad \{R_{6}\}; 2; \)^{\sigma_1+\sigma_2}/\sqrt{2}, \sigma_1, -i\sigma_2;
\quad \{R_{7}\}; 2; -^{\sigma_1-\sigma_2}/\sqrt{2}, \sigma_1, -i\sigma_2;

\(V; \quad Z V; \quad C_{4z}^+, \sigma_x, E, \mathcal{T}; \quad R_{13}; 2; ^{(i\sigma_1+i\sigma_2)}/\sqrt{2}, \sigma_1, \sigma_0, -i\sigma_2;
\quad R_{14}; 2; ^{\sigma_2+\sigma_3}/\sqrt{2}, \sigma_1, \sigma_0, -i\sigma_2;
\quad W; \quad X P; \quad C_{2x}, \sigma_{da}, I, \mathcal{T}; \quad \{R_5, R_6\}; 2; i\sigma_0, i\sigma_3, -i\sigma_2;
\quad \{R_7, R_8\}; 2; -i\sigma_0, -i\sigma_3, -i\sigma_2;
\quad \Sigma; \quad \Gamma Z/\Gamma \Sigma; \quad C_{2x}, \sigma_z, I, \mathcal{T}; \quad \{R_5\}; 2; i\sigma_2, i\sigma_1, -i\sigma_2;
\quad \{R_7, R_8\}; 2; -i\sigma_0, -i\sigma_3, -i\sigma_2;
\quad \Phi; \quad Z F; \quad C_{2x}, \sigma_z, I, \mathcal{T}; \quad \{R_5\}; 2; -i\sigma_2, i\sigma_1, -i\sigma_2;
\quad \{R_7, R_8\}; 2; i\sigma_0, i\sigma_3, -i\sigma_2;
\quad \Omega; \quad N P; \quad C_{2y}, E, I, \mathcal{T}; \quad \{R_5, R_6\}; 2; -i\sigma_0, -i\sigma_3, -i\sigma_2;
\quad \{R_7, R_8\}; 2; -i\sigma_0, -i\sigma_3, -i\sigma_2;
\quad \Delta; \quad \Gamma X; \quad C_{2x}, \sigma_z, I, \mathcal{T}; \quad \{R_5\}; 2; i\sigma_2, i\sigma_1, -i\sigma_2;
\quad \{R_7, R_8\}; 2; -i\sigma_0, -i\sigma_3, -i\sigma_2;
\quad U; \quad Z U; \quad C_{2x}, \sigma_z, I, \mathcal{T}; \quad \{R_5, R_6\}; 2; i\sigma_0, i\sigma_3, -i\sigma_2;
\quad \{R_7, R_8\}; 2; -i\sigma_0, -i\sigma_3, -i\sigma_2;
\quad \gamma; \quad X Z / X Y; \quad C_{2x}, \sigma_{da}, I, \mathcal{T}; \quad \{R_5, R_6\}; 2; i\sigma_0, i\sigma_3, -i\sigma_2;
\quad \{R_7, R_8\}; 2; -i\sigma_0, -i\sigma_3, -i\sigma_2;
\( \Gamma_h; \{ C_3^+ |000 \}, T; \) Non-Centrosymmetric; with SOC

\[
\begin{array}{ll}
\Gamma; (000); & C_3^+ T; \{ R_2, R_0 \}; 2; \frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}, -i \sigma_2; C-1 WP; 1 \\
\quad & \{ R_4, R_4 \}; 2; -\sigma_0, -i \sigma_2; C-3 WP; 3 \\
M; (0 \frac{1}{2} 0); & \bar{E}, T; \{ R_2, R_2 \}; 2; -\sigma_0, -i \sigma_2; C-1 WP; 1 \\
A; (00 \frac{1}{2}); & \bar{C}, T; \{ R_2, R_0 \}; 2; \frac{\sigma_0 + i \sqrt{3} \sigma_2}{2}, -i \sigma_2; C-1 WP; 1 \\
\quad & \{ R_4, R_4 \}; 2; -\sigma_0, -i \sigma_2; C-3 WP; 3 \\
L; (0 \frac{1}{2} \frac{1}{2}); & \bar{E}, T; \{ R_2, R_2 \}; 2; -\sigma_0, -i \sigma_2; C-1 WP; 1 \\
K; (\frac{1}{3} \frac{2}{3} 0); & C_3^+ \:
\begin{array}{ccc}
R_2 & 1; & \sqrt{-1} \\
R_4 & 1; & -1 \\
R_6 & 1; & (-1)^{2/3} \\
\end{array} \\
H; (\frac{1}{3} \frac{2}{3} \frac{1}{2}); & C_3^+ \:
\begin{array}{ccc}
R_2 & 1; & \sqrt{-1} \\
R_4 & 1; & -1 \\
R_6 & 1; & (-1)^{2/3} \\
\end{array} \\
\Delta; \Gamma A; & C_3^+ \:
\begin{array}{ccc}
R_2 & 1; & \sqrt{-1} \\
R_4 & 1; & -1 \\
R_6 & 1; & (-1)^{2/3} \\
\end{array} \\
U; ML; & \bar{E}; \:
\begin{array}{ccc}
R_2 & 1; & -1 \\
\end{array} \\
P; KH; & C_3^+ \:
\begin{array}{ccc}
R_2 & 1; & \sqrt{-1} \\
R_4 & 1; & -1 \\
R_6 & 1; & (-1)^{2/3} \\
\end{array} \\
T; \Gamma K; & \bar{E}; \:
\begin{array}{ccc}
R_2 & 1; & -1 \\
\end{array} \\
S; AH; & \bar{E}; \:
\begin{array}{ccc}
R_2 & 1; & -1 \\
\end{array} \\
T'; MK; & \bar{E}; \:
\begin{array}{ccc}
R_4 & 1; & -1 \\
\end{array} \\
S'; LH; & \bar{E}; \:
\begin{array}{ccc}
R_4 & 1; & -1 \\
\end{array} \\
\Sigma; \Gamma M; & \bar{E}; \:
\begin{array}{ccc}
R_2 & 1; & -1 \\
\end{array} \\
R; AL; & \bar{E}; \:
\begin{array}{ccc}
R_2 & 1; & -1 \\
\end{array}
\end{array}
\]
| Point | Group | Non-Centrosymmetric with SOC |
|-------|-------|-------------------------------|
| Γh; {C\(^+\)_3[001], T} | Non-Centrosymmetric with SOC |
| Γ; (000); C\(^+\)_3, T; \{R_2, R_6\}; 2; \(\frac{\sigma_3 + i\sqrt{3}\sigma_2}{2}, -i\sigma_2\); C-1 WP; 1 |
| M; (0\(_{1/2}\)0); \(\bar{E}, T\); \{R_2, R_2\}; 2; -\(\sigma_0, -i\sigma_2\); C-1 WP; 1 |
| A; (00\(_1/2\))\(^{-}\); C\(^{-}\)_3, T; \{R_2, R_6\}; 2; \(\frac{\sigma_3 + i\sqrt{3}\sigma_2}{2}, -i\sigma_2\); C-1 WP; 1 |
| L; (0\(_{1/2}\)1\(_1/2\)); \(\bar{E}, T\); \{R_2, R_2\}; 2; -\(\sigma_0, -i\sigma_2\); C-1 WP; 1 |
| K; (\(_{1/2}\)\(_{3/3}\)0); C\(^+\)_3; \(\bar{R}_2\); 1; \(\sqrt{-1}\) |
| \(\bar{R}_4\); 1; -1 |
| \(\bar{R}_6\); 1; \(-(-1)^{2/3}\) |
| H; (\(_{1/2}\)\(_{3/3}\)1); C\(^{-}\)_3; \(\bar{R}_2\); 1; \(\sqrt{-1}\) |
| \(\bar{R}_4\); 1; -1 |
| \(\bar{R}_6\); 1; \(-(-1)^{2/3}\) |
| Δ; ΓA; C\(^+\)_3; \(\bar{R}_2\); 1; \(\sqrt{-1}\) |
| \(\bar{R}_4\); 1; -1 |
| \(\bar{R}_6\); 1; \(-(-1)^{2/3}\) |
| U; ML; \(\bar{E}\); \(\bar{R}_2\); 1; -1 |
| P; KH; C\(^+\)_3; \(\bar{R}_2\); 1; \(\sqrt{-1}\) |
| \(\bar{R}_4\); 1; -1 |
| \(\bar{R}_6\); 1; \(-(-1)^{2/3}\) |
| T; ΓK; \(\bar{E}\); \(\bar{R}_2\); 1; -1 |
| S; AH; \(\bar{E}\); \(\bar{R}_2\); 1; -1 |
| T'; MK; \(\bar{E}\); \(\bar{R}_2\); 1; -1 |
| S'; LH; \(\bar{E}\); \(\bar{R}_2\); 1; -1 |
| Σ; ΓM; \(\bar{E}\); \(\bar{R}_2\); 1; -1 |
| R; AL; \(\bar{E}\); \(\bar{R}_2\); 1; -1 |
\[ \Gamma \text{h}; \{ C^+_3 \{002 \}, T; \text{Non-Centrosymmetric; with SOC}\}

\[ \Gamma; (000); C^+_3, T; \{ R_2, R_0 \}; 2; \frac{\sigma_0 + i \sqrt{3} \sigma_3}{2}, -i\sigma_2; C-1 \text{ WP}; 1 \]

\[ \{ R_4, R_4 \}; 2; -\sigma_0, -i\sigma_2; C-3 \text{ WP}; 3 \]

\[ M; (0_{\frac{1}{2}}0); \bar{E}, T; \{ R_2, R_2 \}; 2; -\sigma_0, -i\sigma_2; C-1 \text{ WP}; 1 \]

\[ A; (00_{\frac{1}{2}}); C^+_3, T; \{ R_2, R_0 \}; 2; \frac{\sigma_0 + i \sqrt{3} \sigma_3}{2}, -i\sigma_2; C-1 \text{ WP}; 1 \]

\[ \{ R_4, R_4 \}; 2; -\sigma_0, -i\sigma_2; C-3 \text{ WP}; 3 \]

\[ L; (0_{\frac{1}{2}}_{\frac{1}{2}}); \bar{E}, T; \{ R_2, R_2 \}; 2; -\sigma_0, -i\sigma_2; C-1 \text{ WP}; 1 \]

\[ K; (\frac{1}{3} \frac{2}{3} 0); C^+_3; \{ R_2 \}; 1; \sqrt{-1} \]

\[ R_4; 1; -1 \]

\[ R_6; 1; -(-1)^{2/3} \]

\[ H; (\frac{1}{3} \frac{2}{3} \frac{1}{3}); C^+_3; \{ R_2 \}; 1; \sqrt{-1} \]

\[ R_4; 1; -1 \]

\[ R_6; 1; -(-1)^{2/3} \]

\[ \Delta; \Gamma A; C^+_3; \{ R_2 \}; 1; \sqrt{-1} \]

\[ R_4; 1; -1 \]

\[ R_6; 1; -(-1)^{2/3} \]

\[ U; ML; \bar{E}; \{ R_2 \}; 1; -1 \]

\[ P; KH; C^+_3; \{ R_2 \}; 1; \sqrt{-1} \]

\[ R_4; 1; -1 \]

\[ R_6; 1; -(-1)^{2/3} \]

\[ T; \Gamma K; \bar{E}; \{ R_2 \}; 1; -1 \]

\[ S; AH; \bar{E}; \{ R_2 \}; 1; -1 \]

\[ T'; MK; \bar{E}; \{ R_2 \}; 1; -1 \]

\[ S'; LH; \bar{E}; \{ R_2 \}; 1; -1 \]

\[ \Sigma; \Gamma M; \bar{E}; \{ R_2 \}; 1; -1 \]

\[ R; AL; \bar{E}; \{ R_2 \}; 1; -1 \]
\( \Gamma_{rh}; \{C^+_3 |000\}, T; \text{Non-Centrosymmetric; with SOC} \)

\[
\begin{align*}
\Gamma; \quad (000): & \quad C^+_3, T; \{R_2, R_6\}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, -i\sigma_2; \text{C-1 WP}; 1 \\
& \quad \{R_4, R_4\}; 2; -\sigma_0, -i\sigma_2; \text{C-3 WP}; 3 \\
Z; \quad \left(\frac{1}{2} \frac{1}{2} \frac{1}{2}\right): & \quad C^+_3, T; \{R_2, R_6\}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, -i\sigma_2; \text{C-1 WP}; 1 \\
& \quad \{R_4, R_4\}; 2; -\sigma_0, -i\sigma_2; \text{C-3 WP}; 3 \\
L; \quad (0 \frac{1}{2} 0); & \quad \bar{E}, T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \text{C-1 WP}; 1 \\
(a)F; \quad (0 \frac{1}{2} \frac{1}{2}); & \quad \bar{E}, T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \text{C-1 WP}; 1 \\
(b)F; \quad (\frac{1}{2} \frac{1}{2} 0); & \quad \bar{E}, T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \text{C-1 WP}; 1 \\
\Lambda; \quad \Gamma\Lambda/\Gamma Z; & \quad C^+_3; \quad R_2; 1; \sqrt{-1}; \\
& \quad R_4; 1; -1; \\
& \quad R_6; 1; -(-1)^{2/3}; \\
P; \quad ZP; & \quad C^+_3; \quad R_2; 1; \sqrt{-1}; \\
& \quad R_4; 1; -1; \\
& \quad R_6; 1; -(-1)^{2/3}; \\
B; \quad ZB; & \quad \bar{E}; \quad R_2; 1; -1; \\
\Sigma; \quad \Gamma F/\Gamma \Sigma; & \quad \bar{E}; \quad R_2; 1; -1; \\
Q; \quad FQ; & \quad \bar{E}; \quad R_2; 1; -1; \\
Y; \quad LZ/LY; & \quad \bar{E}; \quad R_2; 1; -1; 
\end{align*}
\]
$\Gamma_h; \{S_0^+ |000\}, \{I|000\}, T; \text{Centrosymmetric; with SOC}$

$\Gamma; \ (000); \ S_0^+, I, T; \ \{R_4, R_0\}; \ 2; \ \frac{i}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0, -i\sigma_2$;
\{R_4, R_4\}; 2; $-\sigma_0, \sigma_0, -i\sigma_2$;
\{R_5, R_7\}; 2; $\sigma_0, -\sigma_0, -i\sigma_2$;
\{R_5, R_11\}; 2; $\frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), -\sigma_0, -i\sigma_2$;

$M; \ (0\frac{1}{2} 0); \ I, \bar{E}, T; \ \{R_2, R_2\}; 2; \sigma_0, -\sigma_0, -i\sigma_2$;
\{R_4, R_4\}; 2; $-\sigma_0, -\sigma_0, -i\sigma_2$;

$\Lambda; \ (00\frac{1}{2}); \ S_0^+, I, T; \ \{R_2, R_0\}; 2; \ \frac{i}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0, -i\sigma_2$;
\{R_4, R_4\}; 2; $-\sigma_0, \sigma_0, -i\sigma_2$;
\{R_5, R_5\}; 2; $\sigma_0, -\sigma_0, -i\sigma_2$;
\{R_5, R_11\}; 2; $\frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), -\sigma_0, -i\sigma_2$;

$L; \ (0\frac{1}{2} \frac{1}{2}); \ I, \bar{E}, T; \ \{R_2, R_2\}; 2; \sigma_0, -\sigma_0, -i\sigma_2$;
\{R_4, R_4\}; 2; $-\sigma_0, -\sigma_0, -i\sigma_2$;

$K; \ (\frac{1}{2} \frac{1}{2} 0); \ C_3^+, I, T; \ \{R_2, R_0\}; 2; \ \frac{i}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2$;
\{R_4, R_4\}; 2; $-\sigma_0, -i\sigma_2$;

$H; \ (\frac{1}{2} \frac{3}{2} 0); \ C_3^+, I, T; \ \{R_2, R_0\}; 2; \ \frac{i}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2$;
\{R_4, R_4\}; 2; $-\sigma_0, -i\sigma_2$;

$\Delta; \ \Gamma A; \ C_3^+, I, T; \ \{R_2, R_0\}; 2; \ \frac{i}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2$;
\{R_4, R_4\}; 2; $-\sigma_0, -i\sigma_2$;

$U; \ ML; \ \bar{E}, I, T; \ \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2$;

$P; \ KH; \ C_3^+, I, T; \ \{R_2, R_0\}; 2; \ \frac{i}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2$;
\{R_4, R_4\}; 2; $-\sigma_0, -i\sigma_2$;

$T; \ \Gamma K; \ \bar{E}, I, T; \ \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2$;

$S; \ AH; \ \bar{E}, I, T; \ \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2$;

$T'; \ MK; \ \bar{E}, I, T; \ \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2$;

$S'; \ LH; \ \bar{E}, I, T; \ \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2$;

$\Sigma; \ \Gamma M; \ \bar{E}, I, T; \ \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2$;

$R; \ AL; \ \bar{E}, I, T; \ \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2$;
\[ \Gamma; (000): S_6^+ \cdot I, T; \{ R_2, R_6 \}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0, -i\sigma_2; \]
\[ \{ R_4, R_4 \}; 2; -\sigma_0, \sigma_0, -i\sigma_2; \]
\[ \{ R_7, R_7 \}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \]
\[ \{ R_9, R_{11} \}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), -\sigma_0, -i\sigma_2; \]
\[ Z; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); S_6^+ \cdot I, T; \{ R_2, R_6 \}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0, -i\sigma_2; \]
\[ \{ R_4, R_4 \}; 2; -\sigma_0, \sigma_0, -i\sigma_2; \]
\[ \{ R_7, R_7 \}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \]
\[ \{ R_9, R_{11} \}; 2; \frac{1}{2} (-\sigma_0 + i\sqrt{3}\sigma_3), -\sigma_0, -i\sigma_2; \]
\[ L; (0 \frac{1}{2} 0); L, E, T; \{ R_2, R_2 \}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \]
\[ \{ R_4, R_4 \}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \]
\[ (a)F; (0 \frac{1}{2} \frac{1}{2}); L, E, T; \{ R_2, R_2 \}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \]
\[ \{ R_4, R_4 \}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \]
\[ (b)F; (\frac{1}{2} \frac{1}{2} 0); L, E, T; \{ R_2, R_2 \}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \]
\[ \{ R_4, R_4 \}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \]
\[ \Lambda; \Gamma \Lambda/\Lambda D; C_3^+ \cdot I, T; \{ R_2, R_6 \}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2; \]
\[ \{ R_4, R_4 \}; 2; -\sigma_0, -i\sigma_2; \]
\[ P; ZP; C_3^+ \cdot I, T; \{ R_2, R_6 \}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2; \]
\[ \{ R_4, R_4 \}; 2; -\sigma_0, -i\sigma_2; \]
\[ B; ZB; \bar{E}, I, T; \{ R_2, R_2 \}; 2; -\sigma_0, -i\sigma_2; \]
\[ \Sigma; GF/G \Sigma; \bar{E}, I, T; \{ R_2, R_2 \}; 2; -\sigma_0, -i\sigma_2; \]
\[ Q; FQ; \bar{E}, I, T; \{ R_2, R_2 \}; 2; -\sigma_0, -i\sigma_2; \]
\[ Y; LZ/LY; \bar{E}, I, T; \{ R_2, R_2 \}; 2; -\sigma_0, -i\sigma_2; \]
\( \Gamma \); (000); \( C_{3v}^+ \), \( C_{2v}^+ \), \( T \); Non-Centrosymmetric; with SOC

\[ \begin{align*}
\Gamma_6: & \quad \{R_3, R_4\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{C-3 WP}; \quad 3 \\
R_6: & \quad 2; -\frac{\sigma_0-i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2; \quad \text{C-1 WP}; \quad 1
\end{align*} \]

\( M \); (000); \( C_{3v}^+ \), \( C_{2v}^+ \), \( T \); \{R_2, R_4\}; 2; \( i\sigma_3, -i\sigma_2 \); \( \text{C-1 WP}; \quad 1 \)

\( A \); (000); \( C_{3v}^+ \), \( C_{2v}^+ \), \( T \); \{R_3, R_4\}; 2; \( -\sigma_0, i\sigma_3, -i\sigma_2 \); \( \text{C-3 WP}; \quad 3 \)

\( R_6: & \quad 2; -\frac{\sigma_0-i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2; \quad \text{C-1 WP}; \quad 1 \\
L \); (000); \( C_{3v}^+ \), \( C_{2v}^+ \), \( T \); \{R_2, R_4\}; 2; \( i\sigma_3, -i\sigma_2 \); \( \text{C-1 WP}; \quad 1 \)

\( K \); (000); \( C_{3v}^+ \), \( C_{2v}^+ \), \( T \); \( R_2 \); 1; \( \sqrt{-1}, 1 \); \( R_4 \); 1; \( -1, 1 \); \( R_6 \); 1; \( (-1)^{2/3}, 1 \);

\( H \); (000); \( C_{3v}^+ \), \( C_{2v}^+ \), \( T \); \( R_2 \); 1; \( \sqrt{-1}, 1 \); \( R_4 \); 1; \( -1, 1 \); \( R_6 \); 1; \( (-1)^{2/3}, 1 \);

\( \Delta \); \( \Gamma A \); \( C_{3v}^+ \), \( C_{2v}^+ \), \( T \); \( R_2 \); 1; \( \sqrt{-1}, 1 \); \( R_4 \); 1; \( -1, 1 \); \( R_6 \); 1; \( (-1)^{2/3}, 1 \);

\( U \); \( ML \); \( \tilde{E}, C_{2v}^+ \), \( T \); \( R_2 \); 1; \( -1, 1 \);

\( P \); \( KH \); \( C_{3v}^+ \), \( C_{2v}^+ \), \( T \); \( R_2 \); 1; \( \sqrt{-1}, 1 \); \( R_4 \); 1; \( -1, 1 \); \( R_6 \); 1; \( (-1)^{2/3}, 1 \);

\( T \); \( \Gamma K \); \( \tilde{E}, C_{2v}^+ \), \( T \); \( R_2 \); 1; \( -1, 1 \);

\( S \); \( AH \); \( \tilde{E}, C_{2v}^+ \), \( T \); \( R_2 \); 1; \( -1, 1 \);

\( T' \); \( MK \); \( \tilde{E}, C_{2v}^+ \), \( T \); \( R_2 \); 1; \( -1, 1 \);

\( S' \); \( LH \); \( \tilde{E}, C_{2v}^+ \), \( T \); \( R_2 \); 1; \( -1, 1 \);

\( \Sigma \); \( \Gamma M \); \( C_{2v}^+ \), \( T \); \( R_2 \); 1; \( i \); \( R_4 \); 1; \( -i \);

\( R \); \( AL \); \( C_{2v}^+ \), \( T \); \( R_2 \); 1; \( i \); \( R_4 \); 1; \( -i \)
\[ \Gamma_h; \{ C^+_{3}\langle000 \rangle, C_{21}^\prime\langle000 \rangle, T; \text{Non-Centrosymmetric with \text{SOC}} \}
\]

\[
\begin{array}{ll}
\Gamma; (000); C^+_{3}, C^\prime_{21}, T; \{ R_3, R_4 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; & \text{C-3 WP}; 3 \\
R_6; 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2; & \text{C-1 WP}; 1 \\
M; (0\frac{1}{2}0); C_{21}''; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2; & \text{C-1 WP}; 1 \\
A; (00\frac{1}{2}); C^+_{3}, C^\prime_{21}, T; \{ R_3, R_4 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; & \text{C-3 WP}; 3 \\
R_6; 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2; & \text{C-1 WP}; 1 \\
L; (0\frac{1}{2}\frac{1}{2}); C_{21}''; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2; & \text{C-1 WP}; 1 \\
K; (\frac{1}{3}\frac{1}{3}0); C^+_{3}, C_{21}''; R_3; 1; -1, i; \\
R_4; 1; -1, -i; \\
R_6; 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3; & \text{C-1 WP}; 1 \\
H; (\frac{1}{3}\frac{1}{3}\frac{1}{2}); C^+_{3}, C_{21}''; R_3; 1; -1, i; \\
R_4; 1; -1, -i; \\
R_6; 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3; & \text{C-1 WP}; 1 \\
\Delta; \Gamma A; C^+_{3}, C_{22}'' T; R_2; 1; \sqrt{-1}, 1; \\
R_4; 1; -1, 1; \\
R_6; 1; -(-1)^{2/3}, 1; \\
U; M L; \bar{E}, C_{21}'' T; R_2; 1; -1, 1; \\
P; K H; C^+_{3}; R_2; 1; \sqrt{-1}; \\
R_4; 1; -1; \\
R_6; 1; -(-1)^{2/3}; \\
T; \Gamma K; C''_{22}; R_2; 1; i; \\
R_4; 1; -i; \\
S; A H; C_{22}''; R_2; 1; i; \\
R_4; 1; -i; \\
T''; M K; C_{21}''; R_2; 1; i; \\
R_4; 1; -i; \\
S''; L H; C_{21}''; R_2; 1; i; \\
R_4; 1; -i; \\
\Sigma; \Gamma M; \bar{E}, C_{21}'' T; R_2; 1; -1, 1; \\
R; A L; \bar{E}, C_{21}'' T; R_2; 1; -1, 1;
\end{array}
\]
## SG 151

\[ \Gamma_h; \{C_3^+|00\frac{1}{4}\}, \{C_{21}'|00\frac{3}{4}\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \begin{array}{llll}
\Gamma; & (000); & C_3^+, C_{21}', T; \{R_3, R_4\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; & \text{C-3 WP; 3} \\
& & R_6; & 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \\
M; & (0\frac{1}{2}0); & C_{21}', T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; & \text{C-1 WP; 1} \\
A; & (00\frac{1}{2}); & C_3^+, C_{21}', T; \{R_3, R_4\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; & \text{C-3 WP; 3} \\
& & R_6; & 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2; \text{C-1 WP; 1} \\
L; & (0\frac{1}{2}\frac{1}{2}); & C_{21}', T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; & \text{C-1 WP; 1} \\
K; & (\frac{1}{2}\frac{1}{2}0); & C_3^+, C_{22}' T; R_2; & 1; \sqrt{3}, 1; \\
& & R_4; & 1; -1, 1; \\
& & R_6; & 1; -(-1)^{2/3}, 1; \\
H; & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & C_3^+, C_{22}' T; R_2; & 1; \sqrt{3}, 1; \\
& & R_4; & 1; -1, 1; \\
& & R_6; & 1; -(-1)^{2/3}, 1; \\
\Delta; & \Gamma A; & C_3^+, C_{22}' T; R_2; & 1; \sqrt{3}, 1; \\
& & R_4; & 1; -1, 1; \\
& & R_6; & 1; -(-1)^{2/3}, 1; \\
U; & \text{ML; } & \vec{E}, C_{21}' T; R_2; & 1; -1, 1; \\
P; & \text{KH; } & C_3^+, C_{22}' T; R_2; & 1; \sqrt{3}, 1; \\
& & R_4; & 1; -1, 1; \\
& & R_6; & 1; -(-1)^{2/3}, 1; \\
T; & \Gamma K; & \vec{E}, C_{22}' T; R_2; & 1; -1, 1; \\
S; & \text{AH; } & \vec{E}, C_{22}' T; R_2; & 1; -1, 1; \\
T'; & \text{MK; } & \vec{E}, C_{21}' T; R_2; & 1; -1, 1; \\
S'; & \text{LH; } & \vec{E}, C_{21}' T; R_2; & 1; -1, 1; \\
\Sigma; & \Gamma M; & C_{21}'; R_2; & 1; i; \\
& & R_4; & 1; -i; \\
& & R_6; & 1; i; \\
R; & \text{AL; } & C_{21}'; R_2; & 1; -i; \\
& & R_6; & 1; i; 
\end{array} \]
\( \Gamma_h; \{ C^+_3 [001], C''_{21} [001/2], T \}; \) Non-Centrosymmetric; with SOC

\[ \Gamma; (000); C^+_3, C''_{21}, T; \{ R_4, R_4 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad C-3 \text{ WP}; 3 \]

\[ R_6; 2; \frac{\sigma_0 - \sqrt{3}i\sigma_2}{2}, i\sigma_3, -i\sigma_2; \quad C-1 \text{ WP}; 1 \]

\( M; (01\frac{1}{2}0); C''_{21}, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2; \quad C-1 \text{ WP}; 1 \]

\( A; (00\frac{1}{2}); C^-_3, C''_{21}, T; \{ R_3, R_4 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad C-3 \text{ WP}; 3 \]

\[ R_6; 2; \frac{\sigma_0 - \sqrt{3}i\sigma_2}{2}, i\sigma_3, -i\sigma_2; \quad C-1 \text{ WP}; 1 \]

\( L; (01\frac{1}{2}); C''_{21}, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2; \quad C-1 \text{ WP}; 1 \]

\( K; (\frac{1}{3}\frac{1}{2}0); C^+_3, C''_{21}; \quad R_3; 1; -1, i; \]

\[ R_4; 1; -1, -i; \]

\[ R_6; 2; \frac{\sigma_0 - i\sqrt{3}i\sigma_2}{2}, i\sigma_3; \quad C-1 \text{ WP}; 1 \]

\( H; (\frac{1}{3}\frac{1}{2}1\frac{1}{2}); C^-_3, C''_{21}; \quad R_3; 1; -1, i; \]

\[ R_4; 1; -1, -i; \]

\[ R_6; 2; \frac{\sigma_0 - i\sqrt{3}i\sigma_2}{2}, i\sigma_3; \quad C-1 \text{ WP}; 1 \]

\( \Delta; \Gamma A; \quad C^+_3, C''_{21} T; \quad R_2; 1; \sqrt{-1}, 1; \]

\[ R_4; 1; -1, 1; \]

\[ R_6; 1; -(1)^{2/3}, 1; \]

\( U; \text{ ML}; \quad \bar{E}, C''_{21} T; \quad R_2; 1; -1, 1; \]

\( P; \text{ KH}; \quad C^+_3; \quad R_2; 1; \sqrt{-1}; \]

\[ R_4; 1; -1; \]

\[ R_6; 1; -(1)^{2/3}; \]

\( T; \Gamma K; \quad C''_{22}; \quad R_2; 1; i; \]

\[ R_4; 1; -i; \]

\( S; \text{ AH}; \quad C''_{22}; \quad R_6; 1; i; \]

\[ R_4; 1; -i; \]

\( T'; \text{ MK}; \quad C''_{21}; \quad R_2; 1; i; \]

\[ R_4; 1; -i; \]

\( S'; \text{ LH}; \quad C''_{21}; \quad R_2; 1; -i; \]

\[ R_8; 1; i; \]

\( \Sigma; \Gamma M; \quad \bar{E}, C''_{21} T; \quad R_2; 1; -1, 1; \]

\( R; \text{ AL}; \quad \bar{E}, C''_{21} T; \quad R_2; 1; -1, 1; \)
Γh; \{C'^{+}\{002\}, C'^{'}\{001\}\}, T; Non-Centrosymmetric; with SOC

Γ; (000); \ C^+; C'^{'}_21; T; \{R_3, R_4\}; \ 2; -\sigma_0, i\sigma_3, -i\sigma_2; \ C-3 \ WP; 3
R_6; 2; \sigma_0-i\sqrt{3}\sigma_2, i\sigma_3, -i\sigma_2; \ C-1 \ WP; 1
M; (0\frac{1}{2}0); \ C'^{'}_21; T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \ C-1 \ WP; 1
A; (00\frac{1}{2}); \ C^+; C'^{'}_21; T; \{R_3, R_4\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \ C-3 \ WP; 3
R_6; 2; \sigma_0-i\sqrt{3}\sigma_2, i\sigma_3, -i\sigma_2; \ C-1 \ WP; 1
L; (0\frac{1}{2}\frac{1}{2}); \ C'^{'}_21; T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \ C-1 \ WP; 1
K; (\frac{1}{2}\frac{1}{2}0); \ C^+; C'^{'}_22; T; \ R_2; 1; \sqrt{-1}, 1;
R_4; 1; -1, 1;
R_6; 1; -(-1)^{2/3}, 1;
H; (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \ C^+; C'^{'}_22; T; \ R_2; 1; \sqrt{-1}, 1;
R_4; 1; -1, 1;
R_6; 1; -(-1)^{2/3}, 1;
Δ; ΓA; \ C^+; C'^{'}_22; T; \ R_2; 1; \sqrt{-1}, 1;
R_4; 1; -1, 1;
R_6; 1; -(-1)^{2/3}, 1;
U; ML; \ E, C'^{'}_21; T; \ R_2; 1; -1, 1;
P; KH; \ C^+; C'^{'}_22; T; \ R_2; 1; \sqrt{-1}, 1;
R_4; 1; -1, 1;
R_6; 1; -(-1)^{2/3}, 1;
T; ΓK; \ E, C'^{'}_22; T; \ R_2; 1; -1, 1;
S; AH; \ E, C'^{'}_22; T; \ R_2; 1; -1, 1;
T'; MK; \ E, C'^{'}_21; T; \ R_2; 1; -1, 1;
S'; LH; \ E, C'^{'}_21; T; \ R_2; 1; -1, 1;
Σ; ΓM; \ C'^{'}_21; \ R_2; 1; i;
R_4; 1; -i;
R_6; 1; i;
R_{12}; 1; -i;
$\Gamma_h; \{C^{+}_{3\bar{1}}[00\bar{2}], C_{21}[00\bar{1}\bar{3}]; T; Non-Centrosymmetric; with SOC$

$\Gamma; (000); \ C^{+}_{3\bar{1}}, C_{21}, T; \{R_3, R_4\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \ C-3 WP; 3$

$M; (0\bar{1}\bar{2}0); \ C'_{21}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \ C-1 WP; 1$

$A; (00\bar{2}); \ C^{+}_{3\bar{1}}, C_{21}, T; \{R_3, R_4\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \ C-3 WP; 3$

$L; (0\bar{1}\bar{2}0); \ C^{+}_{21}, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \ C-1 WP; 1$

$K; (\bar{1}\bar{2}\bar{1}\bar{0}); \ C^{+}_{3\bar{1}}, C_{21}; \ R_3; 1; -1, i$

$\ R_4; 1; -1, -i$

$\ R_6; 2; \frac{\sigma_0-i\sqrt{3}\sigma_2}{2}, i\sigma_3; \ C-1 WP; 1$

$H; (\bar{1}\bar{2}\bar{1}\bar{1}); \ C^{+}_{3\bar{1}}, C_{21}; \ R_3; 1; -1, i$

$\ R_4; 1; -1, -i$

$\ R_6; 2; \frac{\sigma_0-i\sqrt{3}\sigma_2}{2}, i\sigma_3; \ C-1 WP; 1$

$\Delta; \ \Gamma A; \ C^{+}_{3\bar{1}}, C_{21}, T; \ R_2; 1; \sqrt[3]{-1}, 1$

$\ R_4; 1; -1, 1$

$\ R_6; 1; -(-1)^{2/3}, 1$

$U; \ \ML; \bar{E}, C_{21}'; T; \ R_2; 1; -1, 1$

$P; \ KH; \ C^{+}_{3\bar{1}}; \ R_2; 1; \sqrt[3]{-1}$

$\ R_4; 1; -1$

$\ R_6; 1; -(-1)^{2/3}$

$T; \ \Gamma K; \ C_{21}'; \ R_2; 1; i$

$\ R_4; 1; -i$

$S; \ \AH; \ C_{21}'; \ R_2; 1; -i$

$\ R_6; 1; i$

$T'; \MK; \ C_{21}'; \ R_2; 1; i$

$\ R_4; 1; -i$

$S'; \ LH; \ C_{21}'; \ R_6; 1; i$

$\ R_{12}; 1; -i$

$\Sigma; \ \Gamma M; \bar{E}, C_{21}'; T; \ R_2; 1; -1, 1$

$R; \ AL; \bar{E}, C_{21}'; T; \ R_2; 1; -1, 1$
| Point | Notation | Symmetry | Reflections | Wave Polarization |
|-------|----------|----------|-------------|------------------|
| Γ     | (000)    | $C_3^+$, $C_{21}'$, $T$; $\{R_3, R_4\}$; $2; -\sigma_0, i\sigma_3, -i\sigma_2$; C-3 WP; 3 | $\Gamma$ | $\Gamma$ |
|       |          |          | $R_6$; $2; \frac{\sigma_0 - i\sqrt{3}\sigma_3}{2}, i\sigma_3, -i\sigma_2$; C-1 WP; 1 | $\Gamma$ | $\Gamma$ |
| Z     | ($\frac{1}{2} \frac{1}{2} \frac{1}{2}$) | $C_3^+ C_{21}' T$; $\{R_3, R_4\}$; $2; -\sigma_0, i\sigma_3, -i\sigma_2$; C-3 WP; 3 | $\Gamma$ | $\Gamma$ |
|       |          |          | $R_6$; $2; \frac{\sigma_0 - i\sqrt{3}\sigma_3}{2}, i\sigma_3, -i\sigma_2$; C-1 WP; 1 | $\Gamma$ | $\Gamma$ |
| L     | (0 $\frac{1}{2}$ 0) | $C_{22}' T$; $\{R_2, R_4\}$; $2; i\sigma_3, -i\sigma_2$; C-1 WP; 1 | $\Gamma$ | $\Gamma$ |
|       | (a)F; (0 $\frac{1}{2}$ $\frac{1}{2}$) | $C_{21}' T$; $\{R_2, R_4\}$; $2; i\sigma_3, -i\sigma_2$; C-1 WP; 1 | $\Gamma$ | $\Gamma$ |
|       | (b)F; ($\frac{1}{2} \frac{1}{2} 0$) | $C_{23}' T$; $\{R_2, R_4\}$; $2; i\sigma_3, -i\sigma_2$; C-1 WP; 1 | $\Gamma$ | $\Gamma$ |
| Λ     | $\Gamma \Lambda / \Gamma Z$; $C_3^+ C_{22}' T$; $R_2$; $1; \sqrt[3]{-1}, 1$; | $\Gamma$ | $\Gamma$ |
|       |          |          | $R_4$; $1; -1, 1$; | $\Gamma$ | $\Gamma$ |
|       |          |          | $R_6$; $1; -(-1)^{2/3}, 1$; | $\Gamma$ | $\Gamma$ |
| Π     | $Z P$; $C_3^+ C_{22}' T$; $R_2$; $1; \sqrt[3]{-1}, 1$; | $\Gamma$ | $\Gamma$ |
|       |          |          | $R_4$; $1; -1, 1$; | $\Gamma$ | $\Gamma$ |
|       |          |          | $R_6$; $1; -(-1)^{2/3}, 1$; | $\Gamma$ | $\Gamma$ |
| Β     | $Z B$; $C_{21}'$; $R_2$; $1; i$; | $\Gamma$ | $\Gamma$ |
|       |          |          | $R_4$; $1; -i$; | $\Gamma$ | $\Gamma$ |
| Σ     | $\Gamma F / \Gamma \Sigma$; $C_{21}'$; $R_2$; $1; i$; | $\Gamma$ | $\Gamma$ |
|       |          |          | $R_4$; $1; -i$; | $\Gamma$ | $\Gamma$ |
| Q     | $F Q$; $C_{23}'$; $R_2$; $1; i$; | $\Gamma$ | $\Gamma$ |
|       |          |          | $R_4$; $1; -i$; | $\Gamma$ | $\Gamma$ |
| Y     | $L Z / L Y$; $C_{22}'$; $R_2$; $1; i$; | $\Gamma$ | $\Gamma$ |
|       |          |          | $R_4$; $1; -i$; | $\Gamma$ | $\Gamma$ |
\[ \Gamma_h; \{ C_3^+|000\}, \{ \sigma_v|000\}, T; \text{Non-Centrosymmetric with SOC} \]

\[ \Gamma; (000): \quad C_3^+ \sigma_v, T; \{ R_3, R_4 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-WNLs;} \]
\[ R_6; \quad 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\Gamma A} \]

\[ M; (0\frac{1}{2}0): \quad \sigma_v, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2; \quad \text{P-WNL;} \]

\[ A; (00\frac{1}{2}): \quad C_3^+ \sigma_v, T; \{ R_3, R_4 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-WNLs;} \]
\[ R_6; \quad 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\Gamma A} \]

\[ L; (0\frac{1}{2}\frac{1}{2}): \quad \sigma_v, T; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2; \quad \text{P-WNL;} \]

\[ K; (\frac{1}{3}\frac{2}{3}0): \quad C_3^+ \sigma_v, T; \{ R_2 \}; 1; \sqrt{-1}, 1; \]
\[ R_4; \quad 1; -1, 1; \]
\[ R_6; \quad 1; -(-1)^{2/3}, 1; \]

\[ H; (\frac{1}{3}\frac{2}{3}\frac{1}{2}): \quad C_3^+ \sigma_v, T; \{ R_2 \}; 1; \sqrt{-1}, 1; \]
\[ R_4; \quad 1; -1, 1; \]
\[ R_6; \quad 1; -(-1)^{2/3}, 1; \]

\[ \Delta; \Gamma A; \quad C_3^+ \sigma_v, R_3; \quad 1; -1, i; \]
\[ R_4; \quad 1; -1, -i; \]
\[ R_6; \quad 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2}, i\sigma_3; \quad \text{WNL}; \pi \]

\[ U; \text{ML}; \quad \sigma_v; \quad R_2; \quad 1; i; \]
\[ R_4; \quad 1; -i; \]

\[ P; \text{KH}; \quad C_3^+ \sigma_v; \quad R_2; \quad 1; \sqrt{-1}; \]
\[ R_4; \quad 1; -1; \]
\[ R_6; \quad 1; -(-1)^{2/3}; \]

\[ T; \Gamma K; \quad \bar{E}, T \sigma_v; \quad R_2; \quad 1; -1, 1; \]

\[ S; \text{AH}; \quad \bar{E}, T \sigma_v; \quad R_2; \quad 1; -1, 1; \]

\[ T'; \text{MK}; \quad \bar{E}, T \sigma_v; \quad R_2; \quad 1; -1, 1; \]

\[ S'; \text{LH}; \quad \bar{E}, T \sigma_v; \quad R_2; \quad 1; -1, 1; \]

\[ \Sigma; \Gamma M; \quad \sigma_v; \quad R_2; \quad 1; i; \]
\[ R_4; \quad 1; -i; \]

\[ R; \text{AL}; \quad \sigma_v; \quad R_2; \quad 1; i; \]
\[ R_4; \quad 1; -i; \]
Γₜ; \{C₃⁺[000], [σ₁₁][000], T\}; Non-Centrosymmetric; with SOC

Γ; (000); \( C₃⁺[σ₁₁,T]; \{R₃,R₄\}; 2; -σ₀, iσ₃, -iσ₂; \)  P-WNLₘ;
   \( R₆; \frac{σ₀-i\sqrt{3}σ₂}{2}, iσ₃, -iσ₂; \)  P-WNLₘ;

M; (012); [σ₁₁,T]; \{R₂,R₄\}; 2; iσ₃, -iσ₂;  P-WNLₘ;

A; (00½); \( C₃⁺[σ₁₁,T]; \{R₃,R₄\}; 2; -σ₀, iσ₃, -iσ₂; \)  P-WNLₘ;
   \( R₆; \frac{σ₀-i\sqrt{3}σ₂}{2}, iσ₃, -iσ₂; \)  P-WNLₘ;  Γₐ;

L; (0½1); [σ₁₁,T]; \{R₂,R₄\}; 2; iσ₃, -iσ₂;  P-WNLₘ;

K; (½30); \( C₃⁺[σ₁₁]; \) \( R₃; \)  1; -1, i;
   \( R₄; \)  1; -1, -i;
   \( R₆; \frac{σ₀-i\sqrt{3}σ₂}{2}, iσ₃, -iσ₂; \)  P-WNLₘ;  Kₗ;

H; (½3½); \( C₃⁺[σ₁₁]; \) \( R₃; \)  1; -1, i;
   \( R₄; \)  1; -1, -i;
   \( R₆; \frac{σ₀-i\sqrt{3}σ₂}{2}, iσ₃, -iσ₂; \)  P-WNLₘ;  Kₗ;

Δ; Γₐ; \( C₃⁺[σ₁₁]; \) \( R₃; \)  1; -1, i;
   \( R₄; \)  1; -1, -i;
   \( R₆; \frac{σ₀-i\sqrt{3}σ₂}{2}, iσ₃, -iσ₂; \)  WNLₘ;  π;

U; ML; [σ₁₁]; \( R₂; \)  1; i;
   \( R₄; \)  1; -i;

P; KH; \( C₃⁺[σ₁₁]; \) \( R₃; \)  1; -1, i;
   \( R₄; \)  1; -1, -i;
   \( R₆; \frac{σ₀-i\sqrt{3}σ₂}{2}, iσ₃, -iσ₂; \)  WNLₘ;  π;

T; Γₖ; [σ₁₂]; \( R₂; \)  1; i;
   \( R₄; \)  1; -i;

S; AH; [σ₁₂]; \( R₂; \)  1; i;
   \( R₄; \)  1; -i;

T'; MK; [σ₁₁]; \( R₂; \)  1; i;
   \( R₄; \)  1; -i;

S'; LH; [σ₁₁]; \( R₂; \)  1; i;
   \( R₄; \)  1; -i;

Σ; Γₘ; \( E,T[σ₁₁]; \) \( R₂; \)  1; -1, 1;

R; AL; \( E,T[σ₁₁]; \) \( R₂; \)  1; -1, 1;
\[ \Gamma_h; \{ C_3^+ |000 \}, \{ \sigma_{v1} |00\frac{1}{2} \}, \mathcal{T}; \text{Non-Centrosymmetric with SOC} \]

\[ \Gamma; (000); C_3^+ \sigma_{v1}, \mathcal{T}; \{ R_3, R_4 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-WNLs;} \]
\[ R_6; 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2; \quad \text{P-WNL}_{\mathcal{T}A}; \]

\[ M; (0\frac{1}{2}0); \sigma_{v1}, \mathcal{T}; \{ R_2, R_4 \}; 2; i\sigma_3, -i\sigma_2; \quad \text{P-WNL;} \]

\[ A; (00\frac{1}{2}); C_3^+ \sigma_{v1}, \mathcal{T}; \{ R_1, R_1 \}; 2; \sigma_0, \sigma_0, -i\sigma_2; \quad \text{P-WNLs;} \]
\[ \{ R_2, R_2 \}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \quad \text{P-WNLs;} \]
\[ \{ R_5, R_5 \}; 4; \Gamma_{0.0 + i\sqrt{3}0.2}, \Gamma_{0.3, i\Gamma_{2.0}}; \quad \text{DP;} \quad 0 \]

\[ L; (0\frac{1}{2}\frac{1}{2}); \sigma_{v1}, \mathcal{T}; \{ R_1, R_1 \}; 2; \sigma_0, -i\sigma_2; \quad \text{P-WNL}_{\mathcal{L}H}; \]
\[ \{ R_3, R_3 \}; 2; -\sigma_0, -i\sigma_2; \quad \text{P-WNL}_{\mathcal{L}H}; \]

\[ K; (\frac{1}{3}00); C_3^+ \mathcal{T}\sigma_{v2}; \]
\[ R_2; 1; \sqrt{3}, 1; \]
\[ R_4; 1; -1, 1; \]
\[ R_6; 1; -(-1)^{2/3}, 1; \]

\[ H; (\frac{1}{3}\frac{1}{3}0); C_3^+ \mathcal{T}\sigma_{v2}; \]
\[ \{ R_2, R_2 \}; 2; \sqrt{3}, -\sigma_0, -i\sigma_2; \quad \text{P-WNLs;} \]
\[ \{ R_4, R_4 \}; 2; -\sigma_0, -i\sigma_2; \quad \text{P-WNLs;} \]
\[ \{ R_6, R_6 \}; 2; -(-1)^{2/3}\sigma_0, -i\sigma_2; \quad \text{P-WNLs;} \]

\[ \Delta; \Gamma_A; C_3^+ \sigma_{v1}; \]
\[ R_3; 1; -1, i; \]
\[ R_4; 1; -1, -i; \]
\[ R_6; 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3; \quad \text{WNL;} \quad \pi \]

\[ U; \text{ML}; \sigma_{v1}; \]
\[ R_2; 1; i; \]
\[ R_4; 1; -i; \]

\[ P; \text{KH}; C_3^+ \sigma_{v1}; \]
\[ R_2; 1; \sqrt{3}, -1; \]
\[ R_4; 1; -1; \]
\[ R_6; 1; -(-1)^{2/3}; \]

\[ T; \Gamma_K; \mathcal{E}, \mathcal{T}\sigma_{v2}; \]
\[ R_2; 1; -1, 1; \]

\[ S; \text{AH}; \mathcal{E}, \mathcal{T}\sigma_{v2}; \]
\[ \{ R_2, R_2 \}; 2; -\sigma_0, -i\sigma_2; \quad \text{WNL;} \quad \pi \]

\[ T'; \text{MK}; \mathcal{E}, \mathcal{T}\sigma_{v1}; \]
\[ R_2; 1; -1, 1; \]

\[ S'; \text{LH}; \mathcal{E}, \mathcal{T}\sigma_{v1}; \]
\[ \{ R_2, R_2 \}; 2; -\sigma_0, -i\sigma_2; \quad \text{WNL;} \quad \pi \]

\[ \Sigma; \Gamma_M; \sigma_{v1}; \]
\[ R_2; 1; i; \]
\[ R_4; 1; -i; \]

\[ R; \text{AL}; \sigma_{v1}; \]
\[ R_2; 1; 1; \]
\[ R_4; 1; -1; \]
Γ; (0 0 0): $C_3^+ \sigma_{d1}, T$: \{R_3, R_4\}; 2: $-\sigma_0, i\sigma_3, -i\sigma_2$; P-WNLs; 

$R_6$: 2: $\frac{i\sigma_0 - \sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2$; P-WNL$_{P-WNL}$; 

M; (0 1/2 0): $\sigma_{d1}, T$: \{R_2, R_4\}; 2: $i\sigma_3, -i\sigma_2$; P-WNL; 

A; (0 0 1/2): $C_3^+ \sigma_{d1}, T$: \{R_1, R_1\}; 2: $\sigma_0, \sigma_0, -i\sigma_2$; P-WNLs; 

$\{R_2, R_2\}$; 2: $\sigma_0, -\sigma_0, -i\sigma_2$; P-WNLs; 

$\{R_5, R_5\}$; 4: $\Gamma_{0,0} + i\sqrt{3}\Gamma_{0,2}, \Gamma_{0,3}, i\Gamma_{2,0}$; DP; 0 0 0 

L; (0 1/2 1/2); $\sigma_{d1}, T$: \{R_1, R_1\}; 2: $\sigma_0, -i\sigma_2$; P-WNL$_{P-WNL}$; 

$\{R_3, R_3\}$; 2: $-\sigma_0, -i\sigma_2$; P-WNL$_{P-WNL}$; 

K; (1/2 3/2 0): $C_3^+ \sigma_{d1}$: 

$R_3$: 1: $-1, i$; 

$R_4$: 1: $-1, -i$; 

$R_6$: 2: $\frac{i}{2} (\sigma_0 - \sqrt{3}\sigma_2), i\sigma_3$; WNL; π 

H; (1/2 3/2 1/2): $C_3^+ \sigma_{d1}$: 

$R_3$: 1: 1 1; 

$R_4$: 1: 1, -1; 

$R_5$: 2: $\frac{i}{2} (-\sigma_0 + i\sqrt{3}\sigma_2), \sigma_3$; WNL; π 

Δ; ΓA; $C_3^+ \sigma_{d1}$: 

$R_3$: 1: $-1, i$; 

$R_4$: 1: $-1, -i$; 

$R_6$: 2: $\frac{i}{2} (\sigma_0 - \sqrt{3}\sigma_2), i\sigma_3$; WNL; π 

U; ML; $\sigma_{d1}$: 

$R_2$: 1: $i$; 

$R_4$: 1: $-i$; 

P; KH; $C_3^+ \sigma_{d1}$: 

$R_3$: 1: $-1, i$; 

$R_4$: 1: $-1, -i$; 

$R_6$: 2: $\frac{i}{2} (\sigma_0 - \sqrt{3}\sigma_2), i\sigma_3$; WNL; π 

T; ΓK; $\sigma_{d2}$: 

$R_2$: 1: $i$; 

$R_4$: 1: $-i$; 

S; AH; $\sigma_{d2}$: 

$R_2$: 1: 1; 

$R_4$: 1: $-1$; 

T'; MK; $\sigma_{d1}$: 

$R_2$: 1: 1; 

$R_4$: 1: $-1$; 

S'; LH; $\sigma_{d1}$: 

$R_2$: 1: 1; 

$R_4$: 1: $-1$; 

Σ; ΓM; $\bar{E}, T \sigma_{d1}$: 

$R_2$: 1: $-1, 1$; 

R; AL; $\bar{E}, T \sigma_{d1}$: 

$\{R_2, R_2\}$; 2: $-\sigma_0, -i\sigma_2$; WNL; π
| Symbol | Description | Notation | Wave Function | Selection Rules | Type |
|--------|-------------|----------|---------------|-----------------|------|
| Γ   | (000) | $C_3^+ \sigma_{d1}, T$ | $(R_3, R_4)$ | 2; $-\sigma_0, i\sigma_3, -i\sigma_2$ | P-WNLs |
| $R_6$ | 2; $\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2$ | P-WNL_{ΓA/ΓZ} |
| Z   | $(\frac{1}{2} \frac{1}{2} \frac{1}{2})$ | $C_3^+ \sigma_{d1}, T$ | $(R_3, R_4)$ | 2; $-\sigma_0, i\sigma_3, -i\sigma_2$ | P-WNLs |
| $R_6$ | 2; $\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2$ | P-WNL_{ΓA/ΓZ} |
| L   | (0120) | $\sigma_{d2}, T$ | $(R_2, R_4)$ | 2; $i\sigma_3, -i\sigma_2$ | P-WNL |
| (a) F | (0120) | $\sigma_{d2}, T$ | $(R_2, R_4)$ | 2; $i\sigma_3, -i\sigma_2$ | P-WNL |
| (b) F | (1120) | $\sigma_{d3}, T$ | $(R_2, R_4)$ | 2; $i\sigma_3, -i\sigma_2$ | P-WNL |
| Λ   | ΓA/ΓZ | $C_3^+ \sigma_{d1}$ | $R_3$ | 1; $-1, i$ | |
| $R_4$ | 1; $-1, -i$ | |
| $R_6$ | 2; $\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3$ | WNL; $\pi$ |
| P   | ZP | $C_3^+ \sigma_{d1}$ | $R_3$ | 1; $-1, -1$ | |
| $R_4$ | 1; $-1, 1$ | |
| $R_6$ | 2; $\frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, -\sigma_3$ | WNL; $\pi$ |
| B   | ZB | $E, T\sigma_{d1}$ | $R_2$ | 1; $-1, 1$ | |
| Σ   | ΓF/ΓΣ | $E, T\sigma_{d1}$ | $R_2$ | 1; $-1, 1$ | |
| Q   | FQ | $E, T\sigma_{d3}$ | $R_2$ | 1; $-1, 1$ | |
| Y   | LZ/LY | $E, T\sigma_{d2}$ | $R_2$ | 1; $-1, 1$ | |
\[ \begin{array}{ll}
\Gamma; & (000); \quad C^+_0, \{ \sigma_{d1} | \frac{1}{2} \frac{1}{2} \}, T; \text{Non-Centrosymmetric; with SOC} \\
R_6; & 2; \quad \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, \sigma_3, -i\sigma_2; \quad \text{P-WNLs; } \Gamma \Lambda / \Gamma Z; \quad \Gamma_0, 0; + \frac{i\Gamma_0}{2}, \Gamma_0, 0, 0; \quad \text{DP; } 0 \\
L; & (\frac{1}{2} \frac{1}{2} 0); \quad \sigma_{d2}, T; \quad \{ R_1, R_4 \}; 2; \quad 0, -i\sigma_2; \quad \text{P-WNLs; } \Gamma \Lambda / \Gamma Z; \quad \Gamma_0, 0; \quad \text{P-WNL; } \pi \\
R_6; & 2; \quad \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3; \quad \text{WNL; } \pi \\
\Sigma; & \Gamma F / \Gamma \Sigma; \quad \tilde{E}, T \sigma_{d1}; \quad \{ R_1, R_4 \}; 2; \quad 0, -i\sigma_2; \quad \text{WNL; } \pi \\
\Sigma; & \Gamma F / \Gamma \Sigma; \quad \tilde{E}, T \sigma_{d1}; \quad \{ R_1, R_4 \}; 2; \quad 0, -i\sigma_2; \quad \text{WNL; } \pi \\
\tilde{E}, T \sigma_{d2}; \quad \{ R_2, R_4 \}; 2; \quad 0, -i\sigma_2; \quad \text{WNL; } \pi \\
\end{array} \]
\( \Gamma_h; \{ C_3^+\{000\}, \{ C_2'\{000\}, \{ I\{000\}, T; \text{Centrosymmetric; with SOC} \)

\( \Gamma; (000); C_3^+ C_2', I, T; \{ R_3, R_4 \}; 2; -\sigma_0,i\sigma_3,\sigma_0,-i\sigma_3;
R_6; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3,\sigma_0,-i\sigma_2;
\{ R_9, R_{10} \}; 2; -\sigma_0,i\sigma_3,\sigma_0,-i\sigma_2;
R_{12}; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3,\sigma_0,-i\sigma_2;
\)

\( M; (01\frac{1}{2}0); C_2', I, T; \{ R_2, R_4 \}; 2; i\sigma_3,\sigma_0,-i\sigma_2;
\{ R_6, R_8 \}; 2; i\sigma_3,\sigma_0,-i\sigma_2;
\)

\( A; (00\frac{1}{2}0); C_2^+ C_2', I, T; \{ R_3, R_4 \}; 2; -\sigma_0,i\sigma_3,\sigma_0,-i\sigma_2;
R_6; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3,\sigma_0,-i\sigma_2;
\{ R_9, R_{10} \}; 2; -\sigma_0,i\sigma_3,\sigma_0,-i\sigma_2;
R_{12}; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3,\sigma_0,-i\sigma_2;
\)

\( L; (0\frac{1}{2}\frac{1}{2}0); C_2^+, I, T; \{ R_2, R_4 \}; 2; i\sigma_3,\sigma_0,-i\sigma_2;
\{ R_6, R_8 \}; 2; i\sigma_3,\sigma_0,-i\sigma_2;
\)

\( K; (\frac{1}{3}\frac{1}{3}0); C_3^+ \sigma_{d1}, I, T; \{ R_3, R_4 \}; 2; -\sigma_0,i\sigma_3,-i\sigma_2;
R_6; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3,-i\sigma_2;
\)

\( H; (\frac{1}{3}\frac{1}{3}\frac{1}{3}0); C_3^+ \sigma_{d1}, I, T; \{ R_3, R_4 \}; 2; -\sigma_0,i\sigma_3,-i\sigma_2;
R_6; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3,-i\sigma_2;
\)

\( \Delta; \Gamma A; C_3^+ \sigma_{d1}, I, T; \{ R_3, R_4 \}; 2; -\sigma_0,i\sigma_3,-i\sigma_2;
R_6; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3,-i\sigma_2;
\)

\( U; M L; \sigma_{d1}, I, T; \{ R_2, R_4 \}; 2; i\sigma_3,-i\sigma_2;
\)

\( P; K H; C_3^+ \sigma_{d1}, I, T; \{ R_3, R_4 \}; 2; -\sigma_0,i\sigma_3,-i\sigma_2;
R_6; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3,-i\sigma_2;
\)

\( T; \Gamma K; \sigma_{d2}, I, T; \{ R_2, R_4 \}; 2; i\sigma_3,-i\sigma_2;
S; \Delta H; \sigma_{d2}, I, T; \{ R_2, R_4 \}; 2; i\sigma_3,-i\sigma_2;
T'; \Delta K; \sigma_{d1}, I, T; \{ R_2, R_4 \}; 2; i\sigma_3,-i\sigma_2;
S'; \Delta L; \sigma_{d1}, I, T; \{ R_2, R_4 \}; 2; i\sigma_3,-i\sigma_2;
\)

\( \Sigma; \Gamma M; C_2', I, T; \{ R_2, R_4 \}; 2; i\sigma_3,-i\sigma_2;
\)

\( R; A L; C_2', I, T; \{ R_2, R_4 \}; 2; i\sigma_3,-i\sigma_2;
\)
\( \Gamma_h; \{C'_3[000], \{C'_2[001}\}, \{I[000]\}, T; \text{Centrosymmetric with SOC} \)

\[
\begin{array}{ll}
\Gamma: & (000); \quad C'_3^+, C'_2, I, T; \quad \{R_3, R_4\}; \quad 2; \quad -\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2; \\
& \quad R_6; \quad 2; \quad \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, \sigma_0, -i\sigma_2; \\
& \quad \{R_0, R_{10}\}; \quad 2; \quad -\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2; \\
& \quad R_{12}; \quad 2; \quad \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -\sigma_0, -i\sigma_2; \\
M: & (00\frac{1}{2}); \quad C'_2, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, \sigma_0, -i\sigma_2; \\
& \quad \{R_6, R_8\}; \quad 2; \quad i\sigma_3, -\sigma_0, -i\sigma_2; \\
A: & (00\frac{1}{2}); \quad C'_3^+, C'_2, I, T; \quad \{R_{10}, R_{10}\}; \quad 4; \quad -\Gamma_0, 0, i\Gamma_0, 3, \Gamma_0, 1, -\Gamma_2, 1; \quad \text{CDP: 0} \\
& \quad \{R_{17}, R_{18}\}; \quad 4; \quad \frac{i\Gamma_0, 0 - i\sqrt{3}\Gamma_0, 2}{2}, i\Gamma_3, 1, \Gamma_0, 3, -i\Gamma_2, 0; \quad \text{DP: 0} \\
L: & (00\frac{1}{2}); \quad C'_2, E, I, T; \quad \{R_{10}, R_{10}\}; \quad 4; \quad i\Gamma_0, 2, -\Gamma_0, 0, \Gamma_0, 3, i\Gamma_2, 0; \quad \text{DP: 0} \\
K: & (\frac{1}{2}\frac{1}{2}0); \quad C'_3^+, \sigma_{d1}, I, T; \quad \{R_3, R_4\}; \quad 2; \quad -\sigma_0, i\sigma_3, -i\sigma_2; \\
& \quad R_6; \quad 2; \quad \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2; \\
H: & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad C'_3^+, \sigma_{d1}, I, T; \quad \{R_1, R_2\}; \quad 2; \quad \sigma_0, \sigma_3, -i\sigma_2; \\
& \quad R_5; \quad 2; \quad \frac{1}{2} (-\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -i\sigma_2; \\
\Delta: \quad \Gamma A; \quad C'_3^+, \sigma_{d1}, I, T; \quad \{R_3, R_4\}; \quad 2; \quad -\sigma_0, i\sigma_3, -i\sigma_2; \\
& \quad R_6; \quad 2; \quad \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2; \\
U: \quad \Gamma L; \quad \sigma_{d1}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, -i\sigma_2; \\
P: \quad \Gamma H; \quad C'_3^+, \sigma_{d1}, I, T; \quad \{R_3, R_4\}; \quad 2; \quad -\sigma_0, i\sigma_3, -i\sigma_2; \\
& \quad R_6; \quad 2; \quad \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2; \\
T: \quad \Gamma K; \quad \sigma_{d2}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, -i\sigma_2; \\
S: \quad \Gamma H; \quad \sigma_{d2}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad \sigma_3, -i\sigma_2; \\
T': \quad \Gamma K; \quad \sigma_{d1}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, -i\sigma_2; \\
S': \quad \Gamma L; \quad \sigma_{d1}, I, T; \quad \{R_2, R_4\}; \quad 2; \quad \sigma_3, -i\sigma_2; \\
\Sigma: \quad \Gamma M; \quad C'_2, I, T; \quad \{R_2, R_4\}; \quad 2; \quad i\sigma_3, -i\sigma_2; \\
R: \quad \Gamma L; \quad C'_2, E, I, T; \quad \{R_3, R_5\}; \quad 2; \quad -\sigma_0, \sigma_0, -i\sigma_2; \\
& \quad \{R_7, R_7\}; \quad 2; \quad i\sigma_0, \sigma_0, -i\sigma_2;
\end{array}
\]
$\Gamma_\chi; (C_3^+|000\rangle, C_2^0|000\rangle, I|000\rangle, T; \text{Centrosymmetric; with SOC})$

$\Gamma$: (000); $C_3^+ C_2^0 I T; \{R_3, R_4\}$: 2; $-\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2$;

$R_6$: 2; $\frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, \sigma_0, -i\sigma_2$;

$\{R_9, R_{10}\}$: 2; $-\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2$;

$R_{12}$: 2; $\frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -\sigma_0, -i\sigma_2$;

$M$: (010); $C_2^0 I T; \{R_2, R_4\}$: 2; $i\sigma_3, \sigma_0, -i\sigma_2$;

$\{R_6, R_8\}$: 2; $i\sigma_3, -\sigma_0, -i\sigma_2$;

$A$: (001); $C_3^+ C_2^0 I T; \{R_3, R_4\}$: 2; $-\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2$;

$R_6$: 2; $\frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, \sigma_0, -i\sigma_2$;

$\{R_9, R_{10}\}$: 2; $-\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2$;

$R_{12}$: 2; $\frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -\sigma_0, -i\sigma_2$;

$L$: (011); $C_2^0 I T; \{R_2, R_4\}$: 2; $i\sigma_3, \sigma_0, -i\sigma_2$;

$\{R_6, R_8\}$: 2; $i\sigma_3, -\sigma_0, -i\sigma_2$;

$K$: (100); $C_3^+ C_2^0 I T; \{R_3, R_4\}$: 2; $-\sigma_0, i\sigma_3, -i\sigma_2$;

$R_6$: 2; $\frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2$;

$H$: (110); $C_3^+ C_2^0 I T; \{R_3, R_4\}$: 2; $-\sigma_0, i\sigma_3, -i\sigma_2$;

$R_6$: 2; $\frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2$;

$\Delta$: $\Gamma A; C_3^+ \sigma_{v1} I T; \{R_3, R_4\}$: 2; $-\sigma_0, i\sigma_3, -i\sigma_2$;

$R_6$: 2; $\frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2$;

$U$: $M L; \sigma_{v1} I T; \{R_2, R_4\}$: 2; $i\sigma_3, -i\sigma_2$;

$P$: $K H; C_3^+ I T; \{R_2, R_4\}$: 2; $\frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2$;

$\{R_4, R_4\}$: 2; $-\sigma_0, -i\sigma_2$;

$T$: $\Gamma K; C_2^0 I T; \{R_2, R_4\}$: 2; $i\sigma_3, -i\sigma_2$;

$S$: $A H; C_2^0 I T; \{R_2, R_4\}$: 2; $i\sigma_3, -i\sigma_2$;

$T'$: $M K; C_2^0 I T; \{R_2, R_4\}$: 2; $i\sigma_3, -i\sigma_2$;

$S'$: $L H; C_2^0 I T; \{R_2, R_4\}$: 2; $i\sigma_3, -i\sigma_2$;

$\Sigma$: $\Gamma M; \sigma_{v1} I T; \{R_2, R_4\}$: 2; $i\sigma_3, -i\sigma_2$;

$R$: $A L; \sigma_{v1} I T; \{R_2, R_4\}$: 2; $i\sigma_3, -i\sigma_2$;
\[ \Gamma_h; \{ C_{3v}^+ \{000\}, \{ C_{6v}^+ \{00\} \}, \{ T \{000\}, T \}; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; (000); \quad C_{3v}^+ \cdot C_{6v}^+, I; T; \{ R_3, R_4 \}; \quad 2; -\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ R_6; \quad 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ \{ R_9, R_{10} \}; \quad 2; -\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2; \]
\[ R_{12}; \quad 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ M; (0\frac{1}{2}0); \quad C_{6v}^+ \cdot I; T; \{ R_2, R_4 \}; \quad 2; i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ R_6; \quad 2; i\sigma_3, -\sigma_0, -i\sigma_2; \]

\[ A; (00\frac{1}{2}); \quad \tilde{C}_{3v}^+ \cdot C_{21}^+, I; T; \{ R_{10}, R_{10} \}; \quad 4; -\Gamma_{0,0}, i\Gamma_{0,3}, \Gamma_{0,3}, -\Gamma_{2,1}; \quad \text{CDP}; \quad 0 \]
\[ \{ R_{17}, R_{18} \}; \quad 4; \frac{\Gamma_{0,0} - i\sqrt{3}\Gamma_{0,3}}{2}, i\Gamma_{3,1}, \Gamma_{0,3}, -i\Gamma_{2,0}; \quad \text{DP}; \quad 0 \]

\[ L; (0\frac{1}{2}0); \quad C_{21}^+ \cdot E, I; T; \{ R_{10}, R_{10} \}; \quad 4; i\Gamma_{0,2}, -\Gamma_{0,0}, \Gamma_{0,3}, i\Gamma_{2,0}; \quad \text{DP}; \quad 0 \]

\[ K; (\frac{1}{3}0\frac{1}{3}); \quad C_{3v}^+ \cdot C_{21}^+, I; T; \{ R_3, R_4 \}; \quad 2; -\sigma_0, i\sigma_3, -i\sigma_2; \]
\[ R_6; \quad 2; \frac{1}{2} \left( \sigma_0 - i\sqrt{3}\sigma_2 \right), i\sigma_3, -i\sigma_2; \]

\[ H; (\frac{1}{3}0\frac{1}{3}); \quad C_{3v}^+ \cdot C_{21}^+, I; T; \{ R_3, R_4 \}; \quad 2; -\sigma_0, i\sigma_3, -i\sigma_2; \]
\[ R_4, R_4; \quad 2; -\sigma_0, -i\sigma_0, -i\sigma_2; \]
\[ R_6, R_6; \quad 4; \frac{\Gamma_{0,0} - i\sqrt{3}\Gamma_{0,3}}{2}, i\Gamma_{0,3}, i\Gamma_{2,0}; \quad \text{DP}; \quad 0 \]

\[ \Delta; \Gamma_\alpha; \quad C_{3v}^+ \cdot \sigma_{v1}, I; T; \{ R_3, R_4 \}; \quad 2; -\sigma_0, i\sigma_3, -i\sigma_2; \]
\[ R_6; \quad 2; \frac{1}{2} \left( \sigma_0 - i\sqrt{3}\sigma_2 \right), i\sigma_3, -i\sigma_2; \]

\[ U; \Gamma \alpha; \quad \sigma_{v1}, I; T; \{ R_2, R_4 \}; \quad 2; i\sigma_3, -i\sigma_2; \]

\[ P; \Gamma \alpha; \quad C_{3v}^+, I; T; \{ R_2, R_4 \}; \quad 2; \frac{1}{2} \left( \sigma_0 + i\sqrt{3}\sigma_3 \right), -i\sigma_2; \]
\[ R_4, R_4; \quad 2; -\sigma_0, -i\sigma_2; \]

\[ T; \Gamma \alpha; \quad C_{21}^+, I; T; \{ R_2, R_4 \}; \quad 2; i\sigma_3, -i\sigma_2; \]

\[ S; \Gamma \alpha; \quad C_{22}^+, I; T; \{ R_5, R_3 \}; \quad 2; -i\sigma_0, \sigma_0, -i\sigma_2; \]
\[ R_7, R_7; \quad 2; i\sigma_0, \sigma_0, -i\sigma_2; \]

\[ T'; \Gamma \alpha; \quad C_{21}^+, I; T; \{ R_2, R_4 \}; \quad 2; i\sigma_3, -i\sigma_2; \]

\[ S'; \Gamma \alpha; \quad C_{22}^+, I; T; \{ R_5, R_3 \}; \quad 2; -i\sigma_0, \sigma_0, -i\sigma_2; \]
\[ R_7, R_7; \quad 2; i\sigma_0, \sigma_0, -i\sigma_2; \]

\[ \Sigma; \Gamma \alpha; \quad \sigma_{v1}, I; T; \{ R_2, R_4 \}; \quad 2; i\sigma_3, -i\sigma_2; \]

\[ R; \Gamma \alpha; \quad \sigma_{v1}, I; T; \{ R_2, R_4 \}; \quad 2; i\sigma_3, -i\sigma_2; \]
\( \Gamma \): (000): \( C_{3d}^+, C_{21}', \Gamma, T \); \( \{ R_3, R_4 \} \); 2; \(-\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2; \)
\( R_6; \) 2; \( \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, \sigma_0, -i\sigma_2; \)
\( \{ R_9, R_{10} \} \); 2; \(-\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2; \)
\( R_{12} \); 2; \( \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -\sigma_0, -i\sigma_2; \)

\( Z \): (\( \frac{1}{2} \frac{1}{2} \frac{1}{2} \)): \( C_{3d}^+, C_{21}', \Gamma, T \); \( \{ R_3, R_4 \} \); 2; \(-\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2; \)
\( R_6; \) 2; \( \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, \sigma_0, -i\sigma_2; \)
\( \{ R_9, R_{10} \} \); 2; \(-\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2; \)
\( R_{12} \); 2; \( \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -\sigma_0, -i\sigma_2; \)

\( L \): (0\( \frac{1}{2} \)0): \( C_{22}', \Gamma, T \); \( \{ R_2, R_4 \} \); 2; \( i\sigma_3, \sigma_0, -i\sigma_2; \)
\( \{ R_6, R_8 \} \); 2; \( i\sigma_3, -\sigma_0, -i\sigma_2; \)

\( a \)F\( (0 \frac{1}{2} \frac{1}{2}) \): \( C_{21}', \Gamma, T \); \( \{ R_2, R_4 \} \); 2; \( i\sigma_3, \sigma_0, -i\sigma_2; \)
\( \{ R_6, R_8 \} \); 2; \( i\sigma_3, -\sigma_0, -i\sigma_2; \)

\( b \)F\( (\frac{1}{2} \frac{1}{2} \frac{1}{2}) \): \( C_{23}', \Gamma, T \); \( \{ R_2, R_4 \} \); 2; \( i\sigma_3, \sigma_0, -i\sigma_2; \)
\( \{ R_6, R_8 \} \); 2; \( i\sigma_3, -\sigma_0, -i\sigma_2; \)

\( \Lambda \): \( \Gamma \Lambda/TZ \); \( C_{3d}^+, \sigma_{d3}, \Gamma, T \); \( \{ R_3, R_4 \} \); 2; \(-\sigma_0, i\sigma_3, -i\sigma_2; \)
\( R_6; \) 2; \( \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2; \)

\( P \): \( ZP \); \( C_{3d}^+, \sigma_{d3}, \Gamma, T \); \( \{ R_3, R_4 \} \); 2; \(-\sigma_0, i\sigma_3, -i\sigma_2; \)
\( R_6; \) 2; \( \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2; \)

\( B \): \( ZB \); \( C_{21}', \Gamma, T \); \( \{ R_2, R_4 \} \); 2; \( i\sigma_3, -i\sigma_2; \)

\( \Sigma \): \( \Gamma \Sigma \); \( C_{21}', \Gamma, T \); \( \{ R_2, R_4 \} \); 2; \( i\sigma_3, -i\sigma_2; \)

\( Q \): \( FQ \); \( C_{23}', \Gamma, T \); \( \{ R_2, R_4 \} \); 2; \( i\sigma_3, -i\sigma_2; \)

\( Y \): \( LZ/LY \); \( C_{22}', \Gamma, T \); \( \{ R_2, R_4 \} \); 2; \( i\sigma_3, -i\sigma_2; \)
\( \Gamma_{00}': \{ C_3^+ |000 \}, \{ C_2 | \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{ I |000 \}; T \); Centrosymmetric with SOC

\[ \begin{align*}
\Gamma; \hspace{0.5cm} (000): & \quad C_3^+ , C_2^1 , I, T; \{ R_3 , R_4 \}; \quad 2; -\sigma_0 , i\sigma_3 , \sigma_0 , -i\sigma_2 ; \\
R_6; & \quad 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2} , i\sigma_3 , \sigma_0 , -i\sigma_2 ; \\
\{ R_9 , R_{10} \}; & \quad 2; -\sigma_0 , i\sigma_3 , -\sigma_0 , -i\sigma_2 ; \\
R_{12}; & \quad 2; \frac{\sigma_0 + i\sqrt{3}\sigma_2}{2} , i\sigma_3 , -\sigma_0 , -i\sigma_2 ; \\
Z; \hspace{0.5cm} (\frac{1}{2} \frac{1}{2} \frac{1}{2}): & \quad C_3^+ , C_2^1 , I, T; \{ R_{10} , R_{10} \}; \quad 4; -\Gamma_{0,0} , i\Gamma_{0,3} , \Gamma_{0,1} , -\Gamma_{2,1} ; \\
\{ R_{17} , R_{18} \}; & \quad 4; \frac{\Gamma_{0,0} - i\sqrt{3}\Gamma_{0,3}}{2} , i\Gamma_{2,1} , \Gamma_{0,3} , -i\Gamma_{2,0} ; \\
\{ \Gamma_{DP} \}; & \quad 0 \\
L; \hspace{0.5cm} (0 \frac{1}{2} 0): & \quad C_2^1 , E , I, T; \{ R_{10} , R_{10} \}; \quad 4; i\Gamma_{0,2} , -\Gamma_{0,0} , \Gamma_{0,3} , i\Gamma_{2,0} ; \\
(a) F; \hspace{0.5cm} (0 \frac{1}{2} \frac{1}{2}): & \quad C_2^1 , I, T; \{ R_2 , R_4 \}; \quad 2; i\sigma_3 , \sigma_0 , -i\sigma_2 ; \\
\{ R_6 , R_8 \}; & \quad 2; i\sigma_3 , -\sigma_0 , -i\sigma_2 ; \\
(b) F; \hspace{0.5cm} (\frac{1}{2} \frac{1}{2} 0): & \quad C_2^1 , I, T; \{ R_2 , R_4 \}; \quad 2; i\sigma_3 , \sigma_0 , -i\sigma_2 ; \\
\{ R_6 , R_8 \}; & \quad 2; i\sigma_3 , -\sigma_0 , -i\sigma_2 ; \\
A; \hspace{0.5cm} \Gamma \Lambda / \Gamma Z; & \quad C_3^+ , \sigma_{d3} , I, T; \{ R_3 , R_4 \}; \quad 2; -\sigma_0 , i\sigma_3 , -i\sigma_2 ; \\
R_6; & \quad 2; \frac{1}{2} \left( \sigma_0 - i\sqrt{3}\sigma_2 \right) , i\sigma_3 , -i\sigma_2 ; \\
P; \hspace{0.5cm} \Gamma \Pi / \Gamma Z; & \quad C_3^+ , \sigma_{d3} , I, T; \{ R_3 , R_4 \}; \quad 2; -\sigma_0 , \sigma_3 , -i\sigma_2 ; \\
R_6; & \quad 2; \frac{1}{2} \left( \sigma_0 - i\sqrt{3}\sigma_2 \right) , \sigma_3 , -i\sigma_2 ; \\
B; \hspace{0.5cm} \Gamma Z B; & \quad C_2^1 , E , I, T; \{ R_5 , R_5 \}; \quad 2; i\sigma_0 , \sigma_0 , -i\sigma_2 ; \\
\{ R_7 , R_7 \}; & \quad 2; -i\sigma_0 , \sigma_0 , -i\sigma_2 ; \\
\Sigma; \hspace{0.5cm} \Gamma F / \Gamma \Sigma; & \quad C_2^1 , I, T; \{ R_2 , R_4 \}; \quad 2; i\sigma_3 , -i\sigma_2 ; \\
Q; \hspace{0.5cm} F Q; & \quad C_2^1 , I, T; \{ R_2 , R_4 \}; \quad 2; -i\sigma_3 , -i\sigma_2 ; \\
Y; \hspace{0.5cm} \Gamma_{LZ} / \Gamma_{LY}; & \quad C_2^1 , E , I, T; \{ R_5 , R_5 \}; \quad 2; -i\sigma_0 , \sigma_0 , -i\sigma_2 ; \\
\{ R_7 , R_7 \}; & \quad 2; i\sigma_0 , \sigma_0 , -i\sigma_2 ; \\
\end{align*} \]
SG 168

Γ; \{C^+_6[000], \mathcal{T}\}; Non-Centrosymmetric; with SOC

\begin{align*}
\Gamma & : (000) \quad C^+_6 \mathcal{T}; \\
& \quad \{R_2, R_{12}\}; 2; \sqrt{3} \sigma_0 + i \sigma_3, -i \sigma_2; \quad \text{C-1 WP}; 1 \\
& \quad \{R_4, R_{10}\}; 2; i \sigma_3, -i \sigma_2; \quad \text{C-3 WP}; 3 \\
& \quad \{R_6, R_8\}; 2; \sqrt{3} \sigma_0 - i \sigma_3, -i \sigma_2; \quad \text{C-1 WP}; 1 \\
M & : (0\frac{1}{2}0) \quad C_2 \mathcal{T}; \\
& \quad \{R_2, R_4\}; 2; i \sigma_3, -i \sigma_2; \quad \text{C-1 WP}; 1 \\
A & : (00\frac{1}{2}) \quad C^+_6 \mathcal{T}; \\
& \quad \{R_2, R_{12}\}; 2; \sqrt{3} \sigma_0 + i \sigma_3, -i \sigma_2; \quad \text{C-1 WP}; 1 \\
& \quad \{R_4, R_{10}\}; 2; i \sigma_3, -i \sigma_2; \quad \text{C-3 WP}; 3 \\
& \quad \{R_6, R_8\}; 2; \sqrt{3} \sigma_0 - i \sigma_3, -i \sigma_2; \quad \text{C-1 WP}; 1 \\
L & : (0\frac{1}{2}\frac{1}{2}) \quad C_2 \mathcal{T}; \\
& \quad \{R_2, R_4\}; 2; i \sigma_3, -i \sigma_2; \quad \text{C-1 WP}; 1 \\
K & : (\frac{1}{2}\frac{1}{2}\frac{1}{2}) \quad C^+_3 \mathcal{T}; \quad \{R_2, R_3\}; 2; \frac{\sigma_0 + i \sqrt{3} \sigma_3}{2}, \frac{\sigma_0 + i \sqrt{3} \sigma_3}{2}; \quad \text{C-1 WP}; 1 \\
& \quad \{R_4\}; 1; -1, 1; \\
H & : (\frac{1}{2}\frac{1}{2}\frac{1}{2}) \quad C^+_3 \mathcal{T}; \quad \{R_2, R_3\}; 2; \frac{\sigma_0 + i \sqrt{3} \sigma_3}{2}, \frac{\sigma_0 + i \sqrt{3} \sigma_3}{2}; \quad \text{C-1 WP}; 1 \\
& \quad \{R_4\}; 1; -1, 1; \\
\Delta & : \Gamma \Lambda; \quad C^+_6; \\
& \quad \{R_2\}; 1; \sqrt{-1}; \\
& \quad \{R_4\}; 1; i; \\
& \quad \{R_6\}; 1; (-1)^{5/6}; \\
& \quad \{R_8\}; 1; -\sqrt{-1}; \\
& \quad \{R_{10}\}; 1; -i; \\
& \quad \{R_{12}\}; 1; -(-1)^{5/6}; \\
U & : ML; \quad C_2; \\
& \quad \{R_2\}; 1; i; \\
& \quad \{R_4\}; 1; -i; \\
P & : KH; \quad C^+_3; \\
& \quad \{R_2\}; 1; \sqrt{-1}; \\
& \quad \{R_4\}; 1; -1; \\
& \quad \{R_6\}; 1; -(-1)^{2/3}; \\
T & : \Gamma \Lambda; \quad \hat{E}, C_2 T; \\
& \quad \{R_2\}; 1; -1, 1; \\
S & : \Lambda \Lambda; \quad \hat{E}, C_2 T; \\
& \quad \{R_2\}; 1; -1, 1; \\
T' & : MK; \quad \hat{E}, C_2 T; \\
& \quad \{R_2\}; 1; -1, 1; \\
S' & : LH; \quad \hat{E}, C_2 T; \\
& \quad \{R_2\}; 1; -1, 1; \\
\Sigma & : \Gamma \Lambda; \quad \hat{E}, C_2 T; \\
& \quad \{R_2\}; 1; -1, 1; \\
R & : AL; \quad \hat{E}, C_2 T; \\
& \quad \{R_2\}; 1; -1, 1; \\
\end{align*}
\( \Gamma_h; \{ C_6^+ [00\frac{1}{2}] \}; T \); Non-Centrosymmetric; with SOC

| \( \Gamma \); (000) \( C_6^+ \); \( T \) | \( \{ R_2, R_{12} \} \); 2; \( \sqrt{3}\sigma_0 + i\sigma_3 \), \(-i\sigma_2 \); | C-1 WP | 1 |
| | \( \{ R_4, R_{10} \} \); 2; \( i\sigma_3 \), \(-i\sigma_2 \); | C-3 WP | 3 |
| | \( \{ R_6, R_8 \} \); 2; \( \sqrt{3}\sigma_0 - i\sigma_3 \), \(-i\sigma_2 \); | C-1 WP | 1 |
| \( M \); (0\( \frac{1}{2} \)) \( C_2 \); \( T \) | \( \{ R_2, R_4 \} \); 2; \( i\sigma_3 \), \(-i\sigma_2 \); | C-1 WP | 1 |
| \( A \); (00\( \frac{1}{2} \)) \( C_6^+ \); \( T \) | \( \{ R_1, R_1 \} \); 2; \( \sigma_0 \), \(-i\sigma_2 \); | P-NS\_ALH |
| | \( \{ R_3, R_{11} \} \); 2; \( \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3) \), \(-i\sigma_2 \); | P-NS\_ALH |
| | \( \{ R_5, R_9 \} \); 2; \( \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3) \), \(-i\sigma_2 \); | P-NS\_ALH |
| | \( \{ R_7, R_7 \} \); 2; \( -\sigma_0 \), \(-i\sigma_2 \); | P-NS\_ALH |
| \( L \); (0\( \frac{1}{2} \)) \( C_2 \); \( T \) | \( \{ R_1, R_1 \} \); 2; \( \sigma_0 \), \(-i\sigma_2 \); | P-NS\_ALH |
| | \( \{ R_3, R_3 \} \); 2; \( -\sigma_0 \), \(-i\sigma_2 \); | P-NS\_ALH |
| \( K \); (0\( \frac{1}{2} \)) \( C_3 \); \( C_6^+ \); \( T \) | \( \{ R_2, R_6 \} \); 2; \( \frac{\sigma_0 + i\sqrt{3}\sigma_3}{\sqrt{2}} \), \( \frac{e^{\frac{i\pi}{3}} (\sigma_1 + \sqrt{3}\sigma_2)}{\sqrt{2}} \); | C-1 WP | 1 |
| | \( R_4 \); 1; \(-1, 1 \); | |
| \( H \); (0\( \frac{1}{2} \)) \( C_3 \); \( C_6^+ \); \( T \) | \( \{ R_2, R_6 \} \); 2; \( \frac{\sigma_0 + i\sqrt{3}\sigma_3}{\sqrt{2}} \), \( \frac{e^{\frac{i\pi}{3}} (\sigma_1 + \sqrt{3}\sigma_2)}{\sqrt{2}} \); | P-NS\_ALH |
| | \( R_4 \); 2; \( -\sigma_0 \), \(-i\sigma_2 \); | P-NS\_ALH |
| \( \Delta \); \( \Gamma A \); \( C_6^+ \); \( R_2 \); 1; \( \sqrt{-T} \); | |
| | \( R_4 \); 1; \( i \); | |
| | \( R_6 \); 1; \((-1)^{5/6} \); | |
| | \( R_8 \); 1; \(-\sqrt{-T} \); | |
| | \( R_{10} \); 1; \(-i \); | |
| | \( R_{12} \); 1; \(-(-1)^{5/6} \); | |
| \( U \); \( ML \); \( C_2 \); \( R_2 \); 1; \( i \); | |
| | \( R_4 \); 1; \(-i \); | |
| \( P \); \( KH \); \( C_3^+ \); \( R_2 \); 1; \( \sqrt{-T} \); | |
| | \( R_4 \); 1; \(-1 \); | |
| | \( R_6 \); 1; \(-(-1)^{2/3} \); | |
| \( T \); \( \Gamma K \); \( \bar{E}, C_2 T \); \( R_2 \); 1; \(-1, 1 \); | |
| \( S \); \( AH \); \( \bar{E}, C_2 T \); \( \{ R_2, R_2 \} \); 2; \( -\sigma_0 \), \(-i\sigma_2 \); | L-NS\_ALH |
| \( T' \); \( MK \); \( \bar{E}, C_2 T \); \( R_2 \); 1; \(-1, 1 \); | |
| \( S' \); \( LH \); \( \bar{E}, C_2 T \); \( \{ R_2, R_2 \} \); 2; \( -\sigma_0 \), \(-i\sigma_2 \); | L-NS\_ALH |
| \( \Sigma \); \( \Gamma M \); \( \bar{E}, C_2 T \); \( R_2 \); 1; \(-1, 1 \); | |
| \( R \); \( AL \); \( \bar{E}, C_2 T \); \( \{ R_2, R_2 \} \); 2; \( -\sigma_0 \), \(-i\sigma_2 \); | L-NS\_ALH |
Γ; \{C_6^+|00\frac{2}{3}\}; T; Non-Centrosymmetric; with SOC

\[ \Gamma_h; \{C_6^+|00\frac{2}{3}\}; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; (000); C_6^+; T; \{R_2, R_{12}\}; 2; \sqrt{\sigma_0}i\sigma_3, -i\sigma_2; \]
\[ \{R_4, R_{10}\}; 2; i\sigma_3, -i\sigma_2; \]
\[ \{R_6, R_8\}; 2; \sqrt{-\sigma_0}i\sigma_3, -i\sigma_2; \]
\[ \text{C-1 WP; 1} \]

\[ M; (0\frac{1}{2}0); C_2; T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \]
\[ \text{C-1 WP; 1} \]

\[ A; (00\frac{1}{2}); C_6^+; T; \{R_1, R_1\}; 2; \sigma_0, -i\sigma_2; \]
\[ \{R_3, R_{11}\}; 2; \frac{\sigma_0+i\sqrt{3}\sigma_3}{2}, -i\sigma_2; \]
\[ \{R_5, R_9\}; 2; \frac{\sigma_0-i\sqrt{3}\sigma_3}{2}, -i\sigma_2; \]
\[ \{R_7, R_7\}; 2; -\sigma_0, -i\sigma_2; \]
\[ \text{P-NS}_{ALH}; \]

\[ L; (0\frac{1}{2}\frac{1}{2}); C_2; T; \{R_1, R_1\}; 2; \sigma_0, -i\sigma_2; \]
\[ \{R_3, R_3\}; 2; -\sigma_0, -i\sigma_2; \]
\[ \text{P-NS}_{ALH}; \]

\[ \Lambda; \Gamma\Lambda; C_6^+; \]
\[ R_2; 1; \sqrt{-T}; \]
\[ R_4; 1; i; \]
\[ R_6; 1; (-1)^{5/6}; \]
\[ R_8; 1; -\sqrt{-T}; \]
\[ R_{10}; 1; -i; \]
\[ R_{12}; 1; (-1)^{5/6}; \]

\[ U; ML; \]
\[ C_2; \]
\[ R_2; 1; i; \]
\[ R_4; 1; -i; \]

\[ P; KH; C_3^+; \]
\[ R_2; 1; \sqrt{-T}; \]
\[ R_4; 1; -1; \]
\[ R_6; 1; (-1)^{2/3}; \]

\[ T; \Gamma K; \]
\[ \bar{E},C_2 T; \]
\[ R_2; 1; -1; 1; \]

\[ S; AH; \]
\[ \bar{E},C_2 T; \]
\[ \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \]
\[ \text{L-NS}_{ALH}; \]

\[ T'; MK; \]
\[ \bar{E},C_2 T; \]
\[ R_2; 1; -1; 1; \]

\[ S'; \bar{L}H; \]
\[ \bar{E},C_2 T; \]
\[ \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \]
\[ \text{L-NS}_{ALH}; \]

\[ \Sigma; \Gamma M; \]
\[ \bar{E},C_2 T; \]
\[ R_2; 1; -1; 1; \]

\[ R; \bar{A}L; \]
\[ \bar{E},C_2 T; \]
\[ \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \]
\[ \text{L-NS}_{ALH}; \]
\[ \Gamma; \; (000) \quad C^+_6, T \quad \{ R_2, R_{12} \}; \quad 2; \; \frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}, -i \sigma_2; \quad C-1 \; WP; \; 1 \\
\{ R_4, R_{10} \}; \quad 2; \; i \sigma_3, -i \sigma_2; \quad C-3 \; WP; \; 3 \\
\{ R_6, R_8 \}; \quad 2; \; \frac{\sqrt{3} \sigma_0 - i \sigma_3}{2}, -i \sigma_2; \quad C-1 \; WP; \; 1 \\
M; \; (01 \frac{1}{2} 0) \quad C_2, T \quad \{ R_2, R_4 \}; \quad 2; \; i \sigma_3, -i \sigma_2; \quad C-1 \; WP; \; 1 \\
A; \; (00 \frac{1}{2}) \quad C^+_6, T \quad \{ R_2, R_{12} \}; \quad 2; \; \frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}, -i \sigma_2; \quad C-1 \; WP; \; 1 \\
\{ R_4, R_{10} \}; \quad 2; \; i \sigma_3, -i \sigma_2; \quad C-3 \; WP; \; 3 \\
\{ R_6, R_8 \}; \quad 2; \; \frac{\sqrt{3} \sigma_0 - i \sigma_3}{2}, -i \sigma_2; \quad C-1 \; WP; \; 1 \\
L; \; (0 \frac{1}{2} \frac{1}{2}) \quad C_2, T \quad \{ R_2, R_4 \}; \quad 2; \; i \sigma_3, -i \sigma_2; \quad C-1 \; WP; \; 1 \\
K; \; (\frac{1}{3} \frac{2}{3} 0) \quad C^+_3, C^+_6, T \quad \{ R_2, R_8 \}; \quad 2; \; \frac{\sqrt{3} \sigma_0 + i \sqrt{3} \sigma_3}{2}, \frac{e^{-\frac{i}{2} \pi (\sigma_1 + \sqrt{3} \sigma_2)}}{\sqrt{3}}, \quad C-1 \; WP; \; 1 \\
\{ R_4 \}; \quad 1; \; -1, 1; \\
H; \; (\frac{1}{3} \frac{2}{3} \frac{1}{2}) \quad C^+_3, C^+_6, T \quad \{ R_2, R_8 \}; \quad 2; \; \frac{\sqrt{3} \sigma_0 + i \sqrt{3} \sigma_3}{2}, \frac{e^{-\frac{i}{2} \pi (\sigma_1 + \sqrt{3} \sigma_2)}}{\sqrt{3}}, \quad C-1 \; WP; \; 1 \\
\{ R_4 \}; \quad 1; \; -1, 1; \\
\Delta; \; \Gamma A \quad C^+_6, T \quad \{ R_2 \}; \quad 1; \; \sqrt{-1}; \\
\{ R_4 \}; \quad 1; \; i; \\
\{ R_6 \}; \quad 1; \; (-1)^{5/6}; \\
\{ R_8 \}; \quad 1; \; -\sqrt{-1}; \\
\{ R_{10} \}; \quad 1; \; -i; \\
\{ R_{12} \}; \quad 1; \; -(-1)^{5/6}; \\
U; \; ML \quad C_2, T \quad \{ R_2 \}; \quad 1; \; i; \\
\{ R_4 \}; \quad 1; \; -i; \\
P; \; KH \quad C^+_3, T \quad \{ R_2 \}; \quad 1; \; \sqrt{-1}; \\
\{ R_4 \}; \quad 1; \; -1; \\
\{ R_6 \}; \quad 1; \; -(-1)^{2/3}; \\
T; \; \Gamma K \quad \tilde{E}, C_2 T \quad \{ R_2 \}; \quad 1; \; -1, 1; \\
S; \; AH \quad \tilde{E}, C_2 T \quad \{ R_2 \}; \quad 1; \; -1, 1; \\
T'; \; MK \quad \tilde{E}, C_2 T \quad \{ R_2 \}; \quad 1; \; -1, 1; \\
S'; \; LH \quad \tilde{E}, C_2 T \quad \{ R_2 \}; \quad 1; \; -1, 1; \\
\Sigma; \; \Gamma M \quad \tilde{E}, C_2 T \quad \{ R_2 \}; \quad 1; \; -1, 1; \\
R; \; AL \quad \tilde{E}, C_2 T \quad \{ R_2 \}; \quad 1; \; -1, 1;
\( \Gamma_h; \{ C^+_6[002] \}; T; \) Non-Centrosymmetric; with SOC

\[ \Gamma; (000); C^+_6, T; \{ R_2, R_{12} \}; 2; \ \frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}, -i \sigma_2; \ C-1 \ WP; 1 \]
\[ \{ R_4, R_{10} \}; 2; i \sigma_3, -i \sigma_2; \ C-3 \ WP; 3 \]
\[ \{ R_6, R_8 \}; 2; \ \frac{\sqrt{3} \sigma_0 - i \sigma_3}{2}, -i \sigma_2; \ C-1 \ WP; 1 \]

\[ M; (0 \frac{1}{2} 0); C_2, T; \{ R_2, R_4 \}; 2; i \sigma_3, -i \sigma_2; \ C-1 \ WP; 1 \]

\[ A; (00 \frac{1}{2}); C^+_6, T; \{ R_2, R_{12} \}; 2; \ \frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}, -i \sigma_2; \ C-1 \ WP; 1 \]
\[ \{ R_4, R_{10} \}; 2; i \sigma_3, -i \sigma_2; \ C-3 \ WP; 3 \]
\[ \{ R_6, R_8 \}; 2; \ \frac{\sqrt{3} \sigma_0 - i \sigma_3}{2}, -i \sigma_2; \ C-1 \ WP; 1 \]

\[ L; (0 \frac{1}{2} \frac{1}{2}); C_2, T; \{ R_2, R_4 \}; 2; i \sigma_3, -i \sigma_2; \ C-1 \ WP; 1 \]

\[ K; (\frac{1}{3} \frac{2}{3} 0); C^+_3, C^+_6, T; \{ R_2, R_6 \}; 2; \ \frac{\sigma_0 + i \sqrt{3} \sigma_3}{2}, \ e^{- \frac{i \pi}{3} (\sigma_1 + \sqrt{3} \sigma_2)}; \ C-1 \ WP; 1 \]
\[ R_4; 1; -1, 1; \]

\[ H; (\frac{1}{3} \frac{2}{3} \frac{1}{2}); C^-_3, C^+_6, T; \{ R_2, R_6 \}; 2; \ \frac{\sigma_0 + i \sqrt{3} \sigma_3}{2}, \ e^{\frac{i \pi}{3} (\sigma_1 - \sqrt{3} \sigma_2)}; \ C-1 \ WP; 1 \]
\[ R_4; 1; -1, 1; \]

\[ \Delta; \Gamma A; \ C^+_6; \]
\[ R_2; 1; \sqrt{-1}; \]
\[ R_4; 1; i; \]
\[ R_6; 1; (-1)^{5/6}; \]
\[ R_8; 1; -\sqrt{-1}; \]
\[ R_{10}; 1; -i; \]
\[ R_{12}; 1; -(-1)^{5/6}; \]

\[ U; \ ML; \ C_2; \]
\[ R_2; 1; -1, 1; \]
\[ R_4; 1; -i; \]

\[ P; \ KH; \ C^+_3; \]
\[ R_2; 1; \sqrt{-1}; \]
\[ R_4; 1; -1; \]
\[ R_6; 1; -(-1)^{2/3}; \]

\[ T; \Gamma K; \ E, C_2 T; \]
\[ R_2; 1; -1, 1; \]

\[ S; \ AH; \ \tilde{E}, C_2 T; \]
\[ R_2; 1; -1, 1; \]

\[ T'; \ MK; \ \tilde{E}, C_2 T; \]
\[ R_2; 1; -1, 1; \]

\[ S'; \ LH; \ \tilde{E}, C_2 T; \]
\[ R_2; 1; -1, 1; \]

\[ \Sigma; \Gamma M; \ \tilde{E}, C_2 T; \]
\[ R_2; 1; -1, 1; \]

\[ R;\ AL; \ \tilde{E}, C_2 T; \]
\[ R_2; 1; -1, 1; \]
Γ; \{C^+_6[001]\}; T: Non-Centrosymmetric; with SOC

\[ \Gamma_h; \{C^+_6[001]\}; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; (000); C^+_6, T; \{R_2, R_{12}\}; 2; \sqrt{\sigma_0 + i\sigma_3}, -i\sigma_2; \quad \text{C-1 WP; 1} \]
\[ \{R_4, R_{10}\}; 2; i\sigma_3, -i\sigma_2; \quad \text{C-3 WP; 3} \]
\[ \{R_6, R_8\}; 2; \sqrt{\sigma_0 - i\sigma_3}, -i\sigma_2; \quad \text{C-1 WP; 1} \]

\[ M; (0^{3}2); C_2, T; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \quad \text{C-1 WP; 1} \]

\[ A; (0^{3}2); C^+_6, T; \{R_1, R_1\}; 2; \sigma_0, -i\sigma_2; \quad \text{P-NS}_{\text{ALH}} \]
\[ \{R_3, R_{11}\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2; \quad \text{P-NS}_{\text{ALH}} \]
\[ \{R_5, R_9\}; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2; \quad \text{P-NS}_{\text{ALH}} \]
\[ \{R_7, R_7\}; 2; -\sigma_0, -i\sigma_2; \quad \text{P-NS}_{\text{ALH}} \]

\[ L; (0^{3}2); C_2, T; \{R_1, R_1\}; 2; \sigma_0, -i\sigma_2; \quad \text{P-NS}_{\text{ALH}} \]
\[ \{R_3, R_3\}; 2; -\sigma_0, -i\sigma_2; \quad \text{P-NS}_{\text{ALH}} \]

\[ K; (1^{3}20); C^+_3, C^+_6, T; \{R_2, R_6\}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \frac{e^{i\pi/3}(\sigma_1 + \sqrt{3}\sigma_2)}{2}; \quad \text{C-1 WP; 1} \]
\[ R_4; 1; -1, 1 \]

\[ H; (1^{3}22); C^+_3, C^+_6, T; \{R_2, R_6\}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \frac{e^{i\pi/3}(\sigma_1 - \sqrt{3}\sigma_2)}{2}; \quad \text{P-NS}_{\text{ALH}} \]
\[ R_4; 2; -\sigma_0, -i\sigma_2; \quad \text{P-NS}_{\text{ALH}} \]

\[ \Delta; \Gamma_A; C^+_6; \]
\[ R_2; 1; \sqrt{-1}; \]
\[ R_4; 1; i \]
\[ R_6; 1; (-1)^{5/6}; \]
\[ R_8; 1; -\sqrt{-1} \]
\[ R_{10}; 1; -i \]
\[ R_{12}; 1; -(-1)^{5/6}; \]

\[ U; \text{ML}; C_2; \]
\[ R_2; 1; i \]
\[ R_4; 1; -i \]

\[ P; \text{KH}; C^+_3; \]
\[ R_2; 1; \sqrt{-1}; \]
\[ R_4; 1; -1 \]
\[ R_6; 1; -(-1)^{2/3}; \]

\[ T; \Gamma_K; \bar{E}, C_2 T; \]
\[ R_2; 1; -1, 1 \]

\[ S; \text{AH}; \bar{E}, C_2 T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \quad \text{L-NS}_{\text{ALH}} \]

\[ T^*; \text{MK}; \bar{E}, C_2 T; \]
\[ R_2; 1; -1, 1 \]

\[ S^*; \text{LH}; \bar{E}, C_2 T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \quad \text{L-NS}_{\text{ALH}} \]

\[ \Sigma; \Gamma_M; \bar{E}, C_2 T; \]
\[ R_2; 1; -1, 1 \]

\[ R; \text{AL}; \bar{E}, C_2 T; \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \quad \text{L-NS}_{\text{ALH}} \]
Γ; (000); $S_3^+T$; \{R_2, R_{12}\}; 2; $\sqrt{\sigma_0+i\sigma_3}, -i\sigma_2$; P-WNLs;
{R_4, R_{10}}; 2; $i\sigma_3, -i\sigma_2$; P-WNLs;
{R_6, R_8}; 2; $\sqrt{\sigma_0-i\sigma_3}, -i\sigma_2$; P-WNLs;
M; (0$1\over 2$0); $\sigma_hT$; \{R_2, R_4\}; 2; $i\sigma_3, -i\sigma_2$; P-WNL;
A; (00$1\over 2$); $S_3^+T$; \{R_2, R_{12}\}; 2; $\sqrt{\sigma_0+i\sigma_3}, -i\sigma_2$; P-WNLs;
{R_4, R_{10}}; 2; $i\sigma_3, -i\sigma_2$; P-WNLs;
{R_6, R_8}; 2; $\sqrt{\sigma_0-i\sigma_3}, -i\sigma_2$; P-WNLs;
L; (0$1\over 2$); $\sigma_hT$; \{R_2, R_4\}; 2; $i\sigma_3, -i\sigma_2$; P-WNL;
K; (1$1\over 2$0); $S_3^+$; \{R_2\}; 1; $\sqrt{-1}$;
R_4; 1; $i$;
R_6; 1; $(-1)^{5/6}$;
R_8; 1; $\sqrt{-1}$;
R_{10}; 1; $-i$;
R_{12}; 1; $-(-1)^{5/6}$;
H; (1$1\over 2$); $S_3^+$; \{R_2\}; 1; $\sqrt{-1}$;
R_4; 1; $i$;
R_6; 1; $(-1)^{5/6}$;
R_8; 1; $\sqrt{-1}$;
R_{10}; 1; $-i$;
R_{12}; 1; $-(-1)^{5/6}$;
Δ; ΓA; $C_3^+S_3^+T$; \{R_2, R_6\}; 2; $\sigma_0+i\sqrt{\sigma_3}, e^{i\pi/3(\sigma_1-\sqrt{\sigma_3})}, QNL$;
R_4; 1; $-1, 1$;
U; ML; $E, T\sigma_h$; \{R_2\}; 1; $-1, 1$;
P; KH; $C_3^+$; \{R_2\}; 1; $\sqrt{-1}$;
R_4; 1; $-1$;
R_6; 1; $(-1)^{2/3}$;
T; ΓK; $\sigma_h$; \{R_2\}; 1; $i$;
R_4; 1; $-i$;
S; AH; $\sigma_h$; \{R_2\}; 1; $i$;
R_4; 1; $-i$;
T'; MK; $\sigma_h$; \{R_2\}; 1; $i$;
R_4; 1; $-i$;
S'; LH; $\sigma_h$; \{R_2\}; 1; $i$;
R_4; 1; $-i$;
Σ; ΓM; $\sigma_h$; \{R_2\}; 1; $i$;
R_4; 1; $-i$;
R; AL; $\sigma_h$; \{R_2\}; 1; $i$;
R_4; 1; $-i$;
\[ \Gamma_h; \{ C^+_6[000], \Gamma[000], T; Centrosymmetric; with SOC \} \]

\[ \Gamma; (000); C^+_6, I,T; \{ R_2, R_{12} \}; 2 \times \left\{ \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), \sigma_0, -i \sigma_2; \right. \]
\[ \rightarrow \{ R_4, R_{10} \}; 2 \times i \sigma_3, \sigma_0, -i \sigma_2; \]
\[ \{ R_6, R_8 \}; 2 \times \left\{ \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), \sigma_0, -i \sigma_2; \right. \]
\[ \{ R_{14}, R_{24} \}; 2 \times \left\{ \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), -\sigma_0, -i \sigma_2; \right. \]
\[ \{ R_{16}, R_{22} \}; 2 \times i \sigma_3, -\sigma_0, -i \sigma_2; \]
\[ \{ R_{18}, R_{20} \}; 2 \times \left\{ \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), -\sigma_0, -i \sigma_2; \right. \]

\[ M; (0\frac{1}{2}0); C^+_2, I,T; \{ R_2, R_4 \}; 2 \times i \sigma_3, \sigma_0, -i \sigma_2; \]
\[ \{ R_6, R_8 \}; 2 \times i \sigma_3, -\sigma_0, -i \sigma_2; \]

\[ A; (00\frac{1}{2}); C^+_6, I,T; \{ R_2, R_{12} \}; 2 \times \left\{ \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), \sigma_0, -i \sigma_2; \right. \]
\[ \rightarrow \{ R_4, R_{10} \}; 2 \times i \sigma_3, \sigma_0, -i \sigma_2; \]
\[ \{ R_6, R_8 \}; 2 \times \left\{ \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), \sigma_0, -i \sigma_2; \right. \]
\[ \{ R_{14}, R_{24} \}; 2 \times \left\{ \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), -\sigma_0, -i \sigma_2; \right. \]
\[ \{ R_{16}, R_{22} \}; 2 \times i \sigma_3, -\sigma_0, -i \sigma_2; \]
\[ \{ R_{18}, R_{20} \}; 2 \times \left\{ \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), -\sigma_0, -i \sigma_2; \right. \]

\[ L; (0\frac{1}{2}\frac{1}{2}); C^+_2, I,T; \{ R_2, R_4 \}; 2 \times i \sigma_3, \sigma_0, -i \sigma_2; \]
\[ \{ R_6, R_8 \}; 2 \times i \sigma_3, -\sigma_0, -i \sigma_2; \]

\[ K; (\frac{1}{2}\frac{2}{3}0); S^+_3, I,T; \{ R_2, R_{12} \}; 2 \times \left\{ \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), -i \sigma_2; \right. \]
\[ \rightarrow \{ R_4, R_{10} \}; 2 \times i \sigma_3, -i \sigma_2; \]
\[ \{ R_6, R_8 \}; 2 \times \left\{ \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), -i \sigma_2; \right. \]

\[ H; (\frac{1}{2}\frac{4}{3}2); S^+_3, I,T; \{ R_2, R_{12} \}; 2 \times \left\{ \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), -i \sigma_2; \right. \]
\[ \rightarrow \{ R_4, R_{10} \}; 2 \times i \sigma_3, -i \sigma_2; \]
\[ \{ R_6, R_8 \}; 2 \times \left\{ \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), -i \sigma_2; \right. \]

\[ \Delta; \Gamma A; C^+_6, I,T; \{ R_2, R_{12} \}; 2 \times \left\{ \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), -i \sigma_2; \right. \]
\[ \rightarrow \{ R_4, R_{10} \}; 2 \times i \sigma_3, -i \sigma_2; \]
\[ \{ R_6, R_8 \}; 2 \times \left\{ \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), -i \sigma_2; \right. \]

\[ U; ML; C^+_2, I,T; \{ R_2, R_4 \}; 2 \times i \sigma_3, -i \sigma_2; \]

\[ P; KH; C^+_3, I,T; \{ R_2, R_6 \}; 2 \times \left\{ \left( \sigma_0 + i \sqrt{3} \sigma_3 \right), -i \sigma_2; \right. \]
\[ \rightarrow \{ R_4, R_4 \}; 2 \times -\sigma_0, -i \sigma_2; \]

\[ T; \Gamma K; \sigma_h, I,T; \{ R_2, R_4 \}; 2 \times i \sigma_3, -i \sigma_2; \]

\[ S; AH; \sigma_h, I,T; \{ R_2, R_4 \}; 2 \times i \sigma_3, -i \sigma_2; \]

\[ T'; MK; \sigma_h, I,T; \{ R_2, R_4 \}; 2 \times i \sigma_3, -i \sigma_2; \]

\[ S'; LH; \sigma_h, I,T; \{ R_2, R_4 \}; 2 \times i \sigma_3, -i \sigma_2; \]

\[ \Sigma; \Gamma M; \sigma_h, I,T; \{ R_2, R_4 \}; 2 \times i \sigma_3, -i \sigma_2; \]

\[ R; AL; \sigma_h, I,T; \{ R_2, R_4 \}; 2 \times i \sigma_3, -i \sigma_2; \]
\( \Gamma_h; \{ C^+_6[00\frac{1}{2}], I[00\frac{1}{2}], T; \) Centrosymmetric; with SOC

\[
\begin{align*}
\Gamma; & \quad (000); \quad C^+_6, I, T; \quad \{ R_2, R_{12} \}; \quad 2; \quad \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), \sigma_0, -i \sigma_2; \\
& \quad \{ R_4, R_{10} \}; \quad 2; \quad i \sigma_3, \sigma_0, -i \sigma_2; \\
& \quad \{ R_6, R_{8} \}; \quad 2; \quad \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), \sigma_0, -i \sigma_2; \\
& \quad \{ R_{14}, R_{24} \}; \quad 2; \quad \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), -\sigma_0, -i \sigma_2; \\
& \quad \{ R_{16}, R_{22} \}; \quad 2; \quad i \sigma_3, -\sigma_0, -i \sigma_2; \\
& \quad \{ R_{18}, R_{20} \}; \quad 2; \quad \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), -\sigma_0, -i \sigma_2; \\
M; & \quad (01\frac{1}{2}); \quad C^+_2, I, T; \quad \{ R_2, R_4 \}; \quad 2; \quad i \sigma_3, \sigma_0, -i \sigma_2; \\
& \quad \{ R_6, R_8 \}; \quad 2; \quad i \sigma_3, -\sigma_0, -i \sigma_2; \\
A; & \quad (00\frac{1}{2}); \quad C^+_6, I, E, T; \quad \{ R_{28}, R_{30} \}; \quad 4; \quad \frac{\Gamma_0.3 - i \sqrt{3} \bar{\Gamma}_{2,0}}{2}, \bar{\Gamma}_{0.1}, -\bar{\Gamma}_{0.0}, -i \bar{\Gamma}_{2,0}; \quad P-DNLs; \\
& \quad \{ R_{29}, R_{29} \}; \quad 4; \quad -\Gamma_{0.3}, \Gamma_{0.1}, -\Gamma_{0.0}, i \Gamma_{2,0}; \quad P-DNLs; \\
L; & \quad (0\frac{1}{2}) ; \quad \sigma_h, E, I, T; \quad \{ R_{10}, R_{10} \}; \quad 4; \quad i \Gamma_{0.2}, -\Gamma_{0.0}, \Gamma_{0.3}, i \Gamma_{2,0}; \quad P-DNL; \\
K; & \quad (\frac{1}{2} \frac{1}{3} 0); \quad S^+_3, I, T; \quad \{ R_2, R_{12} \}; \quad 2; \quad \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), -i \sigma_2; \\
& \quad \{ R_4, R_{10} \}; \quad 2; \quad i \sigma_3, -i \sigma_2; \\
& \quad \{ R_6, R_{8} \}; \quad 2; \quad \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), -i \sigma_2; \\
H; & \quad (\frac{1}{2} \frac{1}{3} 2); \quad S^+_3, I, T; \quad \{ R_2, R_6 \}; \quad 2; \quad \frac{1}{2} \left( \sqrt{3} \sigma_3 + i \sigma_0 \right), -i \sigma_2; \\
& \quad \{ R_4, R_4 \}; \quad 2; \quad i \sigma_0, -i \sigma_2; \\
& \quad \{ R_6, R_{12} \}; \quad 2; \quad -\frac{1}{2} i \left( \sigma_0 - i \sqrt{3} \sigma_3 \right), -i \sigma_2; \\
& \quad \{ R_{10}, R_{10} \}; \quad 2; \quad -i \sigma_0, -i \sigma_2; \\
\Delta; & \quad \Gamma_A; \quad C^+_6, I, T; \quad \{ R_2, R_{12} \}; \quad 2; \quad \frac{1}{2} \left( \sqrt{3} \sigma_0 + i \sigma_3 \right), -i \sigma_2; \\
& \quad \{ R_4, R_{10} \}; \quad 2; \quad i \sigma_3, -i \sigma_2; \\
& \quad \{ R_6, R_{8} \}; \quad 2; \quad \frac{1}{2} \left( -\sqrt{3} \sigma_0 + i \sigma_3 \right), -i \sigma_2; \\
U; & \quad ML; \quad C^+_2, I, T; \quad \{ R_2, R_4 \}; \quad 2; \quad i \sigma_3, -i \sigma_2; \\
P; & \quad KH; \quad C^+_3, I, T; \quad \{ R_2, R_6 \}; \quad 2; \quad \frac{1}{2} \left( \sigma_0 + i \sqrt{3} \sigma_3 \right), -i \sigma_2; \\
& \quad \{ R_4, R_4 \}; \quad 2; \quad i \sigma_0, -i \sigma_2; \\
T; & \quad \Gamma_K; \quad \sigma_h, I, T; \quad \{ R_2, R_4 \}; \quad 2; \quad i \sigma_3, -i \sigma_2; \\
S; & \quad \Lambda H; \quad \sigma_h, I, T; \quad \{ R_2, R_2 \}; \quad 2; \quad i \sigma_0, -i \sigma_2; \\
& \quad \{ R_4, R_4 \}; \quad 2; \quad -i \sigma_0, -i \sigma_2; \\
T'; & \quad \Gamma_K; \quad \sigma_h, I, T; \quad \{ R_2, R_4 \}; \quad 2; \quad i \sigma_3, -i \sigma_2; \\
S'; & \quad LH; \quad \sigma_h, I, T; \quad \{ R_2, R_2 \}; \quad 2; \quad i \sigma_0, -i \sigma_2; \\
& \quad \{ R_4, R_4 \}; \quad 2; \quad -i \sigma_0, -i \sigma_2; \\
}\]
\[ \Gamma_h; \{ C_6^+ \{000\}, \{ C_{21}^+ \{000\} \}, T; \text{Non-Centrosymmetric} \text{ with SOC} \]
Γ: (000); $C_6^+\cdot C_{21}^T$;
$R_5$; 2; $i\sigma_3, i\sigma_1, -i\sigma_2$; C-3 WP; 3
$R_6$; 2; $\frac{\sqrt{-\sigma_0 + i\sigma_2}}{2}, i\sigma_1, -i\sigma_2$; C-1 WP; 1
$R_9$; 2; $-\frac{\sqrt{\sigma_0 + i\sigma_2}}{2}, i\sigma_1, -i\sigma_2$; C-1 WP; 1

M: (0 1 0); $C_2^+ C_{21}^T$;
$R_5$; 2; $i\sigma_2, i\sigma_1, -i\sigma_2$; C-1 WP; 1

A: (00 1/2); $C_6^+\cdot C_{21}^T$;
$\{R_{10}, R_{11}\}$; 2; $\sigma_0, i\sigma_3, -i\sigma_2$; P-NSALH;
$\{R_{12}, R_{13}\}$; 2; $-\sigma_0, i\sigma_3, -i\sigma_2$; P-NSALH;
$R_{14}$; 2; $\frac{\sigma_0 + i\sqrt{\sigma_2}}{2}, i\sigma_1, -i\sigma_2$; P-NSALH;
$R_{15}$; 2; $\frac{\sigma_0 - i\sqrt{\sigma_2}}{2}, i\sigma_1, -i\sigma_2$; P-NSALH;

L: (0 1/2 0); $C_2^+ C_{21}^T$;
$\{R_5, R_6\}$; 2; $-\sigma_0, i\sigma_3, -i\sigma_2$; P-NSALH;
$\{R_7, R_8\}$; 2; $\sigma_0, -i\sigma_3, -i\sigma_2$; P-NSALH;

K: (1/3 0 0); $C_3^+, C_{21}^T$;
$R_3$; 1; $-1, i, 1$;
$R_4$; 1; $-1, -i, 1$;
$R_6$; 2; $\frac{\sigma_0 - i\sqrt{\sigma_2}}{2}, i\sigma_3, \frac{\sigma_0 + i\sqrt{\sigma_2}}{2}$; C-1 WP; 1

H: (1/3 1/3 0); $C_3^-, C_{21}^T$;
$\{R_3, R_4\}$; 2; $-\sigma_0, i\sigma_3, -i\sigma_2$; P-NSALH;
$R_6$; 2; $\frac{\sigma_0 - i\sqrt{\sigma_2}}{2}, i\sigma_3, \frac{\sqrt{-\sigma_0 + i\sigma_2}}{2}$; P-NSALH;

Δ: ΓA; $C_6^+\cdot C_{23}^T$;
$R_2$; 1; $\sqrt{-1}, 1$;
$R_4$; 1; $i, 1$;
$R_6$; 1; $(-1)^{5/6}, 1, 1$;
$R_8$; 1; $-\sqrt{-1}, 1$;
$R_{10}$; 1; $-i, 1$;
$R_{12}$; 1; $-(-1)^{5/6}, 1$;

U: ML; $C_2^+ C_{21}^T$;
$R_2$; 1; $i, 1$;
$R_4$; 1; $-i, 1$;

P: KH; $C_3^+\cdot C_{23}^T$;
$R_2$; 1; $\sqrt{-1}, 1$;
$R_4$; 1; $-1, 1$;
$R_6$; 1; $-(-1)^{2/3}, 1$;

T: ΓK; $C_{22}^+ C_{22}^T$;
$R_2$; 1; $i, 1$;
$R_4$; 1; $-i, 1$;

S: AH; $C_{22}^+, E, C_{22}^T$;
$\{R_{17}, R_{23}\}$; 2; $i\sigma_3, -\sigma_0, \sigma_1$; L-NSALH;

T*: MK; $C_{21}^+, C_{2}^T$;
$R_2$; 1; $i, 1$;
$R_4$; 1; $-i, 1, 1$;

S': LH; $C_{21}^+, E, C_{2}^T$;
$\{R_5, R_7\}$; 2; $-i\sigma_3, -\sigma_0, -i\sigma_2$; L-NSALH;

Σ: ΓM; $C_{21}^+, C_{22}^T$;
$R_2$; 1; $i, 1$;
$R_4$; 1; $-i, 1$;

R: AL; $C_{21}^+, C_{21}^T$;
$\{R_2, R_4\}$; 2; $i\sigma_3, \sigma_1$; L-NSALH;
\( \Gamma_h; \{ C_6^+[00\frac{5}{2}], C_6^+[000], T; \noncentrosymmetric; \text{with SOC} \)
\[
\begin{array}{llll}
\Gamma_h; \{C_6^+ [001], C_9^+ [000], T\}; \text{Non-Centrosymmetric; with SOC} & \\
\Gamma; (000); C_6^+, C_2^+, T; & R_7; 2; \sigma_1, -i\sigma_2; & \text{C-3 WP; 3} \\
& R_8; 2; \frac{\sqrt{3}}{2}, i\sigma_1, -i\sigma_2; & \text{C-1 WP; 1} \\
& R_9; 2; \frac{\sqrt{3}}{2}, i\sigma_1, -i\sigma_2; & \text{C-1 WP; 1} \\
M; (0 \frac{1}{2} 0); C_2, C_2^+ ; T; & R_2; 2; \sigma_2, i\sigma_1, -i\sigma_2; & \text{C-1 WP; 1} \\
A; (00 \frac{1}{2}); C_6^+, C_2^+, T; & R_7; 2; \sigma_1, i\sigma_1, -i\sigma_2; & \text{C-3 WP; 3} \\
& R_8; 2; \frac{\sqrt{3}}{2}, i\sigma_1, -i\sigma_2; & \text{C-1 WP; 1} \\
& R_9; 2; \frac{\sqrt{3}}{2}, i\sigma_1, -i\sigma_2; & \text{C-1 WP; 1} \\
L; (0 \frac{1}{2} \frac{1}{2}); C_2, C_2^+ ; T; & R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; & \text{C-1 WP; 1} \\
K; (\frac{1}{2} \frac{1}{2} 0); C_3^+, C_2^+ , C_6^+ ; T; & R_3; 1; -1, i, 1; & \\
& R_4; 1; -1, -i, 1; & \\
& R_6; 2; \frac{\sigma_3 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, \frac{\sigma_3 + i\sqrt{3}\sigma_2}{2}; & \text{C-1 WP; 1} \\
H; (\frac{1}{3} \frac{1}{3} 0); C_3^+, C_2^+ , C_6^+ ; T; & R_3; 1; -1, i, 1; & \\
& R_4; 1; -1, -i, 1; & \\
& R_6; 2; \frac{\sigma_3 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, \frac{\sigma_3 + i\sqrt{3}\sigma_2}{2}; & \text{C-1 WP; 1} \\
\Delta; \Gamma \Lambda; \quad C_6^+, C_2^+ ; T; & R_2; 1; \sqrt{-1}, 1; & \\
& R_4; 1; i, 1; & \\
& R_6; 1; (-1)^{5/6}, 1; & \\
& R_8; 1; -\sqrt{-1}, 1; & \\
& R_{10}; 1; -i, 1; & \\
& R_{12}; 1; (-1)^{5/6}, 1; & \\
U; \text{ML}; \quad C_2, C_2^+ ; T; & R_2; 1; i, 1; & \\
& R_4; 1; -i, 1; & \\
P; \text{KH}; \quad C_3^+, C_2^+ ; T; & R_2; 1; \sqrt{-1}, 1; & \\
& R_4; 1; -1, 1; & \\
& R_6; 1; (-1)^{2/3}, 1; & \\
T; \Gamma \Pi; \quad C_2^+, C_2^+ ; T; & R_2; 1; i, 1; & \\
& R_4; 1; -i, 1; & \\
S; \text{AH}; \quad C_6^+, C_2^+ ; T; & R_6; 1; i, 1; & \\
& R_{12}; 1; -i, 1; & \\
T^*; \text{MK}; \quad C_2^+, C_2^+ ; T; & R_2; 1; i, 1; & \\
& R_4; 1; -i, 1; & \\
S^*; \text{LH}; \quad C_6^+, C_2^+ ; T; & R_2; 1; i, 1; & \\
& R_4; 1; -i, 1; & \\
\Sigma; \text{GM}; \quad C_2^+, C_2^+ ; T; & R_2; 1; i, 1; & \\
& R_4; 1; -i, 1; & \\
R; \text{AL}; \quad C_2^+, C_2^+ ; T; & R_2; 1; i, 1; & \\
& R_4; 1; -i, 1; & 
\end{array}
\]
SG 181

Γh: \{C^+_6[00\frac{2}{3}], \{C^+_2[000]\}; T\}; Non-Centrosymmetric; with SOC

| Γ; (000); C^+_6.C^+_21,T; | R_7; 2; i\sigma_1, i\sigma_1, -i\sigma_2; | C-3 WP; 3 |
| R_8; 2; \frac{i\sigma_0 + i\sigma_2}{2}, i\sigma_1, -i\sigma_2; | C-1 WP; 1 |
| R_9; 2; \frac{-i\sigma_0 + i\sigma_2}{2}, i\sigma_1, -i\sigma_2; | C-1 WP; 1 |

| M; (0\frac{1}{2}0); C_2.C''_{21},T; | R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; | C-1 WP; 1 |

| A; (00\frac{1}{2}); C^+_6.C^+_21,T; | R_7; 2; i\sigma_1, i\sigma_1, -i\sigma_2; | C-3 WP; 3 |
| R_8; 2; \frac{\sqrt{3}\sigma_0 + i\sigma_2}{2}, i\sigma_1, -i\sigma_2; | C-1 WP; 1 |
| R_9; 2; \frac{-\sqrt{3}\sigma_0 + i\sigma_2}{2}, i\sigma_1, -i\sigma_2; | C-1 WP; 1 |

| L; (0\frac{1}{2}\frac{1}{2}); C_2.C''_{21},T; | R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; | C-1 WP; 1 |

| K; (\frac{1}{4}\frac{1}{4}0); C^+_3.C^+_22,C^+_6.T; | R_3; 1; -i, i, 1; |
| R_4; 1; -1, -i, 1; |
| R_6; 2; \frac{\sigma_0 - (\sqrt{3}+4)\sigma_2}{2}, i\sigma_3, \frac{-\sigma_0 + 4\sqrt{3}\sigma_2}{2}; | C-1 WP; 1 |

| H; (\frac{1}{4}\frac{1}{4}\frac{1}{4}); C^+_3.C^+_22,C^+_6.T; | R_3; 1; -i, i, 1; |
| R_4; 1; -1, -i, 1; |
| R_6; 2; \frac{\sigma_0 - (\sqrt{3}+4)\sigma_2}{2}, i\sigma_3, \frac{-\sigma_0 + 4\sqrt{3}\sigma_2}{2}; | C-1 WP; 1 |

| Δ; ΓA; C^+_6.C^+_22,T; | R_2; 1; \sqrt{-1}, 1; |
| R_4; 1; i, 1; |
| R_6; 1; (-1)^{5/6}, 1; |
| R_8; 1; -\sqrt{-1}, 1; |
| R_{10}; 1; -i, 1; |
| R_{12}; 1; (-1)^{5/6}, 1; |

| U; ML; C_2.C''_{21},T; | R_2; 1; i, 1; |
| R_4; 1; -i, 1; |

| P; KH; C^+_3.C^+_22,T; | R_2; 1; \sqrt{-1}, 1; |
| R_4; 1; -1, 1; |
| R_6; 1; (-1)^{2/3}, 1; |

| T; ΓK; C''_{22}.C^+_22,T; | R_2; 1; i, 1; |
| R_4; 1; -i, 1; |

| S; AH; C''_{22}.C^+_22,T; | R_2; 1; -i, 1; |
| R_4; 1; i, 1; |

| T'; MK; C''_{21}.C^+_2,T; | R_2; 1; i, 1; |
| R_4; 1; -i, 1; |

| S'; LH; C''_{21}.C^+_2,T; | R_2; 1; i, 1; |
| R_4; 1; -i, 1; |

| Σ; ΓM; C^+_21.C^+_21,T; | R_2; 1; i, 1; |
| R_4; 1; -i, 1; |

| R; AL; C^+_21.C^+_21,T; | R_2; 1; i, 1; |
| R_4; 1; -i, 1; |
\( \Gamma_h; \{ C^+_6[00\frac{1}{2}], C^+_2[000], T; \) Non-Centrosymmetric; with SOC

\[
\begin{align*}
\Gamma; \quad & (000); \quad C^+_6, C^+_2; \quad R_5; \quad 2; i\sigma_3, i\sigma_1, -i\sigma_2; \quad C-3 \text{ WP; 3} \\
& \quad R_8; \quad 2; \frac{\sqrt{3}\sigma_0 + i\sigma_3}{2}, i\sigma_1, -i\sigma_2; \quad C-1 \text{ WP; 1} \\
& \quad R_9; \quad 2; \frac{-\sqrt{3}\sigma_0 + i\sigma_3}{2}, i\sigma_1, -i\sigma_2; \quad C-1 \text{ WP; 1} \\
M; \quad & (0\frac{1}{2}0); \quad C_2, C^+_2; \quad R_5; \quad 2; i\sigma_2, i\sigma_1, -i\sigma_2; \quad C-1 \text{ WP; 1} \\
A; \quad & (00\frac{1}{2}); \quad C^+_6, C^+_2; \quad \{ R_{10}, R_{11} \}; \quad 2; \sigma_0, i\sigma_3, -i\sigma_2; \quad P-\text{NS}_{ALH;} \\
& \quad \{ R_{12}, R_{13} \}; \quad 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad P-\text{NS}_{ALH;} \\
& \quad R_{14}; \quad 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), i\sigma_1, -i\sigma_2; \quad P-\text{NS}_{ALH;} \\
& \quad R_{15}; \quad 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), i\sigma_1, -i\sigma_2; \quad P-\text{NS}_{ALH;} \\
L; \quad & (0\frac{1}{2}\frac{1}{2}); \quad C_2, C^+_2; \quad \{ R_5, R_6 \}; \quad 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad P-\text{NS}_{ALH;} \\
& \quad \{ R_7, R_8 \}; \quad 2; \sigma_0, -i\sigma_3, -i\sigma_2; \quad P-\text{NS}_{ALH;} \\
K; \quad & (\frac{1}{2}\frac{1}{2}0); \quad C^+_3, C^+_2; \quad R_3; \quad 1; -1, i, 1; \\
& \quad R_4; \quad 1; -1, -i, 1; \\
& \quad R_6; \quad 2; \frac{\sigma_0 - i\sqrt{3}\sigma_3}{2}, i\sigma_3, \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}; \quad C-1 \text{ WP; 1} \\
H; \quad & (\frac{1}{2}\frac{1}{2}\frac{1}{2}); \quad C^+_3, C^+_2; \quad \{ R_3, R_4 \}; \quad 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad P-\text{NS}_{ALH;} \\
& \quad R_6; \quad 2; \frac{\sigma_0 - i\sqrt{3}\sigma_3}{2}, i\sigma_3, \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}; \quad P-\text{NS}_{ALH;} \\
\Delta; \quad \Gamma A; \quad C^+_6, C^+_2; \quad R_2; \quad 1; \sqrt{-1}, 1; \\
& \quad R_4; \quad 1; i, 1; \\
& \quad R_6; \quad 1; (-1)^{5/6}, 1; \\
& \quad R_8; \quad 1; -\sqrt{-1}, 1; \\
& \quad R_{10}; \quad 1; -i, 1; \\
& \quad R_{12}; \quad 1; -(-1)^{5/6}, 1; \\
U; \quad ML; \quad C_2, C^+_2; \quad R_2; \quad 1; i, 1; \\
& \quad R_4; \quad 1; -i, 1; \\
P; \quad KH; \quad C^+_3, C^+_2; \quad R_2; \quad 1; \sqrt{-1}, 1; \\
& \quad R_4; \quad 1; -1, 1; \\
& \quad R_6; \quad 1; -(-1)^{2/3}, 1; \\
T; \quad \Gamma K; \quad C^+_2, C^+_2; \quad R_2; \quad 1; i, 1; \\
& \quad R_4; \quad 1; -i, 1; \\
S; \quad AH; \quad C^+_2, E, C^+_2; \quad \{ R_5, R_7 \}; \quad 2; -i\sigma_3, \sigma_0, \sigma_1; \quad L-\text{NS}_{ALH;} \\
T'; \quad MK; \quad C^+_2, C^+_2; \quad R_2; \quad 1; i, 1; \\
& \quad R_4; \quad 1; -i, 1; \\
S'; \quad LH; \quad C^+_2, E, C^+_2; \quad \{ R_5, R_7 \}; \quad 2; -i\sigma_3, \sigma_0, -i\sigma_2; \quad L-\text{NS}_{ALH;} \\
\Sigma; \quad \Gamma M; \quad C^+_2, C^+_2; \quad R_2; \quad 1; i, 1; \\
& \quad R_4; \quad 1; -i, 1; \\
R; \quad AL; \quad C^+_2, C^+_2; \quad \{ R_2, R_4 \}; \quad 2; i\sigma_3, \sigma_1; \quad L-\text{NS}_{ALH;}
\[ \Gamma_h; \{C_4^+[000], \{\sigma_d[000], T; \text{Non-Centrosymmetric with SOC} \}

\]

\[
\begin{align*}
\Gamma; \ (000); & \quad C_4^+; \sigma_{d1}; T; \\
& \quad \Gamma \in \{ \sigma_3, \sigma_1, -\sigma_2 \}; \\
& \quad P-CNL_{GA}; \\
& \quad R_8; \ 2; \frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}, \sigma_1, -i \sigma_2; \\
& \quad P-WNL_{GA}; \\
& \quad R_0; \ 2; \frac{-\sqrt{3} \sigma_0 + i \sigma_3}{2}, \sigma_1, -i \sigma_2; \\
& \quad P-WNL_{GA}; \\
M; \ (0\frac{1}{2}0); & \quad C_2; \sigma_{v1}; T; \\
& \quad \Gamma \in \{ \sigma_3, \sigma_1, -i \sigma_2 \}; \\
& \quad P-WNL_{ML}; \\
A; \ (00\frac{1}{2}); & \quad C_3^+; \sigma_{d1}; T; \\
& \quad \Gamma \in \{ \sigma_3, \sigma_1, -i \sigma_2 \}; \\
& \quad P-CNL_{GA}; \\
& \quad R_8; \ 2; \frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}, \sigma_1, -i \sigma_2; \\
& \quad P-WNL_{GA}; \\
& \quad R_0; \ 2; \frac{-\sqrt{3} \sigma_0 + i \sigma_3}{2}, \sigma_1, -i \sigma_2; \\
& \quad P-WNL_{GA}; \\
L; \ (0\frac{1}{2}0); & \quad C_2; \sigma_{v1}; T; \\
& \quad \Gamma \in \{ \sigma_3, \sigma_1, -i \sigma_2 \}; \\
& \quad P-WNL_{ML}; \\
K; \ (0\frac{2}{3}0); & \quad C_3^+; \sigma_{d1}; T; \sigma_{v1}; \\
& \quad \Gamma \in \{ -1, i, 1 \}; \\
& \quad R_4; \ 1; \ -1, -i, 1; \\
& \quad R_6; \ 2\left(\frac{\sqrt{3} \sigma_0}{2}, \sigma_3, \frac{\sqrt{3} \sigma_1 + \sigma_3}{2} \right); \\
& \quad P-WNL_{KH}; \\
H; \ (0\frac{2}{3}0); & \quad C_3^+; \sigma_{d1}; T; \sigma_{v1}; \\
& \quad \Gamma \in \{ -1, i, 1 \}; \\
& \quad R_4; \ 1; \ -1, -i, 1; \\
& \quad R_6; \ 2\left(\frac{\sqrt{3} \sigma_0}{2}, \sigma_3, \frac{\sqrt{3} \sigma_1 + \sigma_3}{2} \right); \\
& \quad P-WNL_{KH}; \\
\Delta; \ GA; & \quad C_6^+; \sigma_{d1}; \\
& \quad \Gamma \in \{ \sigma_3, \sigma_1 \}; \\
& \quad P-CNL; \pi \\
& \quad R_8; \ 2; \frac{\sqrt{3} \sigma_0}{2}, \frac{-\sqrt{3} \sigma_0 + i \sigma_3}{2}, \sigma_1; \\
& \quad WNL; \pi \\
& \quad R_0; \ 2; \frac{\sqrt{3} \sigma_0}{2}, \frac{-\sqrt{3} \sigma_0 + i \sigma_3}{2}, \sigma_1; \\
& \quad WNL; \pi \\
U; \ ML; & \quad C_2; \sigma_{v1}; \\
& \quad \Gamma \in \{ \sigma_3, \sigma_1 \}; \\
& \quad WNL; \pi \\
P; \ KH; & \quad C_3^+; \sigma_{d1}; \\
& \quad \Gamma \in \{ -1, i \}; \\
& \quad R_4; \ 1; \ -1, -i; \\
& \quad R_6; \ 2\left(\frac{\sigma_0}{2}, i \sigma_3 \right); \\
& \quad WNL; \pi \\
T; \ \Gamma K; & \quad \sigma_{d2}; C_2; T; \\
& \quad \Gamma \in \{ i \sigma_1 \}; \\
& \quad R_4; \ 1; \ -i, 1; \\
S; \ AH; & \quad \sigma_{d2}; C_2; T; \\
& \quad \Gamma \in \{ i \sigma_1 \}; \\
& \quad R_4; \ 1; \ -i, 1; \\
T'; \ MK; & \quad \sigma_{d1}; T\sigma_{v1}; \\
& \quad \Gamma \in \{ i \sigma_1 \}; \\
& \quad R_4; \ 1; \ -i, 1; \\
S'; \ LH; & \quad \sigma_{d1}; T\sigma_{v1}; \\
& \quad \Gamma \in \{ i \sigma_1 \}; \\
& \quad R_4; \ 1; \ -i, 1; \\
\Sigma; \ GM; & \quad \sigma_{v1}; C_2; T; \\
& \quad \Gamma \in \{ i \sigma_1 \}; \\
& \quad R_4; \ 1; \ -i, 1; \\
R; \ AL; & \quad \sigma_{v1}; C_2; T; \\
& \quad \Gamma \in \{ i \sigma_1 \}; \\
& \quad R_4; \ 1; \ -i, 1;
\end{align*}
\]
\[ \Gamma_h; \{ C_6^+|000\}, \{ \sigma_{d1}|00\}; T; \text{Non-Centrosymmetric; with SOC} \]

| \(|000\)| | \(C_6^+ \sigma_{d1}, T\) | \(R_7\); | 2; \(i\sigma_3, i\sigma_1, -i\sigma_2\); | P-CNL\(\Gamma\)A; |
|---|---|---|---|---|---|
| \(R_8\); | \(\sqrt{3}\sigma_0 + i\sigma_3, i\sigma_1, -i\sigma_2\); | P-WNL\(\Gamma\)A; |
| \(R_9\); | \(-\sqrt{3}\sigma_0 + i\sigma_3, i\sigma_1, -i\sigma_2\); | P-WNL\(\Gamma\)A; |
| \(M; (0\frac{1}{2}0)\); \(C_2, \sigma_{e1}, T\) | \(R_5\); | 2; \(i\sigma_2, i\sigma_1, -i\sigma_2\); | P-WNL\(\Gamma\)L; |
| \(|00\frac{1}{2}\); \(C_6^+ \sigma_{d1}, T\) | \(\{ R_7, R_7 \}\); | 4; \(\frac{\sqrt{3}\sigma_0 + i\sigma_3, \Gamma_{0,1}, -\Gamma_{2,1}}{2};\) | DP; 0 |
| \(R_8, R_8\); | 4; \(\frac{\sqrt{3}\sigma_0 + i\sigma_3, \Gamma_{0,1}, -\Gamma_{2,1}}{2};\) | DP; 0 |
| \(R_9, R_9\); | 4; \(i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1};\) | CDP; 0 |
| \(L; (0\frac{1}{2}1); \ C_2, \sigma_{e1}, T\) | \(\{ R_9, R_9 \}\); | 4; \(i\Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1};\) | DP; 0 |
| \(K; (\frac{1}{2}2\frac{1}{2}0)\); \(C_3^+ \sigma_{d1}, T \sigma_{e4}\) | \(R_3\); | 1; \(-1,i,1;\) |
| \(R_4\); | 1; \(-1,-i,1;\) |
| \(R_5\); | \(-i\sigma_3, i\sigma_1;\) |
| \(\Delta; \ \Gamma\)A \(C_6^+ \sigma_{d1}\) | \(R_7\); | 2; \(i\sigma_3, i\sigma_1;\) |
| \(R_8\); | \(\frac{1}{2}; \ \Gamma_{0,3}, i\sigma_1;\) |
| \(R_9\); | \(\frac{1}{2}; \ \Gamma_{0,3}, i\sigma_1;\) |
| \(U\); \(\text{ML}; \ C_2, \sigma_{e1}\) | \(R_5\); | 2; \(i\sigma_2, i\sigma_1;\) |
| \(P\); \(\text{KH}; \ C_3^+ \sigma_{d1}\) | \(R_3\); | 1; \(-1,i,1;\) |
| \(R_4\); | 1; \(-1,-i,1;\) |
| \(S\); \(\text{AH}; \ \sigma_{d2}, C_2, T\) | \(R_2\); | 1; \(i,1;\) |
| \(R_4\); | 1; \(-i,1;\) |
| \(T\); \(\text{MK}; \ \sigma_{d1}, T \sigma_{e1}\) | \(R_2\); | 1; \(i,1;\) |
| \(R_4\); | 1; \(-i,1;\) |
| \(S\); \(\text{AH}; \ \sigma_{d2}, C_2, T\) | \(R_2, R_4\); | 2; \(\sigma_3, \sigma_1;\) |
| \(T\); \(\text{MK}; \ \sigma_{d1}, T \sigma_{e1}\) | \(R_2\); | 1; \(i,1;\) |
| \(R_4\); | 1; \(-i,1;\) |
| \(S\); \(\text{LH}; \ \sigma_{d1}, T \sigma_{e1}\) | \(R_2, R_4\); | 2; \(\sigma_3, -i\sigma_2;\) |
| \(\Sigma\); \(\Gamma\)M \(\sigma_{e1}, C_2, T\) | \(R_2\); | 1; \(i,1;\) |
| \(R_4\); | 1; \(-i,1;\) |
| \(R\); \(\text{AL}; \ \sigma_{e1}, C_2, T\) | \(R_2, R_4\); | 2; \(\sigma_3, \sigma_1;\) | WNL; \(\pi\) |
\[ \Gamma_h; \{ C^+_6 [000 \frac{1}{2}] \}, \{ \sigma_{d1} [000] \}; \text{T; Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \text{ (000): } C^+_6 \sigma_{d1} T; \]
\[ R_6; 2; i \sigma_3, i \sigma_1, -i \sigma_2; \]
\[ R_8; 2; \frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}, i \sigma_1, -i \sigma_2; \]
\[ R_6; 2; -\frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}, i \sigma_1, -i \sigma_2; \]

\[ M; \text{ (000): } C_2 \sigma_{e1} T; \]
\[ R_5; 2; i \sigma_2, i \sigma_1, -i \sigma_2; \]

\[ A; \text{ (000): } C^+_3 \sigma_{d1} C_2 T; \]
\[ \{ R_{13}, R_{13} \}; 4; -\Gamma_{0,0}, i \Gamma_{0,1}, \Gamma_{0,3}, -\Gamma_{2,3}; \]
\[ \{ R_{14}, R_{15} \}; 4; \frac{\Gamma_{0,0} + i \Gamma_{3,3}}{2}, i \Gamma_{3,3}, \Gamma_{3,2}, -i \Gamma_{2,0}; \]

\[ L; \text{ (000): } \sigma_{d1} \sigma_{e1} T; \]
\[ \{ R_9, R_9 \}; 4; i \Gamma_{0,3}, \Gamma_{0,1}, -\Gamma_{2,1}; \]

\[ K; \text{ (000): } C^+_3 \sigma_{d1} T \sigma_{e1}; \]
\[ R_5; 1; -1, i, 1; \]
\[ R_5; 1; -1, -i, 1; \]
\[ R_6; 2; \frac{\sigma_0 - i \sqrt{3} \sigma_2}{2}, i \sigma_3, \frac{\sqrt{3} \sigma_0 + \sigma_3}{2}; \]

\[ H; \text{ (000): } C^+_3 \sigma_{d1} T \sigma_{e1}; \]
\[ \{ R_3, R_3 \}; 2; -\sigma_0, i \sigma_0, -i \sigma_2; \]
\[ \{ R_4, R_4 \}; 2; -\sigma_0, -i \sigma_0, -i \sigma_2; \]
\[ \{ R_6, R_6 \}; 4; \frac{\Gamma_{0,0} - i \Gamma_{3,3}}{2}, i \Gamma_{0,3}, \frac{\sqrt{3} \Gamma_{2,1} + \Gamma_{2,3}}{2}; \]

\[ \Delta; \text{ GA: } C^+_6 \sigma_{d1}; \]
\[ R_7; 2; i \sigma_3, i \sigma_1; \]
\[ R_8; 2; \frac{1}{2} (\sqrt{3} \sigma_0 + i \sigma_3), i \sigma_1; \]
\[ R_0; 2; \frac{1}{2} (-\sqrt{3} \sigma_0 + i \sigma_3), i \sigma_1; \]

\[ U; \text{ ML: } C_2 \sigma_{e1}; \]
\[ R_5; 2; i \sigma_2, i \sigma_1; \]

\[ P; \text{ KH: } C^+_3 \sigma_{d1}; \]
\[ R_3; 1; -1, i; \]
\[ R_4; 1; -1, -i; \]
\[ R_6; 2; \frac{1}{2} (\sigma_0 - i \sqrt{3} \sigma_2), i \sigma_3; \]

\[ T; \text{ GK: } \sigma_{d2} C_2 T; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ S; \text{ AH: } \sigma_{d2} C_2 T; \]
\[ \{ R_2, R_2 \}; 2; i \sigma_0, -i \sigma_2; \]
\[ \{ R_4, R_4 \}; 2; -i \sigma_0, -i \sigma_2; \]

\[ T'; \text{ MK: } \sigma_{d1} T \sigma_{e1}; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ S'; \text{ LH: } \sigma_{d1} T \sigma_{e1}; \]
\[ \{ R_2, R_2 \}; 2; i \sigma_0, -i \sigma_2; \]
\[ \{ R_4, R_4 \}; 2; -i \sigma_0, -i \sigma_2; \]

\[ \Sigma; \text{ GM: } \sigma_{e1} C_2 T; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ R; \text{ AL: } \sigma_{e1} C_2 T; \]
\[ \{ R_2, R_4 \}; 2; \sigma_3, -i \sigma_2; \]
| Γ | (000) | \(C_6^+|00\frac{1}{2}\), \(\sigma_{d1}|00\frac{1}{2}\), \(T\); Non-Centrosymmetric; with SOC |
|---|---|---|
| | | \(\Gamma_h\); \(\{\sigma_{d1}|00\frac{1}{2}\}, \Gamma_0\); |
| | | \(\sigma_{d1}, \sigma_{v1}, \Gamma_0\); |
| R\(_7\) | \(2; i\sigma_3, -i\sigma_2; \) | P-CN\(\Gamma\)_A; |
| R\(_8\) | \(2; \sqrt{\frac{\sigma_0 + i\sigma_3}{2}}, \sigma_1, -i\sigma_2; \) | P-WNL\(\Gamma\)_A; |
| R\(_9\) | \(2; \sqrt{\frac{\sigma_0 + i\sigma_3}{2}}, i\sigma_1, -i\sigma_2; \) | P-WNL\(\Gamma\)_A; |
| M | (0\(\frac{1}{2}\)0) | \(C_2, \sigma_{v1}, T\); |
| | | \(\{R_9, R_9\}; 4; i\Gamma_0, i\Gamma_0, -\Gamma_2; \) |
| A | (00\(\frac{1}{2}\)) | \(C_3^+, \sigma_{v1}, C_2, T\); |
| | | \(\{R_{13}, R_{13}\}; 4; \Gamma_{\frac{1}{2}}, \Gamma_{\frac{1}{2}}, \Gamma_{1}, \Gamma_{3}; \) |
| | | \(\{R_{14}, R_{14}\}; 4; \Gamma_{\frac{1}{2}}, \Gamma_{\frac{1}{2}}, \Gamma_{1}, \Gamma_{3}; \) |
| L | (0\(\frac{1}{2}\)\(\frac{1}{2}\)) | \(\sigma_{v1}, C_2, T\); |
| | | \(\{R_9, R_9\}; 4; i\Gamma_0, i\Gamma_0, -\Gamma_2; \) |
| K | (\(\frac{1}{2}\)\(\frac{1}{2}\)0) | \(C_3^+, \sigma_{d1}, T\sigma_{v1}; \) |
| | | \(\{R_3, R_3\}; 3; \sigma; \) |
| H | (\(\frac{1}{2}\)\(\frac{1}{2}\)\(\frac{1}{2}\)) | \(\sigma_{d1}, T\sigma_{v1}; \) |
| | | \(\{R_3, R_3\}; 3; \sigma; \) |
| \(\Delta\) | \(\Gamma\)_A | \(C_6^+, \sigma_{d1}; \) |
| | | \(\{R_7, R_7\}; 2; i\sigma_3, i\sigma_1; \) |
| | | \(\{R_8, R_8\}; 2; \frac{1}{2} \sigma_0 + i\sigma_3, i\sigma_1; \) |
| | | \(\{R_9, R_9\}; 2; \frac{1}{2} \sigma_0 + i\sigma_3, i\sigma_1; \) |
| U | ML | \(C_2, \sigma_{v1}; \) |
| | | \(\{R_3, R_3\}; 2; i\sigma_2, i\sigma_1; \) |
| P | KH | \(C_3^+, \sigma_{d1}; \) |
| | | \(\{R_3, R_3\}; 2; i\sigma_2, i\sigma_1; \) |
| T | \(\Gamma\)_K | \(\sigma_{d2}, C_2 T; \) |
| | | \(\{R_2, R_4\}; 2; \sigma_3, -i\sigma_2; \) |
| S | AH | \(\sigma_{d2}, C_2 T; \) |
| | | \(\{R_2, R_4\}; 2; \sigma_3, -i\sigma_2; \) |
| T' | MK | \(\sigma_{d1}, T\sigma_{v1}; \) |
| | | \(\{R_2, R_4\}; 2; \sigma_3, \sigma_1; \) |
| S' | LH | \(\sigma_{d1}, T\sigma_{v1}; \) |
| | | \(\{R_2, R_4\}; 2; \sigma_3, \sigma_1; \) |
| Σ | \(\Gamma\)_M | \(\sigma_{v1}, C_2 T; \) |
| | | \(\{R_2, R_4\}; 2; \sigma_3, \sigma_1; \) |
| R | AL | \(\sigma_{v1}, C_2 T; \) |
| | | \(\{R_2, R_4\}; 2; \sigma_3, \sigma_1; \) |
\[ \Gamma; \text{(000): } S^+_3 \Gamma A; C^+_2 T; \]
\[ R_7; \text{2; } i\sigma_3, i\sigma_1, -i\sigma_2; \]
\[ R_6; \text{2; } \sqrt{\sigma_0\sigma_3}, i\sigma_1, -i\sigma_2; \]
\[ R_5; \text{2; } \sqrt{\sigma_0\sigma_3 - \sigma_2}, i\sigma_1, -i\sigma_2; \]

\[ M; \text{(010): } C^+_2 T; \]
\[ R_5; \text{2; } i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ A; \text{(001): } S^+_3 C^+_2 T; \]
\[ R_7; \text{2; } i\sigma_3, i\sigma_1, -i\sigma_2; \]
\[ R_6; \text{2; } \sqrt{\sigma_0\sigma_3 - \sigma_2}, i\sigma_1, -i\sigma_2; \]
\[ R_5; \text{2; } \sqrt{\sigma_0\sigma_3 - \sigma_2}, i\sigma_1, -i\sigma_2; \]

\[ L; \text{(011): } C^+_2 T; \]
\[ R_5; \text{2; } i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ K; \text{(110): } S^+_3 T; \]
\[ R_2; \text{1; } \sqrt{-1}, 1; \]
\[ R_4; \text{1; } i, 1; \]
\[ R_6; \text{1; } (-1)^{5/6}, 1; \]
\[ R_5; \text{1; } -\sqrt{-1}, 1; \]
\[ R_{10}; \text{1; } -i, 1; \]
\[ R_{12}; \text{1; } (-1)^{5/6}, 1; \]

\[ H; \text{(111): } S^+_3 T; \]
\[ R_2; \text{1; } \sqrt{-1}, 1; \]
\[ R_4; \text{1; } i, 1; \]
\[ R_6; \text{1; } (-1)^{5/6}, 1; \]
\[ R_5; \text{1; } -\sqrt{-1}, 1; \]
\[ R_{10}; \text{1; } -i, 1; \]
\[ R_{12}; \text{1; } (-1)^{5/6}, 1; \]

\[ \Delta; \Gamma A; \]
\[ C^+_3 T; \]
\[ R_5; \text{1; } -1, i, 1; \]
\[ R_4; \text{1; } -1, -i, 1; \]
\[ R_6; \text{2; } \frac{\sigma_0 + i\sqrt{\sigma_2}}{2}, i\sigma_3, \frac{\sigma_0 - i\sqrt{\sigma_2}}{2}; \]

\[ U; \text{ML; } \sigma_{v1}; \]
\[ R_2; \text{1; } i, 1; \]
\[ R_4; \text{1; } -i, 1; \]

\[ P; \text{KH; } C^+_3 C^+_2 T; \]
\[ R_2; \text{1; } \sqrt{-1}, 1; \]
\[ R_4; \text{1; } -1, 1; \]
\[ R_6; \text{1; } (-1)^{2/3}, 1; \]

\[ T; \text{Gamma; } \sigma_h; \]
\[ R_2; \text{1; } i, 1; \]
\[ R_4; \text{1; } -i, 1; \]

\[ S; \text{AH; } \sigma_h; \]
\[ R_2; \text{1; } i, 1; \]
\[ R_4; \text{1; } -i, 1; \]

\[ T'; \text{MK; } \sigma_h; \]
\[ R_2; \text{1; } i, 1; \]
\[ R_4; \text{1; } -i, 1; \]

\[ S'; \text{LH; } \sigma_h; \]
\[ R_2; \text{1; } i, 1; \]
\[ R_4; \text{1; } -i, 1; \]

\[ \Sigma; \text{Gamma; } C^+_2 T; \]
\[ R_5; \text{2; } i\sigma_2, i\sigma_1; \]

\[ R; \text{AL; } C^+_2 T; \]
\[ R_5; \text{2; } i\sigma_2, i\sigma_1; \]

P-WNLs;  
QNL;  
WNL;  
WNL;
\[ \Gamma_h; \{ S_{3h}^+ |000\}, \{ C_{21}^l |00\tfrac{1}{2}\} ; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; (000); S_{3h}^+ C_{21}^l T; \]
\[ R_5; \quad 2; i \sigma_3, -i \sigma_2; \quad \text{P-WNLs;} \]
\[ R_8; \quad 2; \sqrt[2]{\sqrt{3}} \sigma_3, i \sigma_1, -i \sigma_2; \quad \text{P-WNLs;} \]
\[ R_9; \quad 2; \sqrt[2]{\sqrt{3}} \sigma_3, -i \sigma_1, -i \sigma_2; \quad \text{P-WNLs;} \]

\[ M; (0\tfrac{1}{2}0); C_{21}^l \sigma_{v1} T; \]
\[ R_5; \quad 2; i \sigma_2, -i \sigma_3; \quad \text{P-WNL}_{\Gamma M}; \]

\[ A; (00\tfrac{1}{2}); \sigma_{v1}, C_{3h}^l \sigma_{v1} T; \]
\[ \{ R_5, R_7 \}; \quad 2; \sigma_0, -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-WNLs;} \]
\[ \{ R_8, R_9 \}; \quad 2; -\sigma_0, -\sigma_0, i \sigma_3, -i \sigma_2; \quad \text{P-WNLs;} \]
\[ \{ R_{11}, R_{12} \}; \quad 4; \Gamma_{0.1}, \Gamma_{0.1}, \Gamma_{3.0}, -i \Gamma_{2.0}; \quad \text{DP}; \quad 0 \]

\[ L; (0\tfrac{1}{2}0); \sigma_{v1}, \sigma_{v1} T; \]
\[ \{ R_5, R_6 \}; \quad 2; -\sigma_0, -i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{\Gamma L}; \]
\[ \{ R_7, R_8 \}; \quad 2; \sigma_0, -i \sigma_3, -i \sigma_2; \quad \text{P-WNL}_{\Gamma L}; \]

\[ K; (\tfrac{1}{2}00); S_{3h}^+ T \sigma_{v2}; \]
\[ R_2; \quad 1; \sqrt{-1}, 1; \]
\[ R_4; \quad 1; i, 1; \]
\[ R_6; \quad 1; (-1)^{3/6}, 1; \]
\[ R_8; \quad 1; -\sqrt{-1}, 1; \]
\[ R_{10}; \quad 1; i, 1; \]
\[ R_{12}; \quad 1; -(-1)^{3/6}, 1; \]

\[ H; (\tfrac{1}{2}0\tfrac{1}{2}); S_{3h}^+ T \sigma_{v2}; \]
\[ \{ R_2, R_3 \}; \quad 2; \sqrt{-1} \sigma_3, i \sigma_2; \quad \text{P-WNLs;} \]
\[ \{ R_4, R_{10} \}; \quad 2; i \sigma_3, -i \sigma_2; \quad \text{P-WNLs;} \]
\[ \{ R_5, R_{12} \}; \quad 2; (-1)^{3/6} \sigma_3, -i \sigma_2; \quad \text{P-WNLs;} \]

\[ \Delta; \Gamma A; \quad C_{3h}^+ \sigma_{v1} S_{3h}^+ T; \]
\[ R_5; \quad 1; -1, i, 1; \]
\[ R_6; \quad 1; -1, -i, 1; \]
\[ R_9; \quad 2; \sigma_0 - i \sqrt{3} \sigma_2, i \sigma_3, \sigma_0 - i \sqrt{3} \sigma_2; \quad \text{QNL}; \quad 0 \]

\[ U; \Gamma L; \quad \sigma_{v1} T \sigma_{v1}; \]
\[ R_2; \quad 1; i, 1; \]
\[ R_4; \quad 1; i, 1; \]

\[ P; \Gamma K; \quad C_{3h}^+ C_{21}^l T; \]
\[ R_2; \quad 1; \sqrt{-1}, 1; \]
\[ R_4; \quad 1; -1, 1; \]
\[ R_6; \quad 1; -(-1)^{3/2}, 1; \]

\[ T; \Gamma K; \quad \sigma_{h}, T \sigma_{v1}; \]
\[ R_2; \quad 1; i, 1; \]
\[ R_4; \quad 1; -i, 1; \]

\[ S; \Gamma A; \quad \sigma_{h}, T \sigma_{v1}; \]
\[ \{ R_2, R_4 \}; \quad 2; i \sigma_3, -i \sigma_2; \quad \text{WNL}; \quad \pi \]

\[ T'; \Gamma K; \quad \sigma_{h}, T \sigma_{v1}; \]
\[ R_2; \quad 1; i, 1; \]
\[ R_4; \quad 1; -i, 1; \]

\[ S'; \Gamma M; \quad C_{21}^l \sigma_{v1} T; \]
\[ R_2; \quad 2; i \sigma_3, -i \sigma_2; \quad \text{WNL}; \quad \pi \]

\[ \Sigma; \Gamma M; \quad C_{21}^l \sigma_{v1}; \]
\[ R_5; \quad 1; i, i; \]
\[ R_6; \quad 1; i, -i; \]
\[ R_7; \quad 1; -i, -i; \]
\[ R_8; \quad 1; -i, i; \]
Γₜ; \{S^+_3|000\}, \{C''_{21}|000\}, T; Non-Centrosymmetric; with SOC

Γ; (000): \(S^+_3, C''_{21}, T\):
\(R_7; 2; i \sigma_3, i \sigma_1, -i \sigma_2\); P-WNLs;
\(R_8; 2; \sqrt{3} \sigma_0 + i \sigma_3, i \sigma_1, -i \sigma_2\); P-WNLs;
\(R_9; 2; \sqrt{3} \sigma_0 + i \sigma_3, i \sigma_1, -i \sigma_2\); P-WNLs;

M; (010): \(C''_{21}, \sigma_{d1}, T\):
\(R_5; 2; i \sigma_2, i \sigma_1, -i \sigma_2\); P-WNL_{MK};

A; (001): \(S^+_3, C''_{21}, T\):
\(R_7; 2; i \sigma_3, i \sigma_1, -i \sigma_2\); P-WNLs;
\(R_8; 2; \sqrt{3} \sigma_0 + i \sigma_3, i \sigma_1, -i \sigma_2\); P-WNLs;
\(R_9; 2; \sqrt{3} \sigma_0 + i \sigma_3, i \sigma_1, -i \sigma_2\); P-WNLs;

L; (01 \frac{1}{2}): \(C''_{21}, \sigma_{d1}, T\):
\(R_5; 2; i \sigma_2, i \sigma_1, -i \sigma_2\); P-WNL_{LH};

K; (\frac{1}{2}00): \(S^+_3, C''_{21}\):
\(R_7; 2; i \sigma_3, i \sigma_1\); P-WNLs;
\(R_8; 2; \frac{1}{2} (\sqrt{3} \sigma_0 + i \sigma_3), i \sigma_1\); P-WNLs;
\(R_9; 2; \frac{1}{2} (\sqrt{3} \sigma_0 + i \sigma_3), i \sigma_1\); P-WNLs;

H; (\frac{1}{2} \frac{1}{2}0): \(S^+_3, C''_{21}\):
\(R_7; 2; i \sigma_3, i \sigma_1\); P-WNLs;
\(R_8; 2; \frac{1}{2} (\sqrt{3} \sigma_0 + i \sigma_3), i \sigma_1\); P-WNLs;
\(R_9; 2; \frac{1}{2} (\sqrt{3} \sigma_0 + i \sigma_3), i \sigma_1\); P-WNLs;

Δ; ΓA; \(C^+_3, \sigma_{d1}, S^+_3, T\):
\(R_3; 1; -1, i, 1\);
\(R_4; 1; -1, -i, 1\);
\(R_5; 2; \sigma_0 - i \sqrt{3} \sigma_2, i \sigma_3, \sigma_0 + i \sqrt{3} \sigma_2\); QNL;

U; ML; \(\sigma_{d1}, T \sigma_h\):
\(R_2; 1; i, 1\);
\(R_4; 1; -i, 1\);

P; KH; \(C^+_3, \sigma_{d1}\):
\(R_3; 1; -1, i\);
\(R_4; 1; -1, -i\);
\(R_5; 2; \frac{1}{2} (\sigma_0 - i \sqrt{3} \sigma_2), i \sigma_3\); WNL;

T; ΓK; \(C''_{22}, \sigma_{d2}\):
\(R_5; 2; i \sigma_2, i \sigma_1\); WNL;

S; AH; \(C''_{22}, \sigma_{d2}\):
\(R_5; 2; i \sigma_2, i \sigma_1\); WNL;

T'; MK; \(C''_{21}, \sigma_{d1}\):
\(R_5; 2; i \sigma_2, i \sigma_1\); WNL;

S'; LH; \(C''_{21}, \sigma_{d1}\):
\(R_5; 2; i \sigma_2, i \sigma_1\); WNL;

Σ; ΓM; \(\sigma_h, T \sigma_{d1}\):
\(R_2; 1; i, 1\);
\(R_4; 1; -i, 1\);

R; AL; \(\sigma_h, T \sigma_{d1}\):
\(R_2; 1; i, 1\);
\(R_4; 1; -i, 1\);
$\Gamma_h; \{S^+_3|000\}, \{C''_{21}|00\frac{1}{2}\}; T; \text{Non-Centrosymmetric; with SOC}$

$\Gamma; (000); S^+_3C''_{21}, T; R_5; 2; i\sigma_3, i\sigma_3, -i\sigma_2; P-WNLs;$

$\Gamma; (000); S^+_3C''_{21}, T; R_5; 2; \sqrt{\frac{\eta_0+i\sigma_3}{2}}, i\sigma_1, -i\sigma_2; P-WNLs;$

$\Gamma; (000); S^+_3C''_{21}, T; R_5; 2; \sqrt{\frac{\eta_0+i\sigma_3}{2}}, i\sigma_1, -i\sigma_2; P-WNLs;$

$M; (0\frac{1}{2}0); C''_{21}, \sigma_4, T; R_5; 2; i\sigma_2, i\sigma_3, -i\sigma_2; P-WNL_{MK};$

$A; (00\frac{1}{2}); \sigma_4,C''_{3}, \sigma_4, T; \{R_5, R_7\}; 2; \sigma_0, -\sigma_0, i\sigma_3, -i\sigma_2; P-WNLs;$

$\{R_5, R_8\}; 2; -\sigma_0, -\sigma_0, i\sigma_3, -i\sigma_2; P-WNLs;$

$\{R_5, R_8\}; 2; -\sigma_0, -\sigma_0, i\sigma_3, -i\sigma_2; P-WNLs;$

$L; (0\frac{1}{2}0); \sigma_4, T; \{R_5, R_6\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; P-WNL_{AL};$

$\{R_7, R_8\}; 2; \sigma_0, -i\sigma_3, -i\sigma_2; P-WNL_{AL};$

$K; (1\frac{2}{3}0); S^+_3 C''_{21}; R_5; 2; i\sigma_3, i\sigma_1; P-WNLs;$

$K; (1\frac{2}{3}0); S^+_3 C''_{21}; R_5; 2; \sqrt{\frac{\eta_0+i\sigma_3}{2}}, i\sigma_1; P-WNLs;$

$K; (1\frac{2}{3}0); S^+_3 C''_{21}; R_5; 2; \sqrt{\frac{\eta_0+i\sigma_3}{2}}, i\sigma_1; P-WNLs;$

$H; (1\frac{2}{3}0); \sigma_4,C''_{3}, \sigma_4; R_5; 1; 1, -1, i; P-WNLs;$

$H; (1\frac{2}{3}0); \sigma_4,C''_{3}, \sigma_4; R_5; 1; 1, -1, i; P-WNLs;$

$H; (1\frac{2}{3}0); \sigma_4,C''_{3}, \sigma_4; R_5; 1; 1, -1, i; P-WNLs;$

$\Delta; \Gamma A; C^+_3, \sigma_4, S^+_3, T; R_5; 1; -1, i, 1; P-WNL_{KH};$

$\Delta; \Gamma A; C^+_3, \sigma_4, S^+_3, T; R_5; 1; -1, -1, i; P-WNL_{KH};$

$\Delta; \Gamma A; C^+_3, \sigma_4, S^+_3, T; R_5; 1; -1, -1, i; P-WNL_{KH};$

$\Delta; \Gamma A; C^+_3, \sigma_4, S^+_3, T; R_5; 1; -1, -1, i; P-WNL_{KH};$

$U; ML; \sigma_4, T\sigma_4; R_5; 1; i, 1; QNL; 0$

$U; ML; \sigma_4, T\sigma_4; R_5; 1; i, 1; QNL; 0$

$P; KH; C^+_3, \sigma_4; R_5; 1; -1, i; WNL; \pi$

$P; KH; C^+_3, \sigma_4; R_5; 1; -1, i; WNL; \pi$

$P; KH; C^+_3, \sigma_4; R_5; 1; -1, i; WNL; \pi$

$T; \Gamma K; C''_{22}, \sigma_4; R_5; 2; i\sigma_2, i\sigma_3; WNL; \pi$

$S; \Gamma H; C''_{22}, \sigma_4; R_5; 1; i, i; WNL; \pi$

$S; \Gamma H; C''_{22}, \sigma_4; R_5; 1; i, i; WNL; \pi$

$T'; MK; C''_{21}, \sigma_4; R_5; 2; i\sigma_2, i\sigma_3; WNL; \pi$

$S'; LH; C''_{21}, \sigma_4; R_5; 1; i, i; WNL; \pi$

$S'; LH; C''_{21}, \sigma_4; R_5; 1; i, i; WNL; \pi$

$\Sigma; \Gamma M; \sigma_4, T\sigma_4; R_5; 1; i, 1; WNL; \pi$

$\Sigma; \Gamma M; \sigma_4, T\sigma_4; R_5; 1; i, 1; WNL; \pi$

$\Sigma; \Gamma M; \sigma_4, T\sigma_4; R_5; 1; i, 1; WNL; \pi$

$R; AL; \sigma_4, T\sigma_4; \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; WNL; \pi$
\[ \Gamma: (000)\; C^+_6, C^+_{21}, I, T; \; R_7; \quad 2; \; \sigma_3, \sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_8; \quad 2; \; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_9; \quad 2; \; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{16}; \quad 2; \; \sigma_3, \sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{17}; \quad 2; \; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{18}; \quad 2; \; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, -\sigma_0, -i\sigma_2; \]

\[ M: (0\frac{1}{2}0); \; C^+_2, C^+_{21}, I, T; \; R_5; \quad 2; \; -\sigma_2, \sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; \quad 2; \; -\sigma_2, \sigma_1, -\sigma_0, -i\sigma_2; \]

\[ A: (00\frac{1}{2})\; C^+_6, C^+_{21}, I, T; \; R_7; \quad 2; \; \sigma_3, \sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_8; \quad 2; \; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_9; \quad 2; \; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{16}; \quad 2; \; \sigma_3, \sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{17}; \quad 2; \; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{18}; \quad 2; \; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, -\sigma_0, -i\sigma_2; \]

\[ L: (0\frac{1}{2}\frac{1}{2}); \; C^+_2, C^+_{21}, I, T; \; R_5; \quad 2; \; \sigma_2, \sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{10}; \quad 2; \; \sigma_2, \sigma_1, -\sigma_0, -i\sigma_2; \]

\[ K: (\frac{1}{2} \frac{1}{2} 0); \; S^+_3, C^+_{21}, I, T; \; R_5; \quad 2; \; \sigma_3, \sigma_1, -i\sigma_2; \]
\[ R_8; \quad 2; \; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, -i\sigma_2; \]
\[ R_9; \quad 2; \; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, -i\sigma_2; \]

\[ H: (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \; S^+_3, C^+_{21}, I, T; \; R_7; \quad 2; \; \sigma_3, \sigma_1, -i\sigma_2; \]
\[ R_8; \quad 2; \; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, -i\sigma_2; \]
\[ R_9; \quad 2; \; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, -i\sigma_2; \]

\[ \Delta: \Gamma A; \; C^+_6, \sigma_{41}, I, T; \; R_7; \quad 2; \; \sigma_3, \sigma_1, -i\sigma_2; \]
\[ R_8; \quad 2; \; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, -i\sigma_2; \]
\[ R_9; \quad 2; \; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), \sigma_1, -i\sigma_2; \]

\[ U; \; M L; \; C^+_2, \sigma_{41}, I, T; \; R_5; \quad 2; \; \sigma_2, \sigma_1, -i\sigma_2; \]

\[ P; \; K H; \; C^+_3, \sigma_{41}, I, T; \; \{R_3, R_4\}; \quad 2; \; -\sigma_0, \sigma_3, -i\sigma_2; \]
\[ R_6; \quad 2; \; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), \sigma_3, -i\sigma_2; \]

\[ T; \; \Gamma K; \; C^+_{22}, \sigma_{42}, I, T; \; R_5; \quad 2; \; \sigma_2, \sigma_1, -i\sigma_2; \]

\[ S; \; A H; \; C^+_{22}, \sigma_{42}, I, T; \; R_5; \quad 2; \; \sigma_2, \sigma_1, -i\sigma_2; \]

\[ T'; \; M K; \; C^+_{22}, \sigma_{41}, I, T; \; R_5; \quad 2; \; \sigma_2, \sigma_1, -i\sigma_2; \]

\[ S'; \; L H; \; C^+_{21}, \sigma_{41}, I, T; \; R_5; \quad 2; \; \sigma_2, \sigma_1, -i\sigma_2; \]

\[ \Sigma; \; \Gamma M; \; C^+_{21}, \sigma_{41}, I, T; \; R_5; \quad 2; \; \sigma_2, \sigma_1, -i\sigma_2; \]

\[ R; \; A L; \; C^+_{21}, \sigma_{41}, I, T; \; R_5; \quad 2; \; \sigma_2, \sigma_1, -i\sigma_2; \]
\[ \Gamma_h; \{C^+_6|000\}, \{C^+_2|001\}, \{I|000\}, T; \text{Centrosymmetric; with SOC} \]

\[
\begin{align*}
\Gamma; \ (000): & \ C^+_6, \ C^+_2, I, T; \\
R_7; & : \ 2; \ i\sigma_3, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_8; & : \ 2; \ \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, \sigma_0, -i\sigma_2; \\
R_9; & : \ 2; \ \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{16}; & : \ i\sigma_3, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_{17}; & : \ 2; \ \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_{18}; & : \ 2; \ \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -\sigma_0, -i\sigma_2; \\
M; \ (0\frac{1}{2}0); & \ C_2, C^\prime_2, I, T; \\
R_5; & : \ 2; \ i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{10}; & : \ 2; \ i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\
A; \ (00\frac{1}{2}); & \sigma_{d1}, C^+_3, \sigma_h, C^+_2, T; \\
\{R_9, R_{20}\}; & : \ 4; \ \Gamma_0, 1, -\Gamma_0, 0, i\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{2,0}; \quad \text{CDP; 0} \\
\{R_{21}, R_{23}\}; & : \ 4; \ \Gamma_0, 1, \frac{\Gamma_{0,0} + i\sqrt{3}\Gamma_{3,3}}{2}, i\Gamma_{3,0}, -i\Gamma_{3,3}, -i\Gamma_{2,0}; \quad \text{DP; 0} \\
\{R_{22}, R_{24}\}; & : \ 4; \ \Gamma_0, 1, \frac{\Gamma_{0,0} + i\sqrt{3}\Gamma_{3,3}}{2}, i\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{2,0}; \quad \text{DP; 0} \\
L; \ (0\frac{1}{2}\frac{1}{2}); & \sigma_{d1}, \sigma_h, I, T; \\
\{R_{13}, R_{14}\}; & : \ 4; \ \Gamma_0, 1, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}, \Gamma_{3,3}; \quad \text{DP; 0} \\
K; \ (\frac{1}{2}\frac{1}{2}0); & \ S^+_3, C^\prime_2, I, T; \\
R_7; & : \ 2; \ i\sigma_3, i\sigma_1, -i\sigma_2; \\
R_8; & : \ 2; \ \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -i\sigma_2; \\
R_9; & : \ 2; \ \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -i\sigma_2; \\
H; \ (\frac{1}{2}\frac{1}{2}\frac{1}{2}); & \sigma_{d1}, C^+_3, \sigma_h, I, T; \\
\{R_5, R_8\}; & : \ 2; \ \sigma_3, -\sigma_0, i\sigma_3, -i\sigma_2; \\
\{R_6, R_7\}; & : \ 2; \ -\sigma_3, -\sigma_0, i\sigma_3, -i\sigma_2; \\
\{R_{11}, R_{12}\}; & : \ 4; \ \Gamma_3, 1, \frac{\Gamma_{0,0} + \sqrt{3}\Gamma_{3,3}}{2}, i\Gamma_{3,0}, -i\Gamma_{2,0}, \Gamma_{3,3}; \quad \text{DP; 0} \\
\Delta; \ \Gamma\Delta; & \ C^+_6, \sigma_{d1}, I, T; \\
R_7; & : \ 2; \ i\sigma_3, i\sigma_1, -i\sigma_2; \\
R_8; & : \ 2; \ \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -i\sigma_2; \\
R_9; & : \ 2; \ \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -i\sigma_2; \\
U; \ \Gamma\Delta; & \ C_2, \sigma_{v1}, I, T; \\
R_3; & : \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
P; \ \Gamma\Delta; & \ C^+_3, \sigma_{d1}, I, T; \\
\{R_3, R_4\}; & : \ 2; \ -\sigma_0, i\sigma_3, -i\sigma_2; \\
R_6; & : \ 2; \ \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2; \\
T; \ \Gamma\Delta; & \ C^\prime_2, \sigma_{d2}, I, T; \\
R_5; & : \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
S; \ \Gamma\Delta; & \ C^\prime_2, \sigma_h, I, T; \\
\{R_3, R_6\}; & : \ 2; \ i\sigma_0, i\sigma_3, -i\sigma_2; \\
\{R_7, R_8\}; & : \ 2; \ -i\sigma_0, -i\sigma_3, -i\sigma_2; \\
T'; \ \Gamma\Delta; & \ C^\prime_2, \sigma_{d1}, I, T; \\
R_5; & : \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
S'; \ \Gamma\Delta; & \ C^\prime_2, \sigma_h, I, T; \\
\{R_5, R_6\}; & : \ 2; \ i\sigma_0, i\sigma_3, -i\sigma_2; \\
\{R_7, R_8\}; & : \ 2; \ -i\sigma_0, -i\sigma_3, -i\sigma_2; \\
\Sigma; \ \Gamma\Delta; & \ C^\prime_2, \sigma_{v1}, I, T; \\
R_5; & : \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \\
R; \ \Gamma\Delta; & \ C^\prime_2, \sigma_h, I, T; \\
\{R_5, R_6\}; & : \ 2; \ i\sigma_0, i\sigma_3, -i\sigma_2; \\
\{R_7, R_8\}; & : \ 2; \ -i\sigma_0, -i\sigma_3, -i\sigma_2; \\
\]
\[ \Gamma_h; \{C_6^+|000\}, \{C_2|000\}, \{I|000\}, \mathcal{T}; \text{Centrosymmetric; with SOC} \]

| Group | (000) | \( C_6^+ \cdot C_{21} | I, \mathcal{T}; R_7 \) | \( \Gamma \) | \( R_8 \) | \( \sqrt{2} \) | \( i \sigma_0 + i \sigma_2 \) | \( \frac{\sqrt{3}}{2} \sigma_0 + i \sigma_2 \) | \( i \sigma_1, i \sigma_1, -i \sigma_2 \) | \( -i \sigma_0, -i \sigma_0, -i \sigma_2 \) |
|-------|-------|---------------------------------|--------|-------|--------|-----------------|-----------------|-----------------|-----------------|
| \( \Gamma \) | (000) | \( C_6^+ \cdot C_{21} | I, \mathcal{T}; R_7 \) | 2 | \( i \sigma_3, i \sigma_1, \sigma_0, -i \sigma_2 \) | \( R_8 \) | \( \sqrt{3} \sigma_0 + i \sigma_2 \) | \( \frac{\sqrt{3}}{2} \sigma_0 + i \sigma_2 \) | \( i \sigma_1, i \sigma_1, -i \sigma_2 \) | \( -i \sigma_0, -i \sigma_0, -i \sigma_2 \) |

\[ M; \{0 \frac{1}{2} 0\}, \{ C_2 \cdot C_{21} | I, \mathcal{T}; R_5 \) | 2 | \( i \sigma_2, i \sigma_1, \sigma_0, -i \sigma_2 \) | \( R_{10} \) | \( i \sigma_2, i \sigma_1, -\sigma_0, -i \sigma_2 \) |

| Group | (000) | \( C_6^+ \cdot C_{21} | I, \mathcal{T}; \{R_{15}, R_{16}\} \) | \( A \) | \( \Gamma \) | \( \sigma_0, -i \sigma_0 \) | \( \sigma_0, -i \sigma_0 \) | \( \sigma_0, -i \sigma_0 \) |
|-------|-------|---------------------------------|-------|--------|--------|-----------------|-----------------|-----------------|
| \( \Gamma \) | (000) | \( C_6^+ \cdot C_{21} | I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) |
| \( \Gamma \) | (000) | \( C_6^+ \cdot C_{21} | I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A; \{ C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; R_7 \) | 2 | \( i \sigma_3, i \sigma_1, -i \sigma_2 \) | \( R_8 \) | \( \frac{\sqrt{3}}{2} \sigma_0 + i \sigma_2 \) | \( \sigma_1, -i \sigma_2 \) | \( \sigma_1, -i \sigma_2 \) | \( \sigma_1, -i \sigma_2 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) | \( -i \Gamma_0, 0 \) |

\[ \Delta; \Gamma A \) | (000) | \( C_6^+ \cdot \sigma, d_i, I, \mathcal{T}; \{R_{15}, R_{16}\} \) | P-DNLs; | \( \Gamma \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) | \( i \Gamma_0, 0 \) |
\[ \begin{array}{l}
\Gamma_0: \{ C^{+}_6 |000 \}, \{ C''_2 |000 \}, \{ I |000 \}, T; \text{Centrosymmetric; with SOC} \\

\Gamma: (000): \ C^{+}_6 . C'_{21} . I . T; \ R_7; \ 2; i\sigma_3, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_8; \ 2; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, \sigma_0, -i\sigma_2; \\
R_9; \ 2; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{10}; \ 2; i\sigma_3, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_{17}; \ 2; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_{18}; \ 2; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -\sigma_0, -i\sigma_2; \\

M: (0^120): \ C_2 . C''_{21} . I . T; \ R_5; \ 2; i\sigma_2, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{10}; \ 2; i\sigma_2, i\sigma_1, -\sigma_0, -i\sigma_2; \\

A: (00^12): \ C^{+}_6 . C''_{21} . I . T; \ \{ R_{15}, R_{16} \}; \ 4; \Gamma_{0.3}, i\Gamma_{3.0}, \Gamma_{0.1}, -i\Gamma_{2.0}; \ P\text{-DNLs}; \\
R_{24}; \ 4; \frac{1}{2} (-\Gamma_{3.0} + i\sqrt{3}\Gamma_{3.3}), i\Gamma_{0.1}, \Gamma_{1.3}, -i\Gamma_{3.2}; \ P\text{-DNLs}; \\

L: (0^1^12): \ \sigma_{d1} . C''_{21} . I . T; \ \{ R_{13}, R_{14} \}; \ 4; \Gamma_{0.1}, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}; \ P\text{-DNL}_{\text{AL}}; \\

K: (0^1^3^0^0): \ S^+_3 . C''_{21} . I . T; \ R_7; \ 2; i\sigma_3, i\sigma_1, -i\sigma_2; \\
R_8; \ 2; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -i\sigma_2; \\
R_9; \ 2; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -i\sigma_2; \\
R_{13}; \ 2; \sigma_1, \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), \sigma_0, -i\sigma_2; \\
R_{12}; \ 2; \sigma_1, \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -\sigma_0, -i\sigma_2; \\

\Delta: \ \Gamma A: \ C^{+}_6 . \sigma_{d1} . I . T; \ R_7; \ 2; i\sigma_3, i\sigma_1, -i\sigma_2; \\
R_8; \ 2; \frac{1}{2} (\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -i\sigma_2; \\
R_9; \ 2; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -i\sigma_2; \\
R_{10}; \ 2; \frac{1}{2} (-\sqrt{3}\sigma_0 + i\sigma_3), i\sigma_1, -i\sigma_2; \\

U: \ \text{ML:} \ C_2 . \sigma_{v1} . I . T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\

P: \ \text{KH:} \ C^{+}_3 . \sigma_{d1} . I . T; \ \{ R_3, R_4 \}; \ 2; -\sigma_0, i\sigma_3, -i\sigma_2; \\
R_6; \ 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2; \\

T: \ \Gamma K: \ C''_{22} . \sigma_{d2} . I . T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\

S: \ \text{AH:} \ \sigma_h . C''_{22} . I . T; \ \{ R_5, R_6 \}; \ 2; i\sigma_0, i\sigma_3, -i\sigma_2; \\
R_7; \ 2; -i\sigma_0, -i\sigma_3, -i\sigma_2; \\

T': \ \Gamma M: \ C''_{21} . \sigma_{d1} . I . T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\

S': \ \text{LH:} \ \sigma_h . C''_{21} . I . T; \ \{ R_5, R_6 \}; \ 2; i\sigma_0, i\sigma_3, -i\sigma_2; \\
R_7; \ 2; -i\sigma_0, -i\sigma_3, -i\sigma_2; \\

\Sigma: \ \Gamma M: \ C''_{21} . \sigma_{v1} . I . T; \ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
R: \ \text{AL:} \ \sigma_{v1} . \sigma_h . I . T; \ \{ R_9, R_6 \}; \ 4; i\Gamma_{0.3}, -i\Gamma_{0.1}, -\Gamma_{2.1}; \ DNL; \ 0
\end{array} \]
\( \Gamma_c; \{ C_{31}^0[000], C_{2v}[000], \bar{C}_{2y}[000], T \}; Non-Centrosymmetric; with SOC \)

\( \Gamma; (000); C_{31}^{-}, C_{2v}, \bar{C}_{2y}, T; R_4; 2; -\sigma_6, -i\sigma_1, i\sigma_2, -i\sigma_2; C-1\ WP; 1 \)

\( \{ R_5, R_6 \}; 4; \Gamma_{11}, -i\Gamma_{3,1}, i\Gamma_{0,2}, -i\Gamma_{2,0}; C-4\ DP; 4 \)

\( X; (0,0,0); C_{2v}, C_{2y}, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; C-1\ WP; 1 \)

\( M; (1,1,0); C_{2v}, C_{2y}, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; C-1\ WP; 1 \)

\( R; (1,1,1); \bar{C}_{31}^+, C_{2v}, \bar{C}_{2y}, T; R_4; 2; -\sigma_6, -i\sigma_1, i\sigma_2, -i\sigma_2; C-1\ WP; 1 \)

\( \{ R_5, R_6 \}; 4; \Gamma_{11}, -i\Gamma_{3,1}, i\Gamma_{0,2}, -i\Gamma_{2,0}; C-4\ DP; 4 \)

\( \Delta; \Gamma_X; C_{2y}, T C_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( \Sigma; \Gamma_M; \bar{E}, T C_{2z}; R_2; 1; -1, 1; \)

\( \Lambda; \Gamma_R; C_{31}^-; R_2; 1; \sqrt[3]{-1}; \)

\( R_4; 1; -1; \)

\( R_6; 1; -(-1)^{2/3}; \)

\( S; \Gamma_R; \bar{E}, T C_{2y}; R_2; 1; -1, 1; \)

\( Z; \Gamma_M; C_{2v}, T C_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( T; \Gamma_R; C_{2v}, T C_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( \Gamma^v \); \{ C_{31}^{-}[000], C_{2v}[000], \bar{C}_{2y}[000], T \}; Non-Centrosymmetric; with SOC

\( \Gamma; (000); C_{31}^{-}, C_{2v}, \bar{C}_{2y}, T; R_4; 2; -\sigma_6, -i\sigma_1, i\sigma_2, -i\sigma_2; C-1\ WP; 1 \)

\( \{ R_5, R_6 \}; 4; \Gamma_{11}, -i\Gamma_{3,1}, i\Gamma_{0,2}, -i\Gamma_{2,0}; C-4\ DP; 4 \)

\( X; (1/2,0); C_{2v}, C_{2y}, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; C-1\ WP; 1 \)

\( L; (1,1,1); \bar{C}_{31}^+, T; \{ R_2, R_6 \}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, -i\sigma_2; C-1\ WP; 1 \)

\( \{ R_4, R_5 \}; 2; -\sigma_0, -i\sigma_2; C-3\ WP; 3 \)

\( W; (1/2,1); C_{2v}, T C_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( \Delta; \Gamma_X; C_{2y}, T C_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( \Lambda; \Gamma_L; C_{31}^-; R_2; 1; \sqrt[3]{-1}; \)

\( R_4; 1; -1; \)

\( R_6; 1; -(-1)^{2/3}; \)

\( \Sigma; \Gamma_S; \bar{E}, T C_{2z}; R_2; 1; -1, 1; \)

\( S; \Gamma_S; \bar{E}, T C_{2y}; R_2; 1; -1, 1; \)

\( Z; \Gamma_W; C_{2v}, T C_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( Q; \Gamma_W; \bar{E}; R_2; 1; -1; \)
\( \Gamma_v; \{C_{3v}[000], \{C_{2v}[000], \{C_{2y}|000\}, T; \text{Non-Centrosymmetric; with SOC} \)

\[
\begin{align*}
\Gamma_v; \{000\};  & \quad C_{3v}, C_{2v}, C_{2y}; \quad R_4; & 2; & -\sigma_6, -i\sigma_1, i\sigma_2, -i\sigma_2; & \text{C-1 WP; 1} \cr
H; \{\frac{1}{2} \frac{1}{2} \frac{1}{2}\};  & \quad C_3, C_{2y}, C_{2y}; \quad R_4; & 2; & -\sigma_6, -i\sigma_1, i\sigma_2, -i\sigma_2; & \text{C-1 WP; 1} \cr
P; \{\frac{1}{2} \frac{1}{2} \frac{1}{2}\};  & \quad C_{31}, C_{2y}, C_{2y}; \quad R_4; & 2; & -\sigma_6, -i\sigma_1, i\sigma_2; & \text{C-1 WP; 1} \cr
N; \{00\};  & \quad C_{2v}, T; \quad R_2, R_4; & 2; & i\sigma_3, -i\sigma_2; & \text{C-1 WP; 1} \cr
\Sigma; \Gamma_N;  & \quad E, TC_{3v}; \quad R_2; & 1; & -1, 1; \cr
\Delta; \Gamma_H;  & \quad C_{2y}, TC_{2z}; \quad R_2; & 1; & i, 1; \cr
\Lambda; \Gamma_P;  & \quad C_{31}; \quad R_2; & 1; & \sqrt{-1}; \cr
D; \Gamma_P;  & \quad C_{2v}; \quad R_2; & 1; & i; \cr
G; \Gamma_P;  & \quad E, TC_{3v}; \quad R_2; & 1; & -1, 1; \cr
F; \Gamma_P;  & \quad C_{34}^+; \quad R_2; & 1; & \sqrt{-1}; \cr
\end{align*}
\]

\( \Gamma_v; \{C_{3v}[000], \{C_{2v}[\frac{1}{2} \frac{1}{2} \frac{1}{2}]\}, T; \text{Non-Centrosymmetric; with SOC} \)

\[
\begin{align*}
\Gamma_v; \{000\};  & \quad C_{3v}, C_{2v}, C_{2v}; \quad R_4; & 2; & -\sigma_6, -i\sigma_1, i\sigma_2, -i\sigma_2; & \text{C-1 WP; 1} \cr
X; \{0 \frac{1}{2} 0\};  & \quad C_{2v}, C_{2v}; \quad R_2; & 2; & -\sigma_0, i\sigma_3, -i\sigma_2; & \text{P-NS_{XMR};} \cr
M; \{\frac{1}{2} \frac{1}{2} \frac{1}{2}\};  & \quad C_{31}, C_{2y}, C_{2y}; \quad R_4; & 2; & \sigma_0, \sigma_0, \sigma_0, -i\sigma_2; & \text{P-NS;} \cr
R; \{\frac{1}{2} \frac{1}{2} \frac{1}{2}\};  & \quad C_{31}, C_{2y}, C_{2y}; \quad R_4; & 2; & \frac{-\sigma_3 + i\sqrt{3}\sigma_0}{2}, \sigma_0, \sigma_0, -i\sigma_2; & \text{P-NS;} \cr
\Delta; \Gamma_X;  & \quad C_{2y}, TC_{2z}; \quad R_2; & 1; & i, 1; \cr
\Sigma; \Gamma_M;  & \quad E, TC_{3v}; \quad R_2; & 1; & -1, 1; \cr
\Lambda; \Gamma_R;  & \quad C_{31}^+; \quad R_2; & 1; & \sqrt{-1}; \cr
S; \Gamma_R;  & \quad E, TC_{3v}; \quad R_2; & 2; & -\sigma_0, -i\sigma_2; & \text{L-NS_{XMR};} \cr
Z; \Gamma_R;  & \quad C_{2y}, E, TC_{3v}; \quad R_2; & 2; & -i\sigma_3, -\sigma_0, \sigma_1; & \text{L-NS_{XMR};} \cr
T; \Gamma_R;  & \quad C_{2y}, E, TC_{3v}; \quad R_2; & 2; & -i\sigma_3, -\sigma_0, -i\sigma_2; & \text{L-NS;} \cr
\end{align*}
\]
| Γ | (000) | \( C_{31}, C_{2z}, C_{2y}, T \); | \( R_4 \); | 2; \( -\sigma_6, -i\sigma_1, i\sigma_2, -i\sigma_2 \); | C-1 WP; 1 |
|---|---|---|---|---|---|
| \( H \); \( (\frac{1}{2} \frac{1}{2} \frac{1}{2}) \) | \( C_{31}, \bar{C}_{2y}, \bar{C}_{2z}, T \); | \( R_4 \); | 2; \( -\sigma_6, -i\sigma_1, i\sigma_2, -i\sigma_2 \); | C-1 WP; 1 |
| | \( \{ R_5, R_6 \} \); | 4; \( \Gamma_{11}, -i\Gamma_{3,1}, i\Gamma_{0,2}, -i\Gamma_{2,0} \); | C-4 DP; 4 |
| \( P \); \( (\frac{1}{4} \frac{1}{4} \frac{1}{4}) \) | \( C_{31}, C_{2z}, C_{2y} \); | \( R_1 \); | 1, 1, 1; |
| | \( R_2 \); | 1; \((-1)^{2/3}, 1, 1; |
| | \( R_3 \); | 1; \(-\sqrt[3]{i}, 1, 1; |
| | \( R_7 \); | 3; \( A_0, -\frac{4\lambda}{3} - \frac{2A_0}{\sqrt{3}} \); |
| \( N \); \( (00 \frac{1}{2}) \) | \( C_{2z}, T \); | \( R_2, R_4 \); | 2; \( i\sigma_3, -i\sigma_2 \); |
| \( \Sigma \); \( \Gamma N \) | \( \bar{E}, TC_{2z} \); | \( R_2 \); | 1; -1, 1; |
| \( \Delta \); \( \Gamma H \) | \( C_{2y}, TC_{2z} \); | \( R_2 \); | 1; \( i, 1; |
| | \( R_4 \); | 1; -i, 1; |
| \( \Lambda \); \( \Gamma P \) | \( \bar{C}_{31} \); | \( R_2 \); | 1; \( \sqrt[3]{-i}; |
| | \( R_4 \); | 1; -1; |
| | \( R_6 \); | 1; \((-1)^{2/3}; |
| \( D \); \( \Gamma P \) | \( C_{2z}, \bar{E} \); | \( R_5 \); | 1; \(-i, -1; |
| | \( R_7 \); | 1; \( i, -1; |
| \( G \); \( \Gamma N \) | \( \bar{E}, TC_{2z} \); | \( R_2 \); | 1; -1, 1; |
| \( F \); \( \Gamma P \) | \( C_{34}, \bar{E} \); | \( R_7 \); | 1; \(-i, -1; |
| | \( R_9 \); | 1; \( \sqrt[3]{-i}, -1; |
| | \( R_{11} \); | 1; \((-1)^{2/3}, -1; |
\[ \Gamma; \{ C_{3}^{000}, (C_{2z})^{\frac{1}{2}00}, (C_{2y})^{000}, (I)^{000}, \mathcal{T} \}; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; \ (000); \ C_{31}^0, C_{2x}, C_{2y}, I, \mathcal{T}; \quad R_{4}; \quad 2; \ \frac{20-\imath\sqrt{3}a_3}{2}, \sigma_7, \sigma_8, \sigma_0, -\imath\sigma_2; \]

\( \{ R_{5}, R_{6} \}; \quad 4; \ \Gamma_8, \Gamma_9, \Gamma_{10}, \Gamma_{00}, -\imath\Gamma_{20}; \quad \text{QCDP}; \ 0 \)

\[ R_{11}; \quad 2; \ \frac{20-\imath\sqrt{3}a_3}{2}, \sigma_7, \sigma_8, -\sigma_0, -\imath\sigma_2; \]

\( \{ R_{12}, R_{13} \}; \quad 4; \ \Gamma_8, \Gamma_9, \Gamma_{10}, -\Gamma_{00}, -\imath\Gamma_{20}; \quad \text{QCDP}; \ 0 \)

\[ X; \ (0 \frac{1}{2}0); \ C_{2x}, C_{2y}, I, \mathcal{T}; \quad R_{5}; \quad 2; \ \imath\sigma_2, \imath\sigma_1, \sigma_0, -\imath\sigma_2; \]

\[ R_{10}; \quad 2; \ \imath\sigma_2, \imath\sigma_1, -\sigma_0, -\imath\sigma_2; \]

\[ M; \ (\frac{1}{2} \frac{1}{2} 0); \ C_{2x}, C_{2y}, I, \mathcal{T}; \quad R_{5}; \quad 2; \ \imath\sigma_2, \imath\sigma_1, \sigma_0, -\imath\sigma_2; \]

\[ R_{10}; \quad 2; \ \imath\sigma_2, \imath\sigma_1, -\sigma_0, -\imath\sigma_2; \]

\[ R; \ (\frac{1}{2} \frac{1}{2} \frac{1}{2}); \ C_{31}^1, C_{2x}, C_{2y}, I, \mathcal{T}; \quad R_{4}; \quad 2; \ \frac{20-\imath\sqrt{3}a_3}{2}, \sigma_7, \sigma_8, \sigma_0, -\imath\sigma_2; \]

\( \{ R_{5}, R_{6} \}; \quad 4; \ \Gamma_8, \Gamma_9, \Gamma_{10}, \Gamma_{00}, -\imath\Gamma_{20}; \quad \text{QCDP}; \ 0 \)

\[ R_{11}; \quad 2; \ \frac{20-\imath\sqrt{3}a_3}{2}, \sigma_7, \sigma_8, -\sigma_0, -\imath\sigma_2; \]

\( \{ R_{12}, R_{13} \}; \quad 4; \ \Gamma_8, \Gamma_9, \Gamma_{10}, -\Gamma_{00}, -\imath\Gamma_{20}; \quad \text{QCDP}; \ 0 \)

\[ \Delta; \ \Gamma X; \ C_{2y}, \sigma_x, I, \mathcal{T}; \quad R_{5}; \quad 2; \ \imath\sigma_2, \imath\sigma_1, -\imath\sigma_2; \]

\[ \Sigma; \ \Gamma M; \ \sigma_z, I, \mathcal{T}; \quad \{ R_{2}, R_{4} \}; \quad 2; \ \imath\sigma_3, -\imath\sigma_2; \]

\[ \Lambda; \ \Gamma R; \ C_{31}^1, I, \mathcal{T}; \quad \{ R_{2}, R_{6} \}; \quad 2; \ \frac{1}{2} (\sigma_0 + \imath\sqrt{3}a_3), -\imath\sigma_2; \]

\( \{ R_{4}, R_{4} \}; \quad 2; \ -\sigma_0, -\imath\sigma_2; \]

\[ S; \ \text{XR}; \ \sigma_y, I, \mathcal{T}; \quad \{ R_{2}, R_{4} \}; \quad 2; \ \imath\sigma_3, -\imath\sigma_2; \]

\[ Z; \ \text{XM}; \ C_{2x}, \sigma_z, I, \mathcal{T}; \quad R_{5}; \quad 2; \ \sigma_2, \sigma_1, -\imath\sigma_2; \]

\[ T; \ \text{MR}; \ C_{2z}, \sigma_y, I, \mathcal{T}; \quad R_{5}; \quad 2; \ -\imath\sigma_2, \sigma_1, -\imath\sigma_2; \]
SG 201

Γc; \{ C_{31}|000\}, \{ C_{2x}|000\}, \{ C_{2y}|000\}, \{ I_{\frac{1}{2}\frac{1}{2}\frac{1}{2}} \}; T; Centrosymmetric; with SOC

Γ; (000); \( C_{31}^{\sigma_{x}}, C_{2x}, C_{2y}, I, T; R_{4}; 2; \frac{\sqrt{2}+i\sqrt{3}}{2}, \sigma_{x}, \sigma_{z}, \sigma_{0}, -i\sigma_{2}; \)
\{ R_{5}, R_{6} \}; 4; \Gamma_{9}, \Gamma_{10}, \Gamma_{0,0}, -i\Gamma_{2,0}; QCDP; 0
\{ R_{11} \}; 2; \frac{\sqrt{2}+i\sqrt{3}}{2}, \sigma_{x}, \sigma_{z}, -\sigma_{0}, -i\sigma_{2};
\{ R_{12}, R_{13} \}; 4; \Gamma_{9}, \Gamma_{10}, -\Gamma_{0,0}, -i\Gamma_{2,0}; QCDP; 0

X; (0\frac{1}{2}0); \sigma_{x}, \sigma_{y}, I, T;
\{ R_{13}, R_{14} \}; 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,1}, -i\Gamma_{2,0}; DP; 0

M; (1\frac{1}{2}10); \sigma_{x}, \sigma_{y}, I, T;
\{ R_{13}, R_{14} \}; 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,1}, -i\Gamma_{2,0}; DP; 0

R; (1\frac{1}{2} \frac{1}{2} \frac{1}{2}); \( C_{31}^{\sigma_{x}}, C_{2x}, C_{2y}, I, T; R_{4}; 2; \frac{\sqrt{2}+i\sqrt{3}}{2}, \sigma_{x}, \sigma_{z}, \sigma_{0}, -i\sigma_{2}; \)
\{ R_{5}, R_{6} \}; 4; \Gamma_{9}, \Gamma_{10}, \Gamma_{0,0}, -i\Gamma_{2,0}; QCDP; 0
\{ R_{11} \}; 2; \frac{\sqrt{2}+i\sqrt{3}}{2}, \sigma_{x}, \sigma_{z}, -\sigma_{0}, -i\sigma_{2};
\{ R_{12}, R_{13} \}; 4; \Gamma_{9}, \Gamma_{10}, -\Gamma_{0,0}, -i\Gamma_{2,0}; QCDP; 0

Δ; ΓX; \( C_{2y, \sigma_{x}, I, T}; \)
\( R_{5}; 2; i\sigma_{2}, i\sigma_{1}, -i\sigma_{2}; \)

Σ; ΓM; \( \sigma_{x}, I, T; \)
\{ R_{2}, R_{4} \}; 2; i\sigma_{3}, -i\sigma_{2};

Λ; ΓR; \( C_{2y, I, T}; \)
\{ R_{2}, R_{6} \}; 2; \frac{1}{2} (\sigma_{0} + i\sqrt{3}\sigma_{3}), -i\sigma_{2};
\{ R_{4}, R_{4} \}; 2; -\sigma_{0}, -i\sigma_{2};

S; XR; \( \sigma_{y}, \tilde{E}, I, T; \)
\{ R_{5}, R_{7} \}; 2; -i\sigma_{3}, -\sigma_{0}, -i\sigma_{2};

Z; XM; \( \sigma_{y}, C_{2x}, I, T; \)
\{ R_{5}, R_{8} \}; 2; i\sigma_{3}, i\sigma_{0}, -i\sigma_{2};
\{ R_{6}, R_{7} \}; 2; i\sigma_{3}, -i\sigma_{0}, -i\sigma_{2};

T; MR; \( C_{2x, \sigma_{x}, I, T}; \)
\( R_{0}; 2; i\sigma_{3}, -\sigma_{1}, -i\sigma_{2}; \)
\[ \Gamma^I_0; \{C_{31}^-\, 000\}, \{C_{2x}\, 000\}, \{C_{2y}\, 000\}, \{I\, 000\}, T; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; \ (000); \ C_{31}^-C_{2x}C_{2y}I,T; R_4; \quad 2; \ \frac{1}{2} \left( \sigma_0 - i\sqrt{3}\sigma_3 \right), \sigma_7, \sigma_8, \sigma_9, -i\sigma_2; \]

\( \{R_5, R_6\}; 4; \Gamma_8, \Gamma_9, \Gamma_{10.0}, -i\Gamma_{2.0}; \quad \text{QCDP; 0} \)

\( R_{11}; 2; \ \frac{1}{2} \left( \sigma_0 - i\sqrt{3}\sigma_3 \right), \sigma_7, \sigma_8, -\sigma_9, -i\sigma_2; \)

\( \{R_{12}, R_{13}\}; 4; \Gamma_8, \Gamma_9, \Gamma_{10.0}, -i\Gamma_{2.0}; \quad \text{QCDP; 0} \)

\[ X; \ \left( \frac{1}{2}0\frac{1}{2} \right); \ C_{2x}C_{2y}I,T; \quad R_5; 2; i\sigma_2, i\sigma_1, \sigma_9, -i\sigma_2; \]

\( R_{10}; 2; i\sigma_2, i\sigma_1, -\sigma_9, -i\sigma_2; \)

\[ L; \ \left( \frac{1}{2}1\frac{1}{2} \right); \ S_{61}^+E, T; \quad \{R_7, R_7\}; 2; \sigma_0, -\sigma_0, -i\sigma_2; \]

\( \{R_8, R_{12}\}; 2; \ \frac{1}{2} \left( \sigma_0 + i\sqrt{3}\sigma_3 \right), -\sigma_9, -i\sigma_2; \)

\( \{R_9, R_{11}\}; 2; \ \frac{1}{2} \left( -\sigma_0 + i\sqrt{3}\sigma_3 \right), -\sigma_9, -i\sigma_2; \)

\( \{R_{10}, R_{10}\}; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \)

\[ W; \ \left( \frac{1}{2}1\frac{3}{2} \right); \ C_{2x}\sigma_2, IT; \quad R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \Delta; \ \Gamma X; \quad C_{2y}\sigma_2, IT; \quad R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \]

\[ \Lambda; \ \Gamma L; \quad C_{31}^-I,T; \quad \{R_2, R_6\}; 2; \ \frac{1}{2} \left( \sigma_0 + i\sqrt{3}\sigma_3 \right), -i\sigma_2; \]

\( \{R_4, R_4\}; 2; -\sigma_0, -i\sigma_2; \)

\[ \Sigma; \ \Gamma \Sigma; \quad \sigma_2, I,T; \quad \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \]

\[ S; \ \Gamma S; \quad \sigma_3, I,T; \quad \{R_2, R_4\}; 2; i\sigma_3, -i\sigma_2; \]

\[ Z; \ \Gamma W; \quad C_{2x}\sigma_2, I,T; \quad R_5; 2; i\sigma_3, i\sigma_1, -i\sigma_2; \]

\[ Q; \ \Gamma W; \quad \bar{E}, I,T; \quad \{R_2, R_2\}; 2; -\sigma_0, -i\sigma_2; \]
\( \Gamma' \); \{\( C_{3v}^+ \{000\}, C_{2h} \{000\}, C_{2v} \{000\}, \{I|\frac{1}{4} \frac{1}{4} \frac{1}{4}\} \); \; \text{T; Centrosymmetric; with SOC} \)

\[
\begin{align*}
\Gamma; \; (000): & \; C_{3v}, C_{2v}, C_{2h}, I, T; \; R_4; \; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_7, \sigma_8, \sigma_0, -i\sigma_2; \\
& \{R_5, R_6\}; \; 4; \Gamma_8, \Gamma_9, \Gamma_{10}, \Gamma_{0,0}, -i\Gamma_{2,0}; \; \text{QCDP; 0} \\
& R_{11}; \; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_7, \sigma_8, -\sigma_0, -i\sigma_2; \\
& \{R_{12}, R_{13}\}; \; 4; \Gamma_8, \Gamma_9, \Gamma_{10}, -\Gamma_{0,0}, -i\Gamma_{2,0}; \; \text{QCDP; 0} \\
X; \; (\frac{1}{2}0\frac{1}{2}); & \; \sigma_x, \sigma_y, I, T; \\
& \{R_{13}, R_{14}\}; \; 4; \Gamma_{0,1}, i\Gamma_{3,0}, \Gamma_{0,3}, -i\Gamma_{2,0}; \; \text{DP; 0} \\
L; \; (\frac{1}{2}\frac{1}{2} \frac{1}{2}); & \; S_{61}, E, T; \\
& \{R_8, R_{12}\}; \; 2; \sigma_0, -\sigma_0, -i\sigma_2; \\
& \{R_9, R_{11}\}; \; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -\sigma_0, -i\sigma_2; \\
& \{R_{10}, R_{10}\}; \; 2; -\sigma_0, -\sigma_0, -i\sigma_2; \\
W; \; (\frac{1}{2}\frac{1}{2} \frac{1}{2}); & \; \sigma_x, C_{2s}, I, T; \\
& \{R_{13}, R_{14}\}; \; 2; -(-1)^{3/4}\sigma_3, i\sigma_0, -i\sigma_2; \\
& \{R_{17}, R_{18}\}; \; 2; -(-1)^{3/4}\sigma_3, -i\sigma_0, -i\sigma_2; \\
\Delta; \; \Gamma_X; & \; C_{2y}, \sigma_z, I, T; \\
& \{R_5\}; \; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
\Lambda; \; \Gamma_L; & \; C_{3v}^-, I, T; \\
& \{R_2, R_6\}; \; 2; \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2; \\
& \{R_4, R_4\}; \; 2; -\sigma_0, -i\sigma_2; \\
\Sigma; \; \Gamma_Y; & \; \sigma_z, I, T; \\
& \{R_2, R_4\}; \; 2; i\sigma_3, -i\sigma_2; \\
S; \; \Gamma_S; & \; \sigma_y, E, I, T; \\
& \{R_5, R_7\}; \; 2; -i\sigma_3, -\sigma_0, -i\sigma_2; \\
Z; \; \Gamma_W; & \; \sigma_y, C_{2s}, I, T; \\
& \{R_5, R_8\}; \; 2; i\sigma_3, i\sigma_0, -i\sigma_2; \\
& \{R_6, R_7\}; \; 2; i\sigma_3, -i\sigma_0, -i\sigma_2; \\
Q; \; \Gamma_W; & \; E, I, T; \\
& \{R_2, R_2\}; \; 2; -\sigma_0, -i\sigma_2; \\
\end{align*}
\]
$\Gamma_0$: \{C_{31}^\pm|000\}, \{C_{2x}|000\}, \{C_{2y}|000\}, \{I|000\}, T; Centrosymmetric; with SOC

$\Gamma$: (000); $C_{31}, C_{2x}, C_{2y}, I, T$; $R_4$; $2: \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_7, \sigma_8, \sigma_9, -i\sigma_2$;

$\{R_5, R_6\}; 4: \Gamma_8, \Gamma_9, \Gamma_{10}, \Gamma_{0.0}, -i\Gamma_{2.0};$ QCDP; 0

$R_{11}$; $2: \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_7, \sigma_8, -\sigma_0, -i\sigma_2$;

$\{R_{12}, R_{13}\}; 4: \Gamma_8, \Gamma_9, \Gamma_{10}, -\Gamma_{0.0}, -i\Gamma_{2.0};$ QCDP; 0

$H$: ($\frac{1}{2} \frac{1}{2} \frac{1}{2}$); $C_{31}^\pm, C_{2x}, C_{2y}, I, T$; $R_4$; $2: \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_7, \sigma_8, -\sigma_0, -i\sigma_2$;

$\{R_5, R_6\}; 4: \Gamma_8, \Gamma_9, \Gamma_{10}, \Gamma_{0.0}, -i\Gamma_{2.0};$ QCDP; 0

$R_{12}$; $2: \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_7, \sigma_8, -\sigma_0, -i\sigma_2$;

$\{R_{12}, R_{13}\}; 4: \Gamma_8, \Gamma_9, \Gamma_{10}, -\Gamma_{0.0}, -i\Gamma_{2.0};$ QCDP; 0

$P$: ($\frac{1}{4} \frac{1}{4} \frac{1}{4}$); $C_{31}^\pm, C_{2x}, C_{2y}, I, T$; $R_4$; $2: -\sigma_6, -i\sigma_1, i\sigma_2, -i\sigma_2$;

$\{R_5, R_6\}; 4: \Gamma_{11}, -i\Gamma_{3.1}, i\Gamma_{0.2}, -i\Gamma_{2.0};$ DP; 0

$N$: (00$\frac{1}{2}$); $C_{2x}, I, T$;

$\{R_2, R_4\}; 2: i\sigma_3, \sigma_0, -i\sigma_2$;

$\{R_6, R_8\}; 2: i\sigma_3, -\sigma_0, -i\sigma_2$;

$\Sigma$: $\Gamma N$; $\sigma_3; I, T$;

$\{R_2, R_4\}; 2: i\sigma_3, -i\sigma_2$;

$\Delta$: $\Gamma H$; $C_{2y}, \sigma_3, I, T$;

$\{R_2, R_6\}; 4: \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2$;

$\{R_4, R_4\}; 2: -\sigma_0, -i\sigma_2$;

$\Lambda$: $\Gamma P$; $C_{31}^\pm, I, T$;

$\{R_2, R_6\}; 2: \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2$;

$\{R_4, R_4\}; 2: -\sigma_0, -i\sigma_2$;

$D$: $\Sigma P$; $C_{2x}, I, T$;

$\{R_2, R_4\}; 2: i\sigma_3, -i\sigma_2$.

$G$: $\Sigma N$; $\sigma_3, I, T$;

$\{R_2, R_4\}; 2: i\sigma_3, -i\sigma_2$;

$F$: $\Pi H$; $C_{34}, I, T$;

$\{R_2, R_6\}; 2: \frac{1}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2$;

$\{R_4, R_4\}; 2: -\sigma_0, -i\sigma_2$;
$\Gamma; \{C_{31}|000\}, \{C_{2z}|\frac{1}{2}\frac{1}{2}\}, \{C_{2y}|0\frac{1}{2}\frac{1}{2}\}, \{I|000\}; T$; Centrosymmetric; with SOC

R:
(0$\bar{2}$)$; C_{31}C_{2z}C_{2y}I; T$;
(011)$; C_{31}C_{2z}C_{2y}I; T$; 2; $\frac{1}{2}\left(\sigma_0 - i\sqrt{3}\sigma_3\right), \sigma_7, \sigma_8, \sigma_0, -i\sigma_2$;
(011)$; C_{31}C_{2z}C_{2y}I; T$; 4; $\Gamma_8, \Gamma_9, \Gamma_{10}, \Gamma_{0.0}, -i\Gamma_{2.0}$;
$R_4$; 2; $\frac{1}{2}\left(\sigma_0 - i\sqrt{3}\sigma_3\right), \sigma_7, \sigma_8, \sigma_0, -i\sigma_2$;

X:
(0$\bar{2}$)$; C_{2y}C_{2z}I; T$;
(011)$; C_{2y}C_{2z}I; T$; 4; $\Gamma_0.1, i\Gamma_{3.0}, \Gamma_{0.3}, -i\Gamma_{2.0}$;

M:
(0$\bar{2}$)$; C_{2z}C_{2z}I; T$;
(011)$; C_{2z}C_{2z}I; T$; 4; $i\Gamma_{0.2}, \Gamma_{0.3}, \Gamma_{0.3}, i\Gamma_{2.0}$;

R:
(0$\bar{2}$)$; C_{31}C_{2z}C_{2y}I; T$;
(011)$; C_{31}C_{2z}C_{2y}I; T$; 2; $\sigma_0, \sigma_0, \sigma_0, -i\sigma_2$;
(011)$; C_{31}C_{2z}C_{2y}I; T$; 2; $\frac{1}{2}\left(-\sigma_0 + i\sqrt{3}\sigma_3\right), \sigma_0, \sigma_0, \sigma_0, -i\sigma_2$;
(011)$; C_{31}C_{2z}C_{2y}I; T$; 6; $S_6, \frac{S_0.0 + 2\sqrt{3}S_0.8}{-3}, -iS_{11}, S_{0.0}, (-1)^{1/2}S_{2.0}$;

$\Delta$: $\Gamma X$;
$
\Sigma$: $\Gamma M$;
$
\Lambda$: $\Gamma R$;
$S$: $X R$;

Z:
(0$\bar{2}$)$; C_{2y}C_{2z}I; T$;
(011)$; C_{2y}C_{2z}I; T$; 4; $i\Gamma_{0.3}, -i\Gamma_{0.1}, -\Gamma_{2.1}$;

T:
(0$\bar{2}$)$; C_{2y}C_{2y}I; T$;
(011)$; C_{2y}C_{2y}I; T$; 2; $\sigma_0, \sigma_0, \sigma_0, -i\sigma_2$;

Z$^\prime$:
(0$\bar{2}$)$; X'M(\frac{1}{2}\frac{1}{2})$; $\sigma_2, C_{2y}I; T$;
(011)$; X'M(\frac{1}{2}\frac{1}{2})$; $\sigma_2, C_{2y}I; T$; 2; $\sigma_0, \sigma_0, \sigma_0, -i\sigma_2$;

For the notation, see Table 6.15, Fig. 5.4 and the text of section 5.5 in Ref. [17].
\( \Gamma_v^\oplus; \{C_{31}^0[000], \{C_{22}[\frac{1}{2} \frac{1}{2} 0], \{C_{22}[0 \frac{1}{2} \frac{1}{2}]\}, \{I[000], T; Centrosymmetric; with SOC
\]

\[
\begin{align*}
\Gamma; (000); & C_{31}, C_{22}, C_{22}, I, T; R_4; & 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_7, \sigma_8, \sigma_0, -i\sigma_2; \\
& \{R_5, R_6\}; & 4; \Gamma_8, \Gamma_9, \Gamma_{10}, \Gamma_{0.0}, -i\Gamma_{2.0}; & QCDP; 0 \\
& \{R_{11}\}; & 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_7, \sigma_8, -\sigma_0, -i\sigma_2; \\
& \{R_{12}, R_{13}\}; & 4; \Gamma_8, \Gamma_9, \Gamma_{10}, -\Gamma_{0.0}, -i\Gamma_{2.0}; & QCDP; 0 \\
H; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); & C_{31}, C_{22}, C_{22}, I, T; R_4; & 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_7, \sigma_8, \sigma_0, -i\sigma_2; \\
& \{R_5, R_6\}; & 4; \Gamma_8, \Gamma_9, \Gamma_{10}, \Gamma_{0.0}, -i\Gamma_{2.0}; & QCDP; 0 \\
& \{R_{11}\}; & 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_3), \sigma_7, \sigma_8, -\sigma_0, -i\sigma_2; \\
& \{R_{12}, R_{13}\}; & 4; \Gamma_8, \Gamma_9, \Gamma_{10}, -\Gamma_{0.0}, -i\Gamma_{2.0}; & QCDP; 0 \\
P; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); & C_{31}, C_{22}, C_{22}, I, T; \{R_1, R_4\}; & 2; \sigma_0, \sigma_0, \sigma_0, -i\sigma_2; \\
& \{R_2, R_3\}; & 2; \frac{-\sigma_0 + \sqrt{3}\sigma_3}{2}, \sigma_0, \sigma_0, -i\sigma_2; \\
& \{R_7, R_7\}; & 4; -S_0, \frac{6\sigma_0 + 2\sqrt{3}S_0}{4}, -iS_{11}, (1)^{\frac{1}{2}} S_2, 0; SP; 0 \\
N; (00\frac{1}{2}); & C_{22}, E, I, T; \{R_{10}, R_{10}\}; & 4; i\Gamma_{0.2}, -\Gamma_{0.0}, \Gamma_{0.3}, i\Gamma_{2.0}; & DP; 0 \\
\Sigma; \Gamma N; & \sigma_4, IT; \{R_2, R_4\}; & 2; i\sigma_3, -i\sigma_2; \\
\Delta; \Gamma H; & C_{22}, \sigma_4, IT; \{R_4, R_4\}; & 2; \sigma_0, \sigma_0, -i\sigma_2; \\
\Lambda; \Gamma P; & C_{31}, IT; \{R_5, R_5\}; & 2; \frac{i}{2} (\sigma_0 + i\sqrt{3}\sigma_3), -i\sigma_2; \\
& \{R_4, R_4\}; & 2; \sigma_0, -\sigma_0, -i\sigma_2; \\
D; \Gamma P; & C_{22}, E, IT; \{R_5, R_5\}; & 2; -i\sigma_0, -\sigma_0, -i\sigma_2; \\
& \{R_7, R_7\}; & 2; i\sigma_0, -\sigma_0, -i\sigma_2; \\
G; \Gamma N; & \sigma_4, IT; \{R_2, R_4\}; & 2; \sigma_3, -i\sigma_2; \\
F; \Gamma H; & C_{34}, E, IT; \{R_7, R_7\}; & 2; -i\sigma_0, -\sigma_0, -i\sigma_2; \\
& \{R_9, R_{11}\}; & 2; \frac{1}{2} (\sqrt{3}\sigma_3 + i\sigma_0), -\sigma_0, -i\sigma_2; \\
\]

\[ \Gamma_c; \{ C_{44}^+|000 \}, \{ C_{33}^-|000 \}, \{ C_{26}|000 \}, T; \text{Non-Centrosymmetric, with SOC} \]

\[ \Gamma; (000); C^{+}_{4x}, C_{31}, C_{20}, T; R_4: 2; \sigma_0 - i\sigma_1, \sigma_0 - i\sigma_2, \sigma_0 + i\sigma_2, \sigma_0 - i\sigma_2; -C-1 \text{ WP; 1} \]

\[ R_5: 2; \frac{\sigma_0 + i\sigma_1}{\sqrt{2}}, \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; -C-1 \text{ WP; 1} \]

\[ R_6: 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; -C-1 \text{ WP; 1} \]

\[ R_7: 2; -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; -C-1 \text{ WP; 1} \]

\[ R_8: 4; \Gamma_4, \Gamma_5, i\Gamma_1, \Gamma_2 + \Gamma_3, \sigma_0 + i\sigma_2, \sigma_0 - i\sigma_2, -i\Gamma_{2,0}; -C-4 \text{ DP; 4} \]

\[ X; (0\frac{1}{2}0); C^{+}_{4g}, C_{22}, T; R_6: 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; -C-1 \text{ WP; 1} \]

\[ R_7: 2; -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; -C-1 \text{ WP; 1} \]

\[ M; (1\frac{1}{2}0); C^{+}_{4x}, C_{24}, T; R_6: 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; -C-1 \text{ WP; 1} \]

\[ R_7: 2; -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; -C-1 \text{ WP; 1} \]

\[ R_8: 4; \Gamma_4, \Gamma_5, i\Gamma_1, \Gamma_2 + \Gamma_3, \sigma_0 + i\sigma_2, \sigma_0 - i\sigma_2, -i\Gamma_{2,0}; -C-4 \text{ DP; 4} \]

\[ \Delta; \Gamma X; C^{+}_{4g}, TC_{2g}; R_2: 1; \sqrt{-1}, 1; \]

\[ R_4: 1; (-1)^{3/4}, 1; \]

\[ R_6: 1; -\sqrt{-1}, 1; \]

\[ R_8: 1; (-1)^{3/4}, 1; \]

\[ \Sigma; \Gamma M; C_{2a}, TC_{2g}; R_2: 1; i, 1; \]

\[ R_4: 1; -i, 1; \]

\[ \Lambda; \Gamma R; C^{-}_{31}, C_{2e} T; R_2: 1; \sqrt{-1}, 1; \]

\[ R_4: 1; -1, 1; \]

\[ R_6: 1; (-1)^{2/3}, 1; \]

\[ \Sigma; \Gamma M; C_{2e}, TC_{2g}; R_2: 1; i, 1; \]

\[ R_4: 1; -i, 1; \]

\[ Z; \Gamma R; C_{2c}, TC_{2g}; R_2: 1; i, 1; \]

\[ R_4: 1; -i, 1; \]

\[ T; \Gamma R; C_{4x}, C_{2a} T; R_2: 1; \sqrt{-1}, 1; \]

\[ R_4: 1; (-1)^{3/4}, 1; \]

\[ R_6: 1; -\sqrt{-1}, 1; \]

\[ R_8: 1; (-1)^{3/4}, 1; \]
\[ \Gamma; (000); \quad C^+_x, C^+_y, C^+_z, T; \quad R_4; 2; \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \quad C-1 \ WP; 1 \]
\[ R_5; 2; \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \quad C-1 \ WP; 1 \]
\[ R_6; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad C-1 \ WP; 1 \]
\[ R_7; 2; -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad C-1 \ WP; 1 \]
\[ R_8; 4; \Gamma_4, \Gamma_5, i\left(\Gamma_{1,3} + \Gamma_{2,5}\right), -i\Gamma_{2,0}; \quad C-4 \ DP; 4 \]

\[ \Delta; \quad \Gamma_X; \quad C^+_y, T C_2; \quad R_2; 1; \sqrt{-1}, 1; \]
\[ R_4; 1; (-1)^{3/4}, 1; \]
\[ R_6; 1; \sqrt{-1}, 1; \]
\[ R_8; 1; (-1)^{3/4}, 1; \]

\[ \Sigma; \quad \Gamma_M; \quad C^+_x, T C_2; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ \Lambda; \quad \Gamma_R; \quad C^+_z, T C_2; \]
\[ R_2; 1; \sqrt{-1}, 1; \]
\[ R_4; 1; -1, 1; \]
\[ R_6; 1; (-1)^{2/3}, 1; \]

\[ S; \quad \Gamma_R; \quad C^+_x, T C_2; \]
\[ R_5; 1; -i, -1, 1; \]
\[ R_7; 1; i, -1, 1; \]

\[ Z; \quad \Gamma_M; \quad C^+_x, T C_2; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ T; \quad \Gamma_R; \quad C^+_x, T C_2; \]
\[ R_2; 1; -\sqrt{-1}, -1, 1; \]
\[ R_4; 1; (-1)^{3/4}, -1, 1; \]
\[ R_6; 1; \sqrt{-1}, -1, 1; \]
\[ R_8; 1; (-1)^{3/4}, -1, 1; \]
Γ: (000); \( C_{4x}^+, C_{31}, C_{20}, T \); \( R_4 \): 2; \( \frac{\sigma_0-i\sigma_1}{\sqrt{2}}, \sigma_0, \frac{(\sigma_1+i\sigma_2)}{\sqrt{2}}, -i\sigma_2 \); C-1 WP; 1
\( R_5 \): 2; \( \frac{\sigma_0-i\sigma_1}{\sqrt{2}}, \sigma_0, \frac{(\sigma_1+i\sigma_2)}{\sqrt{2}}, -i\sigma_2 \); C-1 WP; 1
\( R_8 \): 4; \( \Gamma_1, \Gamma_5, \frac{i(\Gamma_{1,3}+\Gamma_{1,3})}{\sqrt{2}}, -i\gamma_2 \); C-4 DP; 4

\( X \); (1/2 0 1/2); \( C_{4y}^+, C_{2z}, T \); \( R_6 \): 2; \( \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2 \); C-1 WP; 1
\( R_7 \): 2; \( -\frac{\sigma_0+i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2 \); C-1 WP; 1

\( L \); (1 1 1 2); \( C_{31}, C_{20}, T \); \( R_3, R_4 \): 2; \( -\sigma_0, i\sigma_3, -i\sigma_2 \); C-3 WP; 3
\( R_6 \): 2; \( \frac{\sigma_0+i\sigma_3}{2}, i\sigma_3, -i\sigma_2 \); C-1 WP; 1

\( W \); (1/2 1/2 1/2); \( C_{2x}, C_{2d}, T; C_{2z} \); \( R_5 \): 2; \( i\sigma_2, i\sigma_1, \frac{(i\sigma_1-i\sigma_3)}{\sqrt{2}} \); C-1 WP; 1

\( \Delta \); \( \Gamma X \); \( C_{4y}^+, T C_{2z} \); \( R_2 \): 1; \( \sqrt{-1}, 1 \);
\( R_4 \): 1; \( (-1)^{3/4}, 1 \);
\( R_6 \): 1; \( -\sqrt{-1}, 1 \);
\( R_8 \): 1; \( (-1)^{3/4}, 1 \);

\( \Lambda \); \( \Gamma L \); \( C_{31}^-, C_{2e}, T \); \( R_2 \): 1; \( \sqrt{-1}, 1 \);
\( R_4 \): 1; \( -1, 1 \);
\( R_6 \): 1; \( (-1)^{2/3}, 1 \);

\( \Sigma \); \( \Gamma \Sigma \); \( C_{2a}, T C_{2z} \); \( R_2 \): 1; \( i \);
\( R_4 \): 1; \( -i \);

\( S \); \( \Gamma S \); \( C_{2e}, T C_{2y} \); \( R_2 \): 1; \( i \);
\( R_4 \): 1; \( -i \);

\( Z \); \( \Gamma W \); \( C_{2e}, T C_{2z} \); \( R_2 \): 1; \( i \);
\( R_4 \): 1; \( -i \);

\( Q \); \( \Gamma W \); \( C_{2f} \); \( R_2 \): 1; \( i \);
\( R_4 \): 1; \( -i \);
\[ \Gamma^f; \{ C_{4z}^+; \Gamma_{\frac{1}{4} \frac{1}{4} \frac{1}{4} f} \}, \{ C_{31}^-; 000 \}, \{ C_{20}^+; \frac{1}{4} \frac{1}{4} \frac{1}{4} \}; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{ 000 \}; C_{4z}^+; C_{31}^-, C_{20}, T; R_4; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0, \frac{\sigma_1 + \sigma_2}{\sqrt{2}}, -i\sigma_2; \text{C-1 WP; 1} \]
\[ R_5; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0, \frac{\sigma_1 + \sigma_2}{\sqrt{2}}, -i\sigma_2; \text{C-1 WP; 1} \]
\[ R_8; 4; \Gamma_4, \Gamma_5, \left\{ \frac{\Gamma_{1,1,1}}{\sqrt{2}}, i\Gamma_{2,0} \right\}; \text{C-4 DP; 4} \]

\[ X; \{ \frac{1}{4} 0 f \}; C_{4y}^-, C_{2x}, T; R_6; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_1, -i\sigma_2; \text{C-1 WP; 1} \]
\[ R_7; 2; -\frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_1, -i\sigma_2; \text{C-1 WP; 1} \]

\[ L; \{ \frac{1}{4} \frac{1}{2} \}; C_{31}^+, C_{20}, T; \{ R_3, R_4 \}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \text{C-3 WP; 3} \]

\[ W; \{ \frac{1}{4} \frac{1}{2} \}; C_{2d}, C_{2y}, T C_{2z}; \{ R_3, R_4 \}; 2; \sigma_3, \sigma_0, \sigma_1; \text{C-2 WP; 2} \]

\[ \Delta; \Gamma X; C_{4y}^+, T C_{2z}; \]
\[ R_2; 1; \sqrt{1/4}, 1; \]
\[ R_4; 1; -1, 1, 1; \]

\[ \Lambda; \Gamma L; C_{31}^-, C_{2x}, T; \]
\[ R_2; 1; \sqrt{1/4}, 1; \]
\[ R_4; 1; -1, 1; \]
\[ R_6; 1; -\sqrt{1/4}, 1; \]
\[ R_8; 1; -(1)^{3/4}, 1; \]

\[ \Sigma; \Gamma \Sigma; C_{2a}, T C_{2z}; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ S; \Gamma S; C_{2e}, \tilde{E}, T C_{2y}; \]
\[ R_5; 1; -i, -1, 1; \]
\[ R_7; 1; i, -1, 1; \]

\[ Z; \Gamma W; C_{2x}, T C_{2z}; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ Q; \Gamma W; C_{2f}, \tilde{E}; \]
\[ R_{10}; 1; -i, -1; \]
\[ R_{14}; 1; i, -1; \]
SG 211

\[ \Gamma_c^+; \{ C_{2a}^+ | 000 \}, \{ \bar{C}_{31}^+ | 000 \}, \{ C_{2b} | 000 \}; T; \text{Non-Centrosymmetric; with SOC} \]

\[
\begin{align*}
\Gamma; (000) & : C_{4d}, \bar{C}_{31}, C_{20}, T; & R_4: 2: & \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_0, & \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; & \text{C-1 WP; 1} \\
R_5: 2: & \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_0, & \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; & \text{C-1 WP; 1} \\
R_6: 4: & \Gamma_4, \Gamma_5, \frac{i(\Gamma_1, 3 \Gamma_2, \Gamma_3)}{\sqrt{2}}, -i\Gamma_2, 0; & \text{C-4 DP; 4} \\
H_1; (\frac{1}{2} \frac{1}{2} \frac{1}{2}) & : C_{4d}, \bar{C}_{31}, C_{20}, T; & R_4: 2: & \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_0, & \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; & \text{C-1 WP; 1} \\
R_5: 2: & \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_0, & \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; & \text{C-1 WP; 1} \\
R_6: 4: & \Gamma_4, \Gamma_5, \frac{i(\Gamma_1, 3 \Gamma_2, \Gamma_3)}{\sqrt{2}}, -i\Gamma_2, 0; & \text{C-4 DP; 4} \\
P; (\frac{1}{2} \frac{1}{2} \frac{1}{2}) & : \bar{C}_{31}, C_{2a}, C_{2b}, C_{4g}, T; & R_4: 2: & -\sigma_0, -i\sigma_1, i\sigma_2, & \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}; & \text{C-1 WP; 1} \\
R_5: 2: & (-1)^{5/3} \sigma_0, -i\sigma_1, i\sigma_2, \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}; & \text{C-1 WP; 1} \\
R_6: 2: & \sqrt{-1} \sigma_0, -i\sigma_1, i\sigma_2, \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}; & \text{C-1 WP; 1} \\
N; (0 \frac{1}{2} ) & : C_{2a}, C_{2b}, T; & R_5: 2: & i\sigma_2, i\sigma_1, -i\sigma_2; & \text{C-1 WP; 1} \\
\Sigma; \Gamma N; & C_{2a}, T C_{2a}; & R_2: 1; & i, 1; \\
 & R_4: 1; & -i, 1; \\
\Delta; \Gamma H; & C_{4g}, T C_{2a}; & R_2: 1; & \sqrt{-1}, 1; \\
 & R_4: 1; & (-1)^{3/4}, 1; \\
 & R_6: 1; & -\sqrt{-1}, 1; \\
 & R_8: 1; & (-1)^{3/4}, 1; \\
\Lambda; \Gamma R; & C_{31}, C_{2b}, T; & R_2: 1; & \sqrt{-1}, 1; \\
 & R_4: 1; & -1, 1; \\
 & R_6: 1; & (-1)^{2/3}, 1; \\
D; \Gamma N P; & C_{2a}, C_{2a}, T; & R_2: 1; & i, 1; \\
 & R_4: 1; & -i, 1; \\
G; \Gamma H N; & C_{2b}, T C_{2a}; & R_2: 1; & i, 1; \\
 & R_4: 1; & -i, 1; \\
F; \Gamma P H; & C_{34}, C_{2a}, T; & R_2: 1; & \sqrt{-1}, 1; \\
 & R_4: 1; & -1, 1; \\
 & R_6: 1; & (-1)^{2/3}, 1; \\
\]
\Gamma_c; \{C^+_{\frac{1}{4} \frac{3}{4} \frac{3}{4}}\}, \{C_{31}^{-}(000)\}, \{C_{2b}^{-}(\frac{1}{4} \frac{1}{4} \frac{1}{4})\}; T; Non-Centrosymmetric; with SOC

\Gamma; (000); C^+_{\frac{1}{4} \frac{3}{4} \frac{3}{4}}, \bar{C}_{\frac{1}{4} \frac{3}{4} \frac{3}{4}}, C_{2b}, T;

\begin{align*}
R_4 &: 2; \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_0, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \quad C-1 \text{ WP}; \quad 1 \\
R_5 &: 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_0, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \quad C-1 \text{ WP}; \quad 1 \\
R_8 &: 4; \Gamma_4, \Gamma_5, \frac{i(\Gamma_{14} + \Gamma_{23})}{\sqrt{2}}, -i\Gamma_2, 0; \quad C-4 \text{ DP}; \quad 4
\end{align*}

\chi; (0\frac{1}{2} 0); C^{-}_{\frac{4}{2} \frac{3}{2} \frac{3}{2}}, C_{2b}, T;

\begin{align*}
\{R_8, R_{10}\} &: 2; \sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-NS}_{XMR}; \\
\{R_9, R_{11}\} &: 2; -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-NS}_{XMR}; \\
R_{14} &: 2; i\sigma_3, i\sigma_2, -i\sigma_2; \quad \text{P-NS}_{XMR};
\end{align*}

\eta; (\frac{1}{4} \frac{1}{2} \frac{1}{2}); C_{2b}, C_{2g}, C_{31}^{-}, C_{2b}, T;

\begin{align*}
\{R_3, R_4\} &: 2; -\sigma_0, \sigma_0, -\sigma_0, i\sigma_3, -i\sigma_2; \quad \text{P-NS}; \\
R_8 &: 2; -\sigma_0, \sigma_0, \frac{\sigma_0 - i\sqrt{3}\sigma_3}{2}, i\sigma_1, -i\sigma_2; \quad \text{P-NS}; \\
\{R_{13}, R_{14}\} &: 6; iS_{11}, -S_7, S_{13}, S_{14}, -iS_{20}; \quad \text{C-4 SP}; \quad 4
\end{align*}

\Delta; \Gamma_X; C^+_{\frac{4}{2} \frac{3}{2} \frac{3}{2}}, T C_{2b};

\begin{align*}
R_2 &: 1; \sqrt{-1}, 1; \\
R_4 &: 1; (1)^{3/4}, 1; \\
R_6 &: 1; -\sqrt{-1}, 1; \\
R_8 &: 1; -(1)^{3/4}, 1;
\end{align*}

\Sigma; \Gamma_M; C_{2b}, T C_{2b};

\begin{align*}
R_2 &: 1; i, 1; \\
R_4 &: 1; -i, 1;
\end{align*}

\Lambda; \Gamma_R; C_{31}^{-}, C_{2b}, T;

\begin{align*}
R_2 &: 1; \sqrt{-1}, 1; \\
R_4 &: 1; -1, 1; \\
R_6 &: 1; -(1)^{2/3}, 1;
\end{align*}

\S; \chi_R; C_{2b}, \tilde{E}, T C_{2b};

\begin{align*}
\{R_{10}, R_{14}\} &: 2; -i\sigma_3, -\sigma_0, -i\sigma_2; \quad \text{L-NS}_{XMR}; \\
\Z; \chi_M; C_{2b}, \tilde{E}, T C_{2b};

\begin{align*}
\{R_5, R_7\} &: 2; -i\sigma_3, -\sigma_0, \sigma_1; \quad \text{L-NS}_{XMR}; \\
\T; \chi_R; C^+_{\frac{4}{2} \frac{3}{2} \frac{3}{2}}, \tilde{E}, C_{2b}, T;

\begin{align*}
\{R_{10}, R_{14}\} &: 2; -\sqrt{-1}\sigma_3, -\sigma_0, \sigma_1; \quad \text{L-NS}; \\
\{R_{12}, R_{16}\} &: 2; -(1)^{3/4}\sigma_3, -\sigma_0, \sigma_1; \quad \text{L-NS};
\end{align*}

\end{align*}
SG 213

Γ: \{ C_{2v}^+(\frac{1}{2} \frac{1}{4} \frac{3}{4}) \}, \{ C_{31}^- \{000\}, \{ C_{2b}^- \frac{3}{4} \frac{3}{4} \}; T; Non-Centrosymmetric; with SOC

\Gamma; (000); C_{4s}^+, C_{31}^-, C_{2b}^+, T; R_4; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; C-1 WP; 1
R_5; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; C-1 WP; 1
R_8; 4; \Gamma_4, \Gamma_5, \frac{i(\Gamma_{11} + \Gamma_{12})}{\sqrt{2}}, -i\Gamma_{2,0}; C-4 DP; 4

X; (0\frac{1}{2}0); C_{4y}^-, C_{2s}^+, T; \{ R_8, R_{10} \}; 2; \sigma_0, i\sigma_3, -i\sigma_2; P-NS_{XMR};
\{ R_9, R_{11} \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; P-NS_{XMR};
R_{14}; 2; i\sigma_3, i\sigma_2, -i\sigma_2; P-NS_{XMR};

M; (\frac{1}{2} \frac{3}{2} 0); C_{4s}^-, C_{2s}^+, T; \{ R_6, R_7 \}; 4; \frac{\Gamma_{6,0} + i\Gamma_{6,3}}{\sqrt{2}}, \Gamma_{0,3}, -i\Gamma_{2,0}; C-2 DP; 2

R; (\frac{1}{2} \frac{1}{2} \frac{1}{2}); C_{2s}, C_{2y}, C_{31}, C_{2b}, T; \{ R_3, R_4 \}; 2; -\sigma_0, \sigma_0, -\sigma_0, i\sigma_3, -i\sigma_2; P-NS;
R_8; 2; -\sigma_0, \sigma_0, \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, i\sigma_3, -i\sigma_2; P-NS;
\{ R_{13}, R_{14} \}; 6; iS_{11}, -S_7, S_{13}, S_{14}, -iS_{2,0}; C-4 SP; 4

Δ; ΓX; C_{4y}^+, TC_{2s};
R_2; 1; \sqrt{-1}, 1;
R_4; 1; (1)^{3/4}, 1;
R_6; 1; -\sqrt{-1}, 1;
R_8; 1; -(-1)^{3/4}, 1;

Σ; ΓM; C_{2b}, TC_{2s};
R_2; 1; i, 1;
R_4; 1; -i, 1;

Λ; ΓR; C_{31}, C_{2e}^+ T;
R_2; 1; \sqrt{-1}, 1;
R_4; 1; -1, 1;
R_6; 1; -(-1)^{2/3}, 1;

S; XR; C_{2s}, E, TC_{2y};
\{ R_{12}, R_{16} \}; 2; i\sigma_3, -\sigma_0, -i\sigma_2; L-NS_{XMR};

Z; XM; C_{2s}, E, TC_{2s};
\{ R_5, R_7 \}; 2; -i\sigma_3, -\sigma_0, \sigma_1; L-NS_{XMR};

T; MR; C_{4s}^+, E, C_{2a} T;
\{ R_{10}, R_{14} \}; 2; -\sqrt{-1}\sigma_3, -\sigma_0, \sigma_1; L-NSs;
\{ R_{12}, R_{16} \}; 2; -(1)^{3/4}\sigma_3, -\sigma_0, \sigma_1; L-NSs;
\[ \Gamma; \{C_{4v}\}, \{C_{2v}\}; \{C_{2h}\} \}; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; (000); C_{4v}^+; C_{2v}^+; C_{2h}^+; T; \]

\[ R_4; 2; \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{C-1 WP; 1} \]

\[ R_5; 2; \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{C-1 WP; 1} \]

\[ H; \{\frac{1}{3} \frac{1}{3} \frac{1}{3}\}; C_{4v}^+; C_{2v}^+; C_{2h}^+; T; \]

\[ R_4; 2; \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{C-1 WP; 1} \]

\[ R_5; 2; \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{C-1 WP; 1} \]

\[ P; \{\frac{1}{3} \frac{1}{3} \frac{1}{3}\}; C_{2v}^+; C_{2h}^+; C_{2h}^+; T; \]

\[ R_4; 1; 1, 1, 1; \]

\[ R_5; 1; (1)^{1/3}, 1, 1, 1; \]

\[ H; \{\frac{1}{3} \frac{1}{3} \frac{1}{3}\}; \]

\[ R_3; 3; A_9, -\frac{A_9}{\sqrt{3}} + \frac{2A_9}{\sqrt{3}}; \text{C-2 TP;} \]

\[ \Sigma; \Gamma; \{A_{2v}\}; \{C_{2v}\}; \{C_{2h}\}; \]

\[ R_2; 1; i; 1; \]

\[ R_4; 1; -i; 1; \]

\[ \Lambda; \Gamma; \{C_{4v}\}; \{C_{2v}\}; \{C_{2h}\}; \]

\[ R_4; 1; \sqrt{1}; 1; \]

\[ R_6; 1; \sqrt{1}; 1; \]

\[ \Lambda; \Gamma; \{C_{4v}\}; \{C_{2v}\}; \{C_{2h}\}; \]

\[ R_4; 1; -1, 1; \]

\[ R_6; 1; -1, 1; \]

\[ D; \{C_{2v}\}; \{C_{2h}\}; \{C_{2h}\}; \]

\[ R_4; 1; -i, -1, 1; \]

\[ R_7; 1; i, -1, 1; \]

\[ G; \{C_{2h}\}; \{C_{2h}\}; \{C_{2h}\}; \]

\[ R_4; 1; -i, -1, 1; \]

\[ R_7; 1; i, -1, 1; \]

\[ F; \{C_{3h}\}; \{C_{2h}\}; \{C_{2h}\}; \]

\[ R_4; 1; -i, -1, 1; \]

\[ R_9; 1; \sqrt{1}; -1, 1; \]

\[ R_{11}; 1; (-1)^{1/6}, -1, 1; \]
\( \Gamma_c; \{S_{4x}^+, \sigma_{db}\}; \{C_{31}^+\}; \{\sigma_{dc}\}; T; \) Non-Centrosymmetric; with SOC

\[ \begin{align*} 
\Gamma; \ (000); \ S_{4x}^+, \ C_{31}^+, \ \sigma_{db}, \ T; 
R_4; & \ 2; \ \frac{\sigma_{0} - i\sigma_1}{\sqrt{2}}, \ \sigma_6, \ \frac{i(\sigma_{1} + \sigma_2)}{\sqrt{2}}, \ -i\sigma_2; \ P-WNLs; \\
R_5; & \ 2; \ \frac{\sigma_{0} - i\sigma_1}{-\sqrt{2}}, \ \sigma_6, \ \frac{i(\sigma_{1} + \sigma_2)}{\sqrt{2}}, \ -i\sigma_2; \ P-WNLs; \\
R_6; & \ 4; \ \Gamma_4, \ \Gamma_5, \ \frac{i(\Gamma_{1,3} + \Gamma_{2,3})}{\sqrt{2}}, \ -i\Gamma_{2,0}; \ DP; \ 0 \\
X; \ (010); \ S_{4y}^+, \ C_{2z}, \ T; 
R_6; & \ 2; \ \frac{\sigma_{0} + i\sigma_2}{\sqrt{2}}, \ \i\sigma_1, \ -i\sigma_2; \ P-WNL_{TX}; \\
R_7; & \ 2; \ \frac{\sigma_{0} - i\sigma_2}{\sqrt{2}}, \ \i\sigma_1, \ -i\sigma_2; \ P-WNL_{TX}; \\
M; \ (1\frac{1}{2} 0); \ S_{4z}^+, \ C_{2z}, \ T; 
R_6; & \ 2; \ \frac{\sigma_{0} + i\sigma_2}{\sqrt{2}}, \ \i\sigma_1, \ -i\sigma_2; \ P-WNL_{MR}; \\
R_7; & \ 2; \ \frac{\sigma_{0} - i\sigma_2}{\sqrt{2}}, \ \i\sigma_1, \ -i\sigma_2; \ P-WNL_{MR}; \\
R; \ (1\frac{1}{2} 1); \ S_{4z}^-, \ C_{31}^+, \ \sigma_{db}, \ T; 
R_4; & \ 2; \ \frac{\sigma_{0} - i\sigma_1}{\sqrt{2}}, \ \sigma_6, \ \frac{i(\sigma_{1} + \sigma_2)}{\sqrt{2}}, \ -i\sigma_2; \ P-WNLs; \\
R_5; & \ 2; \ \frac{\sigma_{0} - i\sigma_1}{-\sqrt{2}}, \ \sigma_6, \ \frac{i(\sigma_{1} + \sigma_2)}{\sqrt{2}}, \ -i\sigma_2; \ P-WNLs; \\
R_6; & \ 4; \ \Gamma_4, \ \Gamma_5, \ \frac{i(\Gamma_{1,3} + \Gamma_{2,3})}{\sqrt{2}}, \ -i\Gamma_{2,0}; \ DP; \ 0 \\
\Delta; \ \Gamma X; \ C_{2y}^+, \ \sigma_{dc}, \ S_{4y}^+, \ T; 
R_5; & \ 2; \ \i\sigma_2, \ \i\sigma_1, \ \frac{\sigma_{0} - i\sigma_2}{\sqrt{2}}; \ WNL; \quad \pi \\
\Sigma; \ \Gamma M; \ \sigma_{db}, \ \mathcal{T} \mathcal{C}_{2z}; 
R_2; & \ 1; \ i, \ 1; \\
R_4; & \ 1; \ -i, \ 1; \\
\Lambda; \ \Gamma R; \ C_{31}^-, \ \sigma_{db}; 
R_3; & \ 1; \ -1, \ i; \\
R_4; & \ 1; \ -1, \ -i; \\
R_6; & \ 2; \ \frac{i}{2} \left( \sigma_0 - i\sqrt{3}\sigma_2 \right), \ \i\sigma_3; \ WNL; \quad \pi \\
S; \ \mathcal{X} R; \ \sigma_{dc}, \ \mathcal{T} \sigma_{dc}; 
R_2; & \ 1; \ i, \ 1; \\
R_4; & \ 1; \ -i, \ 1; \\
Z; \ \mathcal{X} M; \ C_{2x}, \ \mathcal{T} C_{2z}; 
R_2; & \ 1; \ i, \ 1; \\
R_4; & \ 1; \ -i, \ 1; \\
T; \ \mathcal{M} R; \ C_{2z}, \ \sigma_{dc}, \ S_{4z}^+, \ T; 
R_5; & \ 2; \ \i\sigma_2, \ \i\sigma_1, \ \frac{\sigma_{0} - i\sigma_2}{\sqrt{2}}; \ WNL; \quad \pi 
\end{align*} \]
\[ \Gamma: (000); S_{4y}^\pm, C_{31}, \sigma_{db}, T; \]
\[ R_4; 2; \frac{a_0 - i\sigma_1}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{ P-WNLs;} \]
\[ R_5; 2; \frac{a_0 - i\sigma_1}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{ P-WNLs;} \]
\[ R_6; 4; \Gamma_4, \Gamma_5, \frac{i(\Gamma_1 + \Gamma_3)}{\sqrt{2}}, -i\Gamma_{2,0}; \text{ DP; } 0 \]

\[ X: \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); S_{4y}^+, C_{2z}, T; \]
\[ R_6; 2; \frac{a_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \text{ P-WNL}_{TX}; \]
\[ R_7; 2; -\frac{a_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \text{ P-WNL}_{TX}; \]

\[ L: \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); C_{31}^+, \sigma_{db}, T; \]
\[ \{ R_3, R_4 \}; 2; -\sigma_0, \sigma_3, -i\sigma_2; \text{ P-WNLs;} \]
\[ R_6; 2; \frac{a_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3, -i\sigma_2; \text{ P-WNL}_{XL}; \]

\[ W: \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); S_{4y}^+, TC_{2z}; \]
\[ R_2; 1; \sqrt{-1}, 1; \]
\[ R_4; 1; (-1)^{3/4}, 1; \]
\[ R_6; 1; -\sqrt{-1}, 1; \]
\[ R_4; 1; -(-1)^{3/4}, 1; \]

\[ \Delta; \Gamma X; \]
\[ C_{2y}, \sigma_{dc}, S_{4y}^+; T; \]
\[ R_5; 2; i\sigma_2, i\sigma_1, -\frac{a_0 - i\sigma_2}{\sqrt{2}}; \text{ WNL; } \pi \]

\[ \Lambda; \Gamma L; \]
\[ C_{31}, \sigma_{db}; \]
\[ R_3; 1; -1, i; \]
\[ R_4; 1; -1, -i; \]
\[ R_6; 2; \frac{a_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3; \text{ WNL; } \pi \]

\[ \Sigma; \Gamma \Sigma; \]
\[ \sigma_{db}, TC_{2z}; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ S; \Sigma S; \]
\[ \sigma_{dc}, T \sigma_{dc}; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ Z; \Sigma W; \]
\[ C_{2z}, TC_{2z}; \]
\[ R_2; 1; i, 1; \]
\[ R_4; 1; -i, 1; \]

\[ Q; \Sigma W; \]
\[ \bar{E}, T \sigma_{dy}; \]
\[ R_2; 1; -i, 1; \]
\( \Gamma_v^\gamma; \{S^\gamma_{4z}(000), \{C^\gamma_{3y}(000), \{\sigma_{db}(000)\}, T; \text{Non-Centrosymmetric; with SOC} \)

\( \Gamma; (000); S^-_{4z}, C^\gamma_{3y}, \sigma_{db}, T; R_4; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \\text{P-WNLs}; \)

\( R_5; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{P-WNLs}; \)

\( R_6; 4; \Gamma_4, \Gamma_5, \frac{i(\Gamma_{15} + \Gamma_{23})}{\sqrt{2}}, -i\Gamma_2, 0; \text{DP}; 0 \)

\( H; \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); S^-_{4z}, C^\gamma_{3y}, \sigma_{db}, T; R_4; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{P-WNLs}; \)

\( R_5; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{P-WNLs}; \)

\( R_6; 4; \Gamma_4, \Gamma_5, \frac{i(\Gamma_{15} + \Gamma_{23})}{\sqrt{2}}, -i\Gamma_2, 0; \text{DP}; 0 \)

\( P; \left( \frac{1}{4} \frac{1}{4} \frac{1}{4} \right); S^-_{4z}, C^\gamma_{3y}, \sigma_{db}; R_4; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{P-WNLs}; \)

\( R_5; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \text{P-WNLs}; \)

\( R_6; 4; \Gamma_4, \Gamma_5, \frac{i(\Gamma_{15} + \Gamma_{23})}{\sqrt{2}}, -i\Gamma_2, 0; \text{DP}; 0 \)

\( N; (00 \frac{1}{2}); C_{2z}, \sigma_{db}, T; R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2; \text{P-WNL}_{NP} \)

\( \Sigma; \Gamma\Theta; \sigma_{db}, TC_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( \Delta; \Gamma\Theta; C_{2y}, \sigma_{db}, S^\gamma_{4y}, T; R_5; 2; i\sigma_2, i\sigma_1, -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}; \text{WNL; } \pi \)

\( \Lambda; \Gamma\Pi; C_{3y}, \sigma_{db}; R_4; 1; -1, i; \)

\( R_4; 1; -1, -i; \)

\( R_6; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_3; \text{WNL; } \pi \)

\( D; \Pi\Theta; C_{2y}, \sigma_{db}; R_5; 2; i\sigma_2, i\sigma_1; \text{WNL; } \pi \)

\( G; \Pi\Theta; \sigma_{db}, TC_{2z}; R_2; 1; i, 1; \)

\( R_4; 1; -i, 1; \)

\( F; \Pi\Theta; C^\gamma_{3y}, \sigma_{db}; R_5; 1; -1, i; \)

\( R_4; 1; -1, -i; \)

\( R_6; 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3; \text{WNL; } \pi \)
Γ: (000); \( S_{4z}^{-}, \bar{C}_{31}, \sigma_{db}, T \); 
\[ \begin{align*} 
\Gamma_4: & \quad 2; \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_0, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \quad \text{P-WNLs;} \\
\Gamma_5: & \quad 2; \frac{\sigma_0 + i\sigma_1}{\sqrt{2}}, \sigma_0, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \quad \text{P-WNLs;} \\
\Gamma_8: & \quad 4\Gamma_4, \Gamma_5, \frac{i(\Gamma_{1,3} + \Gamma_{1,4})}{\sqrt{2}}, -i\Gamma_{2,0}; \quad \text{DP;} \quad 0 \\
\end{align*} \]

X: (0\( \frac{1}{2} \)0); \( S_{4y}^{+}, \sigma_{dc}, T \); 
\[ \{ R_6, R_\Pi \}; \quad \begin{align*} 
\Gamma_4: & \quad 4; \frac{\Gamma_{0,1} + i\Gamma_{3,0}}{\sqrt{2}}, \Gamma_{0,3}, -i\Gamma_{2,0}; \quad \text{DP;} \quad 0 \\
\end{align*} \]

M: (\( \frac{1}{2} \)\( \frac{1}{2} \)0); \( S_{4z}^{+}, C_{2z}, T \); 
\[ \{ R_6, R_\Pi \}; \quad \begin{align*} 
\Gamma_5: & \quad 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{MR}; \\
\Gamma_\Pi: & \quad 2; -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \quad \text{P-WNL}_{MR}; \\
\end{align*} \]

R: (\( \frac{1}{2} \)\( \frac{1}{2} \)\( \frac{1}{2} \)); \( C_{2x}, C_{2y}, C_{31}, \sigma_{db}, T \); 
\[ \{ R_{15}, R_{15} \}; \quad \begin{align*} 
\Gamma_5: & \quad 8; \frac{(Q_{0,0,2} + Q_{0,3,3})}{\sqrt{2}}, \frac{(Q_{0,0,2} - Q_{0,3,3})}{i\sqrt{2}}, Q_{2}, Q_{0,0,3}, -iQ_{2,1,0}; \quad \text{OP;} \quad 0 \\
\end{align*} \]

Δ: ΓX; \( C_{2y}, \sigma_{dc}, S_{4y}^{+}, T \); 
\[ \Gamma_5: \quad 2; i\sigma_2, i\sigma_1, -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}; \quad \text{WNL;} \quad \pi \\
\]

Σ: ΓM; \( \sigma_{db}, TC_{2z} \); 
\[ \Gamma_2; \quad 1; i, 1; \\
\Gamma_4; \quad 1; -i, 1; \\
\]

Λ: ΓR; \( C_{31}, \sigma_{db} \); 
\[ \Gamma_3; \quad 1; -i, i; \\
\Gamma_4; \quad 1; -i, -i; \\
\Gamma_6; \quad 2; -\frac{\sigma_0 - i\sqrt{3}\sigma_2}{\sqrt{2}}, i\sigma_3; \quad \text{WNL;} \quad \pi \\
\]

S: XR; \( \sigma_{dc}, T \sigma_{dc} \); 
\[ \{ R_2, R_4 \}; \quad \begin{align*} 
\Gamma_2: & \quad 2; \sigma_3, -i\sigma_2; \quad \text{WNL;} \quad \pi \\
\end{align*} \]

Z: XM; \( C_{2x}, TC_{2z} \); 
\[ \Gamma_2; \quad 1; i, 1; \\
\Gamma_4; \quad 1; -i, 1; \\
\]

T: MR; \( C_{2z}, \sigma_{da}, S_{4z}^{+}, T \); 
\[ \Gamma_5; \quad 2; i\sigma_2, -i\sigma_1, -\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}; \quad \text{WNL;} \quad \pi \]
\( \Gamma_U; \{ S_{2\pi, 1/2 \pi, 2/2 \pi}, \{ C_{31, 000}, \{ \sigma_{db, 1/2 \pi, 1/2 \pi} \}, T; \) Non-Centrosymmetric; with SOC

\[
\begin{align*}
\Gamma; (000); & \quad S_{2\pi, 1/2 \pi, 2/2 \pi}, C_{31, \sigma_{db}, T}; \\
R_4; & \quad 2; \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \quad \text{P-WNLs}; \\
R_5; & \quad 2; \frac{\sigma_0 - i\sigma_1}{\sqrt{2}}, \sigma_6, \frac{i(\sigma_1 + \sigma_2)}{\sqrt{2}}, -i\sigma_2; \quad \text{P-WNLs}; \\
R_6; & \quad 4; \Gamma_4, \Gamma_5, \frac{i(\Gamma_1, \Gamma_2)}{\sqrt{2}}, -i\Gamma_2, 0; \quad \text{DP}; \quad 0
\end{align*}
\]

\( \Sigma; \quad \Gamma \Sigma; \) Non-Centrosymmetric; with SOC

\[
\begin{align*}
\Delta; \quad \Gamma X; \quad C_{2y, \sigma_{dc}, \sigma_{db}, T}; \\
R_5; & \quad 2; \frac{i\sigma_2, i\sigma_1, -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}}; \quad \text{WNL}; \quad \pi
\end{align*}
\]

\[
\begin{align*}
\Lambda; \quad \Gamma L; \quad C_{31, \sigma_{db}, T}; \\
R_3; & \quad 1; -1, i; \\
R_4; & \quad 1; -1, -i; \\
R_6; & \quad 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{\sqrt{2}}, i\sigma_3; \quad \text{WNL}; \quad \pi
\end{align*}
\]

\[
\begin{align*}
\Sigma; \quad \Gamma \Sigma; \quad \sigma_{db}, \tau C_{2x}; \\
R_2; & \quad 1; i, 1; \\
R_4; & \quad 1; -i, 1;
\end{align*}
\]

\[
\begin{align*}
\Lambda; \quad \Gamma L; \quad C_{31, \sigma_{dc}, \sigma_{dc}, T}; \\
R_2; & \quad 1; -i, 1; \\
R_4; & \quad 1; i, 1;
\end{align*}
\]

\[
\begin{align*}
\Delta; \quad \Gamma X; \quad C_{2y, \sigma_{dc}, \sigma_{db}, T}; \\
R_5; & \quad 2; \frac{i\sigma_2, i\sigma_1, -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}}; \quad \text{WNL}; \quad \pi
\end{align*}
\]

\[Q; \quad \text{LW}; \quad \bar{E}, \tau \sigma_{dc}; \quad \{ R_2, R_2 \}; \quad 2; -\sigma_0, -i\sigma_2; \quad \text{WNL}; \quad \pi
\]
\( \Gamma_v^0; \{ S_{4x}^{\alpha} | \frac{1}{2} 00 \}, \{ C_{31}^v | 000 \}, \{ \sigma_{db}^\alpha | \frac{1}{2} \frac{1}{2} \} \); Non-Centrosymmetric; with SOC

| \( \Gamma \) | (000) | \( S_{4x}^\alpha \), \( C_{31}^v \), \( \sigma_{db}^\alpha \), \( \mathcal{T} \) | \( R_4 \) | \( 2; \frac{\sigma_6 - i\sigma_4}{\sqrt{2}}, \frac{\sigma_6 + i\sigma_4}{\sqrt{2}}, \sigma_2 - i\sigma_2 \) | P-WNLs |
|---|---|---|---|---|---|
| \( R_5 \) | \( 2; \frac{\sigma_6 - i\sigma_4}{\sqrt{2}}, \frac{\sigma_6 + i\sigma_4}{\sqrt{2}}, \sigma_2 - i\sigma_2 \) | P-WNLs |
| \( R_6 \) | \( 4; \Gamma_4, \Gamma_5, \frac{i(\Gamma_{1,3} + \Gamma_{2,3})}{\sqrt{2}}, -i\Gamma_{2,0} \) | DP; 0 |
| \( \mathcal{H} \); \( \{ \frac{1}{3} \frac{1}{3} \frac{1}{2} \} \); \( C_{2x}, C_{2y}, C_{31}^v, \sigma_{db}^\alpha, \mathcal{T} \); \( \{ R_6, R_7 \} \) | \( 4; \Gamma_6, \Gamma_7, \frac{i}{2} \left( -\Gamma_{0,0} - i\sqrt{3}\Gamma_{3,3} \right), \Gamma_{0,1}, -i\Gamma_{2,0} \) | DP; 0 |
| \( \{ R_{15}, R_{16} \} \) | \( 8; \left( \frac{Q_{0,0,2} - Q_{0,3,3}}{\sqrt{2}} \right), Q_2, Q_{0,0,3}, -iQ_{2,1,0} \) | OP; 0 |
| \( \mathcal{P} \); \( \{ \frac{1}{4} \frac{1}{4} \} \); \( C_{32}^+, C_{2y}, C_{2x}, S_{14}^\alpha \) | \( R_{17} \) | \( 1; i, \sqrt{-1}, \sqrt{-1} \) | P-WNLs |
| \( R_{18} \) | \( 1; i, \sqrt{-1}, \sqrt{-1} \) | P-WNLs |
| \( R_{21} \) | \( 2; \frac{1}{2} \left( \sqrt{3}\sigma_3 + i\sigma_0 \right), i\sigma_0, i\sigma_0, \sqrt{-1}\sigma_1 \) | P-WNLs |
| \( R_{27} \) | \( 3; -iA_9, -\frac{i(\sqrt{3}A_8 + 2A_0)}{3}, iA_{10}, -\frac{(1+i)A_{18}}{\sqrt{2}} \) | TP; 0 |
| \( R_{28} \) | \( 3; -iA_9, -\frac{i(\sqrt{3}A_8 + 2A_0)}{3}, iA_{10}, \sqrt{-1}A_{18} \) | TP; 0 |
| \( \mathcal{N} \); \( \{ \frac{1}{2} \} \); \( \sigma_{db}, C_{2x}, \mathcal{T} \); \( \{ R_5, R_6 \} \) | \( 2; -\sigma_0, i\sigma_3, -i\sigma_2 \) | P-WNLs |
| \( \{ R_7, R_8 \} \) | \( 2; \sigma_0, -i\sigma_3, -i\sigma_2 \) | P-WNLs |
| \( \Sigma \); \( \mathcal{G}_N \); \( \sigma_{db}, \mathcal{T} C_{2x} \) | \( R_2 \) | \( 1; i, 1 \) | P-WNLs |
| \( R_4 \) | \( 1; -i, 1 \) | |
| \( \Delta \); \( \mathcal{G}_H \); \( C_{2y}, \sigma_{db}, S_{14}^+ \) | \( R_5 \) | \( 2; i\sigma_2, i\sigma_1, -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}} \) | WNL; \( \pi \) |
| \( \Lambda \); \( \mathcal{G}_P \); \( C_{31}^-, \sigma_{db} \) | \( R_8 \) | \( 1; -1, i \) | |
| \( R_4 \) | \( 1; -1, -i \) | |
| \( R_6 \) | \( 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2}, i\sigma_3 \) | WNL; \( \pi \) |
| \( D \); \( \mathcal{N}_P \); \( C_{2x}, \sigma_{db} \) | \( R_5 \) | \( 1; i, 1 \) | |
| \( R_6 \) | \( 1; i, -1 \) | |
| \( R_7 \) | \( 1; -i, 1 \) | |
| \( R_8 \) | \( 1; -i, 1 \) | |
| \( G \); \( \mathcal{H}_N \); \( \sigma_{db}, \mathcal{T} C_{2x} \); \( \{ R_2, R_4 \} \) | \( 2; i\sigma_3, i\sigma_1 \) | WNL; \( \pi \) |
| \( F \); \( \mathcal{P}_H \); \( C_{34}^+, \sigma_{db}, E \) | \( R_9 \) | \( 1; -i, \sqrt{-1}, 1 \) | |
| \( R_{10} \) | \( 1; -i, -\sqrt{-1}, 1 \) | |
| \( R_{12} \) | \( 2; \frac{1}{2} \left( \sqrt{3}\sigma_2 + i\sigma_0 \right), \sqrt{-1}\sigma_3, \sigma_0 \) | WNL; \( \pi \) |
SG 221

Γc; \{C^+_{4z}|000\}, \{\bar{C}^-_{31}|000\}, \{C^2_{2b}|000\}, \{I|000\}; \mathcal{T}; \text{Centrosymmetric; with SOC}

\Gamma; (000); C^+_{4z}, \bar{C}^-_{31}, C_{2b}, I, \mathcal{T}; R_4; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, \sigma_0, -i\sigma_2;
R_5; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_4, -\sigma_5, \sigma_0, -i\sigma_2;
R_6; 4; \frac{\Gamma_{10} + \Gamma_{01}}{\sqrt{2}}, \Gamma_1, \Gamma_2, \Gamma_{00}, -i\Gamma_{02}; \text{ QCDP; 0}
R_{12}; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, -\sigma_0, -i\sigma_2;
R_{13}; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_4, -\sigma_5, -\sigma_0, -i\sigma_2;
R_{16}; 4; \frac{\Gamma_{10} + \Gamma_{01}}{\sqrt{2}}, \Gamma_1, \Gamma_2, -\Gamma_{00}, -i\Gamma_{02}; \text{ QCDP; 0}

X; \left(0\frac{1}{2}|0\right); C^+_{4y}, C_{2x}, I, \mathcal{T};
R_6; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2;
R_7; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2;
R_{13}; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2;
R_{14}; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2;

M; \left(1\frac{1}{2}|0\right); C^+_{4z}, C_{2x}, I, \mathcal{T};
R_6; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2;
R_7; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2;
R_{13}; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2;
R_{14}; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2;

R; \left(1\frac{1}{2}|\frac{3}{2}\right); C^+_{4z}, \bar{C}^-_{31}, C_{2b}, I, \mathcal{T};
R_4; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, \sigma_0, -i\sigma_2;
R_5; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, \sigma_0, -i\sigma_2;
R_8; 4; \frac{\Gamma_{10} + \Gamma_{01}}{\sqrt{2}}, \Gamma_1, \Gamma_2, \Gamma_{00}, -i\Gamma_{02}; \text{ QCDP; 0}
R_{12}; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, \sigma_0, -i\sigma_2;
R_{13}; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, -\sigma_5, -\sigma_0, -i\sigma_2;
R_{16}; 4; \frac{\Gamma_{10} + \Gamma_{01}}{\sqrt{2}}, \Gamma_1, \Gamma_2, -\Gamma_{00}, -i\Gamma_{02}; \text{ QCDP; 0}

\Delta; \Gamma X; C^+_{4y}, \sigma_1, I, \mathcal{T};
R_6; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2;
R_7; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2;

\Sigma; \Gamma M; C_{2a}, \sigma_2, I, \mathcal{T};
R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2;

\Lambda; \Gamma R; C^+_{31}, \sigma_6, I, \mathcal{T}; \{R_3, R_4\}; 2; -\sigma_0, i\sigma_3, -i\sigma_2;
R_6; 2; \frac{1}{2} \left(\sigma_0 - i\sqrt{3}\sigma_2\right), i\sigma_3, -i\sigma_2;
R_7; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2;

S; \chi R; C^+_{4z}, \sigma_9, I, \mathcal{T};
R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2;

Z; \chi M; C^+_{2x}, \sigma_7, I, \mathcal{T};
R_5; 2; i\sigma_2, i\sigma_1, -i\sigma_2;

T; \chi R; C^+_{4z}, \sigma_9, I, \mathcal{T};
R_5; 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2;
R_7; 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2;
\[ \Gamma_c: \{C_4^+|000\}, \{C_{31}^-|000\}, \{C_{20}|000\}, \{I^\frac{1}{2}|\frac{1}{2}\}, T; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; \ (000); \ C_{4z}^+, C_{31}, C_{20}, I, T; \]

\[ R_4; \ 2; \ \frac{\sigma_0 + i\sigma_2}{\sqrt{2}} \]

\[ R_5; \ 2; \ -\frac{\sigma_0 + i\sigma_2}{\sqrt{2}} \]

\[ R_8; \ 4; \ \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}} \]

\[ R_{12}; \ 2; \ \frac{\sigma_0 + i\sigma_2}{\sqrt{2}} \]

\[ R_{13}; \ 2; \ -\frac{\sigma_0 + i\sigma_2}{\sqrt{2}} \]

\[ R_{16}; \ 4; \ \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}} \]

\[ X; \ (0\frac{1}{2}0); \ I, \sigma_z, C_{4y}, T; \]

\[ \{R_{19}, R_{20}\}; \ 4; \ \Gamma_{3,0}, \Gamma_{0,2}, \frac{\Gamma_{0,0} + i\Gamma_{0,2}}{\sqrt{2}}, -i\Gamma_{2,0}; \]

\[ \{R_{21}, R_{22}\}; \ 4; \ \Gamma_{3,2}, \Gamma_{0,3}, \frac{\Gamma_{0,0} + i\Gamma_{0,2}}{\sqrt{2}}, -i\Gamma_{2,0}; \]

\[ M; \ (1\frac{1}{2}0); \ C_{4z}^+, C_{31}, C_{20}, T; \]

\[ R_{19}; \ 4; \ -\frac{\Gamma_{3,0} - i\Gamma_{3,1}}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3}, -i\Gamma_{3,2}; \]

\[ R_{18}; \ 4; \ \frac{\Gamma_{3,0} - i\Gamma_{3,3}}{\sqrt{2}}, i\Gamma_{0,1}, \Gamma_{3,1}, -i\Gamma_{0,2}; \]

\[ \Delta; \ \Gamma_X; \ C_{4y}^+, \sigma_z, I, T; \]

\[ R_6; \ 2; \ \frac{\sigma_0 + i\sigma_2}{\sqrt{2}} \]

\[ R_7; \ 2; \ -\frac{\sigma_0 + i\sigma_2}{\sqrt{2}} \]

\[ \Sigma; \ \Gamma_M; \ C_{20}, \sigma_z, I, T; \]

\[ R_5; \ 2; i\sigma_2, i\sigma_1, -i\sigma_2 \]

\[ \Lambda; \ \Gamma_R; \ C_{31}^-, \sigma_y, I, T; \]

\[ \{R_3, R_4\}; \ 2; -i\sigma_0, \sigma_3, -i\sigma_2; \]

\[ \{R_6, R_7\}; \ 2; \frac{\sigma_0 - i\sqrt{3}\sigma_2}{2} \]

\[ S; \ \Gamma_X; \ C_{20}, I, T; \]

\[ \{R_5, R_8\}; \ 2; i\sigma_3, i\sigma_0, -i\sigma_2; \]

\[ Z; \ \Gamma_M; \ C_{20}, I, T; \]

\[ \{R_5, R_8\}; \ 2; i\sigma_3, i\sigma_0, -i\sigma_2; \]

\[ T; \ \Gamma_R; \ C_{4z}^+, \sigma_z, I, T; \]

\[ R_6; \ 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, -\sigma_3, -i\sigma_2; \]

\[ R_7; \ 2; \frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, -\sigma_3, -i\sigma_2; \]
Γ; \{C_{31}^{+}[\frac{1+1}{2} 2], \{C_{31}^{-}[000], \{C_{20}^{+}[\frac{1+1}{2} 2], \{J[000], T; Centrosymmetric; with SOC

Γ; (000); C_{4x}^{+}, C_{31}, C_{20}, I, T; R_{4}; 2; \frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, \sigma_{4}, \sigma_{5}, \sigma_{0}, -i\sigma_{2};
R_{5}; 2; -\frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, \sigma_{4}, -\sigma_{5}, \sigma_{0}, -i\sigma_{2};
R_{6}; 4; \frac{\Gamma_{3,0}^{0}i\sigma_{0}}{\sqrt{2}}, \Gamma_{1}, \Gamma_{2}, \Gamma_{0,0}, -i\Gamma_{0,2};
R_{12}; 2; \frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, \sigma_{4}, \sigma_{5}, -\sigma_{0}, -i\sigma_{2};
R_{13}; 2; -\frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, \sigma_{4}, -\sigma_{5}, -\sigma_{0}, -i\sigma_{2};
R_{16}; 4; \frac{\Gamma_{3,0}^{0}i\sigma_{0}}{\sqrt{2}}, \Gamma_{1}, \Gamma_{2}, -\Gamma_{0,0}, -i\Gamma_{0,2};

X; (0^{1+1}); C_{2y}^{+}, C_{31}, C_{2e}, I, T; R_{19}; 4; -\frac{\Gamma_{3,0}^{0}i\sigma_{0}}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3}, -i\Gamma_{3,2};

M; (\frac{1+1}{2}); C_{4x}^{+}, C_{2y}, I, T; R_{6}; 2; \frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, i\sigma_{1}, \sigma_{0}, -i\sigma_{2};
R_{7}; 2; -\frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, i\sigma_{1}, \sigma_{0}, -i\sigma_{2};
R_{13}; 2; \frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, i\sigma_{1}, -\sigma_{0}, -i\sigma_{2};
R_{14}; 2; -\frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, i\sigma_{1}, -\sigma_{0}, -i\sigma_{2};

R; (\frac{1+1}{2}); C_{4x}^{+}, C_{2e}, C_{31}, I, T; R_{18}; 4; \frac{\Gamma_{3,0}^{0}i\sigma_{0}}{\sqrt{2}}, \Gamma_{0,1}, \Gamma_{3,0}, -i\Gamma_{0,2};

\Delta; \Gamma X; C_{2y}^{+}, \sigma_{5}, I, T; R_{6}; 2; \frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, i\sigma_{1}, -i\sigma_{2};
R_{7}; 2; -\frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, i\sigma_{1}, -i\sigma_{2};

\Sigma; \Gamma M; C_{2e}, \sigma_{5}, I, T; R_{5}; 2; i\sigma_{2}, i\sigma_{1}, -i\sigma_{2};

\Lambda; \Gamma R; C_{31}, \sigma_{5}, I, T; \{R_{3}, R_{4}\}; 2; -\sigma_{0}, \sigma_{3}, -i\sigma_{2};
R_{6}; 2; \frac{1}{2} (\sigma_{0} - i\sqrt{3}\sigma_{2}), i\sigma_{3}, -i\sigma_{2};

\Sigma; \Sigma X; C_{2e}, \sigma_{5}, I, T; \{R_{5}, R_{6}\}; 2; i\sigma_{0}, i\sigma_{3}, -i\sigma_{2};
\{R_{7}, R_{8}\}; 2; -i\sigma_{0}, -i\sigma_{3}, -i\sigma_{2};

Z; \Sigma M; C_{2e}, \sigma_{5}, I, T; R_{5}; 2; i\sigma_{2}, i\sigma_{1}, -i\sigma_{2};

T; \Sigma R; C_{4x}^{+}, \sigma_{5}, E, I, T; R_{13}; 2; \frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, i\sigma_{1}, \sigma_{0}, -i\sigma_{2};
R_{14}; 2; \frac{\sigma_{x}+i\sigma_{y}}{\sqrt{2}}, i\sigma_{1}, \sigma_{0}, -i\sigma_{2};

\text{QCDP; 0 DP; 0 OP; 0}
\[ \Gamma; (000): \quad C_{4x}^+; C_{31}^+; C_{2b}; \text{QCDP}; 0 \]

\[ \Gamma; (010): \quad C_{4y}^+; C_{22}^+; \text{QCDP}; 0 \]

\[ \Gamma; (1 \frac{1}{2} 0): \quad C_{4z}^+; C_{22}^+; \text{QCDP}; 0 \]

\[ \Delta; \quad \Gamma_{17}; \quad C_{4y}^+; C_{22}^+; \text{QCDP}; 0 \]

\[ \Sigma; \quad \Gamma_{20}; \quad C_{22}^+; \text{QCDP}; 0 \]

\[ \Lambda; \quad \Gamma_{21}; \quad C_{31}^+; \text{QCDP}; 0 \]

\[ S; \quad \Gamma_{26}; \quad C_{22}^+; \text{QCDP}; 0 \]

\[ Z; \quad \Gamma_{27}; \quad C_{22}^+; \text{QCDP}; 0 \]

\[ T; \quad \Gamma_{31}; \quad C_{4z}^+; \text{QCDP}; 0 \]
\[ \Gamma; \ (000); \ C_{4x}^+, \bar{C}_{31}, C_{20}, I, T; \ R_4; \ 2; \ \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, \sigma_0, -i\sigma_2; \]
\[ R_5; \ 2; \ -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, \sigma_4, -\sigma_5, \sigma_0, -i\sigma_2; \]
\[ R_6; \ 4; \ \Gamma_3, \Gamma_0, \Gamma_{00}, -i\Gamma_{02}; \ QCDP; \ 0 \]
\[ R_{12}; \ 2; \ \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, -\sigma_0, -i\sigma_2; \]
\[ R_{13}; \ 2; \ -\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, -\sigma_5, -\sigma_0, -i\sigma_2; \]
\[ R_{16}; \ 4; \ \Gamma_3, \Gamma_{00}, \Gamma_{00}, -i\Gamma_{02}; \ QCDP; \ 0 \]
\[ X; \ (\frac{1}{2}0 \frac{1}{2}); \ C_{4y}^+, C_{2z}, I, T; \ R_6; \ 2; \ \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_7; \ 2; \ -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \]
\[ R_{13}; \ 2; \ \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ R_{14}; \ 2; \ -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \]
\[ L; \ (\frac{1}{2}1 \frac{1}{2}); \ C_{31}^+, \ C_{20}, I, T; \ (R_3, R_4); \ 2; \ -\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ R_6; \ 2; \ \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, \sigma_0, -i\sigma_2; \]
\[ (R_9, R_{10}); \ 2; \ -\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2; \]
\[ R_{12}; \ 2; \ \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -\sigma_0, -i\sigma_2; \]
\[ W; \ (\frac{1}{2} \frac{3}{2} \frac{1}{2}); \ S_{4x}^+, C_{2d}, I, T; \ R_6; \ 2; \ \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ R_7; \ 2; \ -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ \Delta; \ \Gamma X; \ C_{4y}^+, \sigma_2, I, T; \ R_6; \ 2; \ \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ R_7; \ 2; \ -\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \]
\[ \Lambda; \ \Gamma L; \ C_{31}^+, \sigma_{db}, I, T; \ (R_3, R_4); \ 2; \ -\sigma_0, i\sigma_3, -i\sigma_2; \]
\[ R_6; \ 2; \ \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2; \]
\[ \Sigma; \ \Gamma \Sigma; \ C_{2a}, \sigma_2, I, T; \ R_3; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ S; \ \times S; \ C_{2b}, \sigma_y, I, T; \ R_3; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ Z; \ \times W; \ C_{2e}, \sigma_z, I, T; \ R_3; \ 2; \ i\sigma_2, i\sigma_1, -i\sigma_2; \]
\[ Q; \ \times W; \ C_{2f}, I, T; \ (R_2, R_4); \ 2; \ i\sigma_3, -i\sigma_2; \]
\[ \begin{align*}
\Gamma_0^0 & \seteq \{ C_{4x}^0 \} \{ 000 \}, \{ C_{31}^0 \} \{ 000 \}, \{ C_{20}^0 \} \{ 000 \}, \{ I \} \frac{1}{2} \frac{1}{2} \frac{1}{2} \}; T; \text{Centrosymmetric; with SOC} \\
\Gamma; (000); C_{4x}^+, C_{31}^+, C_{20}^+, I, T; \Gamma_0^0; \\
R_4; & 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, \sigma_0, -i\sigma_2; \\
R_5; & 2; \frac{-\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, -\sigma_5, \sigma_0, -i\sigma_2; \\
R_6; & 4; \frac{\Gamma_3^0 + \Gamma_0^1}{\sqrt{2}}, \Gamma_1, \Gamma_2, \Gamma_0, 0, -i\Gamma_0; \text{QCDP}; 0 \\
R_12; & 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, -\sigma_0, -i\sigma_2; \\
R_{13}; & 2; \frac{-\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, -\sigma_5, -\sigma_0, -i\sigma_2; \\
R_{16}; & 4; \frac{\Gamma_3^0 + \Gamma_0^1}{\sqrt{2}}, \Gamma_1, \Gamma_2, -\Gamma_0, 0, -i\Gamma_0; \text{QCDP}; 0 \\
X; \left( \frac{1}{2} 0 \frac{1}{2} \right); C_{4y}^+, C_{2z}^+, I, T; \\
R_6; & 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_7; & 2; \frac{-\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, \sigma_0, -i\sigma_2; \\
R_{13}; & 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \\
R_{14}; & 2; \frac{-\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -\sigma_0, -i\sigma_2; \\
L; \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); C_{31}^+, C_{20}^+, I, T; \\
\{ R_{10}, R_{10} \}; 4; -\Gamma_0, \Gamma_0, 0, 0, -\Gamma_{2,1}; \text{CDP}; 0 \\
\{ R_{17}, R_{18} \}; 4; \frac{\Gamma_0, 0, -i\sqrt{3}}{\sqrt{2}}, i\Gamma_3, 1, 0, -i\Gamma_{2,0}; \text{DP}; 0 \\
W; \left( \frac{1}{2} \frac{1}{2} \frac{1}{2} \right); S_{4z}^+, C_{2f}^+, I, T; \\
\{ R_6, R_7 \}; 4; \frac{\Gamma_3^0 + \Gamma_0^1}{\sqrt{2}}, i\Gamma_0, 1, -i\Gamma_{2,0}; \text{DP}; 0 \\
\Delta; \Gamma X; C_{4y}^+, \sigma, I, T; \\
R_6; & 2; \frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \\
R_7; & 2; \frac{-\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2; \\
\Lambda; \Gamma L; C_{31}^+, \sigma, I, T; \\
\{ R_3, R_4 \}; 2; -\sigma_0, i\sigma_3, -i\sigma_2; \\
R_6; & 2; \frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, -i\sigma_2; \\
\Sigma; \Gamma \Sigma; C_{2a}^+, \sigma, I, T; \\
R_3; & 2; i\sigma_2, i\sigma_1, -i\sigma_2; \\
S; \Gamma S; C_{2c}^+, \sigma, I, T; \\
R_3; & 2; i\sigma_2, -i\sigma_1, -i\sigma_2; \\
Z; \Gamma W; C_{2f}^+, \sigma, I, T; \\
R_3; & 2; i\sigma_2, -i\sigma_1, -i\sigma_2; \\
Q; \Gamma W; C_{2f}^+, I, T; \\
\{ R_2, R_2 \}; 2; i\sigma_0, -i\sigma_2; \\
\{ R_4, R_4 \}; 2; -i\sigma_0, -i\sigma_2; \\
\end{align*} \]
$\Gamma^I$: $\{C_{4v}^{+}\{\frac{1}{2} \frac{1}{2} \frac{1}{2}\}\}, \{C_{3v}\{000\}\}$, $\{C_{2v}\{\frac{1}{2} \frac{1}{2} \frac{1}{2}\}\}, \{I\{\frac{1}{2} \frac{1}{2} \frac{1}{2}\}\}$; Centrosymmetric; with SOC

$\Gamma$: (000); $C_{4v}^{+}, C_{3v}, C_{2v}, I, T$; $R_4$: 2; $\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, \sigma_0, -i\sigma_2$;
$R_5$: 2; $-\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, -\sigma_5, \sigma_0, -i\sigma_2$;
$R_6$: 4; $\Gamma_{3c}, \Gamma_{00}, \Gamma_1, \Gamma_2, \Gamma_0, -i\Gamma_{0,2}$; QCDP; 0
$R_{12}$: 2; $\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, \sigma_5, -\sigma_0, -i\sigma_2$;
$R_{13}$: 2; $-\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, \sigma_4, -\sigma_5, -\sigma_0, -i\sigma_2$;
$R_{16}$: 4; $\Gamma_{3c}, \Gamma_{00}, \Gamma_1, \Gamma_2, -\Gamma_0, -i\Gamma_{0,2}$; QCDP; 0

$X$: ($\frac{1}{2}0\frac{1}{2}$); $C_{4v}^{+}, \sigma_x, C_{2v}, T$; $R_{19}$: 4; $-\frac{\Gamma_{3c,0} - i\Gamma_{3,1}}{\sqrt{2}}, \Gamma_{1,2}, i\Gamma_{0,3}, -i\Gamma_{3,2}$; DP; 0

$L$: ($\frac{1}{2} \frac{1}{2} \frac{1}{2}$); $\bar{C}_{3v}^{+}, C_{2v}, I, T$; $\{R_3, R_4\}$: 2; $-\sigma_0, i\sigma_3, \sigma_0, -i\sigma_2$;
$R_6$: 2; $\frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), i\sigma_3, \sigma_0, -i\sigma_2$;
$\{R_9, R_{10}\}$: 2; $-\sigma_0, i\sigma_3, -\sigma_0, -i\sigma_2$;
$R_{12}$: 2; $\frac{1}{2} (\sigma_0 - i\sqrt{3}\sigma_2), -i\sigma_3, -\sigma_0, -i\sigma_2$;

$W$: ($\frac{1}{2} \frac{1}{2} \frac{1}{2}$); $S_{4v}^{+}, \sigma_y, I, T$; $\{R_{13}, R_{14}\}$: 2; $\sqrt{-1}\sigma_0, \sqrt{-1}\sigma_3, -i\sigma_2$;
$\{R_{15}, R_{16}\}$: 2; $\sqrt{-1}\sigma_0, \sqrt{-1}\sigma_3, -i\sigma_2$;
$R_{20}$: 2; $(-1)^{3/4}\sigma_2, \sqrt{-1}\sigma_3, -i\sigma_2$;

$\Delta$: $\Gamma X$; $C_{4v}, \sigma_x, I, T$; $R_6$: 2; $\frac{\sigma_0 + i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2$;
$R_2$: 2; $\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_1, -i\sigma_2$;

$L$: $\Gamma L$; $C_{3v}^{+}, \sigma_y, I, T$; $\{R_5, R_4\}$: 2; $-\sigma_0, i\sigma_3, -i\sigma_2$;
$R_6$: 2; $-\frac{\sigma_0 - i\sigma_2}{\sqrt{2}}, i\sigma_3, -i\sigma_2$;

$\Sigma$: $\Gamma \Sigma$; $C_{2v}, \sigma_x, I, T$; $R_5$: 2; $i\sigma_2, i\sigma_1, -i\sigma_2$;

$S$: $\gamma_S$: $\sigma_y, \sigma_y, I, T$; $R_9$: 2; $i\sigma_3, -i\sigma_1, -i\sigma_2$;

$Z$: $\gamma_S$: $\sigma_y, \sigma_y, I, T$; $\{R_5, R_7\}$: 2; $i\sigma_3, -i\sigma_2$;
$\{R_6, R_8\}$: 2; $i\sigma_3, -i\sigma_2$;

$Q$: $\Gamma W$; $C_{2v}, E, I, T$; $\{R_{10}, R_{14}\}$: 2; $-i\sigma_3, -\sigma_0, -i\sigma_2$;
\[ \Gamma_r; \{ C_{4v}^+; \{ C_{31}^+; \{ C_{42}^+; \{ T; \text{Centrosymmetric; with SOC} \} \} \} \}\]
Γ; (000); $C_{4x}^+; C_{31}^-; C_{2b}; I; T$; $R_4$; 2; $\frac{\sigma_0+i\sigma_2}{\sqrt{2}}$, $\sigma_4$, $\sigma_5$, $\sigma_0$, $-i\sigma_2$;
$R_5$; 2; $-\frac{\sigma_0+i\sigma_2}{\sqrt{2}}$, $\sigma_4$, $-\sigma_5$, $\sigma_0$, $-i\sigma_2$;
$R_8$; 4; $\Gamma_{3,0}+i\Gamma_{0,2}$, $\Gamma_1$, $\Gamma_2$, $\Gamma_0$, $-i\Gamma_{0,2}$; QCDP; 0
$R_{12}$; 2; $\frac{\sigma_0+i\sigma_2}{\sqrt{2}}$, $\sigma_4$, $-\sigma_5$, $-\sigma_0$, $-i\sigma_2$;
$R_{13}$; 2; $-\frac{\sigma_0+i\sigma_2}{\sqrt{2}}$, $\sigma_4$, $-\sigma_5$, $-\sigma_0$, $-i\sigma_2$;
$R_{16}$; 4; $\Gamma_{3,0}+i\Gamma_{0,2}$, $\Gamma_1$, $\Gamma_2$, $-\Gamma_0$, $-i\Gamma_{0,2}$; QCDP; 0

$H$; $\left(\frac{1}{2} \frac{1}{2} \frac{1}{2}\right)$; $C_{4x}^+; C_{31}^-; C_{2b}; I; T$; $R_4$; 2; $\frac{\sigma_0+i\sigma_2}{\sqrt{2}}$, $\sigma_4$, $\sigma_5$, $\sigma_0$, $-i\sigma_2$;
$R_5$; 2; $-\frac{\sigma_0+i\sigma_2}{\sqrt{2}}$, $\sigma_4$, $-\sigma_5$, $\sigma_0$, $-i\sigma_2$;
$R_8$; 4; $\Gamma_{3,0}+i\Gamma_{0,2}$, $\Gamma_1$, $\Gamma_2$, $\Gamma_0$, $-i\Gamma_{0,2}$; QCDP; 0
$R_{12}$; 2; $\frac{\sigma_0+i\sigma_2}{\sqrt{2}}$, $\sigma_4$, $-\sigma_5$, $-\sigma_0$, $-i\sigma_2$;
$R_{13}$; 2; $-\frac{\sigma_0+i\sigma_2}{\sqrt{2}}$, $\sigma_4$, $-\sigma_5$, $-\sigma_0$, $-i\sigma_2$;
$R_{16}$; 4; $\Gamma_{3,0}+i\Gamma_{0,2}$, $\Gamma_1$, $\Gamma_2$, $-\Gamma_0$, $-i\Gamma_{0,2}$; QCDP; 0

$P$; $\left(\frac{1}{2} \frac{1}{2} \frac{1}{2}\right)$; $S_{4x}^-; C_{31}^-; \sigma_{db}; I; T$; $R_4$; 2; $\frac{\sigma_0-i\sigma_2}{\sqrt{2}}$, $\sigma_6$, $-i(\sigma_1+i\sigma_2)$, $-i\sigma_2$;
$R_5$; 2; $\frac{\sigma_0-i\sigma_2}{\sqrt{2}}$, $\sigma_6$, $-i(\sigma_1+i\sigma_2)$, $-i\sigma_2$;
$R_8$; 4; $\Gamma_4$, $\Gamma_5$, $-i(\Gamma_{3,3}+\Gamma_{2,2})$, $-i\Gamma_{2,0}$; DP; 0

$N$; (001); $C_{2b}; C_{2b}; I; T$; $R_2$; 2; $\sigma_2$, $i\sigma_1$, $\sigma_0$, $-i\sigma_2$;
$R_{16}$; 2; $\sigma_2$, $i\sigma_1$, $\sigma_0$, $-i\sigma_2$;

$\Sigma$; $\Gamma\Pi$; $C_{2b}; \sigma_3; I; T$; $R_3$; 2; $\sigma_3$, $i\sigma_1$, $-i\sigma_2$;

$\Delta$; $\Gamma\Pi$; $C_{4y}^+; \sigma_3; I; T$; $R_6$; 2; $\frac{\sigma_0+i\sigma_2}{\sqrt{2}}$, $i\sigma_1$, $-i\sigma_2$;
$R_7$; 2; $-\frac{\sigma_0-i\sigma_2}{\sqrt{2}}$, $i\sigma_1$, $-i\sigma_2$;

$\Lambda$; $\Gamma\Pi$; $C_{31}^-; \sigma_{db}; I; T$; $\{R_3, R_4\}$; 2; $-\sigma_0$, $i\sigma_3$, $-i\sigma_2$;
$R_6$; 2; $\frac{1}{2}$ $(\sigma_0 - i\sqrt{3}\sigma_2)$, $i\sigma_3$, $-i\sigma_2$;

$D$; $NP$; $C_{2b}; \sigma_{db}; I; T$; $R_3$; 2; $\sigma_2$, $i\sigma_1$, $-i\sigma_2$;

$G$; $HN$; $C_{2b}; \sigma_{db}; I; T$; $R_2$; 2; $\sigma_2$, $i\sigma_1$, $-i\sigma_2$;

$F$; $PH$; $C_{34}^+; \sigma_{db}; I; T$; $\{R_3, R_4\}$; 2; $-\sigma_0$, $i\sigma_3$, $-i\sigma_2$;
$R_6$; 2; $\frac{1}{2}$ $(\sigma_0 - i\sqrt{3}\sigma_2)$, $i\sigma_3$, $-i\sigma_2$;
\[ \Gamma_v: \{C_4^+|00\frac{1}{2}\}, \{C_3^+|000\}, \{C_{28}|\frac{1}{2} \frac{1}{2} \frac{1}{2}\}, \{I|000\}; T; Centrosymmetric; with \text{SOC} \]

\[
\begin{align*}
\Gamma: (000): & \quad C_{4x}^+, \bar{C}_{31}, C_{2b}, I, T; & R_{44}: 2; & \frac{a_0 + i a_2}{\sqrt{2}}, & a_4, a_5, a_9, -i a_2; \\
& & R_{55}: 2; & -\frac{a_0 + i a_2}{\sqrt{2}}, & a_4, -a_5, a_9, -i a_2; \\
& & R_{66}: 4; & \frac{\Gamma_{3,0} + i \Gamma_{3,1}}{\sqrt{2}}, & \Gamma_1, \Gamma_2, \Gamma_{0,0}, -i \Gamma_{0,2}; & \text{QCDP; 0} \\
& & R_{112}: 2; & \frac{a_0 + i a_2}{\sqrt{2}}, & a_4, -a_5, -a_9, -i a_2; \\
& & R_{113}: 2; & -\frac{a_0 + i a_2}{\sqrt{2}}, & a_4, -a_5, -a_9, -i a_2; \\
& & R_{116}: 4; & \frac{\Gamma_{3,0} + i \Gamma_{3,1}}{\sqrt{2}}, & \Gamma_1, \Gamma_2, -\Gamma_{0,0}, -i \Gamma_{0,2}; & \text{QCDP; 0} \\
H: (\frac{1}{2} \frac{1}{2} \frac{1}{2}); & \quad C_{4x}^+, C_{2y}^+, \bar{C}_{31}, I, T; & R_{118}: 4; & \frac{\Gamma_{3,0} - i \Gamma_{3,1}}{\sqrt{2}}, & i \Gamma_{0,1}, \Gamma_3, i \Gamma_{2,0}, -i \Gamma_{0,2}; & \text{DP; 0} \\
& & \{R_{21}, R_{22}\}: 8; & \frac{\Gamma_{3,0} - i \Gamma_{3,1}}{\sqrt{2}}, & i \Gamma_{0,1}, \Gamma_3, i \Gamma_{2,0}, -i \Gamma_{0,2}; & \text{DP; 0} \\
P: (\frac{1}{2} \frac{1}{2} \frac{1}{2}); & \quad C_{32}^+, C_{2y}^+, C_{2x}^+, S_{4z}^+, I, T; & \{R_{17}, R_{18}\}: 2; & -i \sigma_0, i \sigma_0, i \sigma_0, -\sqrt{3} \sigma_3, -i \sigma_2; \\
& & \{R_{21}\}: 2; & \frac{\sqrt{3} \sigma_3 + i \sigma_0}{2}, & i \sigma_0, i \sigma_0, (1)^{\frac{3}{2}} \sigma_1, -i \sigma_2; \\
& & \{R_{27}, R_{28}\}: 6; & i S_6, & S_6, 2 i \sqrt{3} S_6, S_1, S_2, -i S_2, 0; & \text{SP; 0} \\
N: (00 \frac{1}{2}); & \quad \sigma_{ds}, \sigma_{ds}, I, T; & \{R_{13}, R_{14}\}: 4; & \Gamma_{0,1}, i \Gamma_{3,0}, \Gamma_{0,3}, -i \Gamma_{2,0}; & \text{DP; 0} \\
\Sigma: \Gamma N; & \quad C_{2a}, \sigma_s, I, T; & R_{55}: 2; & i \sigma_2, i \sigma_1, -i \sigma_2; \\
\Delta: \Gamma H; & \quad C_{4y}^+, \sigma_x, I, T; & R_{66}: 2; & \frac{a_0 + i a_2}{\sqrt{2}}, & i \sigma_1, -i \sigma_2; \\
& & R_{77}: 2; & -\frac{a_0 + i a_2}{\sqrt{2}}, & i \sigma_1, -i \sigma_2; \\
\Lambda: \Gamma P; & \quad C_{31}, \sigma_{ds}, I, T; & \{R_{3}, R_{4}\}: 2; & -i \sigma_0, i \sigma_3, -i \sigma_2; \\
& & \{R_{6}\}: 2; & \frac{1}{2} (\sigma_0 - i \sqrt{3} \sigma_2), i \sigma_3, -i \sigma_2; \\
D: \Gamma P; & \quad C_{2x}, \sigma_{ds}, I, T; & \{R_{5}, R_{6}\}: 2; & i \sigma_0, i \sigma_3, -i \sigma_2; \\
& & \{R_{7}, R_{8}\}: 2; & -i \sigma_0, -i \sigma_3, -i \sigma_2; \\
G: \Gamma N; & \quad C_{2b}, \sigma_{ds}, I, T; & \{R_{5}, R_{6}\}: 2; & i \sigma_0, i \sigma_3, -i \sigma_2; \\
& & \{R_{7}, R_{8}\}: 2; & -i \sigma_0, -i \sigma_3, -i \sigma_2; \\
F: \Pi H; & \quad C_{34}^+, \sigma_{ds}, E, I, T; & \{R_{9}, R_{10}\}: 2; & -i \sigma_0, \sqrt{3} \Gamma_3, \sigma_0, -i \sigma_2; \\
& & \{R_{112}\}: 2; & \frac{1}{2} (\sqrt{3} \sigma_2 + i \sigma_0), \sqrt{3} \Gamma_3, \sigma_0, -i \sigma_2; \\
\]
B. The accidental degeneracies on high-symmetry line

1. Notes to Sec. S8 B

(i) For each table in Sec. S8 B, the first line presents the SG number.
(ii) Below the first line, the columns from left to right (separated by the semicolons) are the high-symmetry momentum $k$, the location of $k$, the generating elements of the little group at $k$ (only point-group operators are presented and a full expression of each generating element can be found in Sec. S5), the two distinct coreps (separated by the comma) of the bands forming the accidental degeneracy, the degeneracy of the accidental degeneracy, the matrix representations of the generating elements, the species and the topological charge of the accidental degeneracy.
(iii) We do not list the type II MSGs that do not exhibit symmetry-protected accidental degeneracies on high-symmetry line.

2. SG 1-10
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma_Z; C_2z; \{R_2\}, \{R_4\}; 2; i\sigma_3; C-1 WP; 1 \]

\[ V; BD; C_2z; \{R_2\}, \{R_4\}; 2; i\sigma_3; C-1 WP; 1 \]

\[ W; YC; C_2z; \{R_2\}, \{R_4\}; 2; i\sigma_3; C-1 WP; 1 \]

\[ U; AE; C_2z; \{R_2\}, \{R_4\}; 2; i\sigma_3; C-1 WP; 1 \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma_Z; C_2z; \{R_2\}, \{R_4\}; 2; i\sigma_3; C-1 WP; 1 \]

\[ V; BD; C_2z; \{R_2\}, \{R_4\}; 2; i\sigma_3; C-1 WP; 1 \]

\[ W; YC; C_2z; \{R_2\}, \{R_4\}; 2; i\sigma_3; C-1 WP; 1 \]

\[ U; AE; C_2z; \{R_2\}, \{R_4\}; 2; i\sigma_3; C-1 WP; 1 \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma_Z; C_2z; \{R_2\}, \{R_4\}; 2; i\sigma_3; C-1 WP; 1 \]

\[ U; AM; C_2z; \{R_2\}, \{R_4\}; 2; i\sigma_3; C-1 WP; 1 \]
Accidental degeneracies on high symmetry line

\[ V; BD; C_{2z},RT; \{R_2, R_2\}, \{R_4, R_4\}; 4; i\Gamma_{3,0},-i\Gamma_{0,2}; DP; 0 \]
\[ U; AE; C_{2z},RT; \{R_2, R_2\}, \{R_4, R_4\}; 4; i\Gamma_{3,0},-i\Gamma_{0,2}; DP; 0 \]

Accidental degeneracies on high symmetry line

\[ V; BD; C_{2z},RT; \{R_2, R_2\}, \{R_4, R_4\}; 4; i\Gamma_{3,0},-i\Gamma_{0,2}; DP; 0 \]
\[ U; AE; C_{2z},RT; \{R_2, R_2\}, \{R_4, R_4\}; 4; i\Gamma_{3,0},-i\Gamma_{0,2}; DP; 0 \]

Accidental degeneracies on high symmetry line

\[ U; AM; C_{2z},RT; \{R_2, R_2\}, \{R_4, R_4\}; 4; i\Gamma_{3,0},-i\Gamma_{0,2}; DP; 0 \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ D; XS; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ P; UR; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ B; ZT; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ \Sigma; \Gamma X; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ C; YS; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ E; TR; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ A; ZU; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ \Lambda; \Gamma Z; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ H; YT; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ Q; SR; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
\[ G; XU; C_{2y},TC_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3,\sigma_0; C-1 WP; 1 \]
Accidental degeneracies on high symmetry line

Δ: ΓY; \(C_{2y}, TC_{2x}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
D: XS; \(C_{2y}, TC_{2x}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
Σ: ΓX; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
C: YS; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
Λ: ΓZ; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
H; YT; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
Q; SR; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
G; UX; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1

Accidental degeneracies on high symmetry line

Δ: ΓY; \(C_{2y}, TC_{2x}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
B; ZT; \(C_{2y}, TC_{2x}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
Σ; ΓX; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
Λ; ΓZ; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
Q; SR; \(C_{2x}, TC_{2y}; \{R_2, R_4\}, \{R_4, R_4\} \); 4; \(i\Gamma_3, 0, -i\Gamma_0, 2\); C-2 DP; 2

Accidental degeneracies on high symmetry line

Δ: ΓY; \(C_{2y}, TC_{2x}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
P; UR; \(C_{2y}, E, TC_{2x}; \{R_5, R_5\}, \{R_7, R_7\} \); 4; \(-i\Gamma_3, 0, -\Gamma_0, 0, -i\Gamma_0, 2\); C-2 DP; 2
Σ; ΓX; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
E; TR; \(C_{2x}, E, TC_{2y}; \{R_5, R_5\}, \{R_7, R_7\} \); 4; \(-i\Gamma_3, 0, -\Gamma_0, 0, -i\Gamma_0, 2\); C-2 DP; 2
Λ; ΓZ; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
Q; SR; \(C_{2x}, E, TC_{2y}; \{R_5, R_5\}, \{R_7, R_7\} \); 4; \(i\Gamma_3, 0, -\Gamma_0, 0, -i\Gamma_0, 2\); C-2 DP; 2

Accidental degeneracies on high symmetry line

Δ: ΓZ; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
H; YT; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
D; SR; \(C_{2x}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3\); C-1 WP; 1
Σ; ΓY; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
Δ; ΓΔ; \(C_{2y}, TC_{2x}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
F; YF; \(C_{2y}, TC_{2x}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
C; YC; \(C_{2x}, TC_{2y}; \{R_2\}, \{R_4\} \); 2; \(i\sigma_3, \sigma_0\); C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ H; Y T; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ D; S R; C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3; \quad C-1 \text{ WP}; 1 \]
\[ A; Z T; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ \Sigma; \Gamma Y; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ \Delta; \Gamma \Delta; C_{2y}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ B; Z B; C_{2y}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ G; T G; C_{2y}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ F; Y F; C_{2y}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ E; T E; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ C; Y C; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ G; X G/X Y; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ H; Y H/Y X; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ Q; Z Q; \quad C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ \Sigma; \Gamma X/\Gamma \Sigma; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ C; Y C/Y Z; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ A; Z A/Z Y; C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ U; X U; \quad C_{2z}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ \Delta; \Gamma Y/\Gamma \Delta; C_{2y}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ D; X D/X Z; C_{2y}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ B; Z B/Z X; C_{2y}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
\[ R; Y R; \quad C_{2y}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 \text{ WP}; 1 \]
Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma \Lambda / \Gamma X; C_{2x}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( G; XG; C_{2x}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( P; T W; C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3; C-1 \) WP; 1
\( \Sigma; \Gamma \Sigma / \Gamma X; C_{2x}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( F; X F; C_{2x}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( D; S W; C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3; C-1 \) WP; 1
\( \Delta; \Gamma \Delta / \Gamma X; C_{2y}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( U; X U; C_{2y}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( Q; R W; C_{2y}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3; C-1 \) WP; 1

Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma \Lambda / \Gamma X; C_{2x}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( G; XG; C_{2x}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( P; T W; C_{2x}, \tilde{E}; \{ R_3 \}, \{ R_7 \} ; 2; i \sigma_3, -\sigma_0; C-1 \) WP; 1
\( \Sigma; \Gamma \Sigma / \Gamma X; C_{2x}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( F; X F; C_{2x}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( D; S W; C_{2x}, \tilde{E}; \{ R_3 \}, \{ R_7 \} ; 2; i \sigma_3, -\sigma_0; C-1 \) WP; 1
\( \Delta; \Gamma \Delta / \Gamma X; C_{2y}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( U; X U; C_{2y}, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; C-1 \) WP; 1
\( Q; R W; C_{2y}, \tilde{E}; \{ R_3 \}, \{ R_7 \} ; 2; i \sigma_3, -\sigma_0; C-1 \) WP; 1

Accidental degeneracies on high symmetry line

\( \Delta; \Gamma Y; \sigma_x, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; P-WNL; \\
\( D; X S; \sigma_x, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; P-WNL; \\
\( P; U R; \sigma_x, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; P-WNL; \\
\( B; Z T; \sigma_x, T C_{2x}; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; P-WNL; \\
\( \Sigma; \Gamma X; \sigma_y, T \sigma_x; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; P-WNL; \\
\( C; Y S; \sigma_y, T \sigma_x; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; P-WNL; \\
\( E; T R; \sigma_y, T \sigma_x; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; P-WNL; \\
\( A; Z U; \sigma_y, T \sigma_x; \{ R_2 \}, \{ R_4 \} ; 2; i \sigma_3, \sigma_0; P-WNL; \\
\)
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; \sigma_x, TC_{2z}; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ D; \text{XS}; \sigma_x, TC_{2z}; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ P; \text{UR}; \sigma_x, TC_{2z}; \{ R_2, R_2 \}, \{ R_4, R_4 \}; \quad \text{4}; i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ B; \text{ZT}; \sigma_x, TC_{2z}; \{ R_2, R_2 \}, \{ R_4, R_4 \}; \quad \text{4}; i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ \Sigma; \Gamma X; \sigma_y, T\sigma_x; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ C; \text{YS}; \sigma_y, T\sigma_x; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; \sigma_x, TC_{2z}; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ D; \text{XS}; \sigma_x, TC_{2z}; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \Sigma; \Gamma X; \sigma_y, T\sigma_x; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ C; \text{YS}; \sigma_y, T\sigma_x; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; \sigma_x, TC_{2z}; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ D; \text{XS}; \sigma_x, TC_{2z}; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \Sigma; \Gamma X; \sigma_y, T\sigma_x; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ A; \text{ZU}; \sigma_y, T\sigma_x; \{ R_2 \}, \{ R_4 \}; \quad 2; i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ H; \text{YT}; C_{2z}, \sigma_y; \quad \{ R_5 \}, \{ R_6 \}; \quad 2; -i\sigma_0, i\sigma_3; \quad \text{P-WNL}; \]
\[ \quad \{ R_5 \}, \{ R_7 \}; \quad 2; -i\sigma_0, i\sigma_3; \quad \text{P-WNL}; \]
\[ \quad \{ R_5 \}, \{ R_8 \}; \quad 2; -i\sigma_3, i\sigma_0; \quad \text{P-WNL}; \]
\[ \quad \{ R_6 \}, \{ R_7 \}; \quad 2; -i\sigma_3, -i\sigma_0; \quad \text{P-WNL}; \]
\[ \quad \{ R_6 \}, \{ R_8 \}; \quad 2; -i\sigma_3, -i\sigma_3; \quad \text{P-WNL}; \]
\[ \quad \{ R_7 \}, \{ R_8 \}; \quad 2; \sigma_0, -i\sigma_3; \quad \text{P-WNL}; \]
\[ Q; \text{SR}; C_{2z}, \sigma_y; \quad \{ R_5 \}, \{ R_6 \}; \quad 2; -i\sigma_0, i\sigma_3; \quad \text{P-WNL}; \]
\[ \quad \{ R_5 \}, \{ R_7 \}; \quad 2; -i\sigma_0, i\sigma_3; \quad \text{P-WNL}; \]
\[ \quad \{ R_5 \}, \{ R_8 \}; \quad 2; -i\sigma_3, i\sigma_0; \quad \text{P-WNL}; \]
\[ \quad \{ R_6 \}, \{ R_7 \}; \quad 2; -i\sigma_3, -i\sigma_0; \quad \text{P-WNL}; \]
\[ \quad \{ R_6 \}, \{ R_8 \}; \quad 2; -i\sigma_3, -i\sigma_3; \quad \text{P-WNL}; \]
\[ \quad \{ R_7 \}, \{ R_8 \}; \quad 2; \sigma_0, -i\sigma_3; \quad \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

| Δ: ΓY; σx,TC2z; {R2}, {R4}; 2; iσ3,σ0; | P-WNL; |
| D: XS; σx,TC2z; {R2}, {R4}; 2; iσ3,σ0; | P-WNL; |
| P; UR; σx,TC2z; {R2}, {R4, R4}; 4; iΓ3,0,−iΓ0,2; DP; | 0 |
| B; ZT; σx,TC2z; {R2, R2}, {R4, R4}; 4; iΓ3,0,−iΓ0,2; DP; | 0 |
| Σ; ΓX; σy,Tσx; {R2}; 2; iσ3,σ0; | P-WNL; |
| E; TR; σy,Tσx; {R2, R2}, {R4, R4}; 4; iΓ3,0,−iΓ0,2; DP; | 0 |

| H; YT; C2z,σy; {R5}, {R6}; 2; −iσ0,iσ3; | P-WNLs; |
| {R5}, {R7}; 2; −iσ3,iσ3; | P-WNL; |
| {R5}, {R8}; 2; −iσ3,σ0; | P-WNL; |
| {R6}, {R7}; 2; −iσ3,−σ0; | P-WNL; |
| {R6}, {R8}; 2; −iσ3,−iσ3; | P-WNL; |
| {R7}, {R8}; 2; σ0,−iσ3; | P-WNLs; |

| Q; SR; C2z,σy; {R5}, {R6}; 2; −iσ0,iσ3; | P-WNLs; |
| {R5}, {R7}; 2; −iσ3,iσ3; | P-WNL; |
| {R5}, {R8}; 2; −iσ3,σ0; | P-WNL; |
| {R6}, {R7}; 2; −iσ3,−σ0; | P-WNL; |
| {R6}, {R8}; 2; −iσ3,−iσ3; | P-WNLs; |
| {R7}, {R8}; 2; σ0,−iσ3; | P-WNLs; |
5. SG 31-40

SG 31

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; \sigma_z, TC_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ D; \chi S; \sigma_x, TC_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \Sigma; \Gamma X; \sigma_y, T \sigma_x; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ A; \chi U; \sigma_y, T \sigma_x; \{ R_2 \}, \{ R_4 \}; 4; i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{DP}; 0 \]
\[ H; \chi T; C_{2z}; \sigma_y; \{ R_5 \}, \{ R_6 \}; 2; -i\sigma_0, i\sigma_3; \text{P-WNL}; \]
\[ \{ R_5 \}, \{ R_7 \}; 2; -i\sigma_3, i\sigma_3; \text{P-WNL}; \]
\[ \{ R_6 \}, \{ R_7 \}; 2; -i\sigma_3, -i\sigma_0; \text{P-WNL}; \]
\[ \{ R_6 \}, \{ R_8 \}; 2; -i\sigma_3, -i\sigma_3; \text{P-WNL}; \]
\[ \{ R_7 \}, \{ R_8 \}; 2; i\sigma_0, -i\sigma_3; \text{P-WNL}; \]
\[ Q; \chi R; C_{2z}; \sigma_y; \{ R_5 \}, \{ R_6 \}; 2; -i\sigma_0, i\sigma_3; \text{P-WNL}; \]
\[ \{ R_5 \}, \{ R_7 \}; 2; -i\sigma_3, i\sigma_3; \text{P-WNL}; \]
\[ \{ R_5 \}, \{ R_8 \}; 2; -i\sigma_3, i\sigma_0; \text{P-WNL}; \]
\[ \{ R_6 \}, \{ R_7 \}; 2; -i\sigma_3, -i\sigma_0; \text{P-WNL}; \]
\[ \{ R_6 \}, \{ R_8 \}; 2; -i\sigma_3, -i\sigma_3; \text{P-WNL}; \]
\[ \{ R_7 \}, \{ R_8 \}; 2; i\sigma_0, -i\sigma_3; \text{P-WNL}; \]

SG 32

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma Y; \sigma_z, TC_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ B; \chi T; \sigma_z, TC_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \Sigma; \Gamma X; \sigma_y, T \sigma_x; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ A; \chi U; \sigma_y, T \sigma_x; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ H; \chi T; C_{2z}; \sigma_y; \{ R_5 \}, \{ R_6 \}; 2; -i\sigma_0, i\sigma_3; \text{P-WNL}; \]
\[ \{ R_5 \}, \{ R_7 \}; 2; -i\sigma_3, i\sigma_3; \text{P-WNL}; \]
\[ \{ R_6 \}, \{ R_7 \}; 2; -i\sigma_3, -i\sigma_0; \text{P-WNL}; \]
\[ \{ R_6 \}, \{ R_8 \}; 2; -i\sigma_3, -i\sigma_3; \text{P-WNL}; \]
\[ \{ R_7 \}, \{ R_8 \}; 2; i\sigma_0, -i\sigma_3; \text{P-WNL}; \]
\[ G; \chi U; C_{2z}; \sigma_y; \{ R_5 \}, \{ R_6 \}; 2; -i\sigma_0, i\sigma_3; \text{P-WNL}; \]
\[ \{ R_5 \}, \{ R_7 \}; 2; -i\sigma_3, i\sigma_3; \text{P-WNL}; \]
\[ \{ R_5 \}, \{ R_8 \}; 2; -i\sigma_3, i\sigma_0; \text{P-WNL}; \]
\[ \{ R_6 \}, \{ R_7 \}; 2; -i\sigma_3, -i\sigma_0; \text{P-WNL}; \]
\[ \{ R_6 \}, \{ R_8 \}; 2; -i\sigma_3, -i\sigma_3; \text{P-WNL}; \]
\[ \{ R_7 \}, \{ R_8 \}; 2; i\sigma_0, -i\sigma_3; \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

| Symmetry | Operation | Space Group | Components | Degeneracy |
|----------|-----------|-------------|------------|------------|
| Δ | ΓY; σzTC2z; \( \{R_2\}, \{R_4\} \) | 2; \( i\sigma_3,\sigma_0 \) | P-WNL; |
| B | ZT; σzTC2z; \( \{R_2, R_2\}, \{R_3, R_4\} \) | 4; \( i\Gamma_{3,0}, -i\Gamma_{0,2} \) | DP; 0 |
| Σ | ΓX; σzTC2z; \( \{R_2\}, \{R_4\} \) | 2; \( i\sigma_3,\sigma_0 \) | P-WNL; |
| E | TR; σyTσz; \( \{R_2, R_2\}, \{R_3, R_4\} \) | 4; \( i\Gamma_{3,0}, -i\Gamma_{0,2} \) | DP; 0 |
| H | YT; C2z,σy; \( \{R_2\}, \{R_6\} \) | 2; \(-i\sigma_0, i\sigma_3 \) | P-WNLs; |
| | \( \{R_5\}, \{R_7\} \) | 2; \(-i\sigma_3, i\sigma_3 \) | P-WNLs; |
| | \( \{R_5\}, \{R_8\} \) | 2; \(-i\sigma_3, i\sigma_0 \) | P-WNLs; |
| | \( \{R_6\}, \{R_7\} \) | 2; \(-i\sigma_3, -i\sigma_0 \) | P-WNLs; |
| | \( \{R_6\}, \{R_8\} \) | 2; \(-i\sigma_3, -i\sigma_3 \) | P-WNLs; |
| G | XU; C2z,σy; \( \{R_5\}, \{R_6\} \) | 2; \(-i\sigma_0, i\sigma_3 \) | P-WNLs; |
| | \( \{R_5\}, \{R_7\} \) | 2; \(-i\sigma_3, i\sigma_3 \) | P-WNLs; |
| | \( \{R_5\}, \{R_8\} \) | 2; \(-i\sigma_3, i\sigma_0 \) | P-WNLs; |
| | \( \{R_6\}, \{R_7\} \) | 2; \(-i\sigma_3, -i\sigma_0 \) | P-WNLs; |
| | \( \{R_6\}, \{R_8\} \) | 2; \(-i\sigma_3, -i\sigma_3 \) | P-WNLs; |
| | \( \{R_7\}, \{R_8\} \) | 2; \( i\sigma_0, -i\sigma_3 \) | P-WNLs; |
Accidental degeneracies on high symmetry line

\[ D: SR; C_{2z}; \{R_2\},\{R_4\}; 2; i\sigma_3; \ C-1 \ WP; 1 \]
\[ A; ZT; \sigma_y,T\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ \Sigma; \Gamma Y; \sigma_y,T\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ \Delta; \Gamma\Delta; \sigma_z,TC_{2z}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ B; ZB; \sigma_z,TC_{22}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ G; TG; \sigma_z,TC_{22}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ F; YF; \sigma_z,TC_{22}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ E; TE; \sigma_y,T\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ C; YC; \sigma_y,T\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]

Accidental degeneracies on high symmetry line

\[ D: SR; C_{2z}; \{R_2\},\{R_4\}; 2; i\sigma_3; \ C-1 \ WP; 1 \]
\[ A; ZT; \sigma_y,T\sigma_z; \{R_2\},\{R_4\}; 2; i\Gamma_{3,0},-i\Gamma_{0,2}; DP; 0 \]
\[ \Sigma; \Gamma Y; \sigma_y,T\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \]
\[ \Delta; \Gamma\Delta; \sigma_z,TC_{2z}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \]
\[ F; YF; \sigma_z,TC_{22}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \]
\[ E; TE; \sigma_y,T\sigma_z; \{R_2\},\{R_4\}; 2; i\Gamma_{3,0},-i\Gamma_{0,2}; DP; 0 \]
\[ C; YC; \sigma_y,T\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \]

Accidental degeneracies on high symmetry line

\[ D: SR; C_{2z}; \{R_2\},\{R_4\}; 2; i\sigma_3; \ C-1 \ WP; 1 \]
\[ \Sigma; \Gamma Y; \sigma_y,T\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \]
\[ \Delta; \Gamma\Delta; \sigma_z,TC_{2z}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \]
\[ F; YF; \sigma_z,TC_{22}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \]
\[ C; YC; \sigma_y,T\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; \sigma_z,TS\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ H; YT; \sigma_z,TS\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ A; ZT; \sigma_z,TS\sigma_z; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ \Sigma; \Gamma Y; \sigma_z,TC_{2y}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ E; TE; \sigma_z,TC_{2y}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
\[ C; YC; \sigma_z,TC_{2y}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; P-WNL; \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; \sigma_z, T \sigma_z; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL; \]
\[ H; YT; \sigma_z, T \sigma_z; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL; \]
\[ \Lambda; \Omega T; \sigma_x, T \sigma_z; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL; \]
\[ \Sigma; \Gamma Y; \sigma_z, T C_{2y}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL; \]
\[ E; \Gamma E; \sigma_z, T C_{2y}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL; \]
\[ C; YC; \sigma_z, T C_{2y}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; \sigma_z, T \sigma_z; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL; \]
\[ H; YT; \sigma_z, T \sigma_z; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL; \]
\[ \Sigma; \Gamma Y; \sigma_z, T C_{2y}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL; \]
\[ B; ZB; \sigma_x, C_{2y}; \{R_5\}, \{R_6\}; 2; i\sigma_0, i\sigma_3; P-WNLs; \]
\[ \{R_5\}, \{R_7\}; 2; i\sigma_3, i\sigma_3; P-WNLs; \]
\[ \{R_5\}, \{R_8\}; 2; i\sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_6\}, \{R_7\}; 2; i\sigma_3, -i\sigma_0; P-WNLs; \]
\[ \{R_6\}, \{R_8\}; 2; i\sigma_3, -i\sigma_3; P-WNLs; \]
\[ \{R_7\}, \{R_8\}; 2; -i\sigma_0, -i\sigma_3; P-WNLs; \]
\[ G; TG; \sigma_z, C_{2y}; \{R_5\}, \{R_6\}; 2; i\sigma_0, i\sigma_3; P-WNLs; \]
\[ \{R_5\}, \{R_7\}; 2; i\sigma_3, i\sigma_3; P-WNLs; \]
\[ \{R_5\}, \{R_8\}; 2; i\sigma_3, \sigma_0; P-WNLs; \]
\[ \{R_6\}, \{R_7\}; 2; i\sigma_3, -i\sigma_0; P-WNLs; \]
\[ \{R_6\}, \{R_8\}; 2; i\sigma_3, -i\sigma_3; P-WNLs; \]
\[ \{R_7\}, \{R_8\}; 2; -i\sigma_0, -i\sigma_3; P-WNLs; \]
\[ C; YC; \sigma_z, T C_{2y}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL; \]
Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma Z; \sigma_x T \sigma_z; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

\( \Pi; \Gamma T; \sigma_x T \sigma_z; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

\( \Sigma; \Gamma Y; \sigma_x T C_{2y}; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

\( B; ZB; \sigma_x C_{2y}; \{R_5\}, \{R_6\}; 2; i \sigma_0, i \sigma_3; P-WNL; \)

\( \{R_5\}, \{R_7\}; 2; i \sigma_3, i \sigma_3; P-WNL; \)

\( \{R_5\}, \{R_8\}; 2; i \sigma_3, i \sigma_0; P-WNLs; \)

\( \{R_6\}, \{R_7\}; 2; i \sigma_3, -i \sigma_0; P-WNLs; \)

\( \{R_6\}, \{R_8\}; 2; i \sigma_3, -i \sigma_3; P-WNL; \)

\( \{R_7\}, \{R_8\}; 2; -i \sigma_0, -i \sigma_3; P-WNL; \)

\( G; TG; \sigma_x C_{2y}; \{R_5\}, \{R_6\}; 2; i \sigma_0, i \sigma_3; P-WNL; \)

\( \{R_5\}, \{R_7\}; 2; i \sigma_3, i \sigma_3; P-WNL; \)

\( \{R_5\}, \{R_8\}; 2; i \sigma_3, i \sigma_0; P-WNLs; \)

\( \{R_6\}, \{R_7\}; 2; i \sigma_3, -i \sigma_0; P-WNLs; \)

\( \{R_6\}, \{R_8\}; 2; i \sigma_3, -i \sigma_3; P-WNL; \)

\( \{R_7\}, \{R_8\}; 2; -i \sigma_0, -i \sigma_3; P-WNL; \)

\( C; YC; \sigma_x T C_{2y}; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

Accidental degeneracies on high symmetry line

\( \Sigma; \Gamma X/\Sigma; \sigma_y T \sigma_x; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

\( C; YC/YZ; \sigma_y T \sigma_x; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

\( A; ZA/ZY; \sigma_y T \sigma_x; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

\( U; XU; \sigma_y T \sigma_x; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

\( \Delta; \Gamma Y/\Gamma \Delta; \sigma_x T C_{2x}; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

\( D; XD/XZ; \sigma_x T C_{2x}; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

\( B; ZB/ZX; \sigma_x T C_{2x}; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)

\( R; YR; \sigma_x T C_{2x}; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; P-WNL; \)
Accidental degeneracies on high symmetry line

\[ G; \text{XG/XY; } C_{2z}, \sigma_y; \{R_5, R_6\}; 2; i\sigma_0, \sigma_3; \text{ P-WNLs;} \]
\[ \{R_5, R_7\}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ H; \text{YH/YX; } C_{2z}, \sigma_y; \{R_5, R_6\}; 2; i\sigma_0, \sigma_3; \text{ P-WNLs;} \]
\[ \{R_5, R_7\}; 2; \sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \Sigma; \Gamma X/\Gamma \Sigma; \sigma_y, \Gamma \sigma_x; \{R_2, R_3\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \Upsilon; \text{UH/UY; } \sigma_y, \Gamma \sigma_x; \{R_2, R_3\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \Delta; \Gamma \Delta/\Gamma \Delta; \sigma_x, \Gamma C_{2z}; \{R_2, R_3\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \Upsilon; \text{UH/UY; } \sigma_x, \Gamma C_{2z}; \{R_2, R_3\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]

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Accidental degeneracies on high symmetry line

\[ P; \text{TW; } C_{2z}; \{R_2, R_4\}; 2; i\sigma_3; \text{ C-1 WP; 1} \]
\[ \Sigma; \Gamma \Sigma/\Gamma X; \sigma_y, \Gamma \sigma_x; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ F; \text{XF; } \sigma_y, \Gamma \sigma_x; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \Delta; \Gamma \Delta/\Gamma X; \sigma_x, \Gamma C_{2z}; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \Upsilon; \text{UH/UY; } \sigma_x, \Gamma C_{2z}; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]

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Accidental degeneracies on high symmetry line

\[ P; \text{TW; } C_{2z}; \{R_2, R_4\}; 2; i\sigma_3; \text{ C-1 WP; 1} \]
\[ \Sigma; \Gamma \Sigma/\Gamma X; \sigma_y, \Gamma \sigma_x; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ F; \text{XF; } \sigma_y, \Gamma \sigma_x; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \Delta; \Gamma \Delta/\Gamma X; \sigma_x, \Gamma C_{2z}; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]
\[ \Upsilon; \text{UH/UY; } \sigma_x, \Gamma C_{2z}; \{R_2, R_4\}; 2; i\sigma_3, \sigma_0; \text{ P-WNL;} \]
Accidental degeneracies on high symmetry line

\[ P; \text{TW}; \quad C_{2z}; \quad \{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3; \quad \text{C-1 WP}; \quad 1 \]
\[ \Sigma; \quad \Gamma\Sigma/\Gamma X; \quad \sigma_y, T\sigma_z; \quad \{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ F; \quad \text{XF}; \quad \sigma_y, T\sigma_z; \quad \{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ \Delta; \quad \Gamma\Delta/\Gamma X; \quad \sigma_z, T C_{2z}; \quad \{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]
\[ U; \quad \text{XU}; \quad \sigma_z, T C_{2z}; \quad \{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3, \sigma_0; \quad \text{P-WNL}; \]

Accidental degeneracies on high symmetry line

\[ D; \quad \text{XS}; \quad \sigma_z, C_{2y}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ B; \quad \text{ZT}; \quad \sigma_z, C_{2y}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ C; \quad \text{YS}; \quad \sigma_y, C_{2x}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad -i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ A; \quad \text{ZU}; \quad \sigma_z, \sigma_y, IT; \quad \{R_5, R_7\}, \{R_6, R_8\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ H; \quad \text{YT}; \quad \sigma_y, C_{2z}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad -i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ G; \quad \text{XU}; \quad \sigma_z, C_{2x}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]

Accidental degeneracies on high symmetry line

\[ P; \quad \text{UR}; \quad \sigma_z, C_{2y}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ B; \quad \text{ZT}; \quad \sigma_z, C_{2y}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ E; \quad \text{TR}; \quad \sigma_z, \sigma_y, IT; \quad \{R_5, R_7\}, \{R_6, R_8\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ A; \quad \text{ZU}; \quad \sigma_z, \sigma_y, IT; \quad \{R_5, R_7\}, \{R_6, R_8\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]

Accidental degeneracies on high symmetry line

\[ D; \quad \text{XS}; \quad \sigma_z, C_{2y}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ P; \quad \text{UR}; \quad \sigma_z, C_{2y}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ C; \quad \text{YS}; \quad \sigma_y, C_{2x}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad -i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ E; \quad \text{TR}; \quad \sigma_y, C_{2z}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad -i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ H; \quad \text{YT}; \quad \sigma_y, C_{2z}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad -i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
\[ G; \quad \text{XU}; \quad \sigma_z, C_{2x}, IT; \quad \{R_5, R_8\}, \{R_6, R_7\}; \quad 4; \quad i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP}; \quad 0 \]
SG 51

Accidental degeneracies on high symmetry line

\[ P; \text{UR}; \sigma_z, C_{2y}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_3,0, i\Gamma_3,3, -i\Gamma_0,2; \text{P-DNL}; \]
\[ B; \text{ZT}; \sigma_z, C_{2y}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_3,0, i\Gamma_3,3, -i\Gamma_0,2; \text{P-DNL}; \]

SG 52

Accidental degeneracies on high symmetry line

\[ D; \text{XS}; \sigma_z, C_{2y}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_3,0, i\Gamma_3,3, -i\Gamma_0,2; \text{DP}; 0 \]
\[ B; \text{ZT}; \sigma_z, C_{2y}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_3,0, i\Gamma_3,3, -i\Gamma_0,2; \text{P-DNL}; \]
\[ C; \text{YS}; \sigma_y, C_{2z}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; -i\Gamma_0,3, i\Gamma_3,3, -i\Gamma_0,2; \text{DP}; 0 \]
\[ E; \text{TR}; \sigma_y, \sigma_x, \bar{E}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_0,3, -i\Gamma_3,0, -i\Gamma_0,2; \text{P-DNL}; \]
\[ H; \text{YT}; \sigma_y, C_{2z}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; -i\Gamma_0,3, i\Gamma_3,0, -i\Gamma_0,2; \text{DP}; 0 \]
\[ G; \text{XU}; \sigma_z, C_{2z}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_0,3, i\Gamma_3,0, -i\Gamma_0,2; \text{DP}; 0 \]

SG 53

Accidental degeneracies on high symmetry line

\[ P; \text{UR}; \sigma_z, C_{2y}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_3,0, i\Gamma_3,3, -i\Gamma_0,2; \text{P-DNL}; \]
\[ B; \text{ZT}; \sigma_z, C_{2y}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_3,0, i\Gamma_3,3, -i\Gamma_0,2; \text{P-DNL}; \]
\[ C; \text{YS}; \sigma_y, C_{2z}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; -i\Gamma_0,3, i\Gamma_3,3, -i\Gamma_0,2; \text{DP}; 0 \]
\[ E; \text{TR}; \sigma_y, C_{2z}, \bar{E}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_0,3, -i\Gamma_3,3, -i\Gamma_0,2; \text{P-DNL}; \]
\[ H; \text{YT}; \sigma_y, C_{2z}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; -i\Gamma_0,3, i\Gamma_3,0, -i\Gamma_0,2; \text{DP}; 0 \]
\[ Q; \text{SR}; \sigma_y, C_{2z}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; -i\Gamma_0,3, i\Gamma_3,0, -i\Gamma_0,2; \text{DP}; 0 \]

SG 54

Accidental degeneracies on high symmetry line

\[ D; \text{XS}; \sigma_z, C_{2y}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_3,0, i\Gamma_3,0, -i\Gamma_0,2; \text{DP}; 0 \]
\[ B; \text{ZT}; \sigma_z, C_{2y}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_3,0, i\Gamma_3,3, -i\Gamma_0,2; \text{P-DNL}; \]
\[ Q; \text{SR}; \sigma_z, C_{2z}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_0,3, i\Gamma_3,0, -i\Gamma_0,2; \text{DP}; 0 \]
\[ G; \text{XU}; \sigma_z, C_{2z}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_0,3, i\Gamma_3,0, -i\Gamma_0,2; \text{DP}; 0 \]

SG 55

Accidental degeneracies on high symmetry line

\[ H; \text{YT}; \sigma_y, C_{2z}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; -i\Gamma_3,0, i\Gamma_3,3, -i\Gamma_0,2; \text{P-DNL}; \]
\[ G; \text{XU}; \sigma_z, C_{2z}, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_3,0, i\Gamma_3,3, -i\Gamma_0,2; \text{P-DNL}; \]
SG 56

Accidental degeneracies on high symmetry line

D: XS; \(C_{2y}, \sigma_x, IT; \), \(\{R_5, R_8\}, \{R_6, R_7\} : 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) P-DNL;
B: ZT; \(\sigma_z, C_{2y}, IT; \), \(\{R_5, R_8\}, \{R_6, R_7\} : 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) DP; 0
C: YS; \(C_{2x}, \sigma_z, IT; \), \(\{R_5, R_7\}, \{R_6, R_8\} : 4; -i\Gamma_{0,3}, -\Gamma_{3,3}, -i\Gamma_{0,2}; \) P-DNL;
A: ZU; \(\sigma_z, \sigma_y, IT; \), \(\{R_5, R_7\}, \{R_6, R_8\} : 4; i\Gamma_{0,3}, \Gamma_{3,3}, -i\Gamma_{0,2}; \) DP; 0

SG 57

Accidental degeneracies on high symmetry line

D: XS; \(C_{2y}, \sigma_x, IT; \), \(\{R_5, R_8\}, \{R_6, R_7\} : 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) P-DNL;
H: YT; \(\sigma_y, C_{2x}, IT; \), \(\{R_5, R_6\}, \{R_7, R_8\} : 4; -i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) P-DNL;
Q: SR; \(\sigma_y, C_{2x}, IT; \), \(\{R_5, R_6\}, \{R_6, R_7\} : 4; -i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) P-DNL;
\{R_5, R_6\}, \{R_5, R_7\} : 4; -i\Gamma_{0,3}, i\Gamma_{0,0}, -i\Gamma_{0,2}; \) P-DNL;
\{R_6, R_7\}, \{R_7, R_8\} : 4; -i\Gamma_{0,0}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) P-DNL;
\{R_6, R_8\}, \{R_6, R_9\} : 4; -i\Gamma_{0,0}, -i\Gamma_{3,0}, -i\Gamma_{0,2}; \) P-DNL;
\{R_7, R_8\}, \{R_7, R_9\} : 4; -i\Gamma_{0,0}, -i\Gamma_{3,0}, -i\Gamma_{0,2}; \) P-DNL;

SG 58

Accidental degeneracies on high symmetry line

P: UR; \(C_{2y}, \sigma_x, \bar{E}, IT; \), \(\{R_5, R_6\}, \{R_7, R_9\} : 4; -i\Gamma_{0,3}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \) P-DNL;
B: ZT; \(\sigma_z, C_{2y}, IT; \), \(\{R_5, R_6\}, \{R_6, R_7\} : 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) DP; 0
E: TR; \(C_{2x}, \sigma_z, IT; \), \(\{R_5, R_6\}, \{R_7, R_8\} : 4; i\Gamma_{0,3}, -i\Gamma_{3,3}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \) P-DNL;
A: ZU; \(\sigma_z, \sigma_y, IT; \), \(\{R_5, R_7\}, \{R_6, R_8\} : 4; i\Gamma_{0,3}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \) DP; 0
H: YT; \(\sigma_y, C_{2x}, IT; \), \(\{R_5, R_6\}, \{R_7, R_8\} : 4; -i\Gamma_{0,3}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \) P-DNL;
G: XU; \(\sigma_z, C_{2x}, IT; \), \(\{R_5, R_6\}, \{R_7, R_8\} : 4; i\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \) P-DNL;

SG 59

Accidental degeneracies on high symmetry line

D: XS; \(C_{2y}, \sigma_x, IT; \), \(\{R_5, R_8\}, \{R_6, R_7\} : 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) P-DNL;
B: ZT; \(\sigma_z, C_{2y}, IT; \), \(\{R_5, R_6\}, \{R_6, R_7\} : 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) P-DNL;
C: YS; \(C_{2x}, \sigma_z, IT; \), \(\{R_5, R_7\}, \{R_6, R_8\} : 4; -i\Gamma_{0,3}, -\Gamma_{3,3}, -i\Gamma_{0,2}; \) P-DNL;
A: TR; \(C_{2x}, \sigma_z, IT; \), \(\{R_5, R_6\}, \{R_7, R_8\} : 4; -\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \) DP; 0
Accidental degeneracies on high symmetry line

\[ P; \text{UR}; C_{2y},\sigma_x,\bar{E},\text{IT}; \{R_6, R_8\}, \{R_7, R_9\}; 4; -i\Gamma_{0.3}, -i\Gamma_{3.0}, -\Gamma_{0.0}, -i\Gamma_{0.2}; \text{P-DNL}; \]
\[ B; \text{ZT}; \sigma_z, C_{2y}, \text{IT}; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0.3}, i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{DP}; 0 \]
\[ C; \text{YS}; C_{2x}, \sigma_z, \text{IT}; \{R_5, R_7\}, \{R_6, R_8\}; 4; -i\Gamma_{0.3}, -i\Gamma_{3.3}, -i\Gamma_{0.2}; \text{P-DNL}; \]
\[ A; \text{ZU}; \sigma_x, \sigma_y, \text{IT}; \{R_5, R_7\}, \{R_6, R_8\}; 4; i\Gamma_{0.3}, i\Gamma_{3.3}, -i\Gamma_{0.2}; \text{DP}; 0 \]
\[ Q; \text{SR}; \sigma_x, C_{2x}, \text{IT}; \{R_5, R_6\}, \{R_7, R_8\}; 4; i\Gamma_{0.0}, i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{P-DNL}; \]
\[ \{R_5, R_5\}, \{R_8, R_8\}; 4; i\Gamma_{3.0}, i\Gamma_{0.0}, -i\Gamma_{0.2}; \text{P-DNL}; \]
\[ \{R_6, R_6\}, \{R_7, R_7\}; 4; i\Gamma_{3.0}, -i\Gamma_{0.0}, -i\Gamma_{0.2}; \text{P-DNL}; \]
\[ \{R_7, R_7\}, \{R_8, R_8\}; 4; -i\Gamma_{0.0}, -i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{P-DNL}; \]
\[ G; \text{XU}; \sigma_x, C_{2x}, \text{IT}; \{R_5, R_6\}, \{R_7, R_8\}; 4; i\Gamma_{3.0}, i\Gamma_{3.3}, -i\Gamma_{0.2}; \text{P-DNL}; \]
Accidental degeneracies on high symmetry line

8. SG 61-70

SG 61

Accidental degeneracies on high symmetry line

\[ P; \text{UR}; C_{2y,\sigma_y, E, IT}; \{R_6, R_6\}, \{R_7, R_7\}; 4; -i\Gamma_{0,0}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNLs}; \]
\[ \{R_6, R_6\}, \{R_8, R_8\}; 4; -i\Gamma_{3,0}, -i\Gamma_{0,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_7, R_7\}, \{R_8, R_8\}; 4; -i\Gamma_{3,0}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_7, R_7\}, \{R_9, R_9\}; 4; -i\Gamma_{3,0}, -i\Gamma_{0,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_8, R_8\}, \{R_9, R_9\}; 4; i\Gamma_{0,0}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNLs}; \]
\[ B; \text{ZT}; \sigma_y, C_{2y, IT}; \{R_0, R_0\}, \{R_7, R_7\}; 4; i\Gamma_{3,0}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ C; \text{YS}; \sigma_y, C_{2x, IT}; \{R_0, R_0\}, \{R_7, R_7\}; 4; -i\Gamma_{3,0}, -i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ E; \text{TR}; C_{2x,\sigma_x, E, IT}; \{R_0, R_0\}, \{R_7, R_7\}; 4; -i\Gamma_{0,0}, \Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNLs}; \]
\[ \{R_6, R_6\}, \{R_8, R_8\}; 4; -i\Gamma_{3,0}, -\Gamma_{0,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_7, R_7\}, \{R_8, R_8\}; 4; -i\Gamma_{3,0}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_7, R_7\}, \{R_9, R_9\}; 4; -i\Gamma_{3,0}, -\Gamma_{0,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_8, R_8\}, \{R_9, R_9\}; 4; i\Gamma_{0,0}, \Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNLs}; \]
\[ Q; \text{SR}; C_{2z,\sigma_y, E, IT}; \{R_0, R_0\}, \{R_7, R_7\}; 4; i\Gamma_{0,0}, \Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNLs}; \]
\[ \{R_6, R_6\}, \{R_8, R_8\}; 4; i\Gamma_{3,0}, -\Gamma_{0,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_9, R_9\}; \{R_6, R_6\}, \{R_8, R_8\}; 4; -i\Gamma_{0,0}, \Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_7, R_7\}, \{R_8, R_8\}; 4; -i\Gamma_{3,0}, -\Gamma_{0,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_7, R_7\}, \{R_9, R_9\}; 4; -i\Gamma_{3,0}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_8, R_8\}, \{R_9, R_9\}; 4; i\Gamma_{0,0}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNLs}; \]

SG 62

Accidental degeneracies on high symmetry line

\[ D; \text{XS}; C_{2y,\sigma_y, IT}; \{R_5, R_5\}, \{R_6, R_6\}; 4; i\Gamma_{0,0}, \Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ B; \text{ZT}; \sigma_y, C_{2y, IT}; \{R_0, R_0\}, \{R_7, R_7\}; 4; i\Gamma_{3,0}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ H; \text{YT}; C_{2z,\sigma_y, IT}; \{R_5, R_5\}, \{R_6, R_6\}; 4; -i\Gamma_{0,0}, \Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ Q; \text{SR}; C_{2z,\sigma_y, IT}; \{R_5, R_5\}, \{R_6, R_6\}; 4; -i\Gamma_{0,0}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNLs}; \]
\[ \{R_6, R_6\}, \{R_7, R_7\}; 4; -i\Gamma_{3,0}, -i\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_7, R_7\}, \{R_8, R_8\}; 4; -i\Gamma_{3,0}, -i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
\[ \{R_8, R_8\}, \{R_9, R_9\}; 4; i\Gamma_{0,0}, -i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNLs}; \]
Accidental degeneracies on high symmetry line

A; ZT; \( \sigma_z, \sigma_y, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \) P-DNL;
E; TE; \( \sigma_z, \sigma_y, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \) P-DNL;

SG 64

Accidental degeneracies on high symmetry line

D; SR; \( C_{2z, IT}; \{ R_2, R_2 \}, \{ R_4, R_4 \}; 4; i\Gamma_{3,0}, -i\Gamma_{0,2}; \) DP; 0
A; ZT; \( \sigma_z, \sigma_y, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_{3,0}, \Gamma_{3,3}, -i\Gamma_{0,2}; \) P-DNL;
E; TE; \( \sigma_z, \sigma_y, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; 4; i\Gamma_{3,0}, \Gamma_{3,3}, -i\Gamma_{0,2}; \) P-DNL;

SG 65

Accidental degeneracies on high symmetry line

SG 66

Accidental degeneracies on high symmetry line

A; ZT; \( \sigma_z, \sigma_y, IT; \{ R_5, R_7 \}, \{ R_6, R_8 \}; 4; i\Gamma_{0,3}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \) DP; 0
B; ZB; \( \sigma_z, C_{2y}, IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) DP; 0
G; TG; \( \sigma_z, C_{2y}, IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) DP; 0
E; TE; \( \sigma_z, \sigma_y, IT; \{ R_5, R_7 \}, \{ R_6, R_8 \}; 4; i\Gamma_{0,3}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \) DP; 0

SG 67

Accidental degeneracies on high symmetry line

D; SR; \( C_{2z, IT}; \{ R_2, R_2 \}, \{ R_4, R_4 \}; 4; i\Gamma_{3,0}, -i\Gamma_{0,2}; \) DP; 0

SG 68

Accidental degeneracies on high symmetry line

D; SR; \( C_{2z, IT}; \{ R_2, R_2 \}, \{ R_4, R_4 \}; 4; i\Gamma_{3,0}, -i\Gamma_{0,2}; \) DP; 0
A; ZT; \( \sigma_z, \sigma_y, IT; \{ R_5, R_7 \}, \{ R_6, R_8 \}; 4; i\Gamma_{0,3}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \) DP; 0
B; ZB; \( \sigma_z, C_{2y}, IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) DP; 0
G; TG; \( \sigma_z, C_{2y}, IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \) DP; 0
E; TE; \( \sigma_z, \sigma_y, IT; \{ R_5, R_7 \}, \{ R_6, R_8 \}; 4; i\Gamma_{0,3}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \) DP; 0

SG 69

Accidental degeneracies on high symmetry line
Accidental degeneracies on high symmetry line

\( G; \text{XG/XY}; \sigma_x, C_2z, I_T; \{ R_5, R_8 \}, \{ R_6, R_7 \}; 4; i\Gamma_{0.3}, i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{DP}; 0 \)

\( H; \text{YH/YX}; \sigma_y, C_2z, I_T; \{ R_5, R_8 \}, \{ R_6, R_7 \}; 4; -i\Gamma_{0.3}, i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{DP}; 0 \)

\( C; \text{YC/YZ}; \sigma_y, C_2x, I_T; \{ R_5, R_8 \}, \{ R_6, R_7 \}; 4; -i\Gamma_{0.3}, i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{DP}; 0 \)

\( A; \text{ZA/ZY}; \sigma_z, \sigma_y, I_T; \{ R_5, R_7 \}, \{ R_6, R_8 \}; 4; i\Gamma_{0.3}, \Gamma_{3.3}, -i\Gamma_{0.2}; \text{DP}; 0 \)

\( D; \text{XD/XZ}; \sigma_x, C_2y, I_T; \{ R_5, R_8 \}, \{ R_6, R_7 \}; 4; i\Gamma_{0.3}, i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{DP}; 0 \)

\( B; \text{ZB/ZX}; \sigma_z, C_2y, I_T; \{ R_5, R_8 \}, \{ R_6, R_7 \}; 4; i\Gamma_{0.3}, i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{DP}; 0 \)
Accidental degeneracies on high symmetry line

\[ D; \text{SW}; C_{2x}, \tilde{E}, IT; \{ R_2, R_2 \}, \{ R_4, R_4 \}; 4; i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]
\[ Q; \text{RW}; C_{2y}, \tilde{E}, IT; \{ R_2, R_2 \}, \{ R_4, R_4 \}; 4; i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]

Accidental degeneracies on high symmetry line

\[ P; \text{TW}; C_{2x}, \tilde{E}, IT; \{ R_5, R_5 \}, \{ R_{7}, R_{7} \}; 4; -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]
\[ D; \text{SW}; C_{2x}, \tilde{E}, IT; \{ R_5, R_5 \}, \{ R_{7}, R_{7} \}; 4; i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]
\[ Q; \text{RW}; C_{2y}, \tilde{E}, IT; \{ R_5, R_5 \}, \{ R_{7}, R_{7} \}; 4; -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]

Accidental degeneracies on high symmetry line

\[ P; \text{TW}; C_{2x}, \tilde{E}, IT; \{ R_5, R_5 \}, \{ R_{7}, R_{7} \}; 4; -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; C_{4x}^{+}; \{ R_2 \}, \{ R_4 \}; 2; \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}; \text{C-1 WP}; 1 \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \sqrt{-1}\sigma_3; \text{C-2 WP}; 2 \]
\[ \{ R_2 \}, \{ R_8 \}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}; \text{C-1 WP}; 1 \]
\[ \{ R_4 \}, \{ R_6 \}; 2; -\frac{\sigma_3 - i\sigma_0}{\sqrt{2}}; \text{C-1 WP}; 1 \]
\[ \{ R_4 \}, \{ R_8 \}; 2; (-1)^{3/4}\sigma_3; \text{C-2 WP}; 2 \]
\[ \{ R_6 \}, \{ R_8 \}; 2; -\frac{\sigma_3 - i\sigma_0}{\sqrt{2}}; \text{C-1 WP}; 1 \]

\[ V; \text{MA}; C_{4x}^{+}; \{ R_2 \}, \{ R_4 \}; 2; \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}; \text{C-1 WP}; 1 \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \sqrt{-1}\sigma_3; \text{C-2 WP}; 2 \]
\[ \{ R_2 \}, \{ R_8 \}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}; \text{C-1 WP}; 1 \]
\[ \{ R_4 \}, \{ R_6 \}; 2; -\frac{\sigma_3 - i\sigma_0}{\sqrt{2}}; \text{C-1 WP}; 1 \]
\[ \{ R_4 \}, \{ R_8 \}; 2; (-1)^{3/4}\sigma_3; \text{C-2 WP}; 2 \]
\[ \{ R_6 \}, \{ R_8 \}; 2; -\frac{\sigma_3 - i\sigma_0}{\sqrt{2}}; \text{C-1 WP}; 1 \]

\[ W; \text{XR}; C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \text{C-1 WP}; 1 \]
Accidental degeneracies on high symmetry line

\( \Lambda; \ \Gamma Z; \ C_{4z}^+; \ \{R_2\}, \{R_4\}; \ 2; \ \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}; \ \text{C-1 WP; 1} \)
\( \{R_2\}, \{R_4\}; \ 2; \ \sqrt{-1}\sigma_3; \ \text{C-2 WP; 2} \)
\( \{R_2\}, \{R_4\}; \ 2; \ \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}; \ \text{C-1 WP; 1} \)
\( \{R_4\}, \{R_6\}; \ 2; \ \frac{-\sigma_3 + i\sigma_0}{\sqrt{2}}; \ \text{C-1 WP; 1} \)
\( \{R_4\}, \{R_6\}; \ 2; \ (-1)^{3/4}\sigma_3; \ \text{C-2 WP; 2} \)
\( \{R_6\}, \{R_6\}; \ 2; \ \frac{-\sigma_3 - i\sigma_0}{\sqrt{2}}; \ \text{C-1 WP; 1} \)

\( V; \ \text{MA}; \ C_{4z}^+; \ \{R_2\}, \{R_4\}; \ 2; \ \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}; \ \text{C-1 WP; 1} \)
\( \{R_2\}, \{R_6\}; \ 2; \ \sqrt{-1}\sigma_3; \ \text{C-2 WP; 2} \)
\( \{R_2\}, \{R_6\}; \ 2; \ \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}; \ \text{C-1 WP; 1} \)
\( \{R_4\}, \{R_6\}; \ 2; \ \frac{-\sigma_3 + i\sigma_0}{\sqrt{2}}; \ \text{C-1 WP; 1} \)
\( \{R_4\}, \{R_6\}; \ 2; \ (-1)^{3/4}\sigma_3; \ \text{C-2 WP; 2} \)
\( \{R_6\}, \{R_8\}; \ 2; \ \frac{-\sigma_3 - i\sigma_0}{\sqrt{2}}; \ \text{C-1 WP; 1} \)

\( W; \ \text{XR}; \ C_{2z}; \ \{R_2\}, \{R_4\}; \ 2; \ i\sigma_3; \ \text{C-1 WP; 1} \)
Accidental degeneracies on high symmetry line

\( \Lambda; \, \Gamma Z; \, C_{4z}^+; \{ R_2 \}, \{ R_4 \}; 2; \frac{\sigma_3 + i \sigma_0}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_2 \}, \{ R_6 \}; 2; \sqrt[4]{-1} \sigma_3; \) C-2 WP; 2

\( \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_0 + i \sigma_3}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_4 \}, \{ R_6 \}; 2; -\frac{\sigma_0 - i \sigma_3}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_4 \}, \{ R_6 \}; 2; (\frac{-1}{3})^{3/4} \sigma_3; \) C-2 WP; 2

\( \{ R_6 \}, \{ R_6 \}; 2; -\frac{\sigma_3 - i \sigma_0}{\sqrt{2}}; \) C-1 WP; 1

\( V; \, M A; \, C_{4x}^+; \{ R_2 \}, \{ R_4 \}; 2; \frac{\sigma_3 + i \sigma_0}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_2 \}, \{ R_6 \}; 2; \sqrt[4]{-1} \sigma_3; \) C-2 WP; 2

\( \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_0 + i \sigma_3}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_4 \}, \{ R_6 \}; 2; -\frac{\sigma_0 - i \sigma_3}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_4 \}, \{ R_6 \}; 2; (\frac{-1}{3})^{3/4} \sigma_3; \) C-2 WP; 2

\( \{ R_6 \}, \{ R_6 \}; 2; -\frac{\sigma_3 - i \sigma_0}{\sqrt{2}}; \) C-1 WP; 1

\( W; \, X R; \, C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3; \) C-1 WP; 1

Accidental degeneracies on high symmetry line

\( \Lambda; \, \Gamma A/\Gamma Z; \, C_{4z}^+; \{ R_2 \}, \{ R_4 \}; 2; \frac{\sigma_3 + i \sigma_0}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_2 \}, \{ R_6 \}; 2; \sqrt[4]{-1} \sigma_3; \) C-2 WP; 2

\( \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_0 + i \sigma_3}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_4 \}, \{ R_6 \}; 2; -\frac{\sigma_0 - i \sigma_3}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_4 \}, \{ R_6 \}; 2; (\frac{-1}{3})^{3/4} \sigma_3; \) C-2 WP; 2

\( \{ R_6 \}, \{ R_6 \}; 2; -\frac{\sigma_3 - i \sigma_0}{\sqrt{2}}; \) C-1 WP; 1

\( V; \, Z V; \, C_{4x}^+; \{ R_2 \}, \{ R_4 \}; 2; \frac{\sigma_3 + i \sigma_0}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_2 \}, \{ R_6 \}; 2; \sqrt[4]{-1} \sigma_3; \) C-2 WP; 2

\( \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_0 + i \sigma_3}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_4 \}, \{ R_6 \}; 2; -\frac{\sigma_0 - i \sigma_3}{\sqrt{2}}; \) C-1 WP; 1

\( \{ R_4 \}, \{ R_6 \}; 2; (\frac{-1}{3})^{3/4} \sigma_3; \) C-2 WP; 2

\( \{ R_6 \}, \{ R_6 \}; 2; -\frac{\sigma_3 - i \sigma_0}{\sqrt{2}}; \) C-1 WP; 1

\( W; \, X P; \, C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3; \) C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma\Lambda/\Gamma Z; C^+_{2z}; \begin{align*}
\{R_2\}, \{R_4\}; & \quad 2; \frac{\sigma_3 + i\sigma_0\sqrt{2}}{\sqrt{2}}; \quad \text{C-1 WP; 1} \\
\{R_2\}, \{R_6\}; & \quad 2; \sqrt{-1}\sigma_3; \quad \text{C-2 WP; 2} \\
\{R_2\}, \{R_8\}; & \quad 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}; \quad \text{C-1 WP; 1} \\
\{R_4\}, \{R_6\}; & \quad 2; -\frac{\sigma_0 - i\sigma_3}{\sqrt{2}}; \quad \text{C-1 WP; 1} \\
\{R_4\}, \{R_8\}; & \quad 2; (-1)^{3/4}\sigma_3; \quad \text{C-2 WP; 2} \\
\{R_6\}, \{R_8\}; & \quad 2; -\frac{\sigma_3 - i\sigma_0}{\sqrt{2}}; \quad \text{C-1 WP; 1} \\
\end{align*} \]

\[ V; ZV; C^+_{4x,E}; \begin{align*}
\{R_2\}, \{R_4\}; & \quad 2; \frac{\sigma_3 + i\sigma_0\sqrt{2}}{\sqrt{2}}, -\sigma_0; \quad \text{C-1 WP; 1} \\
\{R_2\}, \{R_6\}; & \quad 2; \sqrt{-1}\sigma_3, -\sigma_0; \quad \text{C-2 WP; 2} \\
\{R_2\}, \{R_8\}; & \quad 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, -\sigma_0; \quad \text{C-1 WP; 1} \\
\{R_4\}, \{R_6\}; & \quad 2; -\frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, -\sigma_0; \quad \text{C-1 WP; 1} \\
\{R_4\}, \{R_8\}; & \quad 2; (-1)^{3/4}\sigma_3, -\sigma_0; \quad \text{C-2 WP; 2} \\
\{R_6\}, \{R_8\}; & \quad 2; -\frac{\sigma_3 - i\sigma_0}{\sqrt{2}}, -\sigma_0; \quad \text{C-1 WP; 1} \\
\end{align*} \]

\[ W; XP; C_{2z}; \begin{align*}
\{R_2\}, \{R_4\}; & \quad 2; i\sigma_3; \quad \text{C-1 WP; 1} \\
\end{align*} \]
Accidental degeneracies on high symmetry line

\begin{align*}
W; XR; C_{2z}; \{R_2\}; \{R_4\}; 2; i\sigma_3; C-1 WP; 1
\end{align*}

Accidental degeneracies on high symmetry line

\begin{align*}
W; XP; C_{2z}; \{R_2\}; \{R_4\}; 2; i\sigma_3; C-1 WP; 1
\end{align*}

\begin{align*}
A: \Gamma_Z; C^+_{4z}; IT; \{R_2, R_8\}, \{R_4, R_6\}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, -i\Gamma_{0,2}; DP; 0
V; MA; C^+_{4z}; IT; \{R_2, R_8\}, \{R_4, R_6\}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, -i\Gamma_{0,2}; DP; 0
\end{align*}

Accidental degeneracies on high symmetry line

\begin{align*}
A: \Gamma_Z; C^+_{4z}; IT; \{R_2, R_8\}, \{R_4, R_6\}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, -i\Gamma_{0,2}; DP; 0
V; MA; C^+_{4z}; IT; \{R_2, R_8\}, \{R_4, R_6\}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, -i\Gamma_{0,2}; DP; 0
\end{align*}

Accidental degeneracies on high symmetry line

\begin{align*}
A: \Gamma_Z; C^+_{4z}; IT; \{R_2, R_8\}, \{R_4, R_6\}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, -i\Gamma_{0,2}; DP; 0
V; MA; C^+_{4z}, IT; \{R_{10}, R_{12}\}, \{R_{14}, R_{16}\}; 4; \frac{-\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, \Gamma_{0,0}, -i\Gamma_{0,2}; DP; 0
W; XR; C_{2z}, IT; \{R_2, R_2\}, \{R_4, R_4\}; 4; i\Gamma_{3,0}, -i\Gamma_{0,2}; DP; 0
\end{align*}

Accidental degeneracies on high symmetry line

\begin{align*}
A: \Gamma_Z; C^+_{4z}, IT; \{R_2, R_8\}, \{R_4, R_6\}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, -i\Gamma_{0,2}; DP; 0
V; MA; C^+_{4z}, IT; \{R_{10}, R_{12}\}, \{R_{14}, R_{16}\}; 4; \frac{-\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, \Gamma_{0,0}, -i\Gamma_{0,2}; DP; 0
W; XR; C_{2z}, IT; \{R_2, R_2\}, \{R_4, R_4\}; 4; i\Gamma_{3,0}, -i\Gamma_{0,2}; DP; 0
\end{align*}
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma_Λ/Γ_Z; C_{4z}^+; IT; \{ R_2, R_3 \}; \{ R_4, R_6 \}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, -i\Gamma_{0,2}; DP; 0 \]
\[ V; ZV; \quad C_{4z}^+; IT; \{ R_2, R_3 \}; \{ R_4, R_6 \}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, -i\Gamma_{0,2}; DP; 0 \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma_Λ/Γ_Z; C_{4z}^+; IT; \{ R_2, R_3 \}; \{ R_4, R_6 \}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,3}}{\sqrt{2}}, -i\Gamma_{0,2}; DP; 0 \]
\[ V; ZV; \quad C_{4z}^+; E, IT; \{ R_{10}, R_{12} \}; \{ R_{14}, R_{16} \}; 4; \frac{-\Gamma_{3,3} - i\Gamma_{0,0}}{\sqrt{2}}, \Gamma_{0,0}, -i\Gamma_{0,2}; DP; 0 \]
\[ W; XP; \quad C_{2z}; IT; \{ R_2, R_3 \}; \{ R_4, R_4 \}; 4; i\Gamma_{3,0}, -i\Gamma_{0,2}; DP; 0 \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_X; \quad C_{2y}, TC_{2z}; \{ R_2 \}; \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad C-1 WP; 1 \]
\[ U; ZR; \quad C_{2y}, TC_{2z}; \{ R_2 \}; \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad C-1 WP; 1 \]
\[ \Lambda; \Gamma_Z; \quad C_{4z}^+; C_{2z}T; \{ R_2 \}; \{ R_4 \}; 2; \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 WP; 1 \]
\[ \{ R_2 \}; \{ R_6 \}; 2; \sqrt{3}\sigma_3, \sigma_0; \quad C-2 WP; 2 \]
\[ \{ R_2 \}; \{ R_8 \}; 2; \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 WP; 1 \]
\[ \{ R_4 \}; \{ R_6 \}; 2; -\frac{\sigma_3 + i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 WP; 1 \]
\[ \{ R_4 \}; \{ R_8 \}; 2; (-1)^{3/4}\sigma_3, \sigma_0; \quad C-2 WP; 2 \]
\[ \{ R_6 \}; \{ R_8 \}; 2; -\frac{\sigma_3 + i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 WP; 1 \]
\[ V; MA; \quad C_{4z}^+; C_{2z}T; \{ R_2 \}; \{ R_4 \}; 2; \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 WP; 1 \]
\[ \{ R_2 \}; \{ R_6 \}; 2; \sqrt{3}\sigma_3, \sigma_0; \quad C-2 WP; 2 \]
\[ \{ R_2 \}; \{ R_8 \}; 2; \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 WP; 1 \]
\[ \{ R_4 \}; \{ R_6 \}; 2; -\frac{\sigma_3 + i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 WP; 1 \]
\[ \{ R_4 \}; \{ R_8 \}; 2; (-1)^{3/4}\sigma_3, \sigma_0; \quad C-2 WP; 2 \]
\[ \{ R_6 \}; \{ R_8 \}; 2; -\frac{\sigma_3 + i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 WP; 1 \]
\[ \Sigma; \Gamma_M; \quad C_{2z}, C_{2z}T; \{ R_2 \}; \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad C-1 WP; 1 \]
\[ S; ZA; \quad C_{2z}, C_{2z}T; \{ R_2 \}; \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad C-1 WP; 1 \]
\[ Y; XM; \quad C_{2z}, TC_{2y}; \{ R_2 \}; \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad C-1 WP; 1 \]
\[ T; RA; \quad C_{2z}, TC_{2y}; \{ R_2 \}; \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad C-1 WP; 1 \]
\[ W; XR; \quad C_{2z}, TC_{2y}; \{ R_2 \}; \{ R_4 \}; 2; i\sigma_3, \sigma_0; \quad C-1 WP; 1 \]
Accidental degeneracies on high symmetry line

$\Delta$: ΓX; $C_{2y}, TC_{2z}$; $\{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1$ WP; 1

$U$: ZR; $C_{2y}, TC_{2z}$; $\{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1$ WP; 1

$\Lambda$: ΓZ; $C_{4z}, C_{2b}T$; $\{R_2\}, \{R_4\}; 2; \frac{\sigma_0+i\sigma_3}{\sqrt{2}}, \sigma_0; C-1$ WP; 1

$\{R_2\}, \{R_4\}; 2; \sqrt{-1}\sigma_3, \sigma_0; C-2$ WP; 2

$\{R_2\}, \{R_6\}; 2; \frac{\sigma_0+i\sigma_3}{\sqrt{2}}, \sigma_0; C-1$ WP; 1

$\{R_4\}, \{R_6\}; 2; \frac{-\sigma_3+i\sigma_0}{\sqrt{2}}, \sigma_0; C-1$ WP; 1

$\{R_4\}, \{R_8\}; 2; (-1)^{3/4}\sigma_3, \sigma_0; C-2$ WP; 2

$\{R_6\}, \{R_8\}; 2; \frac{-\sigma_3-i\sigma_0}{\sqrt{2}}, \sigma_0; C-1$ WP; 1

$V$: MA; $C_{4z}, C_{2b}T$; $\{R_2, R_6\}, \{R_4, R_8\}; 4; \frac{\Gamma_{3.3}+i\Gamma_{0.3}}{\sqrt{2}}, \Gamma_{0.1}; C-2$ DP; 2

$\Sigma$: ΓM; $C_{2a}, C_{2b}T$; $\{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1$ WP; 1

$S$: ZA; $C_{2a}, C_{2b}T$; $\{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1$ WP; 1
Accidental degeneracies on high symmetry line

\( \Delta: \Gamma X; C_{2y}, T C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

\( \Lambda: \Gamma Z; C_{4z}^{+}, C_{2b} T; \{R_2\}, \{R_4\}; 2; \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\( \{R_2\}, \{R_6\}; 2; \sqrt[4]{-1}\sigma_3, \sigma_0; \) C-2 WP; 2

\( \{R_4\}, \{R_8\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\( \{R_4\}, \{R_6\}; 2; \frac{\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\( \{R_4\}, \{R_8\}; 2; (-1)^{3/4}\sigma_3, \sigma_0; \) C-2 WP; 2

\( \{R_6\}, \{R_8\}; 2; \frac{-\sigma_3 - i\sigma_0}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\( \Sigma: \Gamma M; C_{2a}, C_{2b} T; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

\( \Omega: \Gamma X; C_{2y}, T C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

\( W: \) XR; \( C_{2z}, T C_{2y}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

Accidental degeneracies on high symmetry line

\( \Delta: \Gamma X; C_{2y}, T C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

\( \Lambda: \Gamma Z; C_{4z}^{+}, C_{2b} T; \{R_2\}, \{R_4\}; 2; \frac{\sigma_3 + i\sigma_0}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\( \{R_2\}, \{R_6\}; 2; \sqrt[4]{-1}\sigma_3, \sigma_0; \) C-2 WP; 2

\( \{R_4\}, \{R_8\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\( \{R_4\}, \{R_6\}; 2; \frac{-\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\( \{R_4\}, \{R_8\}; 2; (-1)^{3/4}\sigma_3, \sigma_0; \) C-2 WP; 2

\( \{R_6\}, \{R_8\}; 2; \frac{-\sigma_3 - i\sigma_0}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\( \Sigma: \Gamma M; C_{2a}, C_{2b} T; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

\( \Omega: \Gamma X; C_{2y}, T C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

\( T: RA; C_{2z}, E T C_{2y}; \{R_5\}, \{R_7\}; 4; -i\Gamma_{3,0}, \Gamma_{0,0}, -i\Gamma_{0,2}; \) C-2 DP; 2
Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma X; \quad C_{2y}, T C_{2z}; \quad \{R_2\}, \{R_4\}; \quad 2; \ i\sigma_3, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ U: \ Z R; \quad C_{2y}, T C_{2z}; \quad \{R_2\}, \{R_4\}; \quad 2; \ i\sigma_3, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ \Lambda: \Gamma Z; \quad C_{4z}, T C_{25}; \quad \{R_2\}, \{R_4\}; \quad 2; \ \frac{\sqrt{3}+i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ \quad \{R_2\}, \{R_6\}; \quad 2; \ \sqrt{-1}\sigma_3, \sigma_0; \quad C-2 \ WP; \ 2 \]

\[ \quad \{R_2\}, \{R_8\}; \quad 2; \ \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ \quad \{R_4\}, \{R_6\}; \quad 2; \ -\frac{\sigma_0-i\sigma_2}{\sqrt{2}}, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ \quad \{R_4\}, \{R_8\}; \quad 2; \ (-1)^{3/4}\sigma_3, \sigma_0; \quad C-2 \ WP; \ 2 \]

\[ \quad \{R_6\}, \{R_8\}; \quad 2; \ -\frac{\sigma_3-i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ V: \ M A; \quad C_{4z}, T C_{25}; \quad \{R_2\}, \{R_4\}; \quad 2; \ \frac{\sigma_3+i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ \quad \{R_2\}, \{R_6\}; \quad 2; \ \sqrt{-1}\sigma_3, \sigma_0; \quad C-2 \ WP; \ 2 \]

\[ \quad \{R_2\}, \{R_8\}; \quad 2; \ \frac{\sigma_0+i\sigma_2}{\sqrt{2}}, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ \quad \{R_4\}, \{R_6\}; \quad 2; \ -\frac{\sigma_0-i\sigma_2}{\sqrt{2}}, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ \quad \{R_4\}, \{R_8\}; \quad 2; \ (-1)^{3/4}\sigma_3, \sigma_0; \quad C-2 \ WP; \ 2 \]

\[ \quad \{R_6\}, \{R_8\}; \quad 2; \ -\frac{\sigma_3-i\sigma_0}{\sqrt{2}}, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ \Sigma: \Gamma M; \quad C_{2a}, T C_{25}; \quad \{R_2\}, \{R_4\}; \quad 2; \ i\sigma_3, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ S: \ Z A; \quad C_{2a}, E, C_{2b} T; \quad \{R_3\}, \{R_7\}; \quad 2; \ i\sigma_3, \sigma_0, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ Y: \ X M; \quad C_{2a}, T C_{2z}; \quad \{R_2\}, \{R_4\}; \quad 2; \ i\sigma_3, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ T: \ R A; \quad C_{2z}, T C_{2y}; \quad \{R_2\}, \{R_4\}; \quad 2; \ i\sigma_3, \sigma_0; \quad C-1 \ WP; \ 1 \]

\[ W: \ X R; \quad C_{2z}, T C_{2y}; \quad \{R_2\}, \{R_4\}; \quad 2; \ i\sigma_3, \sigma_0; \quad C-1 \ WP; \ 1 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y}, T C_{2z}; \{ R_z \}, \{ R_4 \}; 2; \begin{cases} i\sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \Lambda; \Gamma Z; C_{4z}^+, T C_{2y}; \{ R_2 \}, \{ R_4 \}; 2; \begin{cases} i\sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \begin{cases} \{ R_2 \}, \{ R_6 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-2 WP; 2} \]
\[ \{ R_2 \}, \{ R_8 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-2 WP; 2} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ V; \Gamma A; C_{2y}^+, T C_{2y}; \{ R_2 \}, \{ R_4 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-2 WP; 2} \]

\[ \{ R_2 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-2 WP; 2} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \Sigma; \Gamma M; C_{2x}, T C_{2y}; \{ R_2 \}, \{ R_4 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-2 WP; 1} \]

\[ \{ R_2 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-2 WP; 1} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ W; \Gamma R; C_{2x}, T C_{2y}; \{ R_2 \}, \{ R_4 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y}, T C_{2z}; \{ R_z \}, \{ R_4 \}; 2; \begin{cases} i\sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \Lambda; \Gamma Z; C_{4z}^+, T C_{2y}; \{ R_2 \}, \{ R_4 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \begin{cases} \{ R_2 \}, \{ R_6 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-2 WP; 2} \]
\[ \{ R_2 \}, \{ R_8 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-2 WP; 2} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ V; \Gamma A; C_{2y}^+, T C_{2y}; \{ R_2 \}, \{ R_4 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-2 WP; 1} \]

\[ \{ R_2 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-2 WP; 1} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \Sigma; \Gamma M; C_{2x}, T C_{2y}; \{ R_2 \}, \{ R_4 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-2 WP; 1} \]

\[ \{ R_2 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-2 WP; 1} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ T; \Gamma R; C_{2x}, T C_{2y}; \{ R_2 \}, \{ R_4 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \begin{cases} \sigma_3, \sigma_0; \end{cases} \text{C-2 WP; 1} \]

\[ \{ R_2 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]

\[ \{ R_4 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-2 WP; 1} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \begin{cases} \sigma_0, \sigma_0; \end{cases} \text{C-1 WP; 1} \]
Accidental degeneracies on high symmetry line

\[ \Lambda: \Gamma_{\Lambda}/\Gamma_Z; C_{12}^{+}\Gamma_{\Gamma}\Gamma_{\Lambda}/\Gamma_Z; C_{-1}\; \{R_{2}\}, \{R_{4}\} : \frac{\sigma_{3}+i\sigma_{0}}{\sqrt{2}}; \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : \frac{1}{\sqrt{2}}\sigma_{3}, \sigma_{0}; C-2 \text{ WP}; 2 \]
\[ \{R_{2}\}, \{R_{4}\} : \frac{\sigma_{3}+i\sigma_{0}}{\sqrt{2}}; \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : \frac{\sigma_{3}+i\sigma_{0}}{\sqrt{2}}; \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{4}\}, \{R_{6}\} : \frac{1}{\sqrt{2}}\sigma_{3}, \sigma_{0}; C-2 \text{ WP}; 2 \]
\[ \{R_{4}\}, \{R_{6}\} : \frac{1}{\sqrt{2}}\sigma_{3}, \sigma_{0}; C-2 \text{ WP}; 2 \]
\[ \{R_{4}\}, \{R_{6}\} : \frac{1}{\sqrt{2}}\sigma_{3}, \sigma_{0}; C-2 \text{ WP}; 2 \]
\[ \{R_{0}\}, \{R_{2}\} : \frac{\sigma_{3}+i\sigma_{0}}{\sqrt{2}}; \sigma_{0}; C-1 \text{ WP}; 1 \]

\[ V: Z_{V}; C_{12}^{+}\Gamma_{\Gamma}_{\Gamma}/\Gamma_{V}; \{R_{2}\}, \{R_{4}\} : \frac{\sigma_{3}+i\sigma_{0}}{\sqrt{2}}; \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : \frac{1}{\sqrt{2}}\sigma_{3}, \sigma_{0}; C-2 \text{ WP}; 2 \]
\[ \{R_{2}\}, \{R_{4}\} : \frac{1}{\sqrt{2}}\sigma_{3}, \sigma_{0}; C-2 \text{ WP}; 2 \]
\[ \{R_{4}\}, \{R_{6}\} : \frac{1}{\sqrt{2}}\sigma_{3}, \sigma_{0}; C-2 \text{ WP}; 2 \]
\[ \{R_{4}\}, \{R_{6}\} : \frac{1}{\sqrt{2}}\sigma_{3}, \sigma_{0}; C-2 \text{ WP}; 2 \]
\[ \{R_{0}\}, \{R_{2}\} : \frac{\sigma_{3}+i\sigma_{0}}{\sqrt{2}}; \sigma_{0}; C-1 \text{ WP}; 1 \]

\[ W: X_{P}; C_{2z}, C_{2b}\Gamma; \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]

\[ \Sigma: \Gamma_{Z}/\Gamma_{\Sigma}; C_{2z}, TC_{2y}; \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]

\[ F: Z_{F}; C_{2z}, TC_{2y}; \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]

\[ Q: N_{P}; C_{2y}; \{R_{2}\}, \{R_{4}\} : i\sigma_{3}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}; C-1 \text{ WP}; 1 \]

\[ \Delta: \Gamma_{X}; C_{2z}, C_{2b}\Gamma; \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]

\[ U: Z_{U}; C_{2z}, C_{2b}\Gamma; \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]

\[ Y: X_{Z}/X_{Y}; C_{2b}, TC_{2z}; \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
\[ \{R_{2}\}, \{R_{4}\} : i\sigma_{3}, \sigma_{0}; C-1 \text{ WP}; 1 \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma\Lambda/\Gamma\Sigma; C_{1z} \cdot C_{20} T; \{ R_2 \}, \{ R_4 \}; 2; \frac{\sigma_3 + i \sigma_0}{\sqrt{2}}, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \sqrt{-1} \sigma_3, \sigma_0; \text{C-2 WP}; 2 \]
\[ \{ R_2 \}, \{ R_8 \}; 2; \frac{\sigma_3 + i \sigma_0}{\sqrt{2}}, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_4 \}, \{ R_6 \}; 2; -\frac{\sigma_3 - i \sigma_0}{\sqrt{2}}, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_4 \}, \{ R_8 \}; 2; (\pm \frac{3}{2}) \sigma_3, \sigma_0; \text{C-2 WP}; 2 \]
\[ \{ R_6 \}, \{ R_8 \}; 2; -\frac{\sigma_3 - i \sigma_0}{\sqrt{2}}, \sigma_0; \text{C-1 WP}; 1 \]

\[ V; \ ZV; C_{1z} \cdot E, C_{20} T; \{ R_{10} \}, \{ R_{12} \}; 2; \frac{\sigma_3 + i \sigma_0}{\sqrt{2}}, \sigma_0, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_{10} \}, \{ R_{14} \}; 2; \sqrt{-1} \sigma_3, \sigma_0, \sigma_0; \text{C-2 WP}; 2 \]
\[ \{ R_{10} \}, \{ R_{16} \}; 2; \frac{\sigma_3 + i \sigma_0}{\sqrt{2}}, \sigma_0, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_{12} \}, \{ R_{14} \}; 2; -\frac{\sigma_3 - i \sigma_0}{\sqrt{2}}, \sigma_0, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_{12} \}, \{ R_{16} \}; 2; (\pm \frac{3}{2}) \sigma_3, \sigma_0, \sigma_0; \text{C-2 WP}; 2 \]
\[ \{ R_{14} \}, \{ R_{16} \}; 2; -\frac{\sigma_3 - i \sigma_0}{\sqrt{2}}, \sigma_0, \sigma_0; \text{C-1 WP}; 1 \]

\[ W; \ XP; C_{2z} \cdot C_{20} T; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{C-1 WP}; 1 \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{C-1 WP}; 1 \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_3, T C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ U; \ ZR; \sigma_3, T C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \Lambda; \Gamma Z; C_{4z}^+, \sigma_3; \{ R_0 \}, \{ R_7 \}; 4; \frac{\Gamma_3 + i \Gamma_1}{\sqrt{2}}, i \Gamma_0; \text{DP}; 0 \]
\[ V; \ MA; C_{4z}^+, \sigma_3; \{ R_0 \}, \{ R_7 \}; 4; \frac{\Gamma_3 + i \Gamma_1}{\sqrt{2}}, i \Gamma_0; \text{DP}; 0 \]
\[ \Sigma; \Gamma M; \sigma_{4z}, T \sigma_{du}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ S; \ ZA; \sigma_{4z}, T \sigma_{du}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ Y; \ XM; \sigma_y, T \sigma_z; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{P-WNL}; \]
\[ T; \ RA; \sigma_y, T \sigma_z; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, T C_2 z; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{P-WNL;} \]

\[ U; \Gamma Z; C_4^+, \sigma_y; \{ R_0 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0} + i \Gamma_{0,2}}{\sqrt{2}}, i \Gamma_{0,1}; \text{DP; 0} \]

\[ V; \Lambda; C_4^+, \sigma_z; \{ R_6 \}, \{ R_7 \}; 2; i \sigma_3, i \sigma_0; \text{P-WNLs; } \]

\[ \Sigma; \Gamma M; \sigma_{db}, T \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{P-WNL;} \]

\[ S; \Gamma A; \sigma_{db}, T \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{P-WNL;} \]

\[ W; \Gamma R; \sigma_y, C_2 z; \{ R_5 \}, \{ R_6 \}; 2; i \sigma_0, i \sigma_3; \text{P-WNL;} \]

\[ \{ R_5 \}, \{ R_7 \}; 2; i \sigma_3, i \sigma_3; \text{P-WNL;} \]

\[ \{ R_6 \}, \{ R_7 \}; 2; i \sigma_3, -i \sigma_0; \text{P-WNLs;} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; i \sigma_3, -i \sigma_3; \text{P-WNL;} \]

\[ \{ R_7 \}, \{ R_8 \}; 2; -i \sigma_0, -i \sigma_3; \text{P-WNL;} \]
SG 101

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, T C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \Lambda; \Gamma Z; C^+_{4z}, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0}^z + i\Gamma_{0,2}^z}{\sqrt{2}}, i\Gamma_{0,1}; \text{ DP}; 0 \]
\[ V; MA; C^+_{4z}, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0}^z + i\Gamma_{0,2}^z}{\sqrt{2}}, i\Gamma_{0,1}; \text{ DP}; 0 \]
\[ \Sigma; \Gamma M; \sigma_{db}, T \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ S; ZA; \sigma_{db}, T \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ Y; XM; \sigma_y, T \sigma_x; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ P-WNL}; \]

SG 102

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, T C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \Lambda; \Gamma Z; C^+_{4z}, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0}^z + i\Gamma_{0,2}^z}{\sqrt{2}}, i\Gamma_{0,1}; \text{ DP}; 0 \]
\[ V; MA; C^+_{4z}, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0}^z + i\Gamma_{0,2}^z}{\sqrt{2}}, i\Gamma_{0,1}; \text{ DP}; 0 \]
\[ \Sigma; \Gamma M; \sigma_{db}, T \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ S; ZA; \sigma_{db}, T \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ T; RA; \sigma_y, E, T \sigma_x; \{ R_5 \}, \{ R_7 \}; 2; i\sigma_3, \sigma_0, \sigma_0; \text{ P-WNL}; \]
\[ W; XR; \sigma_y, C_{2z}; \{ R_5 \}, \{ R_6 \}; 2; i\sigma_0, i\sigma_3; \text{ P-WNL}; \]
\[ \{ R_5 \}, \{ R_6 \}; 2; i\sigma_3, i\sigma_3; \text{ P-WNL}; \]
\[ \{ R_5 \}, \{ R_6 \}; 2; i\sigma_3, i\sigma_0; \text{ P-WNL}; \]
\[ \{ R_6 \}, \{ R_7 \}; 2; i\sigma_3, -i\sigma_0; \text{ P-WNL}; \]
\[ \{ R_6 \}, \{ R_7 \}; 2; i\sigma_3, -i\sigma_3; \text{ P-WNL}; \]
\[ \{ R_7 \}, \{ R_7 \}; 2; -i\sigma_0, -i\sigma_3; \text{ P-WNL}; \]

SG 103

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, T C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ \Lambda; \Gamma Z; C^+_{4z}, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0}^z + i\Gamma_{0,2}^z}{\sqrt{2}}, i\Gamma_{0,1}; \text{ DP}; 0 \]
\[ V; MA; C^+_{4z}, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0}^z + i\Gamma_{0,2}^z}{\sqrt{2}}, i\Gamma_{0,1}; \text{ DP}; 0 \]
\[ \Sigma; \Gamma M; \sigma_{db}, T \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ P-WNL}; \]
\[ Y; XM; \sigma_y, T \sigma_x; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{ P-WNL}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, TC_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL;} \]
\[ \Lambda; \Gamma Z; C_{4z}^+, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{0,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}; \text{DP; 0} \]
\[ V; \text{MA}; C_{4z}^+, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{0,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}; \text{DP; 0} \]
\[ \Sigma; \Gamma M; \sigma_{db}, T \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL;} \]
\[ T; \text{RA}; \sigma_y, E \tau \sigma_x; \{ R_6 \}, \{ R_7 \}; 2; i\sigma_3, \sigma_0, \sigma_0; \text{P-WNL;} \]
\[ W; \text{XR}; \sigma_y, C_{2z}; \{ R_5 \}, \{ R_6 \}; 2; i\sigma_0, i\sigma_3; \text{P-WNL;} \]
\[ \{ R_5 \}, \{ R_6 \}; 2; i\sigma_3, i\sigma_3; \text{P-WNLs;} \]
\[ \{ R_7 \}, \{ R_8 \}; 2; i\sigma_3, -i\sigma_3; \text{P-WNL;} \]
\[ \{ R_6 \}, \{ R_8 \}; 2; i\sigma_3, -i\sigma_3; \text{P-WNL;} \]
\[ \{ R_7 \}, \{ R_8 \}; 2; -i\sigma_0, -i\sigma_3; \text{P-WNL;} \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma\Lambda/\Gamma Z; C_{4z}^+, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}; \text{DP}; 0 \]

\[ V; Z V; C_{4z}^+, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}; \text{DP}; 0 \]

\[ \Sigma; \Gamma Z/\Sigma; \sigma_y, \Gamma \sigma_z; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ F; Z F; \sigma_y, \Gamma \sigma_z; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Delta; \Gamma X; \sigma_{db}, \Gamma \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ U; Z U; \sigma_{db}, \Gamma \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ Y; X Z/X Y; \sigma_{da}, \Gamma C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma\Lambda/\Gamma Z; C_{4z}^+, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}; \text{DP}; 0 \]

\[ V; Z V; C_{4z}^+, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}; \text{DP}; 0 \]

\[ \Sigma; \Gamma Z/\Sigma; \sigma_y, \Gamma \sigma_z; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ F; Z F; \sigma_y, \Gamma \sigma_z; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Delta; \Gamma X; \sigma_{db}, \Gamma \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ U; Z U; \sigma_{db}, \Gamma \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ Y; X Z/X Y; \sigma_{da}, \Gamma C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma\Lambda/\Gamma Z; C_{4z}^+, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}; \text{DP}; 0 \]

\[ V; Z V; C_{4z}^+, \sigma_y; \{ R_6 \}, \{ R_7 \}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}; \text{DP}; 0 \]

\[ W; X P; \sigma_{da}, \Gamma C_{2z}; \{ R_5 \}, \{ R_6 \}; 2; i\sigma_0, i\sigma_3; \text{P-WNL}; \]

\[ \{ R_5 \}, \{ R_7 \}; 2; i\sigma_3, i\sigma_3; \text{P-WNL}; \]

\[ \{ R_5 \}, \{ R_8 \}; 2; i\sigma_3, i\sigma_0; \text{P-WNLs}; \]

\[ \{ R_6 \}, \{ R_7 \}; 2; i\sigma_3, -i\sigma_0; \text{P-WNLs}; \]

\[ \{ R_6 \}, \{ R_8 \}; 2; i\sigma_3, -i\sigma_3; \text{P-WNL}; \]

\[ \{ R_7 \}, \{ R_8 \}; 2; -i\sigma_0, -i\sigma_3; \text{P-WNL}; \]

\[ \Sigma; \Gamma Z/\Sigma; \sigma_y, \Gamma \sigma_z; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ F; Z F; \sigma_y, \Gamma \sigma_z; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Delta; \Gamma X; \sigma_{db}, \Gamma \sigma_{da}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]
Accidental degeneracies on high symmetry line

Λ: \( \Gamma\Lambda/\Gamma\Sigma; C_{4z}^{+},\sigma_{y}; \{ R_{6} \}, \{ R_{7} \}; 4; \frac{\Gamma_{3,0}+i\Gamma_{0,3}}{\sqrt{2}}, i\Gamma_{0,1}; \) DP; 0

V: \( ZV; \quad C_{4z}^{+},\sigma_{ab}; \{ R_{6} \}, \{ R_{7} \}; 4; \frac{\Gamma_{3,0}+i\Gamma_{0,3}}{\sqrt{2}}, i\Gamma_{0,1}; \) DP; 0

W: \( XP; \quad \sigma_{da},C_{2s}; \{ R_{5} \}, \{ R_{6} \}; 2; i\sigma_{0}, i\sigma_{3}; \) P-WNL;
\{ R_{5} \}, \{ R_{7} \}; 2; i\sigma_{3}, i\sigma_{3}; \) P-WNL;
\{ R_{5} \}, \{ R_{8} \}; 2; i\sigma_{3}, i\sigma_{0}; \) P-WNL;
\{ R_{6} \}, \{ R_{7} \}; 2; i\sigma_{3}, -i\sigma_{0}; \) P-WNL;
\{ R_{6} \}, \{ R_{8} \}; 2; i\sigma_{3}, -i\sigma_{3}; \) P-WNL;
\{ R_{7} \}, \{ R_{8} \}; 2; -i\sigma_{0}, -i\sigma_{3}; \) P-WNL;

Σ: \( \Gamma\Sigma/\Gamma\Sigma; \sigma_{y},T\sigma_{x}; \{ R_{2} \}, \{ R_{4} \}; 2; i\sigma_{3},\sigma_{0}; \) P-WNL;

F: \( ZF; \quad \sigma_{y},T\sigma_{x}; \{ R_{2} \}, \{ R_{4} \}; 2; i\sigma_{3},\sigma_{0}; \) P-WNL;

Δ: \( \Gamma\chi; \quad \sigma_{da},T\sigma_{da}; \{ R_{2} \}, \{ R_{4} \}; 2; i\sigma_{3},\sigma_{0}; \) P-WNL;
Accidental degeneracies on high symmetry line

SG 111

\[ \Delta: \Gamma X; C_{2y}, TC_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; C-1 WP; 1 \]

SG 112

Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma X; C_{2y}, TC_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; C-1 WP; 1 \]

SG 113

Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma X; C_{2y}, TC_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; C-1 WP; 1 \]

SG 114

Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma X; C_{2y}, TC_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; C-1 WP; 1 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, T \sigma_y; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; P-WNL; \]

\[ U; Z \sigma_x; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; P-WNL; \]

\[ \Sigma; \Gamma M; C_{2s}, C_{2b} T; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; C-1 WP; 1 \]

\[ S; Z A; C_{2a}, C_{2b} T; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; C-1 WP; 1 \]

\[ Y; X M; \sigma_y, T C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; P-WNL; \]

\[ T; R A; \sigma_y, T C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; P-WNL; \]

SG 116

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, T \sigma_y; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; P-WNL; \]

\[ \Sigma; \Gamma M; C_{2s}, C_{2b} T; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; C-1 WP; 1 \]

\[ S; Z A; C_{2a}, E, C_{2b} T; \{ R_3 \}, \{ R_5 \}; 2; i \sigma_3, \sigma_0, \sigma_0; C-1 WP; 1 \]

\[ Y; X M; \sigma_y, T C_{2z}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; P-WNL; \]

SG 117

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, T \sigma_y; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; P-WNL; \]

\[ U; Z \sigma_x; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; P-WNL; \]

\[ \Sigma; \Gamma M; C_{2s}, C_{2b} T; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; C-1 WP; 1 \]

\[ S; Z A; C_{2s}, C_{2b} T; \{ R_3 \}, \{ R_5 \}; 2; i \sigma_3, \sigma_0; C-1 WP; 1 \]

\[ W; X R; \sigma_y, C_{2s}; \{ R_3 \}, \{ R_6 \}; 2; i \sigma_0, i \sigma_3; P-WNL; \]

\[ \{ R_3 \}, \{ R_7 \}; 2; i \sigma_3, i \sigma_3; P-WNL; \]

\[ \{ R_5 \}, \{ R_8 \}; 2; i \sigma_3, i \sigma_0; P-WNLs; \]

\[ \{ R_6 \}, \{ R_7 \}; 2; i \sigma_3, -i \sigma_0; P-WNLs; \]

\[ \{ R_7 \}, \{ R_8 \}; 2; i \sigma_3, -i \sigma_3; P-WNL; \]

\[ \{ R_7 \}, \{ R_8 \}; 2; -i \sigma_0, -i \sigma_3; P-WNL; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; \sigma_x, T \sigma_y; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ P-WNL;} \]

\[ \Sigma; \Gamma M; C_{26}, C_{2b} T; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ S; \Sigma A; C_{26}, E, C_{2b} T; \{ R_5 \}, \{ R_7 \}; 2; i \sigma_3, \sigma_0, \sigma_0; \text{ C-1 WP; 1} \]

\[ T; \Sigma A; \sigma_y, E, C_{2b} T; \{ R_5 \}, \{ R_7 \}; 2; i \sigma_3, \sigma_0, \sigma_0; \text{ P-WNL;} \]

\[ W; \Sigma A; \sigma_y, C_{2b}; \{ R_5 \}, \{ R_7 \}; 2; i \sigma_0, i \sigma_3; \text{ P-WNL;} \]

\[ \{ R_5 \}, \{ R_7 \}; 2; i \sigma_0, i \sigma_3; \text{ P-WNL;} \]

\[ \{ R_5 \}, \{ R_7 \}; 2; i \sigma_3, i \sigma_0; \text{ P-WNL;} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; i \sigma_3, i \sigma_0; \text{ P-WNL;} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; i \sigma_3, -i \sigma_0; \text{ P-WNL;} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; i \sigma_3, -i \sigma_0; \text{ P-WNL;} \]

\[ \{ R_7 \}, \{ R_8 \}; 2; -i \sigma_0, -i \sigma_3; \text{ P-WNL;} \]

Accidental degeneracies on high symmetry line

\[ W; \Sigma A; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ \Sigma; \Gamma Z/T \Sigma; \sigma_y, T C_{2b}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ P-WNL;} \]

\[ F; \Sigma A; \sigma_y, T C_{2b}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ P-WNL;} \]

\[ \Delta; \Gamma X; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ U; \Sigma A; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ \Sigma A; \{ R_5 \}, \{ R_7 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_5 \}, \{ R_7 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_5 \}, \{ R_7 \}; 2; i \sigma_3, -i \sigma_0; \text{ P-WNL;} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; i \sigma_3, -i \sigma_0; \text{ P-WNL;} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; i \sigma_3, i \sigma_0; \text{ P-WNL;} \]

\[ \{ R_7 \}, \{ R_8 \}; 2; -i \sigma_0, -i \sigma_3; \text{ P-WNL;} \]

Accidental degeneracies on high symmetry line

\[ W; \Sigma A; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ \Sigma; \Gamma Z/T \Sigma; \sigma_y, T C_{2b}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ P-WNL;} \]

\[ F; \Sigma A; \sigma_y, T C_{2b}; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ P-WNL;} \]

\[ \Delta; \Gamma X; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ U; \Sigma A; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ \Sigma A; \{ R_5 \}, \{ R_7 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_5 \}, \{ R_7 \}; 2; i \sigma_3, \sigma_0; \text{ C-1 WP; 1} \]

\[ \{ R_5 \}, \{ R_7 \}; 2; i \sigma_3, -i \sigma_0; \text{ P-WNL;} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; i \sigma_3, -i \sigma_0; \text{ P-WNL;} \]

\[ \{ R_6 \}, \{ R_8 \}; 2; i \sigma_3, i \sigma_0; \text{ P-WNL;} \]

\[ \{ R_7 \}, \{ R_8 \}; 2; -i \sigma_0, -i \sigma_3; \text{ P-WNL;} \]
Accidental degeneracies on high symmetry line

\[ \Sigma; \Gamma Z/\Gamma \Sigma; C_{2x},TC_{2y}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; C-1 \text{ WP}; 1 \]

\[ F; ZF; C_{2x},TC_{2y}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; C-1 \text{ WP}; 1 \]

\[ Q; NP; C_{2y}; \{R_2\},\{R_4\}; 2; i\sigma_3; C-1 \text{ WP}; 1 \]

\[ \Delta; \Gamma X; \sigma_{db},T\sigma_{da}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \text{P-WNL}; \]

\[ U; ZU; \sigma_{db},T\sigma_{da}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \text{P-WNL}; \]

\[ Y; \text{XZ}/XY; \sigma_{da},TC_{2z}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \text{P-WNL}; \]

Accidental degeneracies on high symmetry line

\[ W; XP; \sigma_{da},C_{2x}; \{R_5\},\{R_6\}; 2; i\sigma_0,\sigma_3; \text{P-WNL}; \]

\[ \{R_3\},\{R_7\}; 2; i\sigma_3,\sigma_3; \text{P-WNL}; \]

\[ \{R_5\},\{R_8\}; 2; i\sigma_3,\sigma_0; \text{P-WNL}; \]

\[ \{R_6\},\{R_7\}; 2; i\sigma_3,\sigma_0; \text{P-WNL}; \]

\[ \{R_6\},\{R_8\}; 2; i\sigma_3,\sigma_3; \text{P-WNL}; \]

\[ \{R_7\},\{R_8\}; 2; -i\sigma_0,-i\sigma_3; \text{P-WNL}; \]

\[ \Sigma; \Gamma Z/\Gamma \Sigma; C_{2x},TC_{2y}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \text{C-1 WP}; 1 \]

\[ F; ZF; C_{2x},E,TC_{2y}; \{R_5\},\{R_7\}; 2; i\sigma_3,\sigma_3,\sigma_0; \text{C-1 WP}; 1 \]

\[ Q; NP; C_{2y},E; \{R_{10}\},\{R_{14}\}; 2; i\sigma_3,\sigma_0; \text{C-1 WP}; 1 \]

\[ \Delta; \Gamma X; \sigma_{db},T\sigma_{da}; \{R_2\},\{R_4\}; 2; i\sigma_3,\sigma_0; \text{P-WNL}; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; C_{4z}^{+}\sigma_y,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{0.0+0.0}}{\sqrt{2}},i\Gamma_{0.1,-i\Gamma_{0.2}}; \text{DP}; 0 \]

\[ V; MA; C_{4z}^{+}\sigma_y,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{0.0+0.0}}{\sqrt{2}},i\Gamma_{0.1,-i\Gamma_{0.2}}; \text{DP}; 0 \]

Accidental degeneracies on high symmetry line

\[ U; ZR; \sigma_x,C_{2x},IT; \{R_6,\{R_8\},\{R_6,\{R_7\}; 4; i\Gamma_{0.3,\Gamma_{3.0}}; i\Gamma_{3.0}; \text{DP}; 0 \]

\[ \Lambda; \Gamma Z; C_{4z}^{+}\sigma_y,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{0.0+0.0}}{\sqrt{2}},i\Gamma_{0.3,-i\Gamma_{0.2}}; \text{DP}; 0 \]

\[ V; MA; C_{4z}^{+}\sigma_y,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{0.0+0.0}}{\sqrt{2}},i\Gamma_{0.3,-i\Gamma_{0.2}}; \text{DP}; 0 \]

\[ S; ZA; \sigma_x,C_{2z},IT; \{R_6,\{R_8\},\{R_6,\{R_7\}; 4; i\Gamma_{0.3,\Gamma_{3.0}}; i\Gamma_{3.0}; \text{DP}; 0 \]

\[ T; RA; \sigma_x,C_{2z},IT; \{R_5,\{R_8\},\{R_6,\{R_7\}; 4; i\Gamma_{0.3,\Gamma_{3.0}}; i\Gamma_{3.0}; \text{DP}; 0 \]
Accidental degeneracies on high symmetry line

A: $\Gamma Z; C_4^+,\sigma_y,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{3,0}+i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2};$ DP; 0

V: MA; $C_4^+,\sigma_x,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{0,1}+i\Gamma_{3,0}}{\sqrt{2}}, i\Gamma_{0,3}, -i\Gamma_{0,2};$ DP; 0

Y: XM; $\sigma_x, C_2x, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ DP; 0

T: RA; $\sigma_y, C_2x, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ DP; 0

W; XR; $\sigma_y, C_2x, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ DP; 0

Accidental degeneracies on high symmetry line

U; ZR; $\sigma_x, C_2y, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ DP; 0

A: $\Gamma Z; C_4^+,\sigma_y,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{3,0}+i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2};$ DP; 0

V: MA; $C_4^+,\sigma_x,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{0,1}+i\Gamma_{3,0}}{\sqrt{2}}, i\Gamma_{0,3}, -i\Gamma_{0,2};$ DP; 0

S; ZA; $\sigma_x, C_2o, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ DP; 0

Y: XM; $\sigma_y, C_2o, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ DP; 0

W; XR; $\sigma_y, C_2o, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ DP; 0

Accidental degeneracies on high symmetry line

A: $\Gamma Z; C_2^+,\sigma_y,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{3,0}+i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2};$ DP; 0

W; XR; $\sigma_y, C_2z, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ DP; 0

Accidental degeneracies on high symmetry line

U; ZR; $\sigma_x, C_2y, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ DP; 0

A: $\Gamma Z; C_4^+,\sigma_y,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{3,0}+i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2};$ DP; 0

S; ZA; $\sigma_x, C_2o, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ DP; 0

T: RA; $C_{2x}, \sigma_y, IT; \{R_5, R_8\}, \{R_7, R_9\}; 4; -i\Gamma_{0,3}, i\Gamma_{3,0}, i\Gamma_{0,0}, -i\Gamma_{0,2};$ P-DNL;

W; XR; $\sigma_y, C_2x, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{0,2};$ P-DNL;

Accidental degeneracies on high symmetry line

A: $\Gamma Z; C_2^+,\sigma_y,IT; \{R_6\},\{R_7\}; 4; \frac{\Gamma_{3,0}+i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2};$ DP; 0

Y: XM; $C_{2x}, \sigma_y, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ P-DNL;

T: RA; $C_{2x}, \sigma_y, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2};$ P-DNL;
Accidental degeneracies on high symmetry line

$U; ZR; \sigma_z, C_{2y}, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; DP; 0$

$\Lambda; \Gamma Z; C_{4z}^+; \sigma_y, IT; \{R_6\}, \{R_7\}; 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; DP; 0$

$S; ZA; \sigma_z, C_{2a}, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; DP; 0$

$Y; XM; C_{2x}, \sigma_y, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; P-DNL; 0$
SG 131

Accidental degeneracies on high symmetry line

\[ \begin{align*}
\Lambda; \Gamma Z; & \ C_{4z}^+ \sigma_y, IT; \{ R_0 \}, \{ R_7 \}; \quad 4; \frac{\Gamma_{3,0} + \Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
V; \text{MA}; & \ C_{4z}^+ \sigma_y, IT; \{ R_0 \}, \{ R_7 \}; \quad 4; \frac{\Gamma_{3,0} + \Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
S; \text{ZA}; & \ C_{2a,0} \sigma_z, IT; \{ R_0, R_6 \}, \{ R_7, R_8 \}; \quad 4; i\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \quad \text{DP; 0}
\end{align*} \]

SG 132

Accidental degeneracies on high symmetry line

\[ \begin{align*}
U; \text{ZR}; & \ \sigma_z, C_{2y} IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad 4; \Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
\Lambda; \Gamma Z; & \ C_{4z}^+ \sigma_y, IT; \{ R_0 \}, \{ R_7 \}; \quad 4; \frac{\Gamma_{3,0} + \Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
V; \text{MA}; & \ C_{4z}^+ \sigma_y, IT; \{ R_0 \}, \{ R_7 \}; \quad 4; \frac{\Gamma_{3,0} + \Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
T; \text{RA}; & \ \sigma_z, C_{2x} IT; \{ R_6, R_8 \}, \{ R_7, R_7 \}; \quad 4; \Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP; 0}
\end{align*} \]

SG 133

Accidental degeneracies on high symmetry line

\[ \begin{align*}
\Lambda; \Gamma Z; & \ C_{4z}^+ \sigma_y, IT; \{ R_0 \}, \{ R_7 \}; \quad 4; \frac{\Gamma_{3,0} + \Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
V; \text{MA}; & \ C_{4z}^+ \sigma_y, IT; \{ R_0 \}, \{ R_7 \}; \quad 4; -\frac{\Gamma_{3,0} + \Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
S; \text{ZA}; & \ C_{2a,0} \sigma_z, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad 4; i\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
Y; \text{XM}; & \ \sigma_y, C_{2z} IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad 4; \Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
T; \text{RA}; & \ \sigma_y, C_{2x} IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
W; \text{XR}; & \ \sigma_y, C_{2z} IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP; 0}
\end{align*} \]

SG 134

Accidental degeneracies on high symmetry line

\[ \begin{align*}
U; \text{ZR}; & \ \sigma_z, C_{2y} IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad 4; \Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
\Lambda; \Gamma Z; & \ C_{4z}^+ \sigma_y, IT; \{ R_0 \}, \{ R_7 \}; \quad 4; \frac{\Gamma_{3,0} + \Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
V; \text{MA}; & \ C_{4z}^+ \sigma_y, IT; \{ R_0 \}, \{ R_7 \}; \quad 4; -\frac{\Gamma_{3,0} + \Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
Y; \text{XM}; & \ \sigma_y, C_{2z} IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad 4; \Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
W; \text{XR}; & \ \sigma_y, C_{2z} IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP; 0}
\end{align*} \]

SG 135

Accidental degeneracies on high symmetry line

\[ \begin{align*}
\Lambda; \Gamma Z; & \ C_{4z}^+ \sigma_y, IT; \{ R_0 \}, \{ R_7 \}; \quad 4; \frac{\Gamma_{3,0} + \Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
S; \text{ZA}; & \ C_{2a,0} \sigma_z, IT; \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad 4; i\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \quad \text{DP; 0} \\
W; \text{XR}; & \ \sigma_y, C_{2z} IT; \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \quad \text{DP; 0}
\end{align*} \]
Accidental degeneracies on high symmetry line

\[ U; \text{ZR}; \sigma_z, C_2y, IT; \{R_5, R_6\}, \{R_6, R_7\}; 4; i\Gamma_{0.3}, i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{DP}; 0 \]

\[ \Lambda; \Gamma Z; C_{4z}^+, \sigma_y, IT; \{R_6\}, \{R_7\}; 4; \frac{\Gamma_{0.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \text{DP}; 0 \]

\[ T; \text{RA}; C_{2x}, \sigma_z, E, IT; \{R_6, R_9\}, \{R_7, R_8\}; 4; i\Gamma_{0.3}, -i\Gamma_{3.3}, -i\Gamma_{0.2}; \text{P-DNL} \]

\[ W; \text{XR}; \sigma_y, C_{2z}, IT; \{R_5, R_6\}, \{R_7, R_9\}; 4; i\Gamma_{3.0}, i\Gamma_{3.3}, -i\Gamma_{0.2}; \text{P-DNL} \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma Z; C_{4z}^+, \sigma_z, IT; \{R_6\}, \{R_7\}; 4; \frac{\Gamma_{0.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \text{DP}; 0 \]

\[ S; \text{ZA}; C_{2z}, \sigma_z, IT; \{R_5, R_6\}, \{R_7, R_8\}; 4; i\Gamma_{0.3}, i\Gamma_{3.3}, -i\Gamma_{0.2}; \text{DP}; 0 \]

\[ Y; \text{XM}; C_{2z}, \sigma_z, IT; \{R_5, R_7\}, \{R_6, R_8\}; 4; i\Gamma_{0.3}, i\Gamma_{3.3}, -i\Gamma_{0.2}; \text{P-DNL} \]

\[ T; \text{RA}; C_{2z}, \sigma_z, IT; \{R_5, R_7\}, \{R_6, R_8\}; 4; i\Gamma_{0.3}, i\Gamma_{3.3}, -i\Gamma_{0.2}; \text{P-DNL} \]

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Accidental degeneracies on high symmetry line

\[ U; \text{ZR}; \sigma_z, C_{2z}, IT; \{R_5, R_6\}, \{R_6, R_7\}; 4; i\Gamma_{0.3}, i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{DP}; 0 \]

\[ \Lambda; \Gamma Z; C_{4z}^+, \sigma_y, IT; \{R_6\}, \{R_7\}; 4; \frac{\Gamma_{0.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \text{DP}; 0 \]

\[ Y; \text{XM}; C_{2z}, \sigma_z, IT; \{R_5, R_7\}, \{R_6, R_8\}; 4; i\Gamma_{0.3}, i\Gamma_{3.3}, -i\Gamma_{0.2}; \text{P-DNL} \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma A/\Gamma Z; C_{4z}^+, \sigma_y, IT; \{R_6\}, \{R_7\}; 4; \frac{\Gamma_{0.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \text{DP}; 0 \]

\[ V; \text{ZF}; C_{4z}^+, \sigma_y, IT; \{R_6\}, \{R_7\}; 4; \frac{\Gamma_{0.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \text{DP}; 0 \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma A/\Gamma Z; C_{4z}^+, \sigma_y, IT; \{R_6\}, \{R_7\}; 4; \frac{\Gamma_{0.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \text{DP}; 0 \]

\[ V; \text{ZF}; C_{4z}^+, \sigma_y, IT; \{R_6\}, \{R_7\}; 4; \frac{\Gamma_{0.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \text{DP}; 0 \]

\[ Q; \text{NP}; C_{2y}, IT; \{R_2, R_3\}, \{R_4, R_4\}; 4; i\Gamma_{3.0}, -i\Gamma_{0.2}; \text{DP}; 0 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \ \Gamma \Lambda / \Gamma Z; \quad C_{4z}^{\pm} \sigma_y, IT; \quad \{ R_6 \}, \{ R_5 \}; \quad 4; \ \frac{\Gamma_{2,0} + i \Gamma_{2,0}}{\sqrt{2}}, i \Gamma_{0,1}, -i \Gamma_{0,2}; \quad DP; 0 \]

\[ \Gamma; \ \zeta \Lambda, E, IT; \quad \{ R_{15} \}, \{ R_{14} \}; \quad 4; \ \frac{\Gamma_{2,0} + i \Gamma_{3,0}}{\sqrt{2}}, i \Gamma_{0,1}, \Gamma_{0,0}, -i \Gamma_{0,2}; \quad DP; 0 \]

\[ W; \ \chi \Lambda; \quad C_{2z} \sigma_z, IT; \quad \{ R_6, R_8 \}; \quad 4; \ \Gamma_{3,0}, \Gamma_{3,3}, -i \Gamma_{0,2}; \quad DP; 0 \]

\[ Q; \ \psi \Lambda; \quad C_{2y} E, IT; \quad \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad 4; \ i \Gamma_{3,0}, i \Gamma_{3,3}, -i \Gamma_{0,2}; \quad DP; 0 \]

\[ \mu; \ \upsilon \Lambda; \quad C_{2s} \sigma_z, IT; \quad \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad 4; \ i \Gamma_{3,0}, i \Gamma_{3,3}, -i \Gamma_{0,2}; \quad DP; 0 \]

\[ Y; \ \pi \Lambda; \quad C_{2s} \sigma_{da}, IT; \quad \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad 4; \ i \Gamma_{3,0}, i \Gamma_{3,3}, -i \Gamma_{0,2}; \quad DP; 0 \]
Accidental degeneracies on high symmetry line

\( \Delta; \Gamma A; C^+_3; \{R_2\}, \{R_4\}; 2; \sigma_9; C-1 \ WP; 1 \)
\( \{R_2\}, \{R_6\}; 2; \frac{\sigma_9 + i \sqrt{3} \sigma_0}{2}; C-1 \ WP; 1 \)
\( \{R_4\}, \{R_6\}; 2; \sigma_{10}; C-1 \ WP; 1 \)

\( P; \ K H; C^+_3; \{R_2\}, \{R_4\}; 2; \sigma_9; C-1 \ WP; 1 \)
\( \{R_2\}, \{R_6\}; 2; \frac{\sigma_9 + i \sqrt{3} \sigma_0}{2}; C-1 \ WP; 1 \)
\( \{R_4\}, \{R_6\}; 2; \sigma_{10}; C-1 \ WP; 1 \)

Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma A/\Gamma Z; C^+_3; \{R_2\}, \{R_4\}; 2; \sigma_9; C-1 \ WP; 1 \)
\( \{R_2\}, \{R_6\}; 2; \frac{\sigma_9 + i \sqrt{3} \sigma_0}{2}; C-1 \ WP; 1 \)
\( \{R_4\}, \{R_6\}; 2; \sigma_{10}; C-1 \ WP; 1 \)

\( P; \ Z P; C^+_3; \{R_2\}, \{R_4\}; 2; \sigma_9; C-1 \ WP; 1 \)
\( \{R_2\}, \{R_6\}; 2; \frac{\sigma_9 + i \sqrt{3} \sigma_0}{2}; C-1 \ WP; 1 \)
\( \{R_4\}, \{R_6\}; 2; \sigma_{10}; C-1 \ WP; 1 \)

Accidental degeneracies on high symmetry line

\( \Delta; \Gamma A; C^+_3, IT; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; DP; 0 \)
\( P; \ K H; C^+_3, IT; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; DP; 0 \)

Accidental degeneracies on high symmetry line

\( \Lambda; \Gamma A/\Gamma Z; C^+_3, IT; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; DP; 0 \)
\( P; \ Z P; C^+_3, IT; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; DP; 0 \)

Accidental degeneracies on high symmetry line

\( \Delta; \Gamma A; C^+_3, C^+_2, T; \{R_2\}, \{R_4\}; 2; \sigma_9, \sigma_0; \ C-1 \ WP; 1 \)
\( \{R_2\}, \{R_6\}; 2; \frac{\sigma_9 + i \sqrt{3} \sigma_0}{2}, \sigma_0; C-1 \ WP; 1 \)
\( \{R_4\}, \{R_6\}; 2; \sigma_{10}, \sigma_0; C-1 \ WP; 1 \)

\( P; \ K H; C^+_3, C^+_2, T; \{R_2\}, \{R_4\}; 2; \sigma_9, \sigma_0; C-1 \ WP; 1 \)
\( \{R_2\}, \{R_6\}; 2; \frac{\sigma_9 + i \sqrt{3} \sigma_0}{2}, \sigma_0; C-1 \ WP; 1 \)
\( \{R_4\}, \{R_6\}; 2; \sigma_{10}, \sigma_0; C-1 \ WP; 1 \)

\( \Sigma; \Gamma M; C^+_2; \{R_2\}, \{R_4\}; 2; i \sigma_3; C-1 \ WP; 1 \)
\( R; \ A L; C^+_2; \{R_2\}, \{R_4\}; 2; i \sigma_3; C-1 \ WP; 1 \)
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_A; C^+_3, C''_{22} T; \{ R_2 \}, \{ R_4 \}; 2; \sigma_9, \sigma_0; \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \sigma_0 + i \sqrt{3} \sigma_3; \text{C-1 WP; 1} \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10}, \sigma_0; \text{C-1 WP; 1} \]

\[ P; \text{KH}; C^+_3; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_9; \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \sigma_0 + i \sqrt{3} \sigma_3; \text{C-1 WP; 1} \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10}; \text{C-1 WP; 1} \]

\[ T; \text{ΓK}; C''_{22}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3; \text{C-1 WP; 1} \]

\[ S; \text{AH}; C''_{22}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3; \text{C-1 WP; 1} \]

\[ T'; \text{MK}; C''_{21}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3; \text{C-1 WP; 1} \]

\[ S'; \text{LH}; C''_{21}; \]
\[ \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3; \text{C-1 WP; 1} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_3^+ , C_3^T; \{ R_2 \}, \{ R_4 \}; 2; \sigma_9,\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_{9} + i\sqrt{3}\sigma_{6}}{2},\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10},\sigma_0; C-1 \ WP; 1 \]

\[ P; \ K H; C_3^+, C_2^T; \{ R_2 \}, \{ R_4 \}; 2; \sigma_9,\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_{9} + i\sqrt{3}\sigma_{6}}{2},\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10},\sigma_0; C-1 \ WP; 1 \]

\[ \Sigma; \ \Gamma M; C_{21}^; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; C-1 \ WP; 1 \]

\[ R; \ \Lambda L; C_{21}^; \{ R_2 \}, \{ R_8 \}; 2; i\sigma_3; C-1 \ WP; 1 \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \ Gamma; C_3^+, C_2^T; \{ R_2 \}, \{ R_4 \}; 2; \sigma_9,\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_{9} + i\sqrt{3}\sigma_{6}}{2},\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10},\sigma_0; C-1 \ WP; 1 \]

\[ P; \ K H; C_3^+, C_2^T; \{ R_2 \}, \{ R_4 \}; 2; \sigma_9,\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_{9} + i\sqrt{3}\sigma_{6}}{2},\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10},\sigma_0; C-1 \ WP; 1 \]

\[ T; \ \Gamma K; C_{22}^; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; C-1 \ WP; 1 \]

\[ S; \ \Lambda H; C_{22}^; \{ R_6 \}, \{ R_{12} \}; 2; i\sigma_3; C-1 \ WP; 1 \]

\[ T^\prime; \ \Gamma K; C_{21}^; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; C-1 \ WP; 1 \]

\[ S^\prime; \ \Lambda H; C_{21}^; \{ R_2 \}, \{ R_8 \}; 2; i\sigma_3; C-1 \ WP; 1 \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \ Gamma; C_3^+, C_2^T; \{ R_2 \}, \{ R_4 \}; 2; \sigma_9,\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_{9} + i\sqrt{3}\sigma_{6}}{2},\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10},\sigma_0; C-1 \ WP; 1 \]

\[ P; \ K H; C_3^+, C_2^T; \{ R_2 \}, \{ R_4 \}; 2; \sigma_9,\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_{9} + i\sqrt{3}\sigma_{6}}{2},\sigma_0; C-1 \ WP; 1 \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10},\sigma_0; C-1 \ WP; 1 \]

\[ \Sigma; \ \Gamma M; C_{21}^; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; C-1 \ WP; 1 \]

\[ R; \ \Lambda L; C_{21}^; \{ R_6 \}, \{ R_{12} \}; 2; i\sigma_3; C-1 \ WP; 1 \]
Accidental degeneracies on high symmetry line

Δ; ΓA; $C^{+}_{3}, C^{+}_{22} T$: \( \{ R_2 \}, \{ R_4 \}; 2; \sigma_0, \sigma_0; \) C-1 WP; 1
\( \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0; \) C-1 WP; 1
\( \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10}, \sigma_0; \) C-1 WP; 1

P; KH; $C^{+}_{3}$:
\( \{ R_2 \}, \{ R_4 \}; 2; \sigma_0; \) C-1 WP; 1
\( \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}; \) C-1 WP; 1
\( \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10}; \) C-1 WP; 1

T; ΓK; $C^{+}_{22}$:
\( \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \) C-1 WP; 1
\( \{ R_2 \}, \{ R_6 \}; 2; i\sigma_3; \) C-1 WP; 1

S; AH; $C^{+}_{22}$;
\( \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \) C-1 WP; 1

T'; MK; $C^{+}_{21}$;
\( \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \) C-1 WP; 1

S'; LH; $C^{+}_{21}$;
\( \{ R_6 \}, \{ R_{12} \}; 2; i\sigma_3; \) C-1 WP; 1

Accidental degeneracies on high symmetry line

Δ; ΓUA/ΓZ; $C^{+}_{3}, C^{+}_{22} T$: \( \{ R_2 \}, \{ R_4 \}; 2; \sigma_0, \sigma_0; \) C-1 WP; 1
\( \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0; \) C-1 WP; 1
\( \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10}, \sigma_0; \) C-1 WP; 1

P; ZP; $C^{+}_{3}, C^{+}_{22} T$: \( \{ R_2 \}, \{ R_4 \}; 2; \sigma_0, \sigma_0; \) C-1 WP; 1
\( \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0; \) C-1 WP; 1
\( \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10}, \sigma_0; \) C-1 WP; 1

B; ZB; $C^{+}_{21}$:
\( \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \) C-1 WP; 1

Σ; ΓF/ΓΣ; $C^{+}_{21}$:
\( \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \) C-1 WP; 1

Q; FQ; $C^{+}_{23}$:
\( \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \) C-1 WP; 1

Y; LZ/LY; $C^{+}_{22}$:
\( \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \) C-1 WP; 1

Accidental degeneracies on high symmetry line

Δ; ΓA; $C^{+}_{3}, \sigma_{01}$; \( \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, i\sigma_3; \) P-WNLs:
\( \{ R_3 \}, \{ R_6 \}; 3; A_{24, \frac{i(A_0 + 2\sqrt{3}A_{24})}{3}, iA_{10}; TP; 0 \)
\( \{ R_4 \}, \{ R_6 \}; 3; A_{24, \frac{i(A_0 + 2\sqrt{3}A_{24})}{3}, iA_{10}; TP; 0 \)

U; ML; $\sigma_{01}$:
\( \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \) P-WNL;

P; KH; $C^{+}_{3}$:
\( \{ R_2 \}, \{ R_4 \}; 2; \sigma_0; \) C-1 WP; 1
\( \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}; \) C-1 WP; 1
\( \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10}; \) C-1 WP; 1

Σ; ΓM; $\sigma_{01}$:
\( \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \) P-WNL;

R; AL; $\sigma_{01}$:
\( \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3; \) P-WNL;
Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma A; C_{3}^{+}, \sigma_{d1}; \{R_3\}, \{R_4\}; 2; -\sigma_0, i\sigma_3; \quad \text{P-WNLs;} \]
\[ \quad \{R_3\}, \{R_6\}; 3; A_{24}, \frac{i(A_0 + 2\sqrt{3}A_8)}{3}; \text{TP}; \quad 0 \]
\[ \quad \{R_4\}, \{R_6\}; 3; A_{24}, iA_{10}; \text{TP}; \quad 0 \]

\[ U: \text{ML;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; i\sigma_3; \quad \text{P-WNL;} \]

\[ P: \text{KH;} \quad C_{3}^{+}, \sigma_{d1}; \quad \{R_3\}, \{R_4\}; 2; -\sigma_0, i\sigma_3; \quad \text{P-WNLs;} \]
\[ \quad \{R_3\}, \{R_6\}; 3; A_{24}, \frac{i(A_0 + 2\sqrt{3}A_8)}{3}; \text{TP}; \quad 0 \]
\[ \quad \{R_4\}, \{R_6\}; 3; A_{24}, iA_{10}; \text{TP}; \quad 0 \]

\[ T: \text{MK;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; 2; \quad \text{P-WNL;} \]

\[ S: \text{AH;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; 2; \quad \text{P-WNL;} \]

\[ S': \text{LH;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; 2; \quad \text{P-WNL;} \]

Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma A; C_{3}^{+}, \sigma_{d1}; \{R_3\}, \{R_4\}; 2; -\sigma_0, i\sigma_3; \quad \text{P-WNLs;} \]
\[ \quad \{R_3\}, \{R_6\}; 3; A_{24}, \frac{i(A_0 + 2\sqrt{3}A_8)}{3}; \text{TP}; \quad 0 \]
\[ \quad \{R_4\}, \{R_6\}; 3; A_{24}, iA_{10}; \text{TP}; \quad 0 \]

\[ U: \text{ML;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; i\sigma_3; \quad \text{P-WNL;} \]

\[ P: \text{KH;} \quad C_{3}^{+}, \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; \sigma_3; \quad \text{C-1 WP;} \quad 1 \]
\[ \quad \{R_2\}, \{R_6\}; 2; \sigma_0, i\sigma_3; \quad \text{C-1 WP;} \quad 1 \]
\[ \quad \{R_3\}, \{R_6\}; 2; \sigma_10; \quad \text{C-1 WP;} \quad 1 \]

\[ \Sigma: \text{GM;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; i\sigma_3; \quad \text{P-WNL;} \]

\[ R: \text{AL;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; i\sigma_3; \quad \text{P-WNL;} \]

Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma A; C_{3}^{+}, \sigma_{d1}; \{R_3\}, \{R_4\}; 2; -\sigma_0, i\sigma_3; \quad \text{P-WNLs;} \]
\[ \quad \{R_3\}, \{R_6\}; 3; A_{24}, \frac{i(A_0 + 2\sqrt{3}A_8)}{3}; \text{TP}; \quad 0 \]
\[ \quad \{R_4\}, \{R_6\}; 3; A_{24}, iA_{10}; \text{TP}; \quad 0 \]

\[ U: \text{ML;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; i\sigma_3; \quad \text{P-WNL;} \]

\[ P: \text{KH;} \quad C_{3}^{+}, \sigma_{d1}; \quad \{R_3\}, \{R_4\}; 2; -\sigma_0, i\sigma_3; \quad \text{P-WNLs;} \]
\[ \quad \{R_3\}, \{R_6\}; 3; A_{24}, \frac{i(A_0 + 2\sqrt{3}A_8)}{3}; \text{TP}; \quad 0 \]
\[ \quad \{R_4\}, \{R_6\}; 3; A_{24}, iA_{10}; \text{TP}; \quad 0 \]

\[ T: \text{MK;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; i\sigma_3; \quad \text{P-WNL;} \]

\[ S: \text{AH;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; i\sigma_3; \quad \text{P-WNL;} \]

\[ S': \text{LH;} \quad \sigma_{d1}; \quad \{R_2\}, \{R_4\}; 2; i\sigma_3; \quad \text{P-WNL;} \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma \Lambda / \Gamma Z; C^+_3, \sigma_{d1}; \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, i\sigma_3; \text{ P-WNLs; } \]
\[ \{ R_3 \}, \{ R_6 \}; 3; A_{24}, \frac{i(A_0 + 2\sqrt{3}A_8)}{3}; \text{ TP; 0} \]
\[ \{ R_3 \}, \{ R_6 \}; 3; A_{24}, iA_{10}; \text{ TP; 0} \]

\[ P; ZP; C^+_3, \sigma_{d1}; \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, i\sigma_3; \text{ P-WNLs; } \]
\[ \{ R_3 \}, \{ R_6 \}; 3; A_{24}, \frac{i(A_0 + 2\sqrt{3}A_8)}{3}; \text{ TP; 0} \]
\[ \{ R_4 \}, \{ R_6 \}; 3; A_{24}, iA_{10}; \text{ TP; 0} \]
### SG 161

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma \Lambda / \Gamma Z; C_3^+ \sigma_{d1}; \{ R_3 \}, \{ R_4 \}; 2; -\sigma_3, i\sigma_3; \quad \text{P-WNLs}; \]
\[ \{ R_3 \}, \{ R_6 \}; 3; A_{24}, \frac{i(A_0 + 2\sqrt{3}A_8)}{4}; \text{TP}; \quad 0 \]
\[ \{ R_4 \}, \{ R_6 \}; 3; A_{24}, iA_{10}; \text{TP}; \quad 0 \]

\[ P; ZP; \quad C_3^+ \sigma_{d1}; \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, i\sigma_3; \quad \text{P-WNLs}; \]
\[ \{ R_3 \}, \{ R_6 \}; 3; A_{24}, \frac{i(A_0 + 2\sqrt{3}A_8)}{4}; \text{TP}; \quad 0 \]
\[ \{ R_4 \}, \{ R_6 \}; 3; A_{24}, iA_{10}; \text{TP}; \quad 0 \]

### SG 162

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma \Lambda; C_3^+ \sigma_{d1}, IT; \{ R_3, R_4 \}, \{ R_6 \}; 4; \Gamma_{13}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]
\[ P; KH; C_3^+ \sigma_{d1}, IT; \{ R_3, R_4 \}, \{ R_6 \}; 4; \Gamma_{13}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]

### SG 163

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma \Lambda; C_3^+ \sigma_{v1}, IT; \{ R_3, R_4 \}, \{ R_6 \}; 4; \Gamma_{13}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]
\[ P; KH; C_3^+ \sigma_{v1}, IT; \{ R_3, R_4 \}, \{ R_6 \}; 4; \Gamma_{13}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]
\[ R; AL; C_2^{21}, E, IT; \{ R_5, R_3 \}, \{ R_7, R_7 \}; 4; -i\Gamma_{3,0}, \Gamma_{0,0}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]

### SG 164

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma \Lambda; C_3^+ \sigma_{v1}, IT; \{ R_3, R_4 \}, \{ R_6 \}; 4; \Gamma_{13}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]
\[ P; KH; C_3^+ \sigma_{v1}, IT; \{ R_2, R_6 \}, \{ R_4, R_4 \}; 4; \Gamma_{12}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]

### SG 165

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma \Lambda; C_3^+ \sigma_{v1}, IT; \{ R_3, R_4 \}, \{ R_6 \}; 4; \Gamma_{13}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]
\[ P; KH; C_3^+ \sigma_{v1}, IT; \{ R_2, R_6 \}, \{ R_4, R_4 \}; 4; \Gamma_{12}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]
\[ S; AH; C_2^{22}, E, IT; \{ R_5, R_3 \}, \{ R_7, R_7 \}; 4; -i\Gamma_{3,0}, \Gamma_{0,0}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]
\[ S'; LH; C_2^{22}, E, IT; \{ R_5, R_3 \}, \{ R_7, R_7 \}; 4; -i\Gamma_{3,0}, \Gamma_{0,0}, -i\Gamma_{0,2}; \text{DP}; \quad 0 \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma/\Gamma Z; C_3^+ \sigma_{d1}, IT; \{R_3, R_4\}, \{R_6\}; 4; \Gamma_{13}, \Gamma_{0,3}, -\Gamma_{0,2}; DP; 0 \]

\[ P; ZP; C_3^+ \sigma_{d1}, IT; \{R_3, R_4\}, \{R_6\}; 4; \Gamma_{13}, \Gamma_{0,3}, -\Gamma_{0,2}; DP; 0 \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma/\Gamma Z; C_3^+ \sigma_{d1}, IT; \{R_3, R_4\}, \{R_6\}; 4; \Gamma_{13}, \Gamma_{0,3}, -\Gamma_{0,2}; DP; 0 \]

\[ P; ZP; C_3^+ \sigma_{d1}, IT; \{R_3, R_4\}, \{R_6\}; 4; \Gamma_{13}, \Gamma_{0,3}, -\Gamma_{0,2}; DP; 0 \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_6^+ \{R_2\}, \{R_{16}\}; 2; \sigma_{12}; C-2 WP; 2 \]

\[ \{R_2\}, \{R_{12}\}; 2; \frac{\sqrt{3} \sigma_{\theta} \sigma_3}{2}; C-1 WP; 1 \]

\[ \{R_2\}, \{R_{4}\}; 2; \sigma_{11}; C-1 WP; 1 \]

\[ \{R_2\}, \{R_{6}\}; 2; \frac{\sqrt{3} \sigma_{\theta} \sigma_3}{2}; C-2 WP; 2 \]

\[ \{R_2\}, \{R_8\}; 2; \sqrt{-1} \sigma_3; C-3 WP; 3 \]

\[ \{R_4\}, \{R_{10}\}; 2; i \sigma_3; C-3 WP; 3 \]

\[ \{R_4\}, \{R_{12}\}; 2; \sigma_{15}; C-2 WP; 2 \]

\[ \{R_4\}, \{R_{6}\}; 2; \sigma_{13}; C-1 WP; 1 \]

\[ \{R_4\}, \{R_8\}; 2; \sigma_{14}; C-2 WP; 2 \]

\[ \{R_6\}, \{R_{10}\}; 2; \sigma_{16}; C-2 WP; 2 \]

\[ \{R_6\}, \{R_{12}\}; 2; (-1)^{3/6} \sigma_3; C-3 WP; 3 \]

\[ \{R_8\}, \{R_8\}; 2; \frac{-\sqrt{3} \sigma_{\theta} \sigma_3}{2} + i \sigma_3; C-1 WP; 1 \]

\[ \{R_8\}, \{R_{10}\}; 2; \sigma_{17}; C-1 WP; 1 \]

\[ \{R_8\}, \{R_{12}\}; 2; \frac{(\theta_0 - i \sqrt{3} \sigma_3)}{2}; C-2 WP; 2 \]

\[ \{R_{10}\}, \{R_{12}\}; 2; \sigma_{18}; C-1 WP; 1 \]

\[ U; ML; C_2; \{R_2\}, \{R_{4}\}; 2; i \sigma_3; C-1 WP; 1 \]

\[ P; KH; C_3^+ \{R_2\}, \{R_{4}\}; 2; \sigma_9; C-1 WP; 1 \]

\[ \{R_2\}, \{R_{6}\}; 2; \frac{\sqrt{3} \sigma_{\theta} \sigma_3}{2} + i \sigma_3; C-1 WP; 1 \]

\[ \{R_4\}, \{R_{6}\}; 2; \sigma_{10}; C-1 WP; 1 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_6^2; \{ R_2 \}, \{ R_{10} \}; 2; \sigma_{12}; \quad \text{C-2 WP; 2} \]
\[ \{ R_2 \}, \{ R_{12} \}; 2; \sqrt[3]{\sigma_0 + i\sigma_3}; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_{11}; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \sqrt[3]{\sigma_3 + i\sigma_0}; \quad \text{C-2 WP; 2} \]
\[ \{ R_2 \}, \{ R_8 \}; 2; \sqrt[3]{-i\sigma_3}; \quad \text{C-3 WP; 3} \]
\[ \{ R_1 \}, \{ R_{10} \}; 2; i\sigma_3; \quad \text{C-3 WP; 3} \]
\[ \{ R_4 \}, \{ R_{12} \}; 2; \sigma_{15}; \quad \text{C-2 WP; 2} \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{13}; \quad \text{C-1 WP; 1} \]
\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{14}; \quad \text{C-2 WP; 2} \]
\[ \{ R_6 \}, \{ R_{10} \}; 2; \sigma_{10}; \quad \text{C-2 WP; 2} \]
\[ \{ R_6 \}, \{ R_{12} \}; 2; \sigma_{19}; \quad \text{C-1 WP; 1} \]
\[ \{ R_6 \}, \{ R_8 \}; 2; \sigma_{17}; \quad \text{C-1 WP; 1} \]
\[ \{ R_8 \}, \{ R_{10} \}; 2; \sigma_{13}; \quad \text{C-1 WP; 1} \]
\[ \{ R_8 \}, \{ R_{12} \}; 2; \sigma_{15}; \quad \text{C-2 WP; 2} \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{13}; \quad \text{C-1 WP; 1} \]
\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{14}; \quad \text{C-2 WP; 2} \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_6^2; \{ R_2 \}, \{ R_{10} \}; 2; \sigma_{12}; \quad \text{C-2 WP; 2} \]
\[ \{ R_2 \}, \{ R_{12} \}; 2; \sqrt[3]{\sigma_0 + i\sigma_3}; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_{11}; \quad \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \sqrt[3]{\sigma_3 + i\sigma_0}; \quad \text{C-2 WP; 2} \]
\[ \{ R_2 \}, \{ R_8 \}; 2; \sqrt[3]{-i\sigma_3}; \quad \text{C-3 WP; 3} \]
\[ \{ R_4 \}, \{ R_{10} \}; 2; i\sigma_3; \quad \text{C-3 WP; 3} \]
\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{14}; \quad \text{C-2 WP; 2} \]
\[ \{ R_6 \}, \{ R_{10} \}; 2; \sigma_{10}; \quad \text{C-2 WP; 2} \]
\[ \{ R_6 \}, \{ R_{12} \}; 2; \sigma_{19}; \quad \text{C-1 WP; 1} \]
\[ \{ R_6 \}, \{ R_8 \}; 2; \sigma_{17}; \quad \text{C-1 WP; 1} \]
\[ \{ R_8 \}, \{ R_{10} \}; 2; \sigma_{13}; \quad \text{C-1 WP; 1} \]
\[ \{ R_8 \}, \{ R_{12} \}; 2; \sigma_{15}; \quad \text{C-2 WP; 2} \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{13}; \quad \text{C-1 WP; 1} \]
\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{14}; \quad \text{C-2 WP; 2} \]
\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{10}; \quad \text{C-1 WP; 1} \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_A; C_6^+; \{ R_2 \}, \{ R_{10} \}; 2; \sigma_{12}; \text{C-2 WP; 2} \]
\[ \{ R_2 \}, \{ R_{12} \}; 2; \frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}; \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_{11}; \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{\sqrt{3} \sigma_3 + i \sigma_0}{2}; \text{C-2 WP; 2} \]
\[ \{ R_2 \}, \{ R_8 \}; 2; \sqrt{-1} \sigma_3; \text{C-3 WP; 3} \]
\[ \{ R_4 \}, \{ R_{10} \}; 2; i \sigma_3; \text{C-3 WP; 3} \]
\[ \{ R_4 \}, \{ R_{12} \}; 2; \sigma_{15}; \text{C-2 WP; 2} \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{13}; \text{C-1 WP; 1} \]
\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{14}; \text{C-2 WP; 2} \]
\[ \{ R_6 \}, \{ R_{10} \}; 2; \sigma_{16}; \text{C-2 WP; 2} \]
\[ \{ R_6 \}, \{ R_{12} \}; 2; \frac{(-1)^{5/6} \sigma_3}{2}; \text{C-3 WP; 3} \]
\[ \{ R_8 \}, \{ R_8 \}; 2; \frac{-\sqrt{3} \sigma_0 + i \sigma_3}{2}; \text{C-1 WP; 1} \]
\[ \{ R_8 \}, \{ R_{10} \}; 2; \sigma_{17}; \text{C-1 WP; 1} \]
\[ \{ R_8 \}, \{ R_{12} \}; 2; \frac{(\sigma_0 - i \sqrt{3} \sigma_3)}{2}; \text{C-2 WP; 2} \]
\[ \{ R_{10} \}, \{ R_{12} \}; 2; \sigma_{18}; \text{C-1 WP; 1} \]

\[ U; \text{ML}; C_2; \{ R_2 \}, \{ R_4 \}; 2; i \sigma_3; \text{C-1 WP; 1} \]

\[ P; \text{KH}; C_3^+; \{ R_2 \}, \{ R_4 \}; 2; \sigma_9; \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_9 + i \sqrt{3} \sigma_3}{2}; \text{C-1 WP; 1} \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{10}; \text{C-1 WP; 1} \]
Accidental degeneracies on high symmetry line

\[ \Delta \cdot \Gamma A; C_6^+; \{ R_2 \}, \{ R_{10} \}; 2; \sigma_{12}; C-2 WP; 2 \]

\[ \{ R_2 \}, \{ R_{12} \}; 2; \sqrt{3} \sigma_{0+io_3}; C-1 WP; 1 \]

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_11; C-1 WP; 1 \]

\[ \{ R_2 \}, \{ R_6 \}; 2; \sqrt{3} \sigma_{0+io_3}; C-2 WP; 2 \]

\[ \{ R_2 \}, \{ R_8 \}; 2; \sqrt[3]{-i} \sigma_3; C-3 WP; 3 \]

\[ \{ R_4 \}, \{ R_{10} \}; 2; i \sigma_3; C-3 WP; 3 \]

\[ \{ R_4 \}, \{ R_{12} \}; 2; \sigma_{15}; C-2 WP; 2 \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{13}; C-1 WP; 1 \]

\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{14}; C-2 WP; 2 \]

\[ \{ R_6 \}, \{ R_{10} \}; 2; \sigma_{16}; C-2 WP; 2 \]

\[ \{ R_6 \}, \{ R_{12} \}; 2; (-1)^{5/6} \sigma_3; C-3 WP; 3 \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \sqrt{3} \sigma_{0+io_3}; C-1 WP; 1 \]

\[ \{ R_8 \}, \{ R_{10} \}; 2; i \sigma_3; C-3 WP; 3 \]

\[ \{ R_8 \}, \{ R_{12} \}; 2; \sigma_{15}; C-2 WP; 2 \]

\[ \{ R_8 \}, \{ R_6 \}; 2; \sigma_0 + i \sqrt[3]{3} \sigma_3; C-1 WP; 1 \]

\[ \{ R_4 \}, \{ R_{10} \}; 2; \sigma_{10}; C-1 WP; 1 \]

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Accidental degeneracies on high symmetry line

\[ \Delta \cdot \Gamma A; C_6^+; \{ R_2 \}, \{ R_{10} \}; 2; \sigma_{12}; C-2 WP; 2 \]

\[ \{ R_2 \}, \{ R_{12} \}; 2; \sqrt{3} \sigma_{0+io_3}; C-1 WP; 1 \]

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_11; C-1 WP; 1 \]

\[ \{ R_2 \}, \{ R_6 \}; 2; \sqrt{3} \sigma_{0+io_3}; C-2 WP; 2 \]

\[ \{ R_2 \}, \{ R_8 \}; 2; \sqrt[3]{-i} \sigma_3; C-3 WP; 3 \]

\[ \{ R_4 \}, \{ R_{10} \}; 2; i \sigma_3; C-3 WP; 3 \]

\[ \{ R_4 \}, \{ R_{12} \}; 2; \sigma_{15}; C-2 WP; 2 \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{13}; C-1 WP; 1 \]

\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{14}; C-2 WP; 2 \]

\[ \{ R_6 \}, \{ R_{10} \}; 2; \sigma_{16}; C-2 WP; 2 \]

\[ \{ R_6 \}, \{ R_{12} \}; 2; (-1)^{5/6} \sigma_3; C-3 WP; 3 \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \sqrt{3} \sigma_{0+io_3}; C-1 WP; 1 \]

\[ \{ R_8 \}, \{ R_{10} \}; 2; i \sigma_3; C-3 WP; 3 \]

\[ \{ R_8 \}, \{ R_{12} \}; 2; \sigma_{15}; C-2 WP; 2 \]

\[ \{ R_8 \}, \{ R_6 \}; 2; \sigma_0 + i \sqrt[3]{3} \sigma_3; C-1 WP; 1 \]

\[ \{ R_4 \}, \{ R_{10} \}; 2; \sigma_{10}; C-1 WP; 1 \]

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Accidental degeneracies on high symmetry line

\[ \Delta \cdot \Gamma A; C_6^+; \{ R_2 \}, \{ R_{10} \}; 2; \sigma_{12}; C-2 WP; 2 \]

\[ \{ R_2 \}, \{ R_{12} \}; 2; \sqrt{3} \sigma_{0+io_3}; C-1 WP; 1 \]

\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_11; C-1 WP; 1 \]

\[ \{ R_2 \}, \{ R_6 \}; 2; \sqrt{3} \sigma_{0+io_3}; C-2 WP; 2 \]

\[ \{ R_2 \}, \{ R_8 \}; 2; \sqrt[3]{-i} \sigma_3; C-3 WP; 3 \]

\[ \{ R_4 \}, \{ R_{10} \}; 2; i \sigma_3; C-3 WP; 3 \]

\[ \{ R_4 \}, \{ R_{12} \}; 2; \sigma_{15}; C-2 WP; 2 \]

\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{13}; C-1 WP; 1 \]

\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{14}; C-2 WP; 2 \]

\[ \{ R_6 \}, \{ R_{10} \}; 2; \sigma_{16}; C-2 WP; 2 \]

\[ \{ R_6 \}, \{ R_{12} \}; 2; (-1)^{5/6} \sigma_3; C-3 WP; 3 \]

\[ \{ R_6 \}, \{ R_8 \}; 2; \sqrt{3} \sigma_{0+io_3}; C-1 WP; 1 \]

\[ \{ R_8 \}, \{ R_{10} \}; 2; i \sigma_3; C-3 WP; 3 \]

\[ \{ R_8 \}, \{ R_{12} \}; 2; \sigma_{15}; C-2 WP; 2 \]

\[ \{ R_8 \}, \{ R_6 \}; 2; \sigma_0 + i \sqrt[3]{3} \sigma_3; C-1 WP; 1 \]

\[ \{ R_4 \}, \{ R_{10} \}; 2; \sigma_{10}; C-1 WP; 1 \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_A; \sigma_h, i\sigma_A; C \equiv \{R_2, R_6\}, \{R_4, R_6\}; 3; \frac{\sqrt{3}(A_{2}+A_{0})}{2}, A_{25}; \text{TP}; 0 \]

\[ P; \text{KH}; C_{3}^{+}, 3 \equiv \{R_2\}, \{R_4\}; 2; \sigma_9; \text{C-1 WP}; 1 \]
\[ \{R_2\}, \{R_4\}; 2; \frac{\sqrt{3}(A_{2}+iA_{0})}{2}; \text{C-1 WP}; 1 \]
\[ \{R_4\}, \{R_6\}; 2; \sigma_{10}; \text{C-1 WP}; 1 \]

\[ T; \Gamma_K; \sigma_h; \{R_2\}, \{R_3\}; 2; i\sigma_3; \text{P-WNL}; \]

\[ S; \Gamma_M; \sigma_h; \{R_2\}, \{R_4\}; 2; i\sigma_3; \text{P-WNL}; \]

\[ T'; \Gamma_M; \sigma_h; \{R_2\}, \{R_4\}; 2; i\sigma_3; \text{P-WNL}; \]

\[ S'; \Gamma_L; \sigma_h; \{R_2\}, \{R_4\}; 2; i\sigma_3; \text{P-WNL}; \]

\[ \Sigma; \Gamma_M; \sigma_h; \{R_2\}, \{R_4\}; 2; i\sigma_3; \text{P-WNL}; \]

\[ R; AL; \sigma_h; \{R_2\}, \{R_4\}; 2; i\sigma_3; \text{P-WNL}; \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_A; C_{0}^{+}, 3 \equiv \{R_2, R_{12}\}, \{R_4, R_{10}\}; 4; \Gamma_{14}, -i\Gamma_{0,2}; \text{DP}; 0 \]
\[ \{R_2, R_{12}\}, \{R_6, R_8\}; 4; \frac{\sqrt{3}(A_{3,0}+i\Gamma_{0,2})}{2}, -i\Gamma_{0,2}; \text{QDP}; 0 \]
\[ \{R_4, R_{10}\}, \{R_6, R_8\}; 4; \Gamma_{15}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ P; \text{KH}; C_{3}^{+}, 3 \equiv \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; \text{DP}; 0 \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_A; C_{0}^{+}, 3 \equiv \{R_2, R_{12}\}, \{R_4, R_{10}\}; 4; \Gamma_{14}, -i\Gamma_{0,2}; \text{DP}; 0 \]
\[ \{R_2, R_{12}\}, \{R_6, R_8\}; 4; \frac{\sqrt{3}(A_{3,0}+i\Gamma_{0,2})}{2}, -i\Gamma_{0,2}; \text{QDP}; 0 \]
\[ \{R_4, R_{10}\}, \{R_6, R_8\}; 4; \Gamma_{15}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ P; \text{KH}; C_{3}^{+}, 3 \equiv \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ S; \text{AH}; \sigma_h, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]

\[ S'; \text{AH}; \sigma_h, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]

\[ R; \text{AL}; \sigma_h, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]

\[ \text{S' } \text{LH}; \sigma_h, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]
Accidental degeneracies on high symmetry line

| $\Delta$ | $\Gamma_A$ | $C_{12}^+C_{23}^T$ | $\{R_2\} \cdot \{R_{10}\}$ | 2 | $\sigma_{12}, \sigma_0$, C-2 WP; 2 |
| --- | --- | --- | --- | --- | --- |
| $\{R_2\} \cdot \{R_{12}\}$ | 2 | $\frac{\sqrt{\sigma_0 + i\sigma_3}}{2}, \sigma_0$; C-1 WP; 1 |
| $\{R_2\} \cdot \{R_4\}$ | 2 | $\sigma_{11}, \sigma_0$, C-1 WP; 1 |
| $\{R_2\} \cdot \{R_6\}$ | 2 | $\frac{\sqrt{\sigma_0 + i\sigma_3}}{2}, \sigma_0$; C-2 WP; 2 |
| $\{R_2\} \cdot \{R_8\}$ | 2 | $\frac{\sqrt{\sigma_0 + i\sigma_3}}{2}, \sigma_0$; C-2 WP; 2 |
| $\{R_4\} \cdot \{R_{10}\}$ | 2 | $i\sigma_3, \sigma_0$, C-3 WP; 3 |
| $\{R_4\} \cdot \{R_{12}\}$ | 2 | $\sigma_{15}, \sigma_0$, C-2 WP; 2 |
| $\{R_4\} \cdot \{R_6\}$ | 2 | $\sigma_{13}, \sigma_0$, C-1 WP; 1 |
| $\{R_4\} \cdot \{R_8\}$ | 2 | $\sigma_{14}, \sigma_0$, C-2 WP; 2 |
| $\{R_6\} \cdot \{R_{10}\}$ | 2 | $\sigma_{16}, \sigma_0$, C-2 WP; 2 |
| $\{R_6\} \cdot \{R_{12}\}$ | 2 | $\left(-1\right)^{\gamma/6} \sigma_3, \sigma_0$, C-3 WP; 3 |
| $\{R_6\} \cdot \{R_8\}$ | 2 | $\frac{\sqrt{\sigma_0 + i\sigma_3}}{2}, \sigma_0$; C-1 WP; 1 |
| $\{R_8\} \cdot \{R_{10}\}$ | 2 | $\sigma_{17}, \sigma_0$, C-1 WP; 1 |
| $\{R_8\} \cdot \{R_{12}\}$ | 2 | $\frac{\sigma_3 - i\sqrt{3}\sigma_0}{2}, \sigma_0$; C-2 WP; 2 |
| $\{R_{10}\} \cdot \{R_{12}\}$ | 2 | $\sigma_{18}, \sigma_0$, C-1 WP; 1 |

**U:** $C_{21} \cdot C_0'' \cdot T$; $\{R_2\} \cdot \{R_4\}$; 2; $i\sigma_3, \sigma_0$, C-1 WP; 1

**P:** $C_{12}^+ \cdot C_{23}^T$; $\{R_2\} \cdot \{R_4\}$; 2; $\sigma_0, \sigma_0$, C-1 WP; 1

| $\{R_2\} \cdot \{R_6\}$ | 2 | $\frac{\sigma_3 + i\sqrt{3}\sigma_0}{2}, \sigma_0$; C-1 WP; 1 |
| $\{R_4\} \cdot \{R_6\}$ | 2 | $\sigma_{10}, \sigma_0$, C-1 WP; 1 |

**T:** $\Gamma_K$; $C_{22}^\prime \cdot C_{22}^\prime \cdot T$; $\{R_2\} \cdot \{R_4\}$; 2; $i\sigma_3, \sigma_0$, C-1 WP; 1

**S:** $\Gamma_H$; $C_{22}'' \cdot C_{22}'' \cdot T$; $\{R_2\} \cdot \{R_4\}$; 2; $i\sigma_3, \sigma_0$, C-1 WP; 1

**T':** $\gamma K$; $C_{12}^\prime \cdot C_{22}^T$; $\{R_2\} \cdot \{R_4\}$; 2; $i\sigma_3, \sigma_0$, C-1 WP; 1

**S':** $\gamma H$; $C_{21}^\prime \cdot C_{22}^T$; $\{R_2\} \cdot \{R_4\}$; 2; $i\sigma_3, \sigma_0$, C-1 WP; 1

**$\Sigma$:** $\gamma M$; $C_{21}^\prime \cdot C_{22}^T$; $\{R_2\} \cdot \{R_4\}$; 2; $i\sigma_3, \sigma_0$, C-1 WP; 1

**R:** $\gamma L$; $C_{21}^\prime \cdot C_{22}^T$; $\{R_2\} \cdot \{R_4\}$; 2; $i\sigma_3, \sigma_0$, C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma_A; C_6^+; C_{21}^{\prime}\Gamma_T; \{R_2\}, \{R_{10}\}; \begin{array}{ll}
  2; & \sigma_{12}, \sigma_0; \\
  2; & \frac{\sqrt{3}\sigma_9 + i\sigma_3}{\sqrt{2}}, \sigma_0; \\
  2; & \sigma_{11}, \sigma_0; \\
  2; & \frac{\sqrt{3}\sigma_9 + i\sigma_3}{\sqrt{2}}, \sigma_0; \\
  2; & \sqrt{-1}\sigma_3, \sigma_0; \\
  2; & i\sigma_3, \sigma_0; \\
  2; & \frac{\sigma_9 - i\sqrt{3}\sigma_3}{\sqrt{2}}, \sigma_0; \\
  2; & \sigma_{18}, \sigma_0; \\
  2; & i\sigma_3, \sigma_0; \\
\end{array} \]

\[ \{R_4\}, \{R_6\}; \begin{array}{ll}
  2; & \sigma_{13}, \sigma_0; \\
  2; & \sigma_{14}, \sigma_0; \\
  2; & \sigma_{15}, \sigma_0; \\
  2; & \sigma_{16}, \sigma_0; \\
  2; & \sigma_{17}, \sigma_0; \\
  2; & \sigma_{18}, \sigma_0; \\
\end{array} \]

\[ U; ML; C_2; C_3^{\prime}\Gamma_T; \{R_2\}, \{R_4\}; \begin{array}{ll}
  2; & \sigma_9, \sigma_0; \\
  2; & i\sigma_3, \sigma_0; \\
\end{array} \]

\[ P; KH; C_3^{+}; C_{22}\Gamma_T; \{R_2\}, \{R_4\}; \begin{array}{ll}
  2; & \sigma_9, \sigma_0; \\
  2; & i\sigma_3, \sigma_0; \\
\end{array} \]

\[ T; \Gamma_K; C_{21}^{\prime}, C_{22}\Gamma_T; \{R_2\}, \{R_4\}; \begin{array}{ll}
  2; & \sigma_9, \sigma_0; \\
\end{array} \]

\[ T'; MK; C_{21}^{\prime}, C_2\Gamma_T; \{R_2\}, \{R_4\}; \begin{array}{ll}
  2; & \sigma_9, \sigma_0; \\
\end{array} \]

\[ \Sigma; \Gamma_M; C_{21}^{\prime}, C_{22}\Gamma_T; \{R_2\}, \{R_4\}; \begin{array}{ll}
  2; & \sigma_9, \sigma_0; \\
\end{array} \]
Accidental degeneracies on high symmetry line

| Symmetry | Operation | Operators | WP |
|----------|-----------|-----------|----|
| $\Delta$ | $\Gamma_A$; $C_{1}^+C_{21}^T$, $\{R_2\}$, $\{R_{10}\}$ | $\{\sigma_{12}, \sigma_0\}$ | C-2 |
| | $\{R_2\}$, $\{R_{12}\}$ | $\frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}, \sigma_0$ | C-1 |
| | $\{R_2\}$, $\{R_4\}$ | $\sigma_{11}, \sigma_0$ | C-1 |
| | $\{R_2\}$, $\{R_6\}$ | $\frac{\sqrt{3} \sigma_0 + i \sigma_3}{2}, \sigma_0$ | C-2 |
| | $\{R_2\}$, $\{R_8\}$ | $\sqrt{-1} \sigma_3, \sigma_0$ | C-3 |
| | $\{R_4\}$, $\{R_{10}\}$ | $i \sigma_3, \sigma_0$ | C-3 |
| | $\{R_4\}$, $\{R_6\}$ | $\sigma_{13}, \sigma_0$ | C-1 |
| | $\{R_4\}$, $\{R_8\}$ | $\sigma_{14}, \sigma_0$ | C-2 |
| | $\{R_6\}$, $\{R_{10}\}$ | $\sigma_{16}, \sigma_0$ | C-2 |
| | $\{R_6\}$, $\{R_{12}\}$ | $(-1)^{5/6} \sigma_3, \sigma_0$ | C-3 |
| | $\{R_8\}$, $\{R_{10}\}$ | $\frac{\sigma_0 - i \sqrt{3} \sigma_3}{2}, \sigma_0$ | C-2 |
| | $\{R_8\}$, $\{R_{12}\}$ | $\sigma_{17}, \sigma_0$ | C-1 |
| | $\{R_{10}\}$, $\{R_{12}\}$ | $\sigma_{18}, \sigma_0$ | C-1 |
| $U$ | $\Gamma_A$; $C_{2}, C_{21}^\alpha T$, $\{R_2\}$, $\{R_4\}$ | $i \sigma_3, \sigma_0$ | C-1 |
| | $\{R_2\}$, $\{R_4\}$ | $\sigma_0, \sigma_0$ | C-1 |
| $P$ | $\Gamma_A$; $C_{3}^+ C_{22}^T$, $\{R_2\}$, $\{R_4\}$ | $\sigma_0, \sigma_0$ | C-1 |
| | $\{R_2\}$, $\{R_6\}$ | $\frac{\sigma_0 + i \sqrt{3} \sigma_3}{2}, \sigma_0$ | C-1 |
| | $\{R_4\}$, $\{R_6\}$ | $\sigma_{10}, \sigma_0$ | C-1 |
| $T'$ | $\Gamma_A$; $C_{22}^\alpha C_{22}^T$, $\{R_2\}$, $\{R_4\}$ | $i \sigma_3, \sigma_0$ | C-1 |
| | $\{R_2\}$, $\{R_4\}$ | $i \sigma_3, \sigma_0$ | C-1 |
| | $\Sigma$ | $\Gamma_A$; $C_{21}^\alpha C_{21}^T$, $\{R_2\}$, $\{R_4\}$ | $i \sigma_3, \sigma_0$ | C-1 |
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_6^+ C_{21} T; \{ R_2 \}, \{ R_{10} \} \]: 2; \[ \sigma_{12}, \sigma_0; C-2 \) WP; 2

\[ \{ R_2 \}, \{ R_{12} \} \]: 2; \[ \sqrt{\sigma_0 + i\sigma_3}, \sigma_0; C-1 \) WP; 1

\[ \{ R_2 \}, \{ R_4 \} \]: 2; \[ \sigma_{11}, \sigma_0; C-1 \) WP; 1

\[ \{ R_2 \}, \{ R_6 \} \]: 2; \[ \frac{\sqrt{+i\sigma_3}}{2}, \sigma_0; C-2 \) WP; 2

\[ \{ R_4 \}, \{ R_8 \} \]: 2; \[ \frac{\sqrt{-i\sigma_3}}{2}, \sigma_0; C-3 \) WP; 3

\[ \{ R_4 \}, \{ R_{10} \} \]: 2; \[ i\sigma_3, \sigma_0; C-3 \) WP; 3

\[ \{ R_6 \}, \{ R_{12} \} \]: 2 \( (-1)^{\beta/6}\sigma_3, \sigma_0; C-3 \) WP; 3

\[ \{ R_6 \}, \{ R_8 \} \]: 2; \[ \frac{\sqrt{\sigma_0 + i\sigma_3}}{2}, \sigma_0; C-1 \) WP; 1

\[ \{ R_8 \}, \{ R_{10} \} \]: 2; \[ \sigma_{17}, \sigma_0; C-1 \) WP; 1

\[ \{ R_8 \}, \{ R_{12} \} \]: 2; \[ \frac{\sigma_0 - i\sqrt{3}\sigma_3}{2}, \sigma_0; C-2 \) WP; 2

\[ \{ R_{10} \}, \{ R_{12} \} \]: 2; \[ \sigma_{18}, \sigma_0; C-1 \) WP; 1

\[ U; ML; C_{21} C_{21} T; \{ R_2 \}, \{ R_4 \} \]: 2; \[ i\sigma_3, \sigma_0; C-1 \) WP; 1

\[ P; KH; C_3^+ C_{22} T; \{ R_2 \}, \{ R_4 \} \]: 2; \[ \sigma_9, \sigma_0; C-1 \) WP; 1

\[ \{ R_2 \}, \{ R_6 \} \]: 2; \[ \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0; C-1 \) WP; 1

\[ \{ R_4 \}, \{ R_{10} \} ; 2; \sigma_{10}, \sigma_0; C-1 \) WP; 1

\[ T; \Gamma K; C_{22} C_{22} T; \{ R_2 \}, \{ R_4 \} \]: 2; \[ i\sigma_3, \sigma_0; C-1 \) WP; 1

\[ S; \Delta H; C_{22} C_{22} T; \{ R_6 \}, \{ R_{12} \} \]: 2; \[ i\sigma_3, \sigma_0; C-1 \) WP; 1

\[ T'; MK; C_{21} C_{22} T; \{ R_2 \}, \{ R_4 \} \]: 2; \[ i\sigma_3, \sigma_0; C-1 \) WP; 1

\[ S'; LH; C_{21} C_{22} T; \{ R_2 \}, \{ R_4 \} \]: 2; \[ i\sigma_3, \sigma_0; C-1 \) WP; 1

\[ \Sigma; \Gamma M; C_{21} C_{21} T; \{ R_2 \}, \{ R_4 \} \]: 2; \[ i\sigma_3, \sigma_0; C-1 \) WP; 1

\[ R; AL; C_{21} C_{21} T; \{ R_2 \}, \{ R_4 \} \]: 2; \[ i\sigma_3, \sigma_0; C-1 \) WP; 1
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C_6^+ C_2^0 T; \{ R_2 \}, \{ R_{10} \}; 2; \sigma_{12}, \sigma_0; \text{C-2 WP; 2} \]
\[ \{ R_2 \}, \{ R_{12} \}; 2; \sqrt[3]{\sigma_{10} + i\sigma_0}; \sigma_0; \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_{11}, \sigma_0; \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{\sqrt[3]{\sigma_{10} + i\sigma_0}}{2}; \sigma_0; \text{C-2 WP; 2} \]
\[ \{ R_2 \}, \{ R_8 \}; 2; \sqrt[3]{-\sigma_{13}}, \sigma_0; \text{C-3 WP; 3} \]
\[ \{ R_4 \}, \{ R_{10} \}; 2; i\sigma_3, \sigma_0; \text{C-3 WP; 3} \]
\[ \{ R_4 \}, \{ R_{12} \}; 2; \sigma_{15}, \sigma_0; \text{C-2 WP; 2} \]
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{13}, \sigma_0; \text{C-1 WP; 1} \]
\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{14}, \sigma_0; \text{C-2 WP; 2} \]
\[ \{ R_6 \}, \{ R_{10} \}; 2; \sigma_{16}, \sigma_0; \text{C-2 WP; 2} \]
\[ \{ R_6 \}, \{ R_{12} \}; 2; (-1)^{\frac{i}{2}} \sigma_{3}, \sigma_0; \text{C-3 WP; 3} \]
\[ \{ R_6 \}, \{ R_8 \}; 2; -\frac{\sqrt[3]{10} + i\sigma_0}{2}; \sigma_0; \text{C-1 WP; 1} \]
\[ \{ R_8 \}, \{ R_{10} \}; 2; \sigma_{17}, \sigma_0; \text{C-1 WP; 1} \]
\[ \{ R_8 \}, \{ R_{12} \}; 2; \sigma_0 - i\frac{\sqrt[3]{10} \sigma_3}{2}; \sigma_0; \text{C-2 WP; 2} \]
\[ \{ R_{10} \}, \{ R_{12} \}; 2; i\sigma_3, \sigma_0; \text{C-1 WP; 1} \]

\[ U; \text{ML}; C_2 C_4^0 T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{C-1 WP; 1} \]
\[ P; \text{KH}; C_3^+ C_2^0 T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{C-1 WP; 1} \]
\[ \{ R_2 \}, \{ R_6 \}; 2; \frac{\sigma_0 + i\sqrt[3]{10} \sigma_3}{2}; \sigma_0; \text{C-1 WP; 1} \]
\[ \{ R_4 \}, \{ R_6 \}; 2; i\sigma_3, \sigma_0; \text{C-1 WP; 1} \]

\[ T; \Gamma K; C_2^0 C_2^1 T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{C-1 WP; 1} \]
\[ S; \text{AH}; C_4^0 C_2^1 T; \{ R_2 \}, \{ R_8 \}; 2; i\sigma_3, \sigma_0; \text{C-1 WP; 1} \]
\[ T'; \text{MK}; C_4^0 C_2^1 T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{C-1 WP; 1} \]
\[ S'; \text{LH}; C_2^0 C_2^1 T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{C-1 WP; 1} \]
\[ \Sigma; \Gamma M; C_2^0 C_2^1 T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{C-1 WP; 1} \]
\[ R; \text{AL}; C_2^0 C_2^1 T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \text{C-1 WP; 1} \]
Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma A; C_6^+ C_{21}^{0T}; \{ R_2 \}, \{ R_{10} \}; 2; \sigma_{12}, \sigma_0; \] C-2 WP; 2
\[ \{ R_2 \}, \{ R_{12} \}; 2; \sqrt{\frac{\sigma_0+\sigma_3}{2}}; \sigma_0; \] C-1 WP; 1
\[ \{ R_2 \}, \{ R_4 \}; 2; \sigma_{11}, \sigma_0; \] C-1 WP; 1
\[ \{ R_2 \}, \{ R_6 \}; 2; \sqrt{\frac{\sigma_0+\sigma_3}{2}}; \sigma_0; \] C-2 WP; 2
\[ \{ R_2 \}, \{ R_8 \}; 2; \sqrt[3]{-1}; \sigma_3, \sigma_0; \] C-3 WP; 3
\[ \{ R_4 \}, \{ R_{10} \}; 2; i\sigma_3, \sigma_0; \] C-3 WP; 3
\[ \{ R_4 \}, \{ R_{12} \}; 2; \sigma_{15}, \sigma_0; \] C-2 WP; 2
\[ \{ R_4 \}, \{ R_6 \}; 2; \sigma_{13}, \sigma_0; \] C-1 WP; 1
\[ \{ R_4 \}, \{ R_8 \}; 2; \sigma_{14}, \sigma_0; \] C-2 WP; 2
\[ \{ R_6 \}, \{ R_{10} \}; 2; \sigma_{16}, \sigma_0; \] C-2 WP; 2
\[ \{ R_6 \}, \{ R_{12} \}; 2; (-1)^{\frac{1}{6}}; \sigma_3, \sigma_0; \] C-3 WP; 3
\[ \{ R_6 \}, \{ R_8 \}; 2; \sqrt{\frac{\sigma_0+\sigma_3}{2}}; \sigma_0; \] C-1 WP; 1
\[ \{ R_8 \}, \{ R_{10} \}; 2; \sigma_{17}, \sigma_0; \] C-1 WP; 1
\[ \{ R_8 \}, \{ R_{12} \}; 2; \frac{\sigma_0+\sqrt{3}}{2}; \sigma_0; \] C-2 WP; 2
\[ \{ R_{10} \}, \{ R_{12} \}; 2; \sigma_{18}, \sigma_0; \] C-1 WP; 1

\[ U: \] ML; \( C_2, C_{21}^{0T} \); \( \{ R_2 \}, \{ R_4 \}; \) 2; \( i\sigma_3, \sigma_0; \) C-1 WP; 1

\[ P; \] KH; \( C_3^+ C_{22}^{0T} \); \( \{ R_2 \}, \{ R_4 \}; \) 2; \( \sigma_0, \sigma_0; \) C-1 WP; 1
\[ \{ R_2 \}, \{ R_6 \}; \) 2; \( \frac{\sigma_0+\sqrt{3}}{2}; \sigma_0; \) C-1 WP; 1
\[ \{ R_4 \}, \{ R_6 \}; \) 2; \( \sigma_{10}, \sigma_0; \) C-1 WP; 1

\[ T; \] GK; \( C_{22}^{0T} C_{22}^{0T} \); \( \{ R_2 \}, \{ R_4 \}; \) 2; \( i\sigma_3, \sigma_0; \) C-1 WP; 1

\[ T'; \] MK; \( C_{21}^{0T} C_2^{0T} \); \( \{ R_2 \}, \{ R_4 \}; \) 2; \( i\sigma_3, \sigma_0; \) C-1 WP; 1

\[ \Sigma; \] GM; \( C_{21}^{0T} C_{22}^{0T} \); \( \{ R_2 \}, \{ R_4 \}; \) 2; \( i\sigma_3, \sigma_0; \) C-1 WP; 1
Accidental degeneracies on high symmetry line

\( \Delta \); GA; \( C^\ast_0, \sigma_{d1}; \{ R_7 \}, \{ R_8 \}; 4; \Gamma_{16}, i\Gamma_{0,1}; \) DP; 0
\( \{ R_7 \}, \{ R_0 \}; 4; \Gamma_{15}, i\Gamma_{0,1}; \) DP; 0
\( \{ R_8 \}, \{ R_0 \}; 4; \sqrt{3i\Delta_{3,0}+i\Delta_{0,3}}, i\Gamma_{0,1}; \) DP; 0

\( P \); KH; \( C^\ast_3, \sigma_{d1}; \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, i\sigma_3; \) P-WNLs;
\( \{ R_3 \}, \{ R_0 \}; 3; A_{24}, \frac{i(\Delta_0+2\Gamma_{A_0})}{4}; \) TP;
\( \{ R_4 \}, \{ R_0 \}; 3; A_{24}, iA_{10}; \) TP;

\( T \); GK; \( \sigma_{d2}, C_2T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \) P-WNL;
\( T' \); MK; \( \sigma_{d1}, \mathcal{T} \sigma_{e1}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \) P-WNL;
\( \Sigma \); GM; \( \sigma_{e1}, C_2T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \) P-WNL;

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Accidental degeneracies on high symmetry line

\( \Delta \); GA; \( C^\ast_0, \sigma_{d1}; \{ R_7 \}, \{ R_8 \}; 4; \Gamma_{16}, i\Gamma_{0,1}; \) DP; 0
\( \{ R_7 \}, \{ R_0 \}; 4; \Gamma_{15}, i\Gamma_{0,1}; \) DP; 0
\( \{ R_8 \}, \{ R_0 \}; 4; \sqrt{3i\Delta_{3,0}+i\Delta_{0,3}}, i\Gamma_{0,1}; \) DP; 0

\( P \); KH; \( C^\ast_3, \sigma_{d1}; \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, i\sigma_3; \) P-WNLs;
\( \{ R_3 \}, \{ R_0 \}; 3; A_{24}, \frac{i(\Delta_0+2\Gamma_{A_0})}{3}; \) TP;
\( \{ R_4 \}, \{ R_0 \}; 3; A_{24}, iA_{10}; \) TP;

\( T \); GK; \( \sigma_{d2}, C_2T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \) P-WNL;
\( T' \); MK; \( \sigma_{d1}, \mathcal{T} \sigma_{e1}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \) P-WNL;
\( \Sigma \); GM; \( \sigma_{e1}, C_2T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \) P-WNL;

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Accidental degeneracies on high symmetry line

\( \Delta \); GA; \( C^\ast_0, \sigma_{d1}; \{ R_7 \}, \{ R_8 \}; 4; \Gamma_{16}, i\Gamma_{0,1}; \) DP; 0
\( \{ R_7 \}, \{ R_0 \}; 4; \Gamma_{15}, i\Gamma_{0,1}; \) DP; 0
\( \{ R_8 \}, \{ R_0 \}; 4; \sqrt{3i\Delta_{3,0}+i\Delta_{0,3}}, i\Gamma_{0,1}; \) DP; 0

\( P \); KH; \( C^\ast_3, \sigma_{d1}; \{ R_3 \}, \{ R_4 \}; 2; -\sigma_0, i\sigma_3; \) P-WNLs;
\( \{ R_3 \}, \{ R_0 \}; 3; A_{24}, \frac{i(\Delta_0+2\Gamma_{A_0})}{3}; \) TP;
\( \{ R_4 \}, \{ R_0 \}; 3; A_{24}, iA_{10}; \) TP;

\( T \); GK; \( \sigma_{d2}, C_2T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \) P-WNL;
\( T' \); MK; \( \sigma_{d1}, \mathcal{T} \sigma_{e1}; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \) P-WNL;
\( \Sigma \); GM; \( \sigma_{e1}, C_2T; \{ R_2 \}, \{ R_4 \}; 2; i\sigma_3, \sigma_0; \) P-WNL;

\( R \); AL; \( \sigma_{e1}, C_2T; \{ R_2,R_2 \}, \{ R_4,R_4 \}; 4; i\Gamma_{3,0}, -i\Gamma_{0,2}; \) DP; 0
Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma A; \quad C_3^+, \sigma v_1, S_3^+ T; \quad \{R_3\}, \{R_4\}; \quad 2; \quad -\sigma_0, i\sigma_3, \sigma_0; \quad \text{P-WNLs;} \]
\[ \{R_3\}, \{R_6\}; \quad 3; \quad A_{24}, \left(\frac{(A_0 + 2v_3)A_8}{3}\right), -A_{24}; \quad \text{TP;} \]
\[ \{R_4\}, \{R_6\}; \quad 3; \quad A_{24}, iA_{10}, -A_{24}; \quad \text{TP;} \]

\[ U; \quad \text{ML;} \quad \sigma v_1, T \sigma h; \quad \{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3, \sigma_0; \quad \text{P-WNL;} \]

\[ P; \quad \text{KH;} \quad C_3^+, C_2^T; \quad \{R_2\}, \{R_4\}; \quad 2; \quad \sigma_9, \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_6\}; \quad 2; \quad \frac{2\sigma_0 + i\sqrt{3}\sigma_8}{2}, \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{R_4\}, \{R_6\}; \quad 2; \quad \sigma_{10}, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ T; \quad \text{\Gamma K;} \quad \sigma h, T \sigma v_2; \quad \{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3, \sigma_0; \quad \text{P-WNL;} \]

\[ S; \quad \text{\Lambda H;} \quad \sigma h, T \sigma v_2; \quad \{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3, \sigma_0; \quad \text{P-WNL;} \]

\[ T'; \quad \text{\Lambda K;} \quad \sigma h, T \sigma v_1; \quad \{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3, \sigma_0; \quad \text{P-WNL;} \]

\[ S'; \quad \text{\Lambda H;} \quad \sigma h, T \sigma v_1; \quad \{R_2\}, \{R_4\}; \quad 2; \quad i\sigma_3, \sigma_0; \quad \text{P-WNL;} \]
Accidental degeneracies on high symmetry line

Δ; ΛA; \( C_{3}^{+}, \sigma_{v1}, S_{3}^{+} T \); \{R_3\}, \{R_4\}; 2; \sigma_{0}, \sigma_{0}^{+} \sigma_{3}^{+}, \sigma_{0};
\{R_3\}, \{R_6\}; 3; A_{24}, \frac{(A_{0}^{+}+2\sqrt{3}A_{h})}{3}, -A_{24}; TP;
\{R_4\}, \{R_6\}; 3; A_{24}, iA_{10}, -A_{24}; TP;

U; ΛL; \sigma_{d1}, T \sigma_{h};
\{R_2\}, \{R_4\}; 2; \sigma_{3}, \sigma_{0};
P; ΛH; \sigma_{d1}^{+}
\{R_3\}, \{R_4\}; 2; -\sigma_{0}, \sigma_{3};
\{R_3\}, \{R_6\}; 3; A_{24}, \frac{(A_{0}^{+}+2\sqrt{3}A_{h})}{3}; TP;
\{R_4\}, \{R_6\}; 3; A_{24}, iA_{10}; TP;

Σ; ΓM; \sigma_{h}, T \sigma_{d1};
\{R_2\}, \{R_4\}; 2; \sigma_{3}, \sigma_{0};
R; ΛL; \sigma_{h}, T \sigma_{d1};
\{R_2\}, \{R_4\}; 2; \sigma_{3}, \sigma_{0};

Accidental degeneracies on high symmetry line

Δ; ΛA; \( C_{3}^{+}, \sigma_{v1}, S_{3}^{+} T \); \{R_3\}, \{R_4\}; 2; \sigma_{0}, \sigma_{0}^{+} \sigma_{3}^{+}, \sigma_{0};
\{R_3\}, \{R_6\}; 3; A_{24}, \frac{(A_{0}^{+}+2\sqrt{3}A_{h})}{3}, -A_{24}; TP;
\{R_4\}, \{R_6\}; 3; A_{24}, iA_{10}, -A_{24}; TP;

U; ΛL; \sigma_{d1}, T \sigma_{h};
\{R_2\}, \{R_4\}; 2; \sigma_{3}, \sigma_{0};
P; ΛH; \sigma_{d1}^{+}
\{R_3\}, \{R_4\}; 2; -\sigma_{0}, \sigma_{3};
\{R_3\}, \{R_6\}; 3; A_{24}, \frac{(A_{0}^{+}+2\sqrt{3}A_{h})}{3}; TP;
\{R_4\}, \{R_6\}; 3; A_{24}, iA_{10}; TP;

S; ΛH; \sigma_{22}^{+} \sigma_{h};
\{R_5\}, \{R_6\}; 2; i\sigma_{0}, i\sigma_{3};
\{R_5\}, \{R_7\}; 2; i\sigma_{3}, i\sigma_{3};
\{R_5\}, \{R_8\}; 2; i\sigma_{3}, i\sigma_{0};
\{R_6\}, \{R_7\}; 2; i\sigma_{3}, -i\sigma_{0};
\{R_6\}, \{R_8\}; 2; i\sigma_{3}, -i\sigma_{3};
\{R_7\}, \{R_8\}; 2; -i\sigma_{0}, -i\sigma_{3};

S'; ΛH; \sigma_{21}^{+} \sigma_{h};
\{R_5\}, \{R_6\}; 2; i\sigma_{0}, i\sigma_{3};
\{R_5\}, \{R_7\}; 2; i\sigma_{3}, i\sigma_{3};
\{R_5\}, \{R_8\}; 2; i\sigma_{3}, i\sigma_{0};
\{R_6\}, \{R_7\}; 2; i\sigma_{3}, -i\sigma_{0};
\{R_6\}, \{R_8\}; 2; i\sigma_{3}, -i\sigma_{3};
\{R_7\}, \{R_8\}; 2; -i\sigma_{0}, -i\sigma_{3};

Σ; ΓM; \sigma_{h}, T \sigma_{d1};
\{R_2\}, \{R_4\}; 2; \sigma_{3}, \sigma_{0};

P-WNL;
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_6, \sigma_{d1}, \Gamma T; \{R_7\}, \{R_8\}; 4; \Gamma_{16, i\Gamma_{0.1}, -i\Gamma_{0.2}}; DP; 0 \]
\[ \{R_7\}, \{R_8\}; 4; \Gamma_{15, i\Gamma_{0.1}, -i\Gamma_{0.2}}; DP; 0 \]
\[ \{R_8\}, \{R_9\}; 4; \sqrt[3]{\Gamma_{3.0, 0, i\Gamma_{0.1}, -i\Gamma_{0.2}}}; QDP; 0 \]

\[ P; KH; C^+_3, \sigma_{d1}, \Gamma T; \{R_3, R_4\}, \{R_6\}; 4; \Gamma_{13, i\Gamma_{0.3}, -i\Gamma_{0.2}}; DP; 0 \]

\[ S; AH; C_{22}^2, \sigma_h, \Gamma T; \{R_5, R_6\}, \{R_7, R_8\}; 4; i\Gamma_{3.0, 0, i\Gamma_{0.3}, -i\Gamma_{0.2}}; DP; 0 \]
\[ S'; LH; C_{21}^2, \sigma_h, \Gamma T; \{R_5, R_6\}, \{R_7, R_8\}; 4; i\Gamma_{3.0, 0, i\Gamma_{0.3}, -i\Gamma_{0.2}}; DP; 0 \]
\[ R; AL; C_{21}^2, \sigma_h, \Gamma T; \{R_5, R_6\}, \{R_7, R_8\}; 4; i\Gamma_{3.0, 0, i\Gamma_{0.3}, -i\Gamma_{0.2}}; DP; 0 \]

SG 193

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_6, \sigma_{d1}, \Gamma T; \{R_7\}, \{R_8\}; 4; \Gamma_{16, i\Gamma_{0.1}, -i\Gamma_{0.2}}; DP; 0 \]
\[ \{R_7\}, \{R_8\}; 4; \Gamma_{15, i\Gamma_{0.1}, -i\Gamma_{0.2}}; DP; 0 \]
\[ \{R_8\}, \{R_9\}; 4; \sqrt[3]{\Gamma_{3.0, 0, i\Gamma_{0.1}, -i\Gamma_{0.2}}}; QDP; 0 \]

\[ P; KH; C^+_3, \sigma_{d1}, \Gamma T; \{R_3, R_4\}, \{R_6\}; 4; \Gamma_{13, i\Gamma_{0.3}, -i\Gamma_{0.2}}; DP; 0 \]
\[ R; AL; \sigma_h, C_{21}^2, \Gamma T; \{R_5, R_6\}, \{R_7, R_8\}; 4; i\Gamma_{3.0, 0, i\Gamma_{0.3}, -i\Gamma_{0.2}}; P-DNL; \]

SG 194

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma A; C^+_6, \sigma_{d1}, \Gamma T; \{R_7\}, \{R_8\}; 4; \Gamma_{16, i\Gamma_{0.1}, -i\Gamma_{0.2}}; DP; 0 \]
\[ \{R_7\}, \{R_8\}; 4; \Gamma_{15, i\Gamma_{0.1}, -i\Gamma_{0.2}}; DP; 0 \]
\[ \{R_8\}, \{R_9\}; 4; \sqrt[3]{\Gamma_{3.0, 0, i\Gamma_{0.1}, -i\Gamma_{0.2}}}; QDP; 0 \]

\[ P; KH; C^+_3, \sigma_{d1}, \Gamma T; \{R_3, R_4\}, \{R_6\}; 4; \Gamma_{13, i\Gamma_{0.3}, -i\Gamma_{0.2}}; DP; 0 \]
\[ S; AH; \sigma_h, C_{22}^2, \Gamma T; \{R_5, R_6\}, \{R_7, R_8\}; 4; i\Gamma_{3.0, 0, i\Gamma_{0.3}, -i\Gamma_{0.2}}; P-DNL; \]
\[ S'; LH; \sigma_h, C_{21}^2, \Gamma T; \{R_5, R_6\}, \{R_7, R_8\}; 4; i\Gamma_{3.0, 0, i\Gamma_{0.3}, -i\Gamma_{0.2}}; P-DNL; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y} \mathcal{T} C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Lambda; \Gamma R; C_{31}^-; \{R_2\}, \{R_4\}; 2; \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_6\}; 2; \frac{\alpha_0 + i\sqrt{3}\alpha_3}{2}; \quad \text{C-1 WP; 1} \]
\[ \{R_4\}, \{R_6\}; 2; \sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ Z; \text{XM}; C_{2x} \mathcal{T} C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ T; \text{MR}; C_{2x} \mathcal{T} C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y} \mathcal{T} C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Lambda; \Gamma L; C_{31}^-; \{R_2\}, \{R_4\}; 2; \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_6\}; 2; \frac{\alpha_0 + i\sqrt{3}\alpha_3}{2}; \quad \text{C-1 WP; 1} \]
\[ \{R_4\}, \{R_6\}; 2; \sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ Z; \text{XW}; C_{2x} \mathcal{T} C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma H; C_{2y} \mathcal{T} C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Lambda; \Gamma P; C_{31}^-; \{R_2\}, \{R_4\}; 2; \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_6\}; 2; \frac{\alpha_0 + i\sqrt{3}\alpha_3}{2}; \quad \text{C-1 WP; 1} \]
\[ \{R_4\}, \{R_6\}; 2; \sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ D; \text{NP}; C_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3; \quad \text{C-1 WP; 1} \]

\[ F; \text{PH}; C_{34}^+; \{R_2\}, \{R_4\}; 2; \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_6\}; 2; \frac{\alpha_0 + i\sqrt{3}\alpha_3}{2}; \quad \text{C-1 WP; 1} \]
\[ \{R_4\}, \{R_6\}; 2; \sigma_{10}; \quad \text{C-1 WP; 1} \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{2y} \mathcal{T} C_{2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \quad \text{C-1 WP; 1} \]

\[ \Lambda; \Gamma R; C_{31}^-; \{R_2\}, \{R_4\}; 2; \sigma_0; \quad \text{C-1 WP; 1} \]
\[ \{R_2\}, \{R_6\}; 2; \frac{\alpha_0 + i\sqrt{3}\alpha_3}{2}; \quad \text{C-1 WP; 1} \]
\[ \{R_4\}, \{R_6\}; 2; \sigma_{10}; \quad \text{C-1 WP; 1} \]

\[ T; \text{MR}; C_{2x} \mathcal{E} \mathcal{T} C_{2z}; \{R_5, R_3\}, \{R_7, R_7\}; 4; -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \quad \text{C-2 DP; 2} \]
Accidental degeneracies on high symmetry line

| Symbol | Group | Line | WP | Value |
|--------|-------|------|----|-------|
| Δ; Γ; | C_{2y}, T_{C_2z}; | \{R_2\}, \{R_4\}; | 2; \pm i\sigma_3, \sigma_0; | C-1 WP; 1 |
| Λ; GR; | C_{31}; | \{R_2\}, \{R_4\}; | 2; \sigma_9; | C-1 WP; 1 |
|       |       | \{R_2\}, \{R_6\}; | 2; \pm \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}; | C-1 WP; 1 |
|       |       | \{R_4\}, \{R_6\}; | 2; \sigma_{10}; | C-1 WP; 1 |
| D; NP; | C_{2z}, \bar{E}; | \{R_5\}, \{R_7\}; | 2; -i\sigma_3, -\sigma_0; | C-1 WP; 1 |
| F; PH; | C_{34}, \bar{E}; | \{R_7\}, \{R_9\}; | 2; \sigma_{19}, -\sigma_0; | C-1 WP; 1 |
|       |       | \{R_9\}, \{R_11\}; | 2; \mp \frac{i\sigma_3 + i\sigma_0}{2}, -\sigma_0; | C-1 WP; 1 |

Accidental degeneracies on high symmetry line

| Symbol | Group | Line | WP | Value |
|--------|-------|------|----|-------|
| Λ; GR; | C_{31}, JT; | \{R_2, R_6\}, \{R_4, R_4\}; | 4; \Gamma_{12}, -i\Gamma_{0,2}; | DP; 0 |
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma R; C_{31}^{-1, IT}; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ Z; \chi M; \sigma_y, C_{2x}, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma L; C_{31}^{-1, IT}; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; \text{DP}; 0 \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma L; C_{31}^{-1, IT}; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ Z; \chi W; \sigma_y, C_{2x}, IT; \{R_5, R_8\}, \{R_6, R_7\}; 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma P; C_{31}^{-1, IT}; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ F; \Phi H; C_{34}^{1, IT}; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; \text{DP}; 0 \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma R; C_{31}^{-1, IT}; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ S; \chi R; \sigma_y, \tilde{E}, IT; \{R_5, R_5\}, \{R_7, R_7\}; 4; -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]

\[ T; \chi R; \sigma_x, \sigma_y, \tilde{E}, IT; \{R_6, R_6\}, \{R_7, R_7\}; 4; -\Gamma_{0,0}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]

\[ \{R_6, R_6\}, \{R_8, R_8\}; 4; -\Gamma_{3,0}, -i\Gamma_{0,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]

\[ \{R_6, R_6\}, \{R_6, R_6\}; 4; -\Gamma_{3,0}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]

\[ \{R_7, R_7\}, \{R_6, R_6\}; 4; -\Gamma_{0,0}, i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]

\[ \{R_7, R_7\}, \{R_6, R_6\}; 4; -\Gamma_{0,0}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]

\[ \{R_8, R_8\}, \{R_6, R_6\}; 4; \Gamma_{0,0}, -i\Gamma_{3,0}, -\Gamma_{0,0}, -i\Gamma_{0,2}; \text{P-DNL}; \]

\[ Z'; \chi M(\frac{1}{2} \alpha 0); \sigma_z, C_{2y}, IT; \{R_5, R_6\}, \{R_7, R_8\}; 4; i\Gamma_{3,0}, i\Gamma_{3,3}, -i\Gamma_{0,2}; \text{P-DNL}; \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma \Gamma; C_{31}; IT; \{R_2, R_6\}, \{R_4, R_4\}; 4; \Gamma_{12}, -i\Gamma_{0.2}; \]  
\[ DP; 0; \]

\[ D; NP; C_{2x}, \bar{E}; IT; \{R_5, R_5\}, \{R_7, R_7\}; 4; -i\Gamma_{3.0}, -\Gamma_{0.0}, -i\Gamma_{0.2}; DP; 0; \]

\[ F; PH; C_{34}, \bar{E}; IT; \{R_7, R_7\}, \{R_9, R_{11}\}; 4; \Gamma_{17}, -\Gamma_{0.0}, -i\Gamma_{0.2}; DP; 0; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{4y}^+, TC_{2x}; \{R_2\}, \{R_4\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0; C-1 WP; 1; \]
\[ \{R_2\}, \{R_6\}; 2; \sqrt{-1}\sigma_3, \sigma_0; C-2 WP; 2; \]
\[ \{R_2\}, \{R_8\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0; C-1 WP; 1; \]
\[ \{R_4\}, \{R_6\}; 2; -i\sigma_3, \sigma_0; C-1 WP; 1; \]
\[ \{R_4\}, \{R_8\}; 2; (-1)^{3/4}\sigma_3, \sigma_0; C-2 WP; 2; \]
\[ \{R_6\}, \{R_8\}; 2; \frac{-\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0; C-1 WP; 1; \]

\[ \Sigma; \Gamma M; C_{2x}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 WP; 1; \]

\[ \Lambda; \Gamma R; C_{31}^-, C_{2y}T; \{R_2\}, \{R_4\}; 2; \sigma_0, \sigma_0; C-1 WP; 1; \]
\[ \{R_2\}, \{R_6\}; 2; \frac{\sigma_0 + i\sqrt{3}\sigma_3}{2}, \sigma_0; C-1 WP; 1; \]
\[ \{R_4\}, \{R_6\}; 2; \sigma_0, \sigma_0; C-1 WP; 1; \]

\[ S; XR; C_{2y}, TC_{2y}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 WP; 1; \]

\[ Z; XM; C_{2x}, TC_{2x}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 WP; 1; \]

\[ T; MR; C_{4z}^+, C_{2y}T; \{R_2\}, \{R_4\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0; C-1 WP; 1; \]
\[ \{R_2\}, \{R_6\}; 2; -\sigma_3, \sigma_0; C-1 WP; 1; \]
\[ \{R_4\}, \{R_6\}; 2; \frac{\sigma_0 + i\sigma_3}{\sqrt{2}}, \sigma_0; C-1 WP; 1; \]
\[ \{R_4\}, \{R_8\}; 2; (-1)^{3/4}\sigma_3, \sigma_0; C-2 WP; 2; \]
\[ \{R_6\}, \{R_8\}; 2; \frac{-\sigma_0 - i\sigma_3}{\sqrt{2}}, \sigma_0; C-1 WP; 1; \]
Accidental degeneracies on high symmetry line

\( \Delta; \Gamma X; C_{4y}^+ T C_{2z}; \) \{\( R_2 \)}, \{\( R_4 \}) \): \( 2; \frac{\sigma_3+i\sigma_0}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\{\( R_2 \)}, \{\( R_6 \}) \): \( 2; \sqrt{-1}\sigma_3, \sigma_0; \) C-2 WP; 2

\{\( R_2 \)}, \{\( R_6 \}) \): \( 2; \frac{\sigma_0+i\sigma_3}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\{\( R_4 \)}, \{\( R_6 \}) \): \( 2; -\frac{\sigma_3-i\sigma_0}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\{\( R_4 \)}, \{\( R_6 \}) \): \( 2; (-1)^{3/4}\sigma_3, \sigma_0; \) C-2 WP; 2

\{\( R_6 \)}, \{\( R_8 \}) \): \( 2; \frac{\sigma_3+i\sigma_0}{\sqrt{2}}, -\sigma_0, \sigma_0; \) C-1 WP; 1

\( \Sigma; \Gamma M; C_{2x} T C_{2z}; \) \{\( R_2 \)}, \{\( R_4 \}) \): \( 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

\( \Lambda; \Gamma R; C_{31} C_{2x} T; \) \{\( R_2 \)}, \{\( R_4 \}) \): \( 2; \sigma_9, \sigma_0; \) C-1 WP; 1

\{\( R_2 \)}, \{\( R_6 \}) \): \( 2; \frac{\sigma_0-i\sigma_3}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\{\( R_4 \)}, \{\( R_6 \}) \): \( 2; -(-1)^{3/4}\sigma_3, -\sigma_0, \sigma_0; \) C-2 WP; 2

\{\( R_6 \)}, \{\( R_8 \}) \): \( 2; \frac{\sigma_3-i\sigma_0}{\sqrt{2}}, -\sigma_0, \sigma_0; \) C-1 WP; 1

Accidental degeneracies on high symmetry line

\( \Delta; \Gamma X; C_{4y}^+ T C_{2z}; \) \{\( R_2 \)}, \{\( R_4 \}) \): \( 2; \frac{\sigma_3+i\sigma_0}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\{\( R_2 \)}, \{\( R_6 \}) \): \( 2; \sqrt{-1}\sigma_3, \sigma_0; \) C-2 WP; 2

\{\( R_2 \)}, \{\( R_6 \}) \): \( 2; \frac{\sigma_0+i\sigma_3}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\{\( R_4 \)}, \{\( R_6 \}) \): \( 2; -\frac{\sigma_3-i\sigma_0}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\{\( R_4 \)}, \{\( R_6 \}) \): \( 2; (-1)^{3/4}\sigma_3, \sigma_0; \) C-2 WP; 2

\{\( R_6 \)}, \{\( R_8 \}) \): \( 2; \frac{\sigma_3+i\sigma_0}{\sqrt{2}}, -\sigma_0, \sigma_0; \) C-1 WP; 1

\( \Lambda; \Gamma L; C_{31} C_{2x} T; \) \{\( R_2 \)}, \{\( R_4 \}) \): \( 2; \sigma_9, \sigma_0; \) C-1 WP; 1

\{\( R_2 \)}, \{\( R_6 \}) \): \( 2; \frac{\sigma_0+i\sqrt{3}\sigma_3}{\sqrt{2}}, \sigma_0; \) C-1 WP; 1

\{\( R_4 \)}, \{\( R_6 \}) \): \( 2; \sigma_{10}, \sigma_0; \) C-1 WP; 1

\( \Sigma; \Gamma \Sigma; C_{2x} T C_{2z}; \) \{\( R_2 \)}, \{\( R_4 \}) \): \( 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

\( S; \chi S; C_{2x} T C_{2y}; \) \{\( R_2 \)}, \{\( R_4 \}) \): \( 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

\( Z; \chi W; C_{2x} T C_{2z}; \) \{\( R_2 \)}, \{\( R_4 \}) \): \( 2; i\sigma_3, \sigma_0; \) C-1 WP; 1

\( Q; \chi W; C_{2f}; \) \{\( R_2 \)}, \{\( R_4 \}) \): \( 2; i\sigma_3; \) C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C^+ \{ R_2 \}, \{ R_4 \}; \frac{\sigma_3 + i \sigma_0}{\sqrt{2}}, \sigma_0; \text{C-1 WP; } 1 \]
\[ \{ R_2 \}, \{ R_6 \}; \sqrt{-1} \sigma_3, \sigma_0; \text{C-2 WP; } 2 \]
\[ \{ R_4 \}, \{ R_6 \}; \frac{\sigma_3 + i \sigma_0}{\sqrt{2}}, \sigma_0; \text{C-1 WP; } 1 \]
\[ \{ R_4 \}, \{ R_8 \}; (-1)^{3/4} \sigma_3, \sigma_0; \text{C-2 WP; } 2 \]
\[ \{ R_6 \}, \{ R_8 \}; \frac{-\sigma_3 - i \sigma_0}{\sqrt{2}}, \sigma_0; \text{C-1 WP; } 1 \]

\[ \Lambda; \Gamma L; C_{31}, C_{2e} T; \{ R_2 \}, \{ R_4 \}; \sigma_9, \sigma_0; \text{C-1 WP; } 1 \]
\[ \{ R_2 \}, \{ R_6 \}; \frac{\sigma_3 + i \sqrt{3} \sigma_0}{2}, \sigma_0; \text{C-1 WP; } 1 \]
\[ \{ R_4 \}, \{ R_6 \}; \sigma_{10}, \sigma_0; \text{C-1 WP; } 1 \]

\[ \Sigma; \Gamma \Sigma; C_{2v}, T C_{2z}; \{ R_2 \}, \{ R_4 \}; i \sigma_3, \sigma_0; \text{C-1 WP; } 1 \]
\[ \{ R_5 \}, \{ R_7 \}; -i \sigma_3, -\sigma_0, \sigma_0; \text{C-1 WP; } 1 \]

\[ Z; \Gamma W; C_{2x}, T C_{2z}; \{ R_2 \}, \{ R_4 \}; i \sigma_3, \sigma_0; \text{C-1 WP; } 1 \]
\[ \{ R_{10} \}, \{ R_{14} \}; -i \sigma_3, -\sigma_0; \text{C-1 WP; } 1 \]

Q; LW; C_{2f}, \bar{E}; \{ R_{10} \}, \{ R_{14} \}; -i \sigma_3, -\sigma_0; \text{C-1 WP; } 1 \]
SG 211

Accidental degeneracies on high symmetry line

\[
\Sigma; \Gamma N; C_{2a}, TC_{2z}; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\Delta; \Gamma H; C_{4g}^+, TC_{2z}; \{R_2\}, \{R_4\}; 2\frac{\sigma_0+4\sigma_3}{\sqrt{2}}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\{R_2\}, \{R_0\}; 2; \frac{\sqrt{-1\sigma_3}}{\sqrt{2}}, \sigma_0; \quad \text{C-2 WP; 2}
\]
\[
\{R_2\}, \{R_4\}; 2\frac{\sigma_0+4\sigma_3}{\sqrt{2}}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\{R_4\}, \{R_0\}; 2; -\frac{\sigma_0-4\sigma_3}{\sqrt{2}}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\{R_4\}, \{R_0\}; 2; (-1)^{\frac{3}{2}}\sigma_3, \sigma_0; \quad \text{C-2 WP; 2}
\]
\[
\{R_0\}, \{R_4\}; 2; -\frac{\sigma_0-4\sigma_3}{\sqrt{2}}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\Lambda; \Gamma P; C_{31}, C_{2a}T; \{R_2\}, \{R_4\}; 2; \sigma_0, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\{R_2\}, \{R_0\}; 2\frac{\sigma_0+4\sqrt{3}\sigma_3}{2}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\{R_4\}, \{R_0\}; 2; \sigma_{10}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
D; \Gamma P; C_{2a}, C_{2a}T; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
G; \Gamma N; C_{2b}, TC_{2z}; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
F; \Gamma H; C_{34}, C_{2a}T; \{R_2\}, \{R_4\}; 2; \sigma_0, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\{R_2\}, \{R_0\}; 2\frac{\sigma_0+4\sqrt{3}\sigma_3}{2}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\{R_4\}, \{R_0\}; 2; \sigma_{10}, \sigma_0; \quad \text{C-1 WP; 1}
\]

SG 212

Accidental degeneracies on high symmetry line

\[
\Delta; \Gamma X; C_{4g}^+, TC_{2z}; \{R_2\}, \{R_4\}; 2; \frac{\sigma_0+4\sigma_3}{\sqrt{2}}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\{R_2\}, \{R_0\}; 2; \frac{\sqrt{-1\sigma_3}}{\sqrt{2}}, \sigma_0; \quad \text{C-2 WP; 2}
\]
\[
\{R_2\}, \{R_4\}; 2; \frac{\sigma_0+4\sigma_3}{\sqrt{2}}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\{R_4\}, \{R_0\}; 2; -\frac{\sigma_0-4\sigma_3}{\sqrt{2}}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\{R_4\}, \{R_0\}; 2; (-1)^{\frac{3}{2}}\sigma_3, \sigma_0; \quad \text{C-2 WP; 2}
\]
\[
\{R_0\}, \{R_4\}; 2; -\frac{\sigma_0-4\sigma_3}{\sqrt{2}}, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\Sigma; \Gamma M; C_{2a}, TC_{2z}; \{R_2\}, \{R_4\}; 2; i \sigma_3, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
\Lambda; \Gamma R; C_{31}, C_{2a}T; \{R_2\}, \{R_4\}; 2; \sigma_9, \sigma_0; \quad \text{C-1 WP; 1}
\]
\[
T; \Gamma R; C_{4a}^+, E, C_{2a}T; \{R_{10}, R_{14}\}, \{R_{12}, R_{16}\}; 4; -\frac{\sigma_3-4\sigma_3}{\sqrt{2}}, -\Gamma_{0,0}, \Gamma_{0,1}; \text{C-2 DP; 2}
\]
Accidental degeneracies on high symmetry line

**Δ; ΓX; C_{4y},TC_{2z};** 
\{R_2\}, \{R_4\}; 2; \frac{\sigma_3+i\sigma_0}{\sqrt{2}}; \sigma_0; C-1 WP; 1
\{R_2\}, \{R_6\}; 2; \sqrt{-1}\sigma_3, \sigma_0; C-2 WP; 2
\{R_2\}, \{R_8\}; 2; \frac{\sigma_0+i\sigma_3}{\sqrt{2}}; \sigma_0; C-1 WP; 1
\{R_4\}, \{R_6\}; 2; \frac{-\sigma_3-i\sigma_0}{\sqrt{2}}; \sigma_0; C-1 WP; 1
\{R_4\}, \{R_8\}; 2; (\sigma_3)^{3/4}\sigma_3, \sigma_0; C-2 WP; 2
\{R_6\}, \{R_8\}; 2; \frac{\sigma_0+i\sqrt{3}\sigma_3}{2}; \sigma_0; P-WNL; 1

**Σ; ΓM; C_{2a},TC_{2z};** 
\{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 WP; 1

**Δ; ΓR; C_{31},C_{26}T;** 
\{R_2\}, \{R_4\}; 2; \sigma_9, \sigma_0; C-1 WP; 1
\{R_2\}, \{R_6\}; 2; \frac{\sigma_0+i\sqrt{3}\sigma_3}{2}; \sigma_0; C-1 WP; 1
\{R_4\}, \{R_6\}; 2; \sigma_10, \sigma_0; C-1 WP; 1

**T; MR; C_{4z},E,TC_{2z};** 
\{R_{10}, R_{14}\}, \{R_{12}, R_{16}\}; 4; \frac{\tau_3+\tau_0}{\sqrt{2}}; -\Gamma_{0,0}, \Gamma_{0,1}; C-2 DP; 2

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**Accidental degeneracies on high symmetry line**

**Σ; ΓN; C_{2a},TC_{2z};** 
\{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 WP; 1

**Δ; ΓH; C_{4y},TC_{2z};** 
\{R_2\}, \{R_4\}; 2; \frac{\sigma_3+i\sigma_0}{\sqrt{2}}; \sigma_0; C-1 WP; 1
\{R_2\}, \{R_6\}; 2; \sqrt{-1}\sigma_3, \sigma_0; C-2 WP; 2
\{R_2\}, \{R_8\}; 2; \frac{\sigma_0+i\sigma_3}{\sqrt{2}}; \sigma_0; C-1 WP; 1
\{R_4\}, \{R_6\}; 2; \frac{-\sigma_3-i\sigma_0}{\sqrt{2}}; \sigma_0; C-1 WP; 1
\{R_4\}, \{R_8\}; 2; (\sigma_3)^{3/4}\sigma_3, \sigma_0; C-2 WP; 2
\{R_6\}, \{R_8\}; 2; \frac{\sigma_0+i\sqrt{3}\sigma_3}{2}; \sigma_0; C-1 WP; 1

**Λ; ΓP; C_{31},C_{26}T;** 
\{R_2\}, \{R_4\}; 2; \sigma_9, \sigma_0; C-1 WP; 1
\{R_2\}, \{R_6\}; 2; \frac{\sigma_0+i\sqrt{3}\sigma_3}{2}; \sigma_0; C-1 WP; 1
\{R_4\}, \{R_6\}; 2; \sigma_10, \sigma_0; C-1 WP; 1

**D; NP; C_{2z},E,TC_{2z};** 
\{R_3\}, \{R_5\}; 2; -i\sigma_3, -\sigma_0, \sigma_0; C-1 WP; 1

**G; HN; C_{26},E,TC_{2z};** 
\{R_3\}, \{R_5\}; 2; -i\sigma_3, -\sigma_0, \sigma_0; C-1 WP; 1

**F; PH; C_{31},E,TC_{2z};** 
\{R_7\}, \{R_{11}\}; 2; \sigma_{20}, -\sigma_0, \sigma_0; C-1 WP; 1
\{R_7\}, \{R_9\}; 2; \sigma_{19}, -\sigma_0, \sigma_0; C-1 WP; 1
\{R_9\}, \{R_{11}\}; 2; \frac{\tau_3+i\sigma_0}{2}, -\sigma_0, \sigma_0; C-1 WP; 1

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**Accidental degeneracies on high symmetry line**

**Σ; ΓM; \sigma_{ab},TC_{2z};** 
\{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL;

**Λ; ΓR; C_{31},\sigma_{db};** 
\{R_3\}, \{R_4\}; 2; -\sigma_0, i\sigma_3; P-WNLs;
\{R_3\}, \{R_6\}; 3; A_{24}, \frac{(\tau_0+2\sqrt{3}\tau_3)}{3}; TP;
\{R_4\}, \{R_6\}; 3; A_{24}, i\tau_{10}; TP;

**S; XR; \sigma_{dc},\tau\sigma_{dc};** 
\{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; P-WNL;

**Z; XM; C_{2x},TC_{2z};** 
\{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; C-1 WP; 1
Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma L; C_{31}^-; \sigma_{db}; \{R_3\}, \{R_4\}; 2; -\sigma_0, \imath \sigma_3; P-WNL; \]
\[ \{R_3\}, \{R_6\}; 3; A_{24}, \frac{\imath (A_0 + 2 \sqrt{3} A_8)}{3}; TP; \]
\[ \{R_4\}, \{R_6\}; 3; A_{24}, \imath A_{10}; TP; \]
\[ \Sigma; \Gamma \Sigma; \sigma_{db}, T C_{2z}; \{R_2\}, \{R_4\}; 2; \imath \sigma_3, \sigma_0; P-WNL; \]
\[ S; X S; \sigma_{dc}, T \sigma_{dc}; \{R_2\}, \{R_4\}; 2; \imath \sigma_3, \sigma_0; P-WNL; \]
\[ Z; X W; C_{2x}, T C_{2z}; \{R_2\}, \{R_4\}; 2; \imath \sigma_3, \sigma_0; C-1 WP; 1 \]

Accidental degeneracies on high symmetry line

\[ \Sigma; \Gamma N; \sigma_{db}, T C_{2z}; \{R_2\}, \{R_4\}; 2; \imath \sigma_3, \sigma_0; P-WNL; \]
\[ \Lambda; \Gamma P; C_{31}^-; \sigma_{db}; \{R_3\}, \{R_4\}; 2; -\sigma_0, \imath \sigma_3; P-WNL; \]
\[ \{R_3\}, \{R_6\}; 3; A_{24}, \frac{\imath (A_0 + 2 \sqrt{3} A_8)}{3}; TP; \]
\[ \{R_4\}, \{R_6\}; 3; A_{24}, \imath A_{10}; TP; \]
\[ G; H N; \sigma_{da}, T C_{2z}; \{R_2\}, \{R_4\}; 2; \imath \sigma_3, \sigma_0; P-WNL; \]
\[ F; P H; C_{34}^+; \sigma_{da}; \{R_3\}, \{R_4\}; 2; -\sigma_0, \imath \sigma_3; P-WNL; \]
\[ \{R_3\}, \{R_6\}; 3; A_{24}, \frac{\imath (A_0 + 2 \sqrt{3} A_8)}{3}; TP; \]
\[ \{R_4\}, \{R_6\}; 3; A_{24}, \imath A_{10}; TP; \]

Accidental degeneracies on high symmetry line

\[ \Sigma; \Gamma M; \sigma_{db}, T C_{2z}; \{R_2\}, \{R_4\}; 2; \imath \sigma_3, \sigma_0; P-WNL; \]
\[ \Lambda; \Gamma R; C_{31}^-; \sigma_{db}; \{R_3\}, \{R_4\}; 2; -\sigma_0, \imath \sigma_3; P-WNL; \]
\[ \{R_3\}, \{R_6\}; 3; A_{24}, \frac{\imath (A_0 + 2 \sqrt{3} A_8)}{3}; TP; \]
\[ \{R_4\}, \{R_6\}; 3; A_{24}, \imath A_{10}; TP; \]
\[ Z; X M; C_{2x}, T C_{2z}; \{R_2\}, \{R_4\}; 2; \imath \sigma_3, \sigma_0; C-1 WP; 1 \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \Gamma L; C_{31}^-; \sigma_{db}; \{R_3\}, \{R_4\}; 2; -\sigma_0, \imath \sigma_3; P-WNL; \]
\[ \{R_3\}, \{R_6\}; 3; A_{24}, \frac{\imath (A_0 + 2 \sqrt{3} A_8)}{3}; TP; \]
\[ \{R_4\}, \{R_6\}; 3; A_{24}, \imath A_{10}; TP; \]
\[ \Sigma; \Gamma \Sigma; \sigma_{db}, T C_{2z}; \{R_2\}, \{R_4\}; 2; \imath \sigma_3, \sigma_0; P-WNL; \]
\[ S; X S; \sigma_{dc}, T \sigma_{dc}; \{R_2\}, \{R_4\}; 2; \imath \sigma_3, \sigma_0; P-WNL; \]
\[ Z; X W; C_{2x}, T C_{2z}; \{R_2\}, \{R_4\}; 2; \imath \sigma_3, \sigma_0; C-1 WP; 1 \]
Accidental degeneracies on high symmetry line

\[ \Sigma; \Gamma\Lambda; \sigma_{\text{db}}, T_{C2z}; \{R_2\}, \{R_4\}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]

\[ \Lambda; \Gamma\Pi; C_{31}; \sigma_{\text{db}}; \{R_3\}, \{R_4\}; 2; -\sigma_0, i\sigma_3; \text{P-WNLs}; \]
\[ \{R_3\}, \{R_6\}; 3; A_{24}, (\frac{A_0 + 2\sqrt{3}A_8}{3}); \text{TP}; \]
\[ \{R_4\}, \{R_6\}; 3; A_{24}, iA_{10}; \text{TP}; \]

\[ D; \Lambda\Pi; C_{2z}; \sigma_{\text{db}}; \{R_5\}, \{R_6\}; 2; i\sigma_0, \sigma_3; \text{P-WNLs}; \]
\[ \{R_5\}, \{R_7\}; 2; i\sigma_3, \sigma_3; \text{P-WNL}; \]
\[ \{R_6\}, \{R_7\}; 2; i\sigma_3, -\sigma_0; \text{P-WNL}; \]
\[ \{R_5\}, \{R_8\}; 2; i\sigma_3, \sigma_0; \text{P-WNL}; \]
\[ \{R_6\}, \{R_8\}; 2; i\sigma_3, -\sigma_3; \text{P-WNL}; \]

\[ F; \Pi\Lambda; C_{34}; \sigma_{\text{da}}, E; \{R_9\}, \{R_{12}\}; 3; -\sigma_0, i\sigma_3, \sigma_0; \text{P-WNLs}; \]
\[ \{R_9\}, \{R_{12}\}; 3; A_{24}, (\frac{i(A_0 + 2\sqrt{3}A_8)}{3}); A_0; \text{TP}; \]
\[ \{R_{10}\}, \{R_{12}\}; 3; A_{24}, iA_{10}, A_0; \text{TP}; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{4y}^+; \sigma_x, IT; \{R_6\}, \{R_7\}; \quad 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ \Lambda; \Gamma R; C_{31}^+; \sigma_{db}, IT; \{R_3, R_4\}, \{R_5\}; \quad 4; \Gamma_{13}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ T; \text{MR}; C_{4z}^+; \sigma_y, IT; \{R_6\}, \{R_7\}; \quad 4; \frac{\Gamma_{0,1} + i\Gamma_{0,2}}{\sqrt{2}}, -\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; 0 \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{4y}^+; \sigma_x, IT; \{R_6\}, \{R_7\}; \quad 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ \Lambda; \Gamma R; C_{31}^+; \sigma_{db}, IT; \{R_4\}, \{R_5\}; \quad 4; \Gamma_{13}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ S; \text{XR}; \sigma_y, C_{2z}, IT; \{R_5, R_6\}, \{R_6, R_7\}; \quad 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ Z; \text{XM}; \sigma_y, C_{2z}, IT; \{R_5, R_6\}, \{R_6, R_7\}; \quad 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ T; \text{MR}; C_{4z}^+; \sigma_z, E, IT; \{R_{13}\}, \{R_{14}\}; \quad 4; \frac{-\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, \Gamma_{0,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{4y}^+; \sigma_x, IT; \{R_6\}, \{R_7\}; \quad 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ \Lambda; \Gamma R; C_{31}^+; \sigma_{db}, IT; \{R_4\}, \{R_5\}; \quad 4; \Gamma_{13}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ Z; \text{XM}; \sigma_y, C_{2z}, IT; \{R_5, R_6\}, \{R_6, R_7\}; \quad 4; i\Gamma_{0,3}, i\Gamma_{3,0}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ T; \text{MR}; C_{4z}^+; \sigma_y, IT; \{R_6\}, \{R_7\}; \quad 4; \frac{-\Gamma_{0,1} + i\Gamma_{3,0}}{\sqrt{2}}, -\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; 0 \]

Accidental degeneracies on high symmetry line

\[ \Delta; \Gamma X; C_{4y}^+; \sigma_x, IT; \{R_6\}, \{R_7\}; \quad 4; \frac{\Gamma_{3,0} + i\Gamma_{0,2}}{\sqrt{2}}, i\Gamma_{0,1}, -i\Gamma_{0,2}; \text{DP}; 0 \]

\[ \Lambda; \Gamma L; C_{31}^+; \sigma_{db}, IT; \{R_5, R_4\}, \{R_6\}; \quad 4; \Gamma_{13}, i\Gamma_{0,3}, -i\Gamma_{0,2}; \text{DP}; 0 \]
Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma X; \quad C_{4y}^+ \sigma_z, IT; \quad \{R_6\}, \{R_7\}; \quad 4; \quad \frac{\Gamma_{3.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ \Lambda: \Gamma L; \quad C_{31}^- \sigma_d, IT; \quad \{R_3, R_4\}, \{R_6\}; \quad 4; \quad \Gamma_{13}, i\Gamma_{0.3}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ Q: LW; \quad C_{2f}, IT; \quad \{R_2, R_3\}, \{R_4, R_4\}; \quad 4; \quad i\Gamma_{3.0}, -i\Gamma_{0.2}; \quad DP; 0 \]

Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma X; \quad C_{4y}^+ \sigma_z, IT; \quad \{R_6\}, \{R_7\}; \quad 4; \quad \frac{\Gamma_{3.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ \Lambda: \Gamma L; \quad C_{31}^- \sigma_d, IT; \quad \{R_3, R_4\}, \{R_6\}; \quad 4; \quad \Gamma_{13}, i\Gamma_{0.3}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ Z: XW; \quad \sigma_y \sigma_z, IT; \quad \{R_3, R_3\}, \{R_6, R_8\}; \quad 4; \quad i\Gamma_{13}, i\Gamma_{0.3}, \Gamma_{0.3}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ Q: LW; \quad C_{2f}, \tilde{E}, IT; \quad \{R_{10}, R_{10}\}, \{R_{14}, R_{14}\}; \quad 4; \quad -i\Gamma_{3.0}, -\Gamma_{0.0}, -i\Gamma_{0.2}; \quad DP; 0 \]

Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma H; \quad C_{4y}^+ \sigma_z, IT; \quad \{R_6\}, \{R_7\}; \quad 4; \quad \frac{\Gamma_{3.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ \Lambda: \Gamma P; \quad C_{31}^- \sigma_d, IT; \quad \{R_3, R_4\}, \{R_6\}; \quad 4; \quad \Gamma_{13}, i\Gamma_{0.3}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ F: PH; \quad C_{34}^+ \sigma_{da}, IT; \quad \{R_3, R_4\}, \{R_6\}; \quad 4; \quad \Gamma_{13}, i\Gamma_{0.3}, -i\Gamma_{0.2}; \quad DP; 0 \]

Accidental degeneracies on high symmetry line

\[ \Delta: \Gamma H; \quad C_{4y}^+ \sigma_z, IT; \quad \{R_6\}, \{R_7\}; \quad 4; \quad \frac{\Gamma_{3.0} + i\Gamma_{0.2}}{\sqrt{2}}, i\Gamma_{0.1}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ \Lambda: \Gamma P; \quad C_{31}^- \sigma_d, IT; \quad \{R_3, R_4\}, \{R_6\}; \quad 4; \quad \Gamma_{13}, i\Gamma_{0.3}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ D: NP; \quad C_{2x}^+ \sigma_d, IT; \quad \{R_5, R_6\}, \{R_7, R_8\}; \quad 4; \quad i\Gamma_{3.0}, \Gamma_{3.3}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ G: HN; \quad C_{2b} \sigma_{da}, IT; \quad \{R_5, R_6\}, \{R_7, R_8\}; \quad 4; \quad i\Gamma_{3.0}, i\Gamma_{3.3}, -i\Gamma_{0.2}; \quad DP; 0 \]
\[ F: PH; \quad C_{34}^+ \sigma_{da}, E, IT; \quad \{R_9, R_{10}\}, \{R_{12}\}; \quad 4; \quad i\Gamma_{13}, i\Gamma_{0.3}, \Gamma_{0.0}, -i\Gamma_{0.2}; \quad DP; 0 \]
C. Effective Hamiltonian of both essential and accidental degeneracies

1. Notes to Sec. S8 C

(i) The top and bottom part of the tables in Sec. S8 C lists the essential and accidental degeneracy, respectively.
(ii) For each table in Sec. S8 C, the first two lines present the SG number, the BZ type, the generating elements of the type II MSG (translations are not included here), whether centrosymmetry is contained in the group, and whether SOC is considered.
(iii) Below the first two lines, the columns from left to right (separated by the semicolons) are the high-symmetry momentum $k$, the corep and the effective Hamiltonian of the symmetry-protected degeneracies.
(iv) In effective Hamiltonian, we use Roman letters (such as $c_i$ and $c_{i,j}$) and Greek letter (such as $\alpha_i$) to denote the real and complex parameters, respectively.
(v) We do not list the type II MSGs that do not exhibit symmetry-protected degeneracies at high-symmetry point and high-symmetry line.

2. SG 1-10
SG 1
\(\Gamma_1; \{E[000]\}, \mathcal{T}; \) Non-Centrosymmetric; with SOC

\(\Gamma; \{R_2, R_3\}; \sum_{i=1}^{3} \sigma_i (c_{i,1k_x} + c_{i,2k_y} + c_{i,3k_z}) + c_1\sigma_0;\)

\(B; \{R_2, R_3\}; \sum_{i=1}^{3} \sigma_i (c_{i,1k_x} + c_{i,2k_y} + c_{i,3k_z}) + c_1\sigma_0;\)

\(F; \{R_2, R_3\}; \sum_{i=1}^{3} \sigma_i (c_{i,1k_x} + c_{i,2k_y} + c_{i,3k_z}) + c_1\sigma_0;\)

\(G; \{R_2, R_3\}; \sum_{i=1}^{3} \sigma_i (c_{i,1k_x} + c_{i,2k_y} + c_{i,3k_z}) + c_1\sigma_0;\)

SG 3
\(\Gamma_m; \{C_{2z}[000]\}, \mathcal{T}; \) Non-Centrosymmetric; with SOC

\(\Gamma; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(B; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(Y; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(Z; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(C; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(D; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(A; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(E; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

Accidental degeneracies on high symmetry line

\(A; \{R_2, R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) ;\)

\(V; \{R_2, R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) ;\)

\(W; \{R_2, R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) ;\)

\(U; \{R_2, R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) ;\)

SG 4
\(\Gamma_m; \{C_{2z}[00\frac{1}{2}]\}, \mathcal{T}; \) Non-Centrosymmetric; with SOC

\(\Gamma; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(B; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(Y; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(Z; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(C; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(D; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(A; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)

\(E; \{R_2, R_3\}; \sum_{i=1}^{2} \sigma_i (c_{i,1k_x} + c_{i,2k_y}) + c_2\sigma_3k_z + c_1\sigma_0;\)
Accidental degeneracies on high symmetry line

\[ \Lambda; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \]
\[ V; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \]
\[ W; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \]
\[ U; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \]

SG 5
\[ \Gamma_{m}; \{ C_{2z} \{000\}; T \}; Non-Centrosymmetric; with SOC \]
\[ \Gamma; \{ R_2, R_4 \}; \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0; \]
\[ A; \{ R_2, R_4 \}; \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0; \]
\[ Z; \{ R_2, R_4 \}; \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0; \]
\[ M; \{ R_2, R_4 \}; \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0; \]
\[ L; \{ R_2, R_4 \}; \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0; \]
\[ V; \{ R_2, R_4 \}; \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \]
\[ U; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \]

SG 6
\[ \Gamma_{m}; \{ \sigma_z \{000\}; T \}; Non-Centrosymmetric; with SOC \]
\[ \Gamma; \{ R_2, R_4 \}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_3 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]
\[ B; \{ R_2, R_4 \}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_3 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]
\[ Y; \{ R_2, R_4 \}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_3 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]
\[ Z; \{ R_2, R_4 \}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_3 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]
\[ C; \{ R_2, R_4 \}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_3 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]
\[ D; \{ R_2, R_4 \}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_3 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]
\[ A; \{ R_2, R_4 \}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_3 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]
\[ E; \{ R_2, R_4 \}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_3 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]
SG 7
\[ \Gamma_m; \{\sigma_z[\frac{1}{2}00]\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{R_2, R_4\}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_4 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]

\[ B; \{R_5, R_3\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ \{R_7, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ Y; \{R_2, R_4\}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_4 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]

\[ Z; \{R_2, R_4\}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_4 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]

\[ C; \{R_2, R_4\}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_4 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]

\[ D; \{R_5, R_3\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ \{R_7, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ A; \{R_5, R_3\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ \{R_7, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ E; \{R_5, R_3\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ \{R_7, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ V; \{R_2, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + \sigma_0 (c_2 k_x + c_1); \]

\[ U; \{R_2, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + \sigma_0 (c_2 k_x + c_1); \]

SG 8
\[ \Gamma_m^0; \{\sigma_z[000]\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{R_2, R_4\}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_4 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]

\[ A; \{R_2, R_4\}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_4 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]

\[ Z; \{R_2, R_2\}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_4 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]

\[ M; \{R_2, R_4\}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_4 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]

\[ L; \{R_2, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) + c_1 \sigma_0; \]

\[ V; \{R_2, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) + c_1 \sigma_0; \]

SG 9
\[ \Gamma_m^0; \{\sigma_z[\frac{1}{2}00]\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{R_2, R_4\}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_4 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]

\[ A; \{R_1, R_1\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ \{R_3, R_3\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ Z; \{R_2, R_4\}; \sigma_3 (c_2 k_x + c_3 k_y) + (c_4 \sigma_1 - c_5 \sigma_2) k_z + c_1 \sigma_0; \]

\[ M; \{R_1, R_1\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ \{R_3, R_3\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + c_1 \sigma_0; \]

\[ L; \{R_2, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) + c_1 \sigma_0; \]

\[ V; \{R_2, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) + c_1 \sigma_0; \]

\[ U; \{R_2, R_2\}; \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) + \sigma_0 (c_2 k_x + c_1); \]
3. SG 11-20

SG 11
\[ \Gamma_m; \{C_{2z}[00\frac{1}{2}], I[00\frac{1}{2}]\}; T; \text{Centrosymmetric; with SOC} \]

- Z: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + \Gamma_{0,2} (c_2 k_x + c_3 k_y) + \sum_{i=1}^{3} c_{i,1} \Gamma_{1,1} k_z; \)
- C: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + \Gamma_{0,2} (c_2 k_x + c_3 k_y) + \sum_{i=1}^{3} c_{i,1} \Gamma_{1,1} k_z; \)
- D: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + \Gamma_{0,2} (c_2 k_x + c_3 k_y) + \sum_{i=1}^{3} c_{i,1} \Gamma_{1,1} k_z; \)
- E: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + \Gamma_{0,2} (c_2 k_x + c_3 k_y) + \sum_{i=1}^{3} c_{i,1} \Gamma_{1,1} k_z; \)

SG 13
\[ \Gamma_m; \{C_{2z}[000], I[\frac{1}{2}0\frac{1}{2}]\}; T; \text{Centrosymmetric; with SOC} \]

- B: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1} k_x + c_{i,2} k_y); \)
- D: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1} k_x + c_{i,2} k_y); \)
- A: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1} k_x + c_{i,2} k_y); \)
- E: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1} k_x + c_{i,2} k_y); \)

Accidental degeneracies on high symmetry line

- V: \( \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \sum_{i=1}^{3} \Gamma_{2,i} (c_{i,1} k_x + c_{i,2} k_y); \)
- U: \( \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \sum_{i=1}^{3} \Gamma_{2,i} (c_{i,1} k_x + c_{i,2} k_y); \)

SG 14
\[ \Gamma_m; \{C_{2z}[00\frac{1}{2}], I[\frac{1}{2}0\frac{1}{2}]\}; T; \text{Centrosymmetric; with SOC} \]

- B: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1} k_x + c_{i,2} k_y); \)
- Z: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + \Gamma_{0,2} (c_2 k_x + c_3 k_y) + \sum_{i=1}^{3} c_{i,1} \Gamma_{1,1} k_z; \)
- C: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + \Gamma_{0,2} (c_2 k_x + c_3 k_y) + \sum_{i=1}^{3} c_{i,1} \Gamma_{1,1} k_z; \)
- A: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1} k_x + c_{i,2} k_y); \)

Accidental degeneracies on high symmetry line

- V: \( \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \sum_{i=1}^{3} \Gamma_{2,i} (c_{i,1} k_x + c_{i,2} k_y); \)
- U: \( \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \sum_{i=1}^{3} \Gamma_{2,i} (c_{i,1} k_x + c_{i,2} k_y); \)

SG 15
\[ \Gamma_m; \{C_{2z}[000], I[\frac{1}{2}0\frac{1}{2}]\}; T; \text{Centrosymmetric; with SOC} \]

- A: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1} k_x + c_{i,2} k_y); \)
- M: \( \{R_0, R_0\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1} k_x + c_{i,2} k_y); \)
Accidental degeneracies on high symmetry line

\[ U: \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \sum_{i=1}^3 \Gamma_{2,i} (c_{i,1} k_x + c_{i,2} k_y); \]

\[ \Delta: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ D: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ P: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ B: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ \Sigma: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ C: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ E: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ A: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ N: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ H: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ Q: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]

\[ G: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_2 \sigma_2 k_x + c_3 \sigma_1 k_z; \]
SG 17

Γ: \( R_5 \):
\[ c_2 \sigma_3 k_x + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z + c_1 \sigma_0; \]

\( Y: R_5 \):
\[ c_2 \sigma_3 k_x + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z + c_1 \sigma_0; \]

\( X: R_5 \):
\[ c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \]

\( Z: \{ R_5, R_6 \} \):
\[ (c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0; \]

\( U: \{ R_5, R_6 \} \):
\[ (c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0; \]

\( T: \{ R_5, R_6 \} \):
\[ (c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0; \]

\( S: R_5 \):
\[ c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \]

\( R: \{ R_5, R_6 \} \):
\[ (c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0; \]

\( P: \{ R_5, R_6 \} \):
\[ \sigma_0 (c_2 k_y + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \]

\( B: \{ R_5, R_6 \} \):
\[ \sigma_0 (c_2 k_y + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \]

\( E: \{ R_5, R_6 \} \):
\[ \sigma_0 (c_2 k_z + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \]

\( A: \{ R_5, R_6 \} \):
\[ \sigma_0 (c_2 k_z + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \]

Accidental degeneracies on high symmetry line

\( \Delta: \{ R_2 \}, \{ R_4 \} \):
\[ \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_z + c_5 \sigma_1 k_z; \]

\( D: \{ R_2 \}, \{ R_4 \} \):
\[ \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_z + c_5 \sigma_1 k_z; \]

\( \Sigma: \{ R_2 \}, \{ R_4 \} \):
\[ \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]

\( C: \{ R_2 \}, \{ R_4 \} \):
\[ \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]

\( \Lambda: \{ R_2 \}, \{ R_4 \} \):
\[ \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]

\( H: \{ R_2 \}, \{ R_4 \} \):
\[ \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]

\( Q: \{ R_2 \}, \{ R_4 \} \):
\[ \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]

\( G: \{ R_2 \}, \{ R_4 \} \):
\[ \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ \{R_2\}, \{R_4\} \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z; \]

\[ B: \{ \{R_2\}, \{R_4\} \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z; \]

\[ \Sigma: \{ \{R_2\}, \{R_4\} \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z; \]

\[ A: \{ \{R_2\}, \{R_4\} \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z; \]

\[ \Lambda: \{ \{R_2\}, \{R_4\} \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z; \]

\[ Q: \{ \{R_2, R_4\}, \{R_4, R_4\} \} : \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 \Gamma_{2,0} k_x + c_5 \Gamma_{1,0} k_y + \sum_{i=1}^{3} (c_{i,1} \Gamma_{i,1} k_x + c_{i,2} \Gamma_{i,2} k_y); \]
$\Gamma$: $R_5$: 
$c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0$;

$Y$: $\{R_5, R_3\}$: 
$(c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0$;

$\{R_7, R_3\}$: 
$(c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0$;

$X$: $\{R_5, R_3\}$: 
$(c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0$;

$\{R_7, R_3\}$: 
$(c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0$;

$Z$: $\{R_5, R_3\}$: 
$(c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0$;

$\{R_7, R_3\}$: 
$(c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0$;

$U$: $\{R_5, R_3\}$: 
$c_1 \Gamma_{0,0} + c_2 \Gamma_{0,3} k_y + \sum_{i=1}^{3} (c_1 \Gamma_{1,2} k_x + c_2 \Gamma_{1,1} k_z)$;

$N$: $\{R_5, R_3\}$: 
$c_1 \Gamma_{0,0} + c_2 \Gamma_{0,3} k_y + \sum_{i=1}^{3} (c_1 \Gamma_{1,2} k_x + c_2 \Gamma_{1,1} k_z)$;

$S$: $\{R_5, R_3\}$: 
$c_1 \Gamma_{0,0} + c_2 \Gamma_{0,3} k_y + \sum_{i=1}^{3} (c_1 \Gamma_{1,2} k_y + c_2 \Gamma_{1,1} k_x)$;

$R$: $\{R_5, R_3\}$: 
$\sigma_0 (c_2 k_x^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + \sum_{i=1}^{3} c_i \sigma_i k_y k_z$;

$\{R_7, R_3\}$: 
$\sigma_0 (c_2 k_x^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + \sum_{i=1}^{3} c_i \sigma_i k_y k_z$;

$\{R_5, R_3\}$: 
$\sigma_0 (c_2 k_y^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + \sum_{i=1}^{3} c_i \sigma_i k_x k_z$;

$\{R_7, R_3\}$: 
$\sigma_0 (c_2 k_y^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + \sum_{i=1}^{3} c_i \sigma_i k_x k_z$;

$D$: $\{R_5, R_3\}$: 
$\sigma_0 (c_2 k_y + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_z$;

$P$: $\{R_5, R_3\}$: 
$\sigma_0 (c_2 k_x^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + \sum_{i=1}^{3} c_i \sigma_i k_y k_z$;

$\{R_7, R_3\}$: 
$\sigma_0 (c_2 k_y^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + \sum_{i=1}^{3} c_i \sigma_i k_x k_z$;

$B$: $\{R_5, R_3\}$: 
$\sigma_0 (c_2 k_y + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_z$;

$C$: $\{R_5, R_3\}$: 
$\sigma_0 (c_2 k_y + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_z$;

$E$: $\{R_5, R_3\}$: 
$\sigma_0 (c_2 k_x^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + \sum_{i=1}^{3} c_i \sigma_i k_y k_z$;

$\{R_7, R_3\}$: 
$\sigma_0 (c_2 k_y^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + \sum_{i=1}^{3} c_i \sigma_i k_x k_z$;

$A$: $\{R_5, R_3\}$: 
$\sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_z$;

$H$: $\{R_5, R_3\}$: 
$(c_2 \sigma_1 - c_4 \sigma_2) k_y + \sigma_0 (c_3 k_y + c_1)$;

$Q$: $\{R_5, R_3\}$: 
$\sigma_0 (c_2 k_x^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + \sum_{i=1}^{3} c_i \sigma_i k_y k_y$;

$\{R_7, R_3\}$: 
$\sigma_0 (c_2 k_y^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + \sum_{i=1}^{3} c_i \sigma_i k_x k_y$;

$G$: $\{R_5, R_3\}$: 
$(c_2 \sigma_1 - c_4 \sigma_2) k_x + \sigma_0 (c_3 k_z + c_1)$;

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Accidental degeneracies on high symmetry line

$\Delta$: $\{R_2\}$, $\{R_4\}$: 
$\sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_z + c_5 \sigma_1 k_z$;

$P$: $\{R_5, R_3\}$, $\{R_7, R_3\}$: 
$\Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 \Gamma_{2,0} k_z + c_5 \Gamma_{1,0} k_z + \sum_{i=1}^{3} (c_i \Gamma_{1,2} k_x + c_i \Gamma_{2,1} k_z)$;

$\Sigma$: $\{R_5\}$, $\{R_3\}$: 
$\sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_z + c_5 \sigma_1 k_z$;

$E$: $\{R_5, R_3\}$, $\{R_7, R_3\}$: 
$\Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 \Gamma_{2,0} k_z + c_5 \Gamma_{1,0} k_y + \sum_{i=1}^{3} (c_i \Gamma_{1,2} k_z + c_i \Gamma_{2,1} k_y)$;

$\Lambda$: $\{R_5\}$, $\{R_3\}$: 
$\sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_z + c_5 \sigma_1 k_y$;

$Q$: $\{R_5, R_3\}$, $\{R_7, R_3\}$: 
$\Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 \Gamma_{2,0} k_z + c_5 \Gamma_{1,0} k_y + \sum_{i=1}^{3} (c_i \Gamma_{1,2} k_z + c_i \Gamma_{2,1} k_y)$;
\( \Gamma_0^\Gamma: \{C_{2v}|00\frac{1}{2}\}, \{C_{2v}|00\frac{1}{4}\}, T; \) Non-Centrosymmetric; with SOC

\[
\begin{align*}
\Gamma: & \quad R_5: \quad c_2 \sigma_3 k_x + c_3 \sigma_3 k_y - c_4 \sigma_2 k_z + c_5 \sigma_0; \\
Y: & \quad R_5: \quad c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_5 \sigma_0; \\
Z: & \quad \{R_5, R_6\}: (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \\
& \quad \{R_7, R_6\}: (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \\
T: & \quad \{R_5, R_6\}: (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \\
& \quad \{R_7, R_6\}: (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \\
S: & \quad \{R_2, R_4\}: \sum_{i=1}^{2} \sigma_i (c_1 k_x + c_i k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0; \\
R: & \quad \{R_5, R_5\}: (c_3 \sigma_1 - c_4 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0; \\
& \quad \{R_7, R_7\}: (c_3 \sigma_1 - c_4 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0; \\
A: & \quad \{R_2, R_4\}: \sigma_0 (c_2 k_x + c_4) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \\
B: & \quad \{R_5, R_7\}: \sigma_0 (c_2 k_y + c_4) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \\
C: & \quad \{R_2, R_4\}: \sigma_0 (c_2 k_x + c_4) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \\
D: & \quad \{R_5, R_7\}: \sigma_0 (c_2 k_y + c_4) + (c_3 \sigma_1 - c_4 \sigma_2) k_z;
\end{align*}
\]

Accidental degeneracies on high symmetry line

\[
\begin{align*}
\Lambda: & \quad \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_1 c k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \\
H: & \quad \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_1 c k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \\
D: & \quad \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_1 c k_z + \sum_{i=1}^{2} \sigma_i (c_1 k_x + c_2 k_y); \\
\Sigma: & \quad \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_1 c k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \\
\Delta: & \quad \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + \sigma_1 c k_y + c_4 \sigma_2 k_z + c_5 \sigma_1 k_z; \\
F: & \quad \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + \sigma_1 c k_y + c_4 \sigma_2 k_z + c_5 \sigma_1 k_z; \\
C: & \quad \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_1 c k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z;
\end{align*}
\]
Accidental degeneracies on high symmetry line

\(\Lambda\): \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z;

\(\Pi\): \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z;

\(\Delta\): \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i \left( c_{i,1} k_x + c_{i,2} k_y \right);

\(\Pi\): \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_z + c_1 \sigma_1 k_y + c_2 \sigma_2 k_z;

\(\Sigma\): \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z;

\(\Delta\): \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z;

\(\Pi\): \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;

\(\Delta\): \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;

\(\Sigma\): \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;

\(\Delta\): \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
Accidental degeneracies on high symmetry line

Λ: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
G: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
H: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
Q: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
S: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
C: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
A: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
U: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;

\sum_{i=1}^{2} \sigma_i (c_i,1 k_x + c_i,2 k_z) + \sigma_2 c_3 k_z + \sigma_3 c_3 k_z + \sigma_4 c_3 k_z + \sigma_5 c_3 k_z;

\sigma_2 c_3 k_z + \sigma_3 c_3 k_z + \sigma_4 c_3 k_z + \sigma_5 c_3 k_z;

C_{2y}[000], C_{2z}[000], T; Non-Centrosymmetric; with SOC

Γ: \{R_5\}; c_2 \sigma_3 k_z + c_2 \sigma_3 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0;
X: \{R_5\}; c_2 \sigma_3 k_z + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0;
R: \{R_2, R_4\}; \sum_{i=1}^{2} \sigma_i (c_i,1 k_x + c_i,2 k_z) + c_2 \sigma_3 k_y + c_1 \sigma_0;
S: \{R_2, R_4\}; \sum_{i=1}^{2} \sigma_i (c_i,1 k_y + c_i,2 k_x) + c_2 \sigma_3 k_z + c_1 \sigma_0;
T: \{R_2, R_4\}; \sum_{i=1}^{2} \sigma_i (c_i,1 k_z + c_i,2 k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0;
W: \{R_5\}; c_2 \sigma_3 k_x + c_3 \sigma_3 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0;

Accidental degeneracies on high symmetry line

Λ: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
G: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
P: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_i,1 k_x + c_i,2 k_y);
Σ: \{R_2\}, \{R_1\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
P: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_x;
D: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_i,1 k_y + c_i,2 k_z);
Δ: \{R_2\}, \{R_1\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
U: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_x + c_5 \sigma_1 k_z;
Q: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_i,1 k_z + c_i,2 k_x);
\( \Gamma_0 \): \{C_{2x}|101, \{C_{2y}|110\}, \; T; \) Non-Centrosymmetric; with SOC

\( \Gamma; \; R_5; \; c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \)
\( X; \; R_5; \; c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \)
\( R; \; \{R_2, R_4\}; \sum_{i=1}^{2} \sigma_i (c_{1,i} k_x + c_{2,i} k_y) + c_2 \sigma_3 k_y + c_1 \sigma_0; \)
\( S; \; \{R_2, R_4\}; \sum_{i=1}^{2} \sigma_i (c_{1,i} k_y + c_{2,i} k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0; \)
\( T; \; \{R_2, R_4\}; \sum_{i=1}^{2} \sigma_i (c_{1,i} k_x + c_{2,i} k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0; \)

Accidental degeneracies on high symmetry line

\( \Lambda; \; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_1 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)
\( \Gamma; \; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_1 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)
\( \Sigma; \; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_1 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)
\( \Delta; \; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_1 k_z + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \)
\( U; \; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_1 k_y + c_4 \sigma_2 k_z + c_3 \sigma_1 k_z; \)
\( Q; \; \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_1 k_y + \sum_{i=1}^{2} \sigma_i (c_{1,i} k_x + c_{2,i} k_z); \)

\( \Gamma_0; \; \{C_{2z}|000, \{\sigma_y|000\}, \; T; \) Non-Centrosymmetric; with SOC

\( \Gamma; \; R_5; \; c_2 \sigma_3 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \)
\( Y; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \)
\( X; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \)
\( Z; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \)
\( U; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \)
\( T; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \)
\( S; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \)
\( R; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \)
\( A; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_4 k_x + c_1); \)
\( H; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_4 k_x + c_1); \)
\( Q; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_4 k_x + c_1); \)
\( G; \; R_5; \; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_4 k_x + c_1); \)
Accidental degeneracies on high symmetry line

\[\Delta: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_1k_x;\]
\[D: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_1k_x;\]
\[P: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_1k_x;\]
\[B: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_1k_x;\]
\[\Sigma: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_y;\]
\[C: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_y;\]
\[\Gamma: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_y;\]

SG 26

\[\Gamma_0; \{C_2v|00\frac{1}{2}\}, \{\sigma_y|00\frac{1}{2}\}, \Gamma; \text{Non-Centrosymmetric; with SOC}\]

\[\Gamma: \{R_2\}; c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0;\]
\[\gamma: \{R_2\}; c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0;\]
\[X: \{R_2\}; c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0;\]
\[\Sigma: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_y;\]
\[R: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_y;\]

Accidental degeneracies on high symmetry line

\[\Delta: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_1k_x;\]
\[D: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_1k_x;\]
\[P: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_1k_x;\]
\[B: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_1k_x;\]
\[\Sigma: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_y;\]
\[C: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_y;\]
SG 27

\(\Gamma_o; \{C_2, [000], \{\sigma_y|00\frac{1}{2}\}\}; T; \) Non-Centrosymmetric; with SOC

\[\begin{align*}
\Gamma: & \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0; \\
Y: & \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0; \\
X: & \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0; \\
Z: & \quad \{R_0, R_4\}; \quad c_1\Gamma_{0,0} + \sum_{i=1}^{3} (c_i, 1\Gamma_{i,2}k_x + c_{i,2}\Gamma_{i,1}k_y + c_{i,3}\Gamma_{i,0}k_z); \\
U: & \quad \{R_0, R_4\}; \quad c_1\Gamma_{0,0} + \sum_{i=1}^{3} (c_i, 1\Gamma_{i,2}k_x + c_{i,2}\Gamma_{i,1}k_y + c_{i,3}\Gamma_{i,0}k_z); \\
T: & \quad \{R_0, R_4\}; \quad c_1\Gamma_{0,0} + \sum_{i=1}^{3} (c_i, 1\Gamma_{i,2}k_x + c_{i,2}\Gamma_{i,1}k_y + c_{i,3}\Gamma_{i,0}k_z); \\
S: & \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0; \\
R: & \quad \{R_0, R_4\}; \quad c_1\Gamma_{0,0} + \sum_{i=1}^{3} (c_i, 1\Gamma_{i,2}k_x + c_{i,2}\Gamma_{i,1}k_y + c_{i,3}\Gamma_{i,0}k_z); \\
P: & \quad \{R_2, R_4\}; \quad \sigma_0 (c_2k_y + c_1) + (c_2\sigma_1 - c_2\sigma_2) k_x + c_4\sigma_3k_z; \\
B: & \quad \{R_2, R_4\}; \quad \sigma_0 (c_3k_y + c_1) + (c_2\sigma_1 - c_3\sigma_2) k_x + c_4\sigma_3k_z; \\
E: & \quad \{R_2, R_4\}; \quad \sigma_0 (c_2k_x + c_1) + (c_3\sigma_1 - c_2\sigma_2) k_y + c_4\sigma_3k_z; \\
A: & \quad \{R_2, R_4\}; \quad \sigma_0 (c_2k_x + c_1) + (c_3\sigma_1 - c_2\sigma_2) k_y + c_4\sigma_3k_z; \\
N: & \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + \sigma_0 (c_4k_z + c_1); \\
H: & \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + \sigma_0 (c_4k_z + c_1); \\
Q: & \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + \sigma_0 (c_4k_z + c_1); \\
G: & \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + \sigma_0 (c_4k_z + c_1); \\
\end{align*}\]

Accidental degeneracies on high symmetry line

\[\begin{align*}
\Delta: & \quad \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_3k_y) + \sigma_3c_3k_y + c_4\sigma_1k_z; \\
D: & \quad \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_3k_y) + \sigma_3c_3k_y + c_4\sigma_1k_z; \\
\Sigma: & \quad \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_3k_y) + \sigma_3c_3k_y + c_4\sigma_2k_y; \\
C: & \quad \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_3k_y) + \sigma_3c_3k_y + c_4\sigma_2k_y; \\
\end{align*}\]
\[ \Gamma_0; \{C_{2v}\}, \{\sigma_y\}; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma: R_5; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]

\[ Y; \{R_5, R_6\}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ \{R_7, R_8\}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ X: R_5; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]

\[ Z: R_5; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]

\[ U: R_5; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]

\[ T: \{R_5, R_6\}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ \{R_7, R_8\}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ S: \{R_5, R_6\}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ \{R_7, R_8\}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ R: \{R_5, R_6\}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ \{R_7, R_8\}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ C: \{R_2, R_4\}; \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_y + c_4 \sigma_3 k_z; \]

\[ E: \{R_2, R_4\}; \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_y + c_4 \sigma_3 k_z; \]

\[ A: \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_y + c_4 \sigma_2 k_y; \]

\[ H: \{R_5, R_6\}, \{R_7, R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ \{R_5, R_7\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_5, R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_6, R_7\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_7, R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ Q: \{R_5, R_6\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]

\[ \{R_5, R_7\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_5, R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_6, R_7\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_7, R_8\}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_3 k_z; \]
$\Gamma_0$: $\{C_2, |\frac{1}{2}\frac{1}{2}\}, \{\sigma_y|00\frac{1}{2}\}$, $T$; Non-Centrosymmetric; with SOC

$\Gamma$: $R_5$: $c_2\sigma_1 k_x + c_3\sigma_3 k_y + c_1 \sigma_0$;

$Y$: $\{R_5, R_6\}$: $(c_2\sigma_1 - c_4\sigma_2) k_y + c_0 \sigma_3 k_z + c_1 \sigma_0$;

$\{R_2, R_3\}$: $(c_2\sigma_1 - c_4\sigma_2) k_y + c_3 \sigma_1 k_z + c_1 \sigma_0$;

$X$: $R_5$: $c_2\sigma_1 k_x + c_0 \sigma_3 k_y + c_1 \sigma_0$;

$Z$: $\{R_6, R_9\}$: $c_1 \Gamma_{0,0} + c_2 \Gamma_{0,3} k_y + \sum_{i=1}^{3} (c_{1,1} \Gamma_{0,0} k_x + c_{1,2} \Gamma_{0,0} k_z)$;

$U$: $\{R_6, R_9\}$: $c_1 \Gamma_{0,0} + c_2 \Gamma_{0,3} k_y + \sum_{i=1}^{3} (c_{1,1} \Gamma_{0,0} k_x + c_{1,2} \Gamma_{0,0} k_z)$;

$T$: $\{R_6, R_9\}$: $(c_3 \sigma_1 - c_0 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0$;

$\{R_7, R_8\}$: $(c_3 \sigma_1 - c_0 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0$;

$\{R_6, R_8\}$: $(c_3 \sigma_1 - c_0 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0$;

$\{R_9, R_9\}$: $(c_3 \sigma_1 - c_0 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0$;

$S$: $\{R_6, R_6\}$: $(c_3 \sigma_1 - c_0 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0$;

$\{R_7, R_7\}$: $(c_3 \sigma_1 - c_0 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0$;

$\{R_8, R_8\}$: $(c_3 \sigma_1 - c_0 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0$;

$P$: $\{R_2, R_2\}$: $\sigma_0 (c_2 k_y + c_1) + (c_1 \sigma_1 - c_0 \sigma_2 + c_3 \sigma_3) k_z$;

$\{R_4, R_4\}$: $\sigma_0 (c_2 k_y + c_1) + (c_1 \sigma_1 - c_0 \sigma_2 + c_3 \sigma_3) k_z$;

$B$: $\{R_2, R_2\}$: $\sigma_0 (c_2 k_y + c_1) + (c_1 \sigma_1 - c_0 \sigma_2 + c_3 \sigma_3) k_z$;

$\{R_4, R_4\}$: $\sigma_0 (c_2 k_y + c_1) + (c_1 \sigma_1 - c_0 \sigma_2 + c_3 \sigma_3) k_z$;

$C$: $\{R_2, R_2\}$: $\sigma_0 (c_2 k_y + c_1) + (c_1 \sigma_1 - c_0 \sigma_2 + c_3 \sigma_3) k_z$;

$E$: $\{R_2, R_2\}$: $\sigma_0 (c_2 k_y + c_1) + (c_1 \sigma_1 - c_0 \sigma_2 + c_3 \sigma_3) k_z$;

$\{R_4, R_4\}$: $\sigma_0 (c_2 k_y + c_1) + (c_1 \sigma_1 - c_0 \sigma_2 + c_3 \sigma_3) k_z$;

$A$: $\{R_2, R_2\}$: $\sigma_0 (c_2 k_y + c_1) + (c_1 \sigma_1 - c_0 \sigma_2 + c_3 \sigma_3) k_z$;

$\{R_5, R_5\}$: $\sigma_0 (c_2 k_y + c_1) + (c_1 \sigma_1 - c_0 \sigma_2 + c_3 \sigma_3) k_z$;

$G$: $R_5$: $\sigma_0 (c_2 k_y + c_1) + (c_1 \sigma_1 - c_0 \sigma_2 + c_3 \sigma_3) k_z$;
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z; \]
\[ D; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z; \]
\[ P; \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{000} + \Gamma_{001} c_1 k_x + \sum_{i=1}^{3} [k_x (c_{i1} \Gamma_{00i} + c_{i2} \Gamma_{30i}) + c_{i3} \Gamma_{2i}]; \]
\[ B; \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{000} + \Gamma_{001} c_1 k_x + \sum_{i=1}^{3} [k_x (c_{i1} \Gamma_{00i} + c_{i2} \Gamma_{30i}) + c_{i3} \Gamma_{2i}]; \]
\[ \Sigma; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y; \]
\[ E; \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{000} (c_1 + c_2 k_z) + \Gamma_{001} c_2 k_x + c_4 \Gamma_{201} k_y + \sum_{i=1}^{3} [k_x (c_{i1} \Gamma_{00i} + c_{i2} \Gamma_{30i}) + c_{i3} \Gamma_{2i}]; \]
\[ H; \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]
\[ \{R_5\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{R_5\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{R_6\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ Q; \{R_6\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]
\[ \{R_7\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]
\[ \{R_5\}, \{R_5\}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_x + c_1 \sigma_0; \]
\[ \{R_7, R_8\}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_x + c_1 \sigma_0; \]
\[ X; \{R_5\}, \{R_5\}; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]
\[ \{R_7, R_8\}; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]
\[ Z; \{R_9, R_9\}; \Gamma_{000} + \sum_{i=1}^{3} (c_{i1} \Gamma_{1i2} k_x + c_{i2} \Gamma_{1i1} k_y + c_{i3} \Gamma_{1i0} k_z); \]
\[ U; \{R_9, R_9\}; \Gamma_{000} + \sum_{i=1}^{3} (c_{i1} \Gamma_{1i2} k_x + c_{i2} \Gamma_{1i1} k_y + c_{i3} \Gamma_{1i0} k_z); \]
\[ T; \{R_9, R_9\}; (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ \{R_7, R_8\}; (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ S; \{R_5, R_6\}; (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ \{R_7, R_8\}; (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ R; \{R_5, R_6\}; (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ \{R_7, R_8\}; (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ P; \{R_2, R_2\}; \sigma_0 (c_3 k_y + c_1) + (c_2 \sigma_1 - c_5 \sigma_2) k_x + c_4 \sigma_3 k_z; \]
\[ B; \{R_2, R_2\}; \sigma_0 (c_3 k_y + c_1) + (c_2 \sigma_1 - c_5 \sigma_2) k_x + c_4 \sigma_3 k_z; \]
\[ C; \{R_2, R_2\}; \sigma_0 (c_3 k_y + c_1) + (c_2 \sigma_1 - c_5 \sigma_2) k_x + c_4 \sigma_3 k_z; \]
\[ A; \{R_2, R_2\}; \sigma_0 (c_3 k_y + c_1) + (c_2 \sigma_1 - c_5 \sigma_2) k_x + c_4 \sigma_3 k_z; \]
\[ N; \{R_5\}; \sigma_0 (c_2 k_x + c_1) + c_3 \sigma_1 k_x + c_4 \sigma_3 k_y; \]
\[ G; \{R_5\}; \sigma_0 (c_2 k_x + c_1) + c_3 \sigma_1 k_x + c_4 \sigma_3 k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_3 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z; \]

\[ D; \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_3 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z; \]

\[ \Sigma; \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y; \]

\[ E; \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y; \]

\[ H; \{R_5\}, \{R_6\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]

\[ \{R_5\}, \{R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_5\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_6\}, \{R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_6\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_7\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]

\[ Q; \{R_5\}, \{R_6\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]

\[ \{R_5\}, \{R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_5\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_6\}, \{R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_6\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_7\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2, R_4\} \; \{R_2, R_4\}; \; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sigma_1 k_x; \]

\[ \Delta: \{R_2, R_4\} \; \{R_2, R_4\}; \; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sigma_1 k_x; \]

\[ \Sigma: \{R_2, R_4\} \; \{R_2, R_4\}; \; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \sigma_2 k_y; \]

\[ \Lambda: \{R_2, R_4\} \; \{R_2, R_4\} \; \{R_4, R_4\}; \; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{0,0} (c_2 k_x) + \Gamma_{0,0} (c_3 k_y) + \sum_{i=1}^{3} [k_x (c_1 \Gamma_{0,1} + c_2 \Gamma_{1,0}) + c_3 k_y \Gamma_{1,1}]; \]

\[ H: \{R_0, R_6\}; \; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]

\[ H: \{R_0, R_6\}; \; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]

\[ Q: \{R_3, R_9\}; \; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]

\[ Q: \{R_3, R_9\}; \; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2, R_4\} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_2 k_y + c_1 \sigma_1 k_z; \]
\[ B: \{R_2, R_4\} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_2 k_y + c_1 \sigma_1 k_z; \]
\[ \Sigma: \{R_2, R_4\} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_2 k_y + c_1 \sigma_1 k_z; \]
\[ A: \{R_2, R_4\} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_2 k_y + c_1 \sigma_1 k_z; \]
\[ H: \{R_2, R_4\} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_2 k_y; \]
\[ \{R_5, R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{R_5, R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{R_6, R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{R_6, R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{R_6, R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{R_6, R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{R_7\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
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\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\[ \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z; \]
\( \Gamma_0; \{ C_{2z}\uparrow\downarrow\uparrow\downarrow\downarrow\}, \{ \sigma_y\uparrow\uparrow\uparrow\uparrow\downarrow\}. \; T; \) Non-Centrosymmetric; with SOC

\( \Gamma; R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0; \)

\( Y; \{ R_5, R_6 \}; \quad (c_2\sigma_1 - c_4\sigma_2)k_y + c_3\sigma_3k_x + c_1\sigma_0; \)

\( \{ R_7, R_8 \}; \quad (c_2\sigma_1 - c_4\sigma_2)k_y + c_3\sigma_3k_x + c_1\sigma_0; \)

\( X; \{ R_5, R_7 \}; \quad (c_2\sigma_1 - c_4\sigma_2)k_z + c_3\sigma_3k_x + c_1\sigma_0; \)

\( \{ R_7, R_8 \}; \quad (c_2\sigma_1 - c_4\sigma_2)k_z + c_3\sigma_3k_x + c_1\sigma_0; \)

\( Z; \{ R_9, R_6 \}; \quad c_1\Gamma_{0,0} + c_2\Gamma_{0,3}k_y + \sum_{i=1}^{3} (c_{i,1}\Gamma_{1,1}k_x + c_{i,2}\Gamma_{1,0}k_y); \)

\( U; \{ R_5, R_3 \}; \quad c_2\sigma_3k_x + c_1\sigma_0; \)

\( \{ R_7, R_8 \}; \quad c_2\sigma_3k_x + c_1\sigma_0; \)

\( T; \{ R_6, R_6 \}; \quad (c_3\sigma_1 - c_4\sigma_2 + c_2\sigma_3)k_x + c_1\sigma_0; \)

\( \{ R_7, R_7 \}; \quad (c_3\sigma_1 - c_4\sigma_2 + c_2\sigma_3)k_x + c_1\sigma_0; \)

\( \{ R_8, R_8 \}; \quad (c_3\sigma_1 - c_4\sigma_2 + c_2\sigma_3)k_x + c_1\sigma_0; \)

\( \{ R_9, R_9 \}; \quad (c_3\sigma_1 - c_4\sigma_2 + c_2\sigma_3)k_x + c_1\sigma_0; \)

\( S; \{ R_9, R_6 \}; \quad c_1\Gamma_{0,0} + \sum_{i=1}^{3} (c_{i,1}\Gamma_{1,2}k_x + c_{i,2}\Gamma_{1,1}k_y + c_{i,3}\Gamma_{1,0}k_z); \)

\( R; \{ R_9, R_9 \}; \quad c_1\Gamma_{0,0} + c_2\Gamma_{0,3}k_x + \sum_{i=1}^{3} (c_{i,1}\Gamma_{1,2}k_y + c_{i,2}\Gamma_{1,0}k_z); \)

\( D; \{ R_2, R_4 \}; \quad \sigma_0 (c_3k_y + c_1) + (c_2\sigma_1 - c_5\sigma_2)k_x + c_4\sigma_3k_z; \)

\( P; \{ R_2, R_4 \}; \quad \sigma_0 (c_2k_y + c_1) + c_3\sigma_3k_z; \)

\( B; \{ R_2, R_5 \}; \quad \sigma_0 (c_2k_y + c_1) + (c_1\sigma_1 - c_5\sigma_2 + c_3\sigma_3)k_z; \)

\( \{ R_4, R_2 \}; \quad \sigma_0 (c_2k_y + c_1) + (c_1\sigma_1 - c_5\sigma_2 + c_3\sigma_3)k_z; \)

\( C; \{ R_2, R_5 \}; \quad \sigma_0 (c_2k_z + c_1) + (c_3\sigma_1 - c_5\sigma_2)k_y + c_4\sigma_3k_z; \)

\( E; \{ R_2, R_5 \}; \quad \sigma_0 (c_2k_z + c_1) + (c_3\sigma_1 - c_5\sigma_2 + c_3\sigma_3)k_z; \)

\( \{ R_4, R_4 \}; \quad \sigma_0 (c_2k_z + c_1) + (c_3\sigma_1 - c_5\sigma_2 + c_3\sigma_3)k_z; \)

\( A; \{ R_2, R_5 \}; \quad \sigma_0 (c_2k_z + c_1) + c_3\sigma_3k_z; \)

\( N; \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + \sigma_0 (c_4k_z + c_1); \)

\( Q; \quad R_{10}; \quad c_2\sigma_1k_x - c_4\sigma_2k_y + \sigma_0 (c_4k_z + c_1); \)
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2\}, \{R_4\} ; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z; \]

\[ B: \{R_2, R_4\}, \{R_4, R_4\} ; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 \Gamma_{1,1} k_x + \sum_{i=1}^{3} [k_x (c_{i,1} \Gamma_{0,i} + c_{i,2} \Gamma_{1,i}) + c_{i,3} k_y \Gamma_{2,i}]; \]

\[ \Sigma: \{R_2\}, \{R_4\} ; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y; \]

\[ E: \{R_2, R_3\}, \{R_4, R_4\} ; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4 \Gamma_{2,0} k_y + \sum_{i=1}^{3} [k_x (c_{i,1} \Gamma_{0,i} + c_{i,2} \Gamma_{1,i}) + c_{i,3} k_y \Gamma_{2,i}]; \]

\[ H: \{R_5\}, \{R_5\} ; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]

\[ G: \{R_5\}, \{R_5\} ; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]

\[ \Gamma_0; \{C_{2z}\}, \{\sigma_y\} , \{ \{ \frac{1}{2}, \frac{1}{2} \} \}; T; \] Non-Centrosymmetric; with SOC

\[ \Gamma; \quad \{R_5\} ; \quad 2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]

\[ Y; \{R_5, R_5\} ; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ Z; \{R_6, R_6\} ; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^{3} (c_{i,1} \Gamma_{1,i} k_x + c_{i,2} \Gamma_{1,i} k_y + c_{i,3} \Gamma_{1,i} k_z); \]

\[ U; \{R_5, R_6\} ; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ T; \{R_5, R_5\} ; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ S; \{R_5, R_5\} ; \quad c_3 \Gamma_{0,0} + \sum_{i=1}^{3} (c_{i,1} \Gamma_{1,i} k_x + c_{i,2} \Gamma_{1,i} k_y + c_{i,3} \Gamma_{1,i} k_z); \]

\[ R; \{R_5\} ; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]

\[ D; \{R_2, R_2\} ; \quad \sigma_0 (c_3 k_y + c_1) + (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_4 \sigma_3 k_z; \]

\[ B; \{R_2, R_2\} ; \quad \sigma_0 (c_3 k_y + c_1) + (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_4 \sigma_3 k_z; \]

\[ C; \{R_2, R_2\} ; \quad \sigma_0 (c_3 k_z + c_1) + (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_4 \sigma_3 k_z; \]

\[ A; \{R_2, R_2\} ; \quad \sigma_0 (c_3 k_x + c_1) + (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_4 \sigma_3 k_z; \]

\[ N; \{R_5\} ; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_3 k_z + c_1); \]

\[ Q; \{R_{10}\} ; \quad c_2 \sigma_1 k_x - c_4 \sigma_2 k_y + \sigma_0 (c_3 k_z + c_1); \]
Accidental degeneracies on high symmetry line

\[ \begin{align*}
\Delta: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_y) + \sigma_2 c_3 k_y + c_4 \sigma_1 k_z; \\
\mathcal{P}: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_y) + \sigma_2 c_3 k_y + c_4 \sigma_1 k_z; \\
\Sigma: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x + c_4 \sigma_2 k_y; \\
\mathcal{E}: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x + c_4 \sigma_2 k_y; \\
\mathcal{H}: \{ R_5 \}, \{ R_6 \}: & \quad \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x; \\
& \quad \{ R_5 \}, \{ R_6 \}: \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x; \\
& \quad \{ R_6 \}, \{ R_7 \}: \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x; \\
& \quad \{ R_7 \}, \{ R_8 \}: \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x; \\
\mathcal{G}: \{ R_5 \}, \{ R_6 \}: & \quad \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x; \\
& \quad \{ R_5 \}, \{ R_6 \}: \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x; \\
& \quad \{ R_6 \}, \{ R_7 \}: \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x; \\
& \quad \{ R_7 \}, \{ R_8 \}: \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x; \\
\end{align*} \]

SG 35
\[ \Gamma_0^s; \{ C_{2z}, \{000 \}, \{000 \}, \mathcal{T}; \text{Non-Centrosymmetric; with SOC} \]
\[ \begin{align*}
\Gamma: & \quad R_5: \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \\
& \quad Y: \quad R_5: \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \\
& \quad Z: \quad R_5: \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \\
& \quad T: \quad R_5: \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \\
S: \{ R_2, R_4 \}: & \quad \sum_{i=1}^{2} \sigma_i (c_{1,i} k_x + c_{2,i} k_y) + c_2 \sigma_3 k_x + c_1 \sigma_0; \\
R: \{ R_2, R_4 \}: & \quad \sum_{i=1}^{2} \sigma_i (c_{1,i} k_x + c_{2,i} k_y) + c_2 \sigma_3 k_x + c_1 \sigma_0; \\
\Lambda: & \quad R_5: \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_1 k_x + c_1) ; \\
H: & \quad R_5: \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_1 k_x + c_1) ;
\end{align*} \]

Accidental degeneracies on high symmetry line

\[ \begin{align*}
D: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1,i} k_x + c_{2,i} k_y); \\
A: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_x) + \sigma_2 c_3 k_x + c_4 \sigma_2 k_y; \\
\Sigma: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_y) + \sigma_2 c_3 k_y + c_4 \sigma_2 k_x; \\
\Delta: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_y) + \sigma_2 c_3 k_y + c_4 \sigma_2 k_x; \\
B: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_y) + \sigma_2 c_3 k_y + c_4 \sigma_1 k_x; \\
G: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_y) + \sigma_2 c_3 k_y + c_4 \sigma_1 k_x; \\
F: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_y) + \sigma_2 c_3 k_y + c_4 \sigma_1 k_x; \\
E: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_y) + \sigma_2 c_3 k_y + c_4 \sigma_2 k_y; \\
C: \{ R_2 \}, \{ R_4 \}: & \quad \sigma_0 (c_1 + c_3 k_y) + \sigma_2 c_3 k_y + c_4 \sigma_2 k_y;
\end{align*} \]
Accidental degeneracies on high symmetry line

\[ D: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{1i} k_x + c_{2i} k_y) \]

\[ A: \{ R_2, R_2 \}, \{ R_4, R_4 \}; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4 \Gamma_{2,0} k_y + \sum_{i=1}^{3} [k_x (c_{1i} \Gamma_{0,1} + c_{2i} \Gamma_{3,1}) + c_{1,3} k_y \Gamma_{1,1}] \]

\[ \Sigma: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y \]

\[ \Delta: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_y \]

\[ F: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_z \]

\[ E: \{ R_2, R_2 \}, \{ R_4, R_4 \}; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4 \Gamma_{2,0} k_y + \sum_{i=1}^{3} [k_x (c_{1i} \Gamma_{0,1} + c_{2i} \Gamma_{3,1}) + c_{1,3} k_y \Gamma_{1,1}] \]

\[ C: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y \]
Accidental degeneracies on high symmetry line

\[ D: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \]
\[ \Sigma: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \]
\[ \Delta: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z; \]
\[ F: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z; \]
\[ C: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \]

SG 38

\[ \Gamma_v: \{C_{2v}\{000\}, \{\sigma_x\{000\}, T; Non-Centrosymmetric; with SOC \]

\[ \Gamma_v: \{C_{2v}\{000\}, \{\sigma_x\{000\}, T; Non-Centrosymmetric; with SOC \]

Accidental degeneracies on high symmetry line

\[ \Lambda: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_z; \]
\[ H: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_z; \]
\[ A: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_z; \]
\[ \Sigma: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_z; \]
\[ E: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_z; \]
\[ C: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_z; \]
$\Gamma^0_6$: \{C\_2\_y\[000\]} , \{\sigma_x|_{\frac{1}{2} \frac{1}{2} 0}\}, $; Non-Centrosymmetric; with SOC

\[ \begin{align*}
\Gamma: & \quad R_5: \quad c_2\sigma_3k_x + c_3\sigma_1k_z + c_1\sigma_0; \\
Y: & \quad R_5: \quad c_2\sigma_3k_x + c_3\sigma_1k_z + c_1\sigma_0; \\
Z: & \quad R_5: \quad c_2\sigma_3k_x + c_3\sigma_1k_z + c_1\sigma_0; \\
T: & \quad R_5: \quad c_2\sigma_3k_x + c_3\sigma_1k_z + c_1\sigma_0; \\
S: & \quad \{R_5, R_5\}: \sum_{\text{dim}=0}^3 \sigma_1 (c_1, k_x + c_1, k_y) + c_1\sigma_0; \\
R: & \quad \{R_5, R_5\}: \sum_{\text{dim}=0}^3 \sigma_1 (c_1, k_x + c_1, k_y) + c_1\sigma_0; \\
\Delta: & \quad R_5: \quad \sigma_0 (c_2k_y + c_1) + \sigma_3k_x + c_4\sigma_1k_z; \\
\Sigma: & \quad \{R_5, R_5\}: \sum_{\text{dim}=0}^3 \sigma_1 (c_1, k_x + c_1, k_y) + c_1\sigma_0; \\
E: & \quad \{R_5, R_5\}: \sum_{\text{dim}=0}^3 \sigma_1 (c_1, k_x + c_1, k_y) + c_1\sigma_0; \\
C: & \quad \{R_5, R_5\}: \sum_{\text{dim}=0}^3 \sigma_1 (c_1, k_x + c_1, k_y) + c_1\sigma_0; \\
A: & \quad \{R_2, R_2\}: \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_z; \\
D: & \quad \{R_1, R_1\}: \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_z; \\
H: & \quad \{R_2, R_2\}: \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_z; \\
F: & \quad \{R_2, R_2\}: \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_2k_z; \\
\end{align*} \]
Accidental degeneracies on high symmetry line

Λ: \{R_2\}, \{R_4\}: σ_0 (c_1 + c_3 k_z) + σ_3 c_3 k_z + c_4 σ_2 k_z;
H: \{R_2\}, \{R_4\}: σ_0 (c_1 + c_3 k_z) + σ_3 c_3 k_z + c_4 σ_2 k_z;
Σ: \{R_2\}, \{R_4\}: σ_0 (c_1 + c_3 k_z) + σ_3 c_3 k_z + c_4 σ_1 k_z;
B: \{R_5\}, \{R_6\}: σ_0 (c_1 + c_3 k_y) + σ_3 c_3 k_y + (c_4 σ_1 + c_5 σ_2) k_z;
\{R_5\}, \{R_7\}: σ_0 (c_1 + c_3 k_y) + σ_3 c_3 k_y + (c_4 σ_1 + c_5 σ_2) k_z;
\{R_6\}, \{R_8\}: σ_0 (c_1 + c_3 k_y) + σ_3 c_3 k_y + (c_4 σ_1 + c_5 σ_2) k_z;
G: \{R_5\}, \{R_6\}: σ_0 (c_1 + c_3 k_y) + σ_3 c_3 k_y + (c_4 σ_1 + c_5 σ_2) k_z;
\{R_5\}, \{R_7\}: σ_0 (c_1 + c_3 k_y) + σ_3 c_3 k_y + (c_4 σ_1 + c_5 σ_2) k_z;
\{R_6\}, \{R_8\}: σ_0 (c_1 + c_3 k_y) + σ_3 c_3 k_y + (c_4 σ_1 + c_5 σ_2) k_z;
C: \{R_2\}, \{R_4\}: σ_0 (c_1 + c_3 k_z) + σ_3 c_3 k_z + c_4 σ_1 k_z;
6. SG 41-50

SG 41

\[ \Gamma_6: \{ C_2y[000], \{ \sigma_x \{ \frac{1}{2} \frac{1}{2} \frac{1}{2} \} \} \}; \] Non-Centrosymmetric; with SOC

\[ \Gamma: \{ R_5 \}; \quad c_2 \sigma_3 k_x + c_3 \sigma_1 k_x + c_1 \sigma_0; \]

\[ Y: \{ R_5 \}; \quad c_2 \sigma_3 k_x + c_3 \sigma_1 k_x + c_1 \sigma_0; \]

\[ Z: \{ R_5, R_6 \}; \quad c_2 \sigma_3 k_y + (c_3 \sigma_1 - c_4 \sigma_2) k_x + c_1 \sigma_0; \]

\[ \{ R_7, R_8 \}; \quad c_2 \sigma_3 k_y + (c_3 \sigma_1 - c_4 \sigma_2) k_x + c_1 \sigma_0; \]

\[ T: \{ R_5, R_6 \}; \quad c_2 \sigma_3 k_y + (c_3 \sigma_1 - c_4 \sigma_2) k_x + c_1 \sigma_0; \]

\[ \{ R_7, R_8 \}; \quad c_2 \sigma_3 k_y + (c_3 \sigma_1 - c_4 \sigma_2) k_x + c_1 \sigma_0; \]

\[ S: \{ R_5, R_5 \}; \quad \sum_{i=1}^3 \sigma_1 (c_1, k_x + c_1, k_y) + c_1 \sigma_0; \]

\[ \{ R_7, R_7 \}; \quad \sum_{i=1}^3 \sigma_1 (c_1, k_x + c_1, k_y) + c_1 \sigma_0; \]

\[ R: \{ R_5, R_5 \}; \quad \sum_{i=1}^3 \sigma_1 (c_1, k_x + c_1, k_y) + c_1 \sigma_0; \]

\[ \{ R_7, R_7 \}; \quad \sum_{i=1}^3 \sigma_1 (c_1, k_x + c_1, k_y) + c_1 \sigma_0; \]

\[ D: \{ R_5, R_5 \}; \quad \sum_{i=1}^3 \sigma_1 (c_1, k_x + c_1, k_y) + \sigma_0 (c_2 k_x + c_1); \]

\[ A: \{ R_5, R_5 \}; \quad \sigma_0 (c_2 k_x + c_1) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]

\[ \Delta: \{ R_5 \}; \quad \sigma_0 (c_2 k_x + c_1) + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z; \]

\[ F: \{ R_5 \}; \quad \sigma_0 (c_2 k_y + c_1) + c_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]

\[ E: \{ R_5, R_5 \}; \quad \sigma_0 (c_2 k_x + c_1) + c_3 \sigma_3 k_y + (c_4 \sigma_1 - c_5 \sigma_2) k_z; \]

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Accidental degeneracies on high symmetry line

\[ A: \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 \sigma_3 k_x + c_4 \sigma_3 k_x; \]

\[ H: \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 \sigma_3 k_x + c_4 \sigma_3 k_x; \]

\[ \Sigma: \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 \sigma_3 k_x + c_4 \sigma_3 k_x; \]

\[ B: \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]

\[ \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]

\[ \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y; \]

\[ \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y; \]

\[ \{ R_6 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]

\[ \{ R_7 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]

\[ \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + \sigma_4 \sigma_1 + c_5 \sigma_2 k_z; \]

\[ \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]

\[ \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y; \]

\[ \{ R_6 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]

\[ \{ R_7 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]

\[ \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + \sigma_4 \sigma_1 + c_5 \sigma_2 k_z; \]

\[ \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + \sigma_4 \sigma_1 + c_5 \sigma_2 k_z; \]

\[ \{ R_6 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]

\[ \{ R_7 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]

\[ \{ R_5 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_x + c_4 \sigma_1 k_z; \]
\[ \Gamma_0' = \{ C_{2z}[000], \{ \sigma_y[000] \}, T \}; \text{Non-Centrosymmetric; with SOC} \]

\[ \begin{align*}
\Gamma: & \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \\
Y: & \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \\
X: & \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \\
Z: & \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \\
L: & \quad \{ R_2, R_2 \}; \quad \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) + c_1 \sigma_0; \\
A: & \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_0 (c_4 k_x + c_1); \\
G: & \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_0 (c_4 k_x + c_1); \\
H: & \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_0 (c_4 k_x + c_1); \\
Q: & \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_0 (c_4 k_x + c_1); \\
\end{align*} \]

Accidental degeneracies on high symmetry line

\[ \begin{align*}
\Sigma: & \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \\
C: & \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \\
A: & \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \\
U: & \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \\
\Delta: & \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \\
D: & \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \\
B: & \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \\
R: & \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \\
\end{align*} \]

\[ \Gamma_0' = \{ C_{2z}[\frac{1}{2}, \frac{1}{2}]; \{ \sigma_y[\frac{1}{2}, 0] \}, T \}; \text{Non-Centrosymmetric; with SOC} \]

\[ \begin{align*}
\Gamma: & \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \\
Y: & \quad \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_x + c_1 \sigma_0; \\
X: & \quad \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_x + c_1 \sigma_0; \\
Z: & \quad \{ R_9, R_9 \}; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^{3} \sigma_i (c_{i,1} \Gamma_{i,0} k_x + c_{i,2} \Gamma_{i,1} k_y + c_{i,3} \Gamma_{i,0} k_z); \\
L: & \quad \{ R_2, R_2 \}; \quad \sum_{i=1}^{3} \sigma_i (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) + c_1 \sigma_0; \\
A: & \quad \{ R_5 \}; \quad \sigma_0 (c_2 k_x + c_1) + c_3 \sigma_1 k_x + c_4 \sigma_3 k_y; \\
Q: & \quad \{ R_5 \}; \quad \sigma_0 (c_2 k_x + c_1) + c_3 \sigma_1 k_x + c_4 \sigma_3 k_y; \\
C: & \quad \{ R_2, R_4 \}; \quad \sigma_0 (c_3 k_y + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_y + c_4 \sigma_3 k_z; \\
A: & \quad \{ R_2, R_4 \}; \quad \sigma_0 (c_3 k_y + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_y + c_4 \sigma_3 k_z; \\
D: & \quad \{ R_2, R_4 \}; \quad \sigma_0 (c_3 k_y + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_y + c_4 \sigma_3 k_z; \\
B: & \quad \{ R_2, R_4 \}; \quad \sigma_0 (c_3 k_y + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_y + c_4 \sigma_3 k_z; \\
\end{align*} \]
Accidental degeneracies on high symmetry line

\[ G; \{ R_5 \}, \{ R_6 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]
\[ \{ R_5 \}, \{ R_7 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y; \]
\[ \{ R_5 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]
\[ \{ R_6 \}, \{ R_7 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]
\[ \{ R_6 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{ R_7 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]

\[ H; \{ R_5 \}, \{ R_6 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]
\[ \{ R_5 \}, \{ R_7 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{ R_5 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]
\[ \{ R_6 \}, \{ R_7 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_z; \]
\[ \{ R_6 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{ R_7 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]

\[ \Sigma; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y; \]
\[ U; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y; \]
\[ \Delta; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_z; \]
\[ R; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z; \]

\[ SG \ 44 \]

\[ \Gamma''; \{ C_2, \{000 \}, \{ \sigma_y \{000 \}, \ T; \ Non-Centrosymmetric; with SOC \]
\( \Gamma_0^0 \): \( \{C_{2v}|000\}, \{\sigma_y|\frac{1}{2} \frac{1}{2} 0\} \), \( T \); Non-Centrosymmetric; with SOC

\( \Gamma \): \( R_5 \); \( c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0 \);
\( X \): \( R_5 \); \( c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0 \);
\( R \): \( \{R_5, R_5\} \); \( \sum_{i=1}^{3} \sigma_i (c_{i1} k_x + c_{i2} k_z) + c_1 \sigma_0 \);
\( S \): \( \{R_5, R_5\} \); \( \sum_{i=1}^{3} \sigma_i (c_{i1} k_y + c_{i2} k_z) + c_1 \sigma_0 \);
\( T \): \( \{R_2, R_4\} \); \( \sum_{i=1}^{2} \sigma_i (c_{i1} k_x + c_{i2} k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0 \);
\( W \): \( \{R_2, R_4\} \); \( (c_3 \sigma_1 - c_4 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0 \);
\( \Lambda \): \( R_5 \); \( c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_4 k_z + c_1) \);
\( G \): \( R_5 \); \( c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_4 k_z + c_1) \);
\( D \): \( \{R_2, R_2\} \); \( \sigma_0 (c_2 k_x + c_1) + \sum_{i=1}^{3} \sigma_i (c_{i1} k_y + c_{i2} k_z) \);
\( Q \): \( \{R_2, R_2\} \); \( \sigma_0 (c_2 k_y + c_1) + \sum_{i=1}^{3} \sigma_i (c_{i1} k_x + c_{i2} k_z) \);

Accidental degeneracies on high symmetry line

\( P \): \( \{R_2, R_5\} \); \( \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{i1} k_x + c_{i2} k_y) \);
\( \Sigma \): \( \{R_2, R_5\} \); \( \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y \);
\( F \): \( \{R_2, R_5\} \); \( \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y \);
\( \Delta \): \( \{R_2, R_4\} \); \( \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x \);
\( U \): \( \{R_2, R_4\} \); \( \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x \);

\( \Gamma_0^0 \): \( \{C_{2v}|000\}, \{\sigma_y|\frac{1}{2} \frac{1}{2} 0\} \), \( T \); Non-Centrosymmetric; with SOC

\( \Gamma \): \( R_5 \); \( c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0 \);
\( X \): \( R_5 \); \( c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0 \);
\( R \): \( \{R_5, R_5\} \); \( \sum_{i=1}^{3} \sigma_i (c_{i1} k_x + c_{i2} k_z) + c_1 \sigma_0 \);
\( S \): \( \{R_5, R_5\} \); \( \sum_{i=1}^{3} \sigma_i (c_{i1} k_y + c_{i2} k_z) + c_1 \sigma_0 \);
\( T \): \( \{R_2, R_4\} \); \( \sum_{i=1}^{2} \sigma_i (c_{i1} k_x + c_{i2} k_y) + c_2 \sigma_3 k_z + c_1 \sigma_0 \);
\( W \): \( \{R_2, R_4\} \); \( (c_2 \sigma_1 - c_4 \sigma_2) k_z + c_3 \sigma_3 k_z + c_1 \sigma_0 \);
\( \Lambda \): \( R_5 \); \( c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_4 k_z + c_1) \);
\( G \): \( R_5 \); \( c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_4 k_z + c_1) \);
\( D \): \( \{R_2, R_2\} \); \( \sigma_0 (c_2 k_x + c_1) + \sum_{i=1}^{3} \sigma_i (c_{i1} k_y + c_{i2} k_z) \);
Accidental degeneracies on high symmetry line

\[ P: \{R_2\}, \{R_4\} : \sigma_0 (c_1 \pm c_2 k_z) + \sigma_3 c_3 k_x + \sum_{i=1}^2 \sigma_i (c_i,1 k_x + c_i,2 k_y) ; \]
\[ \Sigma: \{R_2\}, \{R_4\} : \sigma_0 (c_1 \pm c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y ; \]
\[ F: \{R_2\}, \{R_4\} : \sigma_0 (c_1 \pm c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y ; \]
\[ \Delta: \{R_2\}, \{R_4\} : \sigma_0 (c_1 \pm c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y ; \]
\[ U: \{R_2\}, \{R_4\} : \sigma_0 (c_1 \pm c_2 k_y) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_z ; \]

SG 48
\[ \Gamma_0; \{C_{2v}[000]\}, \{C_{2v}[000]\}, \{I\frac{3}{2}\frac{1}{2}\}\}, \mathcal{T}; \text{Centrosymmetric; with SOC} \]
\[ Y: \{R_{13}, R_{14}\} : c_1 \Gamma_{0,0} + c_2 \Gamma_{3,1} k_x + k_y (c_4 \Gamma_{1,1} + c_2 \Gamma_{2,1}) - c_5 \Gamma_{0,2} k_z ; \]
\[ X: \{R_{13}, R_{14}\} : c_1 \Gamma_{0,0} + k_x (c_4 \Gamma_{1,1} - c_2 \Gamma_{2,1}) - c_5 \Gamma_{0,2} k_z + c_5 \Gamma_{3,1} k_z ; \]
\[ Z: \{R_{13}, R_{14}\} : c_1 \Gamma_{0,0} - c_4 \Gamma_{0,2} k_x + c_2 \Gamma_{3,1} k_y + k_y (c_4 \Gamma_{1,1} - c_2 \Gamma_{2,1}) ; \]
\[ U: \{R_{13}, R_{14}\} : c_1 \Gamma_{0,0} + c_2 \Gamma_{3,1} k_x + k_y (c_4 \Gamma_{1,1} - c_2 \Gamma_{2,1}) - c_5 \Gamma_{0,2} k_z ; \]
\[ T: \{R_{13}, R_{14}\} : c_1 \Gamma_{0,0} + k_x (c_4 \Gamma_{1,1} - c_4 \Gamma_{2,1}) - c_5 \Gamma_{0,2} k_y + c_5 \Gamma_{3,1} k_z ; \]
\[ S: \{R_{13}, R_{14}\} : c_1 \Gamma_{0,0} - c_4 \Gamma_{0,2} k_x + c_2 \Gamma_{3,1} k_y + k_x (c_4 \Gamma_{1,1} - c_5 \Gamma_{2,1}) ; \]

Accidental degeneracies on high symmetry line

\[ D: \{R_{5}, R_{6}\}, \{R_{6}, R_{7}\} : \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_x + k_z (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}) ; \]
\[ B: \{R_{5}, R_{6}\}, \{R_{6}, R_{7}\} : \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_x + k_z (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_z (c_6 \Gamma_{1,1} + c_7 \Gamma_{2,2}) ; \]
\[ C: \{R_{5}, R_{6}\}, \{R_{6}, R_{7}\} : \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_x + k_y (c_4 \Gamma_{2,1} + c_2 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}) ; \]
\[ A: \{R_{5}, R_{7}\}, \{R_{6}, R_{8}\} : \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_x + k_y (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_z (c_6 \Gamma_{1,1} + c_7 \Gamma_{2,2}) ; \]
\[ H: \{R_{5}, R_{6}\}, \{R_{6}, R_{7}\} : \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_x + k_z (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_y (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}) ; \]
\[ G: \{R_{5}, R_{8}\}, \{R_{6}, R_{7}\} : \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_x + k_z (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_y (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}) ; \]

SG 49
\[ \Gamma_0; \{C_{2v}[000]\}, \{C_{2v}[000]\}, \{I\frac{0}{2}\frac{0}{2}\}\}, \mathcal{T}; \text{Centrosymmetric; with SOC} \]
\[ Z: \{R_{13}, R_{14}\} : c_1 \Gamma_{0,0} - c_4 \Gamma_{0,2} k_x + c_2 \Gamma_{3,1} k_y + k_z (c_4 \Gamma_{1,1} - c_5 \Gamma_{2,1}) ; \]
\[ U: \{R_{13}, R_{14}\} : c_1 \Gamma_{0,0} - c_4 \Gamma_{0,2} k_x + c_2 \Gamma_{3,1} k_y + k_z (c_4 \Gamma_{1,1} - c_5 \Gamma_{2,1}) ; \]
\[ T: \{R_{13}, R_{14}\} : c_1 \Gamma_{0,0} - c_4 \Gamma_{0,2} k_x + c_2 \Gamma_{3,1} k_y + k_z (c_4 \Gamma_{1,1} - c_5 \Gamma_{2,1}) ; \]
\[ R: \{R_{13}, R_{14}\} : c_1 \Gamma_{0,0} - c_4 \Gamma_{0,2} k_x + c_2 \Gamma_{3,1} k_y + k_z (c_4 \Gamma_{1,1} - c_5 \Gamma_{2,1}) ; \]

Accidental degeneracies on high symmetry line

\[ P: \{R_{5}, R_{8}\} , \{R_{6}, R_{7}\} : \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_z (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_z (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}) ; \]
\[ B: \{R_{5}, R_{8}\} , \{R_{6}, R_{7}\} : \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_z (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_z (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}) ; \]
\[ E: \{R_{5}, R_{7}\} , \{R_{6}, R_{8}\} : \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + k_y (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_z (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}) ; \]
\[ A: \{R_{5}, R_{7}\} , \{R_{6}, R_{8}\} : \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + k_y (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_z (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}) ; \]
Γ₀; \{C_{2z}[000], C_{2y}[000], \{1\frac{1}{2} 0\}\}, T; Centrosymmetric; with SOC

\[ Y; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{3,3} k_x + k_y (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}) - c_5 \Gamma_{0,2} k_z; \]

\[ X; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + k_x (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_y - c_5 \Gamma_{0,2} k_z; \]

\[ U; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + k_x (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_y - c_5 \Gamma_{0,2} k_z; \]

\[ T; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{3,3} k_x + k_y (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}) - c_5 \Gamma_{0,2} k_z; \]

\[ S; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} - c_4 \Gamma_{0,2} k_x + c_2 \Gamma_{3,1} k_y + k_z (c_3 \Gamma_{1,1} - c_5 \Gamma_{2,1}); \]

\[ R; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} - c_4 \Gamma_{0,2} k_x + c_2 \Gamma_{3,1} k_y + k_z (c_3 \Gamma_{1,1} - c_5 \Gamma_{2,1}); \]

Accidental degeneracies on high symmetry line

\[ D; \{R_{5}, R_{8}\}, \{R_{6}, R_{7}\}; \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \]

\[ P; \{R_{5}, R_{8}\}, \{R_{6}, R_{7}\}; \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \]

\[ C; \{R_{5}, R_{8}\}, \{R_{6}, R_{7}\}; \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \]

\[ E; \{R_{5}, R_{8}\}, \{R_{6}, R_{7}\}; \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \]

\[ H; \{R_{5}, R_{8}\}, \{R_{6}, R_{7}\}; \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_y (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}); \]

\[ G; \{R_{5}, R_{8}\}, \{R_{6}, R_{7}\}; \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_y (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \]
7. SG 51-60

SG 51

| Γ₀: {C₂₁|001}, {C₂₂|000}, {I|000}, T; Centrosymmetric; with SOC |
|---|
| **Z:** \{R₁₃, R₁₄\}: \(c₁Γ₀ + c₃Γ₀₂k₂ + k₃ (c₂Γ₁₁ + c₄Γ₂₁)\); |
| **U:** \{R₁₃, R₁₄\}: \(c₁Γ₀ + c₃Γ₀₂k₂ + k₃ (c₂Γ₁₁ + c₄Γ₂₁)\); |
| **T:** \{R₁₃, R₁₄\}: \(c₁Γ₀ + c₃Γ₀₂k₂ + k₃ (c₂Γ₁₁ + c₄Γ₂₁)\); |
| **R:** \{R₁₃, R₁₄\}: \(c₁Γ₀ + c₃Γ₀₂k₂ + k₃ (c₂Γ₁₁ + c₄Γ₂₁)\); |
| **E:** \{R₀, R₀\}: \(Γ₀ (c₂k₂ + c₁) + c₃Γ₀₁k₂ + \sum_{i=1}^3 c₁Γ₃Ik₂); |
| **A:** \{R₀, R₀\}: \(Γ₀ (c₂k₂ + c₁) + c₃Γ₀₁k₂ + \sum_{i=1}^3 c₁Γ₃Ik₂); |

Accidental degeneracies on high symmetry line

| P: \{R₅, R₆\}, \{R₇, R₈\}; \(Γ₀ (c₁ + c₂k₂) + \Gamma₃₁₀k₂ + k₃ (c₄Γ₁₀ + c₅Γ₂₃)\); |
| B: \{R₅, R₆\}, \{R₇, R₈\}; \(Γ₀ (c₁ + c₂k₂) + \Gamma₃₁₀k₂ + k₃ (c₄Γ₁₀ + c₅Γ₂₃)\); |

SG 52

| Γ₀: {C₂₁|001}, {C₂₂|000}, {I|000}, T; Centrosymmetric; with SOC |
|---|
| **Y:** \{R₁₃, R₁₄\}: \(c₁Γ₀ + c₂Γ₃₁k₂ + k₃ (c₃Γ₁₁ + c₄Γ₂₁) - c₅Γ₀₂k₂\); |
| **X:** \{R₁₃, R₁₄\}: \(c₁Γ₀ + k₃ (c₃Γ₁₁ + c₄Γ₂₁) - c₅Γ₀₂k₂ + c₆Γ₃₁k₂\); |
| **Z:** \{R₁₃, R₁₄\}: \(c₁Γ₀ + c₂Γ₃₁k₂ + k₃ (c₃Γ₁₁ + c₄Γ₂₁)\); |
| **U:** \{R₁₀, R₁₀\}: \(c₁Γ₀ + k₃ (c₃Γ₁₁ + c₄Γ₂₁) + c₅Γ₃₁k₂\); |
| **S:** \{R₁₃, R₁₄\}: \(c₁Γ₀ - c₄Γ₀₂k₂ + c₃Γ₃₁k₂ + k₃ (c₃Γ₁₁ + c₄Γ₂₁)\); |
| **R:** \{R₁₃, R₁₄\}: \(c₁Γ₀ + c₂Γ₃₁k₂ + k₃ (c₃Γ₁₁ + c₄Γ₂₁)\); |
| **P:** \{R₀, R₀\}: \(Γ₀ (c₂k₂ + c₁) + c₄Γ₀₁k₂ + \sum_{i=1}^3 c₁Γ₃Ik₂); |
| **A:** \{R₀, R₀\}: \(Γ₀ (c₂k₂ + c₁) + c₃Γ₀₁k₂ + \sum_{i=1}^3 c₁Γ₃Ik₂); |

Accidental degeneracies on high symmetry line

| D: \{R₅, R₆\}, \{R₆, R₇\}; \(Γ₀ (c₁ + c₂k₂) + \Gamma₃₀c₃k₂ + k₃ (c₄Γ₂₁ + c₅Γ₂₂) + k₃ (c₄Γ₂₃ + c₇Γ₁₀)\); |
| B: \{R₅, R₆\}, \{R₇, R₈\}; \(Γ₀ (c₁ + c₂k₂) + \Gamma₃₀c₃k₂ + k₃ (c₄Γ₁₀ + c₅Γ₂₃)\); |
| C: \{R₀, R₀\}, \{R₆, R₇\}; \(Γ₀ (c₁ + c₂k₂) + \Gamma₃₀c₃k₂ + k₃ (c₄Γ₁₀ + c₅Γ₂₃) + k₃ (c₄Γ₂₃ + c₇Γ₁₀)\); |
| E: \{R₆, R₈\}, \{R₇, R₉\}; \(Γ₀ (c₁ + c₂k₂) + \Gamma₃₀c₃k₂ + k₃ (c₄Γ₁₀ + c₅Γ₂₃)\); |
| H: \{R₀, R₀\}, \{R₆, R₇\}; \(Γ₀ (c₁ + c₂k₂) + \Gamma₃₀c₃k₂ + k₃ (c₄Γ₁₀ + c₅Γ₂₃) + k₃ (c₄Γ₂₃ + c₇Γ₁₀)\); |
| G: \{R₅, R₆\}, \{R₆, R₇\}; \(Γ₀ (c₁ + c₂k₂) + \Gamma₃₀c₃k₂ + k₃ (c₄Γ₂₁ + c₅Γ₂₂) + k₃ (c₄Γ₂₃ + c₇Γ₁₀)\); |
Accidental degeneracies on high symmetry line

| P   | {R5, R6} ; {R7, R8} ; \Gamma_{0,0} \left( c_1 + c_2 k_y \right) + \Gamma_{3,0} c_3 k_y + k_z \left( c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3} \right); |
|-----|--------------------------------------------------|
| B   | {R5, R6} ; {R7, R8} ; \Gamma_{0,0} \left( c_1 + c_2 k_y \right) + \Gamma_{3,0} c_3 k_y + k_z \left( c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3} \right); |
| C   | {R5, R6} ; \Gamma_{0,0} \left( c_1 + c_2 k_x \right) + \Gamma_{3,0} c_3 k_x + k_y \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2} \right) + k_z \left( c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0} \right); |
| E   | {R6, R8} ; \Gamma_{0,0} \left( c_1 + c_2 k_x \right) + \Gamma_{3,0} c_3 k_x + k_y \left( c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3} \right); |
| H   | {R5, R6} ; \Gamma_{0,0} \left( c_1 + c_2 k_x \right) + \Gamma_{3,0} c_3 k_x + k_y \left( c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3} \right) + k_y \left( c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2} \right); |
| Q   | {R5, R6} ; \Gamma_{0,0} \left( c_1 + c_2 k_x \right) + \Gamma_{3,0} c_3 k_x + k_y \left( c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3} \right) + k_y \left( c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2} \right); |

Accidental degeneracies on high symmetry line

| D   | {R5, R6} ; \Gamma_{0,0} \left( c_1 + c_2 k_y \right) + \Gamma_{3,0} c_3 k_y + k_z \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2} \right) + k_z \left( c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0} \right); |
|-----|--------------------------------------------------|
| B   | {R5, R6} ; \Gamma_{0,0} \left( c_1 + c_2 k_y \right) + \Gamma_{3,0} c_3 k_y + k_z \left( c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3} \right); |
| Q   | {R5, R6} ; \Gamma_{0,0} \left( c_1 + c_2 k_z \right) + \Gamma_{3,0} c_3 k_z + k_y \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2} \right) + k_y \left( c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0} \right); |
| G   | {R5, R6} ; \Gamma_{0,0} \left( c_1 + c_2 k_z \right) + \Gamma_{3,0} c_3 k_z + k_y \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2} \right) + k_y \left( c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0} \right); |
Accidental degeneracies on high symmetry line

\[ Y: \{ R_{13}, R_{14} \}; \quad \Gamma_{0,0} + c_1 \Gamma_{1,1} + c_2 \Gamma_{2,1} + k_y (c_3 \Gamma_{1,3} + c_4 \Gamma_{2,3}) \]

\[ X: \{ R_{13}, R_{14} \}; \quad c_1 \Gamma_{0,0} + k_x (c_2 \Gamma_{1,1} + c_3 \Gamma_{2,1}) + c_4 \Gamma_{3,1} k_y \]

\[ Z: \{ R_{13}, R_{14} \}; \quad c_1 \Gamma_{0,0} - c_4 \Gamma_{0,2} k_x + c_3 \Gamma_{1,3} k_y + k_x (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) \]

SG 56

\[ \Gamma_0; \{ C_2y[000], C_2y[\frac{1}{2} \frac{1}{2} 0], I[000] \}; \quad T; \text{Centrosymmetric; with SOC} \]

\[ Y: \{ R_{13}, R_{14} \}; \quad c_1 \Gamma_{0,0} + k_y (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_z; \]

\[ X: \{ R_{13}, R_{14} \}; \quad c_1 \Gamma_{0,0} + k_x (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_z; \]

\[ U: \{ R_{13}, R_{14} \}; \quad c_1 \Gamma_{0,0} + k_x (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_z; \]

\[ T: \{ R_{13}, R_{14} \}; \quad c_1 \Gamma_{0,0} + k_y (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_z; \]

\[ S: \{ R_9, R_9 \}; \quad \Gamma_{0,0} (c_2 k_x^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + c_5 \Gamma_{0,2} k_x k_y + c_6 \Gamma_{0,1} k_y k_z + [(\alpha_1 \Gamma_{1,3} + c_7 \Gamma_{2,3}) k_x k_y + h.c.]; \]

\[ R: \{ R_9, R_9 \}; \quad \Gamma_{0,0} (c_2 k_x^2 + c_3 k_y^2 + c_4 k_z^2 + c_1) + c_5 \Gamma_{0,2} k_x k_y + c_6 \Gamma_{0,1} k_y k_z + [(\alpha_1 \Gamma_{1,3} + c_7 \Gamma_{2,3}) k_x k_y + h.c.]; \]

\[ D: \{ R_9, R_9 \}; \quad \Gamma_{0,0} (c_2 k_y + c_1) + c_3 \Gamma_{0,1} k_x + \sum_{i=1}^3 c_i \Gamma_{1,1} k_z; \]

\[ P: \{ R_9, R_9 \}; \quad \Gamma_{0,0} (c_2 k_y + c_1) + c_3 \Gamma_{0,1} k_x + \sum_{i=1}^3 c_i \Gamma_{1,1} k_z; \]

\[ C: \{ R_9, R_9 \}; \quad \Gamma_{0,0} (c_2 k_x + c_1) + c_3 \Gamma_{0,2} k_x + \sum_{i=1}^3 c_i \Gamma_{1,1} k_y; \]

\[ E: \{ R_9, R_9 \}; \quad \Gamma_{0,0} (c_2 k_x + c_1) + c_3 \Gamma_{0,2} k_x + \sum_{i=1}^3 c_i \Gamma_{1,1} k_y; \]

\[ Q: \{ R_9, R_9 \}; \quad \Gamma_{0,0} (c_2 k_x + c_1) + c_3 \Gamma_{0,2} k_x + c_4 \Gamma_{0,1} k_y; \]
Accidental degeneracies on high symmetry line

\[ D: \{ R_5, R_8 \}, \{ R_6, R_7 \}; \Gamma_{0,0} (c_1 + c_2k_y) + \Gamma_{3,0} c_3k_y + k_x (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}); \]

\[ B: \{ R_5, R_8 \}, \{ R_6, R_7 \}; \Gamma_{0,0} (c_1 + c_2k_y) + \Gamma_{3,0} c_3k_y + k_x (c_4 \Gamma_{1,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}); \]

\[ C: \{ R_5, R_7 \}, \{ R_6, R_8 \}; \Gamma_{0,0} (c_1 + c_2k_z) + \Gamma_{3,0} c_3k_z + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}); \]

\[ A: \{ R_5, R_7 \}, \{ R_6, R_8 \}; \Gamma_{0,0} (c_1 + c_2k_z) + \Gamma_{3,0} c_3k_z + k_y (c_4 \Gamma_{1,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}); \]

SG 57

\[ \Gamma_0: \{ C_{2z}, [000], \{ C_{2y}, [\frac{1}{2}, \frac{1}{2}, 0], \{ I, [0, \frac{1}{2}, 0] \}; T; \text{Centrosymmetric with SOC} \]

\[ Y: \{ R_{13}, R_{14} \}; c_1 \Gamma_{0,0} + k_y (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_z; \]

\[ X: \{ R_{13}, R_{14} \}; c_1 \Gamma_{0,0} + k_x (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_y; \]

\[ U: \{ R_{13}, R_{14} \}; c_1 \Gamma_{0,0} + k_x (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_y; \]

\[ T: \{ R_{13}, R_{14} \}; c_1 \Gamma_{0,0} + k_y (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_z; \]

\[ S: \{ R_9, R_9 \}; c_1 \Gamma_{0,0} + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i + c_2 \Gamma_{0,2} k_i; \]

\[ \{ R_{10}, R_{10} \}; c_1 \Gamma_{0,0} + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i + c_2 \Gamma_{0,2} k_i; \]

\[ R: \{ R_9, R_9 \}; c_1 \Gamma_{0,0} + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i + c_2 \Gamma_{0,2} k_i; \]

\[ \{ R_{10}, R_{10} \}; c_1 \Gamma_{0,0} + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i + c_2 \Gamma_{0,2} k_i; \]

\[ C: \{ R_9, R_9 \}; \Gamma_{0,0} (c_2 k_x + c_1) + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i + c_3 \Gamma_{0,2} k_i; \]

\[ E: \{ R_9, R_9 \}; \Gamma_{0,0} (c_2 k_x + c_1) + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i + c_3 \Gamma_{0,2} k_i; \]

\[ G: \{ R_5, R_5 \}; \Gamma_{0,0} (c_2 k_z + c_1) + c_3 \Gamma_{0,3} k_y + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i; \]

Accidental degeneracies on high symmetry line

\[ D: \{ R_5, R_8 \}, \{ R_6, R_7 \}; \Gamma_{0,0} (c_1 + c_2k_y) + \Gamma_{3,0} c_3k_y + k_x (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}); \]

\[ P: \{ R_5, R_8 \}, \{ R_6, R_7 \}; \Gamma_{0,0} (c_1 + c_2k_y) + \Gamma_{3,0} c_3k_y + k_x (c_4 \Gamma_{1,1} + c_5 \Gamma_{2,2}); \]

\[ H: \{ R_5, R_8 \}, \{ R_7, R_7 \}; \Gamma_{0,0} (c_1 + c_2k_z) + \Gamma_{3,0} c_3k_z + k_y (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,2}); \]

\[ Q: \{ R_5, R_5 \}, \{ R_6, R_6 \}; \Gamma_{0,0} (c_1 + c_2k_z) + \Gamma_{3,0} c_3k_z + (c_4 \Gamma_{1,0} + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i) k_z; \]

\[ Q: \{ R_5, R_5 \}, \{ R_7, R_7 \}; \Gamma_{0,0} (c_1 + c_2k_z) + \Gamma_{3,0} c_3k_z + (c_4 \Gamma_{1,0} + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i) k_y; \]

\[ Q: \{ R_5, R_5 \}, \{ R_8, R_8 \}; \Gamma_{0,0} (c_1 + c_2k_z) + \Gamma_{3,0} c_3k_z + (c_4 \Gamma_{1,0} + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i) k_y; \]

\[ Q: \{ R_7, R_7 \}, \{ R_8, R_8 \}; \Gamma_{0,0} (c_1 + c_2k_z) + \Gamma_{3,0} c_3k_z + (c_4 \Gamma_{1,0} + \sum_{i=1}^3 c_i \Gamma_{1,1} k_i) k_z; \]
Accidental degeneracies on high symmetry line

\[ P: \{ R_6, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2} \right); \]

\[ B: \{ R_6, R_9 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x \left( c_4 \Gamma_{1,0} + c_5 \Gamma_{2,2} \right) + k_z \left( c_6 \Gamma_{1,1} + c_7 \Gamma_{2,2} \right); \]

\[ E: \{ R_6, R_9 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_y \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2} \right); \]

\[ A: \{ R_6, R_9 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_y \left( c_4 \Gamma_{1,0} + c_5 \Gamma_{2,2} \right) + k_z \left( c_6 \Gamma_{1,1} + c_7 \Gamma_{2,2} \right); \]

\[ H: \{ R_6, R_9 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_y \left( c_4 \Gamma_{1,0} + c_5 \Gamma_{2,2} \right); \]

\[ G: \{ R_6, R_9 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_y \left( c_4 \Gamma_{1,0} + c_5 \Gamma_{2,2} \right); \]

Accidental degeneracies on high symmetry line

\[ D: \{ R_6, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2} \right); \]

\[ P: \{ R_6, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2} \right) + k_z \left( c_6 \Gamma_{1,1} + c_7 \Gamma_{2,2} \right); \]

\[ C: \{ R_6, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_y \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2} \right) + k_z \left( c_6 \Gamma_{1,1} + c_7 \Gamma_{2,2} \right); \]

\[ A: \{ R_6, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_y \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2} \right) + k_z \left( c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0} \right); \]
\( \Gamma_0: \{C_2, [000], \{C_2, \frac{1}{2} \frac{1}{2} \frac{1}{2} \}, \{I\} \} \), \( T \); Centrosymmetric; with SOC

\[ Y; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{3,3} k_y + k_z (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}) \; ; \]
\[ X; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + k_x (c_2 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_z \; ; \]
\[ Z; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} - c_4 \Gamma_{0,2} k_x + c_2 \Gamma_{3,1} k_y + k_z (c_3 \Gamma_{1,1} - c_5 \Gamma_{2,1}) \; ; \]
\[ T; \{R_9, R_{10}\}; c_1 \Gamma_{0,0} + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_y \; ; \]
\[ \{R_{10}, R_{10}\}; c_1 \Gamma_{0,0} + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_y \; ; \]
\[ S; \{R_9, R_9\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_z \; ; \]
\[ \{R_{10}, R_{10}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_z \; ; \]
\[ R; \{R_9, R_9\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_y \; ; \]
\[ \{R_{10}, R_{10}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_y \; ; \]
\[ D; \{R_9, R_9\}; \Gamma_{0,0} (c_2 k_y + c_1) + c_3 \Gamma_{0,1} k_z + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_z \; ; \]
\[ E; \{R_9, R_9\}; \Gamma_{0,0} (c_2 k_y + c_1) + c_3 \Gamma_{0,1} k_z + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_y \; ; \]
\[ H; \{R_5, R_5\}; \Gamma_{0,0} (c_2 k_z + c_1) + c_3 \Gamma_{0,1} k_x + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_y \; ; \]

Accidental degeneracies on high symmetry line

\[ P; \{R_6, R_6\}, \{R_7, R_7\}; \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_z (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) \; ; \]
\[ B; \{R_5, R_9\}, \{R_6, R_7\}; \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_z (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_x (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}) \; ; \]
\[ C; \{R_5, R_9\}, \{R_6, R_8\}; \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) \; ; \]
\[ A; \{R_5, R_9\}, \{R_6, R_8\}; \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + k_y (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_x (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}) \; ; \]
\[ Q; \{R_5, R_9\}, \{R_6, R_6\}; \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_z) \; ; \]
\[ \{R_5, R_9\}, \{R_7, R_7\}; \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_z) \; ; \]
\[ \{R_5, R_9\}, \{R_8, R_8\}; \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_z) \; ; \]
\[ \{R_6, R_6\}, \{R_7, R_7\}; \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z \; ; \]
\[ \{R_6, R_6\}, \{R_8, R_8\}; \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_z) \; ; \]
\[ \{R_7, R_7\}, \{R_8, R_8\}; \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i \Gamma_{1,i} k_z) \; ; \]
\[ G; \{R_5, R_6\}, \{R_7, R_8\}; \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + k_x (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) \; ; \]
SG 61

\[ \Gamma_0; \{C_{2z}|_2 0 \}, \{C_{2y}|_2 0 \}, \{I|000\}, T; \text{Centrosymmetric; with SOC} \]

\[ Y; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{3,1} k_x + k_y (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}); \]

\[ X; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + k_x (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_z; \]

\[ Z; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{3,1} k_y + k_x (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}); \]

\[ U; \{R_9, R_3\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_y + \sum_{i=1}^{3} c_i,1 \Gamma_{1,1} k_z; \]

\[ \{R_{10}, R_{10}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_y + \sum_{i=1}^{3} c_i,1 \Gamma_{1,1} k_z; \]

\[ T; \{R_0, R_0\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_y + \sum_{i=1}^{3} c_i,1 \Gamma_{1,1} k_y; \]

\[ \{R_{10}, R_{10}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_y + \sum_{i=1}^{3} c_i,1 \Gamma_{1,1} k_y; \]

\[ S; \{R_0, R_3\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} c_i,1 \Gamma_{1,1} k_z; \]

\[ \{R_{10}, R_{10}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + \sum_{i=1}^{3} c_i,1 \Gamma_{1,1} k_z; \]

\[ D; \{R_0, R_0\}; \Gamma_0,0 (c_2 k_y + c_1) + c_3 \Gamma_{0,1} k_x + \sum_{i=1}^{3} c_i,1 \Gamma_{1,3} k_z; \]

\[ A; \{R_0, R_0\}; \Gamma_0,0 (c_2 k_x + c_1) + c_3 \Gamma_{0,1} k_y + \sum_{i=1}^{3} c_i,1 \Gamma_{1,3} k_z; \]

\[ H; \{R_9, R_3\}; \Gamma_0,0 (c_2 k_x + c_1) + c_3 \Gamma_{0,1} k_x + \sum_{i=1}^{3} c_i,1 \Gamma_{1,3} k_y; \]

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Accidental degeneracies on high symmetry line

\[ P; \{R_6, R_0\}, \{R_7, R_7\}; \Gamma_0,0 (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y; \]

\[ \{R_6, R_6\}, \{R_8, R_8\}; \Gamma_0,0 (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i,1 \Gamma_{2,1}); \]

\[ \{R_6, R_0\}, \{R_9, R_9\}; \Gamma_0,0 (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i,1 \Gamma_{2,1}); \]

\[ \{R_7, R_7\}, \{R_8, R_8\}; \Gamma_0,0 (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i,1 \Gamma_{2,1}); \]

\[ \{R_7, R_9\}, \{R_9, R_9\}; \Gamma_0,0 (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i,1 \Gamma_{2,1}); \]

\[ \{R_8, R_8\}, \{R_9, R_9\}; \Gamma_0,0 (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y; \]

\[ Q; \{R_6, R_8\}, \{R_7, R_7\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x; \]

\[ \{R_6, R_6\}, \{R_8, R_8\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_x (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i,1 \Gamma_{2,1}); \]

\[ \{R_7, R_7\}, \{R_8, R_8\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_x (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i,1 \Gamma_{2,1}); \]

\[ \{R_7, R_9\}, \{R_9, R_9\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_x (c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_i,1 \Gamma_{2,1}); \]

\[ \{R_8, R_8\}, \{R_9, R_9\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x; \]

\[ G; \{R_5, R_5\}, \{R_7, R_7\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_x (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,2}); \]
Accidental degeneracies on high symmetry line

\[ \{ \Gamma_5, \Gamma_6, \Gamma_7 \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ \Gamma_8, \Gamma_9, \Gamma_{10} \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ \Gamma_{11}, \Gamma_{12}, \Gamma_{13} \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ \Gamma_{14}, \Gamma_{15}, \Gamma_{16} \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

Accidental degeneracies on high symmetry line

\[ \{ R_3, R_4 \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ R_5, R_6 \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ R_7, R_8 \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ R_9, R_{10} \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ R_{11}, R_{12} \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ R_{13}, R_{14} \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ R_{15}, R_{16} \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

Accidental degeneracies on high symmetry line

\[ \{ \Gamma_5, \Gamma_6, \Gamma_7 \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ \Gamma_8, \Gamma_9, \Gamma_{10} \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ \Gamma_{11}, \Gamma_{12}, \Gamma_{13} \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]

\[ \{ \Gamma_{14}, \Gamma_{15}, \Gamma_{16} \} : \Gamma_0 = \{ c_1 \Gamma_0,0 + c_2 \Gamma_0,1 + c_3 \Gamma_0,2 \} \]
\[ \Gamma_{64} \} = \{ C_{2z} \llbracket 00 \frac{1}{2} \rrbracket \}, \{ C_{2y} \llbracket 00 \frac{1}{2} \rrbracket \}, \{ I \llbracket \frac{1}{2} \frac{1}{2} 0 \rrbracket \}, T; \text{Centrosymmetric; with SOC} \]

\[ Z: \{ R_{13}, R_{14} \}; c_{1}\Gamma_{0,0} + c_{3}\Gamma_{0,2}k_{z} + k_{z} (c_{2}\Gamma_{1,1} + c_{4}\Gamma_{2,1}) \]

\[ T: \{ R_{13}, R_{14} \}; c_{1}\Gamma_{0,0} + c_{3}\Gamma_{0,2}k_{z} + k_{z} (c_{2}\Gamma_{1,1} + c_{4}\Gamma_{2,1}) \]

\[ S: \{ R_{0}, R_{0} \}; c_{1}\Gamma_{0,0} + c_{2}\Gamma_{0,2}k_{z} + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1}k_{x} + c_{i,2}k_{y}) \]

\[ B: \{ R_{0}, R_{0} \}; \Gamma_{0,0} (c_{0}k_{y} + c_{1}) + c_{2}\Gamma_{0,1}k_{x} + \sum_{i=1}^{3} c_{i,1}k_{x} \Gamma_{i,1} \]

\[ G: \{ R_{0}, R_{0} \}; \Gamma_{0,0} (c_{1}k_{y} + c_{1}) + c_{2}\Gamma_{0,1}k_{x} + \sum_{i=1}^{3} c_{i,1}k_{x} \Gamma_{i,1} \]

Accidental degeneracies on high symmetry line

\[ D: \{ R_{2}, R_{2} \}, \{ R_{4}, R_{4} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + \Gamma_{1,0} (c_{4}k_{x} + c_{5}k_{y}) + \sum_{i=1}^{3} \Gamma_{2,i} (c_{i,1}k_{x} + c_{i,2}k_{y}) \]

\[ A: \{ R_{5}, R_{5} \}, \{ R_{7}, R_{7} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + k_{z} (c_{2}\Gamma_{1,1} + c_{5}\Gamma_{2,1}) \]

\[ E: \{ R_{5}, R_{5} \}, \{ R_{7}, R_{7} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + k_{z} (c_{2}\Gamma_{1,1} + c_{5}\Gamma_{2,1}) \]

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\[ \Gamma_{66} \} = \{ C_{2z} \llbracket 00 \frac{1}{2} \rrbracket \}, \{ C_{2y} \llbracket 00 \frac{1}{2} \rrbracket \}, \{ I \llbracket 00 \frac{1}{2} \rrbracket \}, T; \text{Centrosymmetric; with SOC} \]

\[ Z: \{ R_{13}, R_{14} \}; c_{1}\Gamma_{0,0} - c_{4}\Gamma_{0,2}k_{z} + c_{2}\Gamma_{3,1}k_{y} + k_{z} (c_{3}\Gamma_{1,1} - c_{5}\Gamma_{2,1}) \]

\[ T: \{ R_{13}, R_{14} \}; c_{1}\Gamma_{0,0} - c_{4}\Gamma_{0,2}k_{z} + c_{2}\Gamma_{3,1}k_{y} + k_{z} (c_{3}\Gamma_{1,1} - c_{5}\Gamma_{2,1}) \]

Accidental degeneracies on high symmetry line

\[ A: \{ R_{5}, R_{5} \}, \{ R_{6}, R_{6} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + k_{y} (c_{4}\Gamma_{1,0} + c_{5}\Gamma_{2,3}) + k_{z} (c_{6}\Gamma_{2,1} + c_{7}\Gamma_{2,2}) \]

\[ B: \{ R_{5}, R_{5} \}, \{ R_{6}, R_{6} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + k_{y} (c_{4}\Gamma_{1,0} + c_{5}\Gamma_{2,3}) + k_{z} (c_{6}\Gamma_{2,1} + c_{7}\Gamma_{2,2}) \]

\[ G: \{ R_{5}, R_{5} \}, \{ R_{6}, R_{6} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + k_{y} (c_{4}\Gamma_{1,0} + c_{5}\Gamma_{2,3}) + k_{z} (c_{6}\Gamma_{2,1} + c_{7}\Gamma_{2,2}) \]

\[ E: \{ R_{5}, R_{5} \}, \{ R_{6}, R_{6} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + k_{y} (c_{4}\Gamma_{1,0} + c_{5}\Gamma_{2,3}) + k_{z} (c_{6}\Gamma_{2,1} + c_{7}\Gamma_{2,2}) \]

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\[ \Gamma_{67} \} = \{ C_{2z} \llbracket 00 \frac{1}{2} \rrbracket \}, \{ C_{2y} \llbracket 00 \frac{1}{2} \rrbracket \}, \{ I \llbracket \frac{1}{2} \frac{1}{2} 0 \rrbracket \}, T; \text{Centrosymmetric; with SOC} \]

\[ S: \{ R_{0}, R_{0} \}; c_{1}\Gamma_{0,0} + c_{2}\Gamma_{0,2}k_{z} + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1}k_{x} + c_{i,2}k_{y}) \]

\[ R: \{ R_{0}, R_{0} \}; c_{1}\Gamma_{0,0} + c_{2}\Gamma_{0,2}k_{z} + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1}k_{x} + c_{i,2}k_{y}) \]

Accidental degeneracies on high symmetry line

\[ D: \{ R_{2}, R_{2} \}, \{ R_{4}, R_{4} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + \Gamma_{1,0} (c_{4}k_{x} + c_{5}k_{y}) + \sum_{i=1}^{3} \Gamma_{2,i} (c_{i,1}k_{x} + c_{i,2}k_{y}) \]
Γ_0^6: \{C_2y,000\}, \{C_2y,000\}, \{I|\frac{1}{2} \frac{1}{2} \frac{1}{2}\}. T; Centrosymmetric; with SOC

\[ Z: \{R_{13}, R_{14}\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 - c_3 \Gamma_1 \Gamma_1 \Gamma_1 + k_x (c_3 \Gamma_1 \Gamma_1 \Gamma_1 - c_3 \Gamma_2 \Gamma_2 \Gamma_2) ; \]

\[ T: \{R_{13}, R_{14}\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_0 \Gamma_3 \Gamma_1 + k_x (c_3 \Gamma_1 \Gamma_1 \Gamma_1 - c_3 \Gamma_2 \Gamma_2 \Gamma_2) ; \]

\[ S: \{R_0, R_9\}; \Gamma_1 \Gamma_1 \Gamma_1 = c_1 \Gamma_1 \Gamma_1 \Gamma_1 + c_2 \Gamma_0 \Gamma_2 \Gamma_2 + \sum_{i=1}^{3} \Gamma_i \Gamma_0 \Gamma_0 (c_1 k_x + c_2 k_y) ; \]

\[ R: \{R_0, R_9\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_0 \Gamma_2 \Gamma_2 + \sum_{i=1}^{3} \Gamma_i \Gamma_0 \Gamma_0 (c_1 k_x + c_2 k_y) ; \]

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Accidental degeneracies on high symmetry line
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\[ D: \{R_2, R_4\}, \{R_4, R_4\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_0 \Gamma_3 \Gamma_1 + \Gamma_1 \Gamma_1 \Gamma_1 = c_4 \Gamma_2 \Gamma_2 \Gamma_2 + \sum_{i=1}^{3} \Gamma_i \Gamma_0 \Gamma_0 (c_1 k_x + c_2 k_y) ; \]

\[ A: \{R_5, R_5\}, \{R_6, R_6\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_3 \Gamma_3 \Gamma_1 + k_x (c_4 \Gamma_1 \Gamma_1 \Gamma_1 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_z (c_6 \Gamma_1 \Gamma_1 \Gamma_1 + c_7 \Gamma_2 \Gamma_2 \Gamma_2) ; \]

\[ B: \{R_5, R_5\}, \{R_6, R_6\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_3 \Gamma_3 \Gamma_1 + k_x (c_4 \Gamma_1 \Gamma_1 \Gamma_1 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_z (c_6 \Gamma_1 \Gamma_1 \Gamma_1 + c_7 \Gamma_2 \Gamma_2 \Gamma_2) ; \]

\[ C: \{R_5, R_5\}, \{R_6, R_6\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_3 \Gamma_3 \Gamma_1 + k_x (c_4 \Gamma_1 \Gamma_1 \Gamma_1 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_z (c_6 \Gamma_1 \Gamma_1 \Gamma_1 + c_7 \Gamma_2 \Gamma_2 \Gamma_2) ; \]

\[ A: \{R_5, R_5\}, \{R_6, R_6\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_3 \Gamma_3 \Gamma_1 + k_x (c_4 \Gamma_1 \Gamma_1 \Gamma_1 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_z (c_6 \Gamma_1 \Gamma_1 \Gamma_1 + c_7 \Gamma_2 \Gamma_2 \Gamma_2) ; \]

\[ D: \{R_5, R_5\}, \{R_6, R_6\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_3 \Gamma_3 \Gamma_1 + k_x (c_4 \Gamma_1 \Gamma_1 \Gamma_1 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_z (c_6 \Gamma_1 \Gamma_1 \Gamma_1 + c_7 \Gamma_2 \Gamma_2 \Gamma_2) ; \]

\[ B: \{R_5, R_5\}, \{R_6, R_6\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_3 \Gamma_3 \Gamma_1 + k_x (c_4 \Gamma_1 \Gamma_1 \Gamma_1 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_z (c_6 \Gamma_1 \Gamma_1 \Gamma_1 + c_7 \Gamma_2 \Gamma_2 \Gamma_2) ; \]

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SG 70
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Γ_0^6: \{C_2y,000\}, \{C_2y,000\}, \{I|\frac{1}{2} \frac{1}{2} \frac{1}{2}\}. T; Centrosymmetric; with SOC

\[ Y: \{R_{13}, R_{14}\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_3 \Gamma_3 \Gamma_3 \Gamma_3 + k_x (c_2 \Gamma_2 \Gamma_2 \Gamma_2 - c_3 \Gamma_2 \Gamma_2 \Gamma_2) + c_3 \Gamma_3 \Gamma_3 \Gamma_3 ; \]

\[ X: \{R_{13}, R_{14}\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_2 \Gamma_2 \Gamma_2 + c_3 \Gamma_3 \Gamma_3 \Gamma_3 - c_3 \Gamma_3 \Gamma_3 \Gamma_3 ; \]

\[ Z: \{R_{13}, R_{14}\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_2 \Gamma_2 \Gamma_2 + c_3 \Gamma_3 \Gamma_3 \Gamma_3 - c_3 \Gamma_3 \Gamma_3 \Gamma_3 ; \]

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Accidental degeneracies on high symmetry line
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\[ G: \{R_5, R_6\}, \{R_6, R_7\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_0 \Gamma_3 \Gamma_1 \Gamma_1 \Gamma_1 + k_x (c_4 \Gamma_2 \Gamma_2 \Gamma_2 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_y (c_6 \Gamma_2 \Gamma_2 \Gamma_2 + c_7 \Gamma_1 \Gamma_1 \Gamma_1) ; \]

\[ H: \{R_5, R_6\}, \{R_6, R_7\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_0 \Gamma_3 \Gamma_1 \Gamma_1 \Gamma_1 + k_x (c_4 \Gamma_2 \Gamma_2 \Gamma_2 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_y (c_6 \Gamma_2 \Gamma_2 \Gamma_2 + c_7 \Gamma_1 \Gamma_1 \Gamma_1) ; \]

\[ C: \{R_5, R_6\}, \{R_6, R_7\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_0 \Gamma_3 \Gamma_1 \Gamma_1 \Gamma_1 + k_x (c_4 \Gamma_2 \Gamma_2 \Gamma_2 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_y (c_6 \Gamma_2 \Gamma_2 \Gamma_2 + c_7 \Gamma_1 \Gamma_1 \Gamma_1) ; \]

\[ A: \{R_5, R_7\}, \{R_6, R_8\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_0 \Gamma_3 \Gamma_1 \Gamma_1 \Gamma_1 + k_x (c_4 \Gamma_2 \Gamma_2 \Gamma_2 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_y (c_6 \Gamma_2 \Gamma_2 \Gamma_2 + c_7 \Gamma_1 \Gamma_1 \Gamma_1) ; \]

\[ D: \{R_5, R_7\}, \{R_6, R_8\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_0 \Gamma_3 \Gamma_1 \Gamma_1 \Gamma_1 + k_x (c_4 \Gamma_2 \Gamma_2 \Gamma_2 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_y (c_6 \Gamma_2 \Gamma_2 \Gamma_2 + c_7 \Gamma_1 \Gamma_1 \Gamma_1) ; \]

\[ B: \{R_5, R_7\}, \{R_6, R_8\}; \Gamma_0 \Gamma_0 \Gamma_0 = c_1 \Gamma_0 \Gamma_0 \Gamma_0 + c_2 \Gamma_0 \Gamma_3 \Gamma_1 \Gamma_1 \Gamma_1 + k_x (c_4 \Gamma_2 \Gamma_2 \Gamma_2 + c_5 \Gamma_2 \Gamma_2 \Gamma_2) + k_y (c_6 \Gamma_2 \Gamma_2 \Gamma_2 + c_7 \Gamma_1 \Gamma_1 \Gamma_1) ; \]

\hline
SG 72
\[ \Gamma^0_v; \{C_{2x}\{000\}, \{C_{2y}\{000\}, \{I\{\frac{1}{2} \frac{1}{2} 0\}\}, T; \text{Centrosymmetric; with SOC} \]

R: \{R_9, R_9\}; \Gamma_{0,0} + c_2 \Gamma_{0,2}k_y + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1}k_x + c_{i,2}k_z);
S: \{R_9, R_9\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2}k_x + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1}k_y + c_{i,2}k_z);
W: \{R_9, R_9\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2}k_x + c_3 \Gamma_{0,1}k_y + \sum_{i=1}^{3} c_{i,1} \Gamma_{i,2}k_z;

Accidental degeneracies on high symmetry line

D: \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2k_x) + \Gamma_{3,0} c_3k_z + \Gamma_{1,0} (c_4k_y + c_5k_z) + \sum_{i=1}^{3} \Gamma_{2,1} (c_{i,1}k_y + c_{i,2}k_z);
Q: \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2k_y) + \Gamma_{3,0} c_3k_y + \Gamma_{1,0} (c_4k_y + c_5k_z) + \sum_{i=1}^{3} \Gamma_{2,1} (c_{i,1}k_x + c_{i,2}k_z);

SG 73
\[ \Gamma^0_v; \{C_{2x}\{\frac{1}{2} 0 \frac{1}{2}\}, \{C_{2y}\{\frac{1}{2} \frac{1}{2} 0\}, \{I\{000\}, T; \text{Centrosymmetric; with SOC} \]

R: \{R_9, R_9\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2}k_y + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1}k_x + c_{i,2}k_z);
S: \{R_9, R_9\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2}k_x + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1}k_y + c_{i,2}k_z);
T: \{R_9, R_9\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2}k_z + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1}k_x + c_{i,2}k_y);

Accidental degeneracies on high symmetry line

P: \{R_5, R_5\}, \{R_7, R_7\}; \Gamma_{0,0} (c_1 + c_2k_x) + \Gamma_{3,0} c_3k_z + \Gamma_{1,0} (c_4k_y + c_5k_z) + \sum_{i=1}^{3} \Gamma_{2,1} (c_{i,1}k_x + c_{i,2}k_y);
D: \{R_5, R_5\}, \{R_7, R_7\}; \Gamma_{0,0} (c_1 + c_2k_x) + \Gamma_{3,0} c_3k_z + \Gamma_{1,0} (c_4k_y + c_5k_z) + \sum_{i=1}^{3} \Gamma_{2,1} (c_{i,1}k_y + c_{i,2}k_z);
Q: \{R_5, R_5\}, \{R_7, R_7\}; \Gamma_{0,0} (c_1 + c_2k_y) + \Gamma_{3,0} c_3k_y + \Gamma_{1,0} (c_4k_y + c_5k_z) + \sum_{i=1}^{3} \Gamma_{2,1} (c_{i,1}k_x + c_{i,2}k_z);

SG 74
\[ \Gamma^0_v; \{C_{2x}\{\frac{1}{2} 0 \frac{1}{2}\}, \{C_{2y}\{\frac{1}{2} \frac{1}{2} 0\}, \{I\{\frac{1}{2} \frac{1}{2} 0\}, T; \text{Centrosymmetric; with SOC} \]

T: \{R_9, R_9\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2}k_z + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1}k_x + c_{i,2}k_y);

Accidental degeneracies on high symmetry line

P: \{R_5, R_5\}, \{R_7, R_7\}; \Gamma_{0,0} (c_1 + c_2k_x) + \Gamma_{3,0} c_3k_z + \Gamma_{1,0} (c_4k_y + c_5k_y) + \sum_{i=1}^{3} \Gamma_{2,1} (c_{i,1}k_x + c_{i,2}k_y)
\[ \Gamma_q; \{ C^+_{4v} | 000 \}, \mathcal{T}; \text{Non-Centrosymmetric with SOC} \]

\[ \Gamma; \{ R_2, R_8 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_+ + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_- + \text{h.c.}) ; \]
\[ \{ R_2, R_8 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_+ + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_- + \text{h.c.}) ; \]
\[ M; \{ R_2, R_8 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_+ + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_- + \text{h.c.}) ; \]
\[ Z; \{ R_2, R_8 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_+ + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_- + \text{h.c.}) ; \]
\[ A; \{ R_2, R_8 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_+ + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_- + \text{h.c.}) ; \]
\[ R; \{ R_2, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + [(\alpha_1 k_x + \alpha_2 k_y) \sigma_+ + \text{h.c.}] ; \]
\[ X; \{ R_2, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + [(\alpha_1 k_x + \alpha_2 k_y) \sigma_+ + \text{h.c.}] ; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_+ \text{+ h.c.}) ; \]
\[ \{ R_2 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_3 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^3_x + \alpha_2 k^2_x) \text{+ h.c.}] ; \]
\[ \{ R_2 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_+ \text{+ h.c.}) ; \]
\[ \{ R_4 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_- \text{+ h.c.}) ; \]
\[ \{ R_4 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_3 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^3_x + \alpha_2 k^2_x) \text{+ h.c.}] ; \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_- \text{+ h.c.}) ; \]
\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_+ \text{+ h.c.}) ; \]
\[ \{ R_2 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_3 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^3_x + \alpha_2 k^2_x) \text{+ h.c.}] ; \]
\[ \{ R_4 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_- \text{+ h.c.}) ; \]
\[ \{ R_4 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_3 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^3_x + \alpha_2 k^2_x) \text{+ h.c.}] ; \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_- \text{+ h.c.}) ; \]
\[ W; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_1 k_x + c_2 k_y) ; \]
Accidental degeneracies on high symmetry line

A: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_5 k_z \sim (\alpha_1 \sigma_1 k_z + h.c.);
\{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_4\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_8\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];

V: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_4\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\{R_8\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];

W: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + \sum_{i=1}^2 \sigma_i (c_{1,i} k_x + c_{2,i} k_y) + \sigma_3 k_z + [\sigma_+ (\alpha_1 k_1^2 + \alpha_2 k_2^2) + h.c.];
\( \Gamma_i; \{C_{4w} \}, T \); Non-Centrosymmetric; with SOC

\[ \Gamma; \{R_2, R_6\}; c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+ k_z + h.c.); \]
\[ \{R_4, R_6\}; c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+ k_z + h.c.); \]

\[ M; \{R_2, R_8\}; c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+ k_z + h.c.); \]
\[ \{R_4, R_6\}; c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+ k_z + h.c.); \]

\[ Z; \{R_2, R_6\}; c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+ k_z + h.c.); \]
\[ \{R_4, R_6\}; c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+ k_z + h.c.); \]

\[ A; \{R_2, R_8\}; c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+ k_z + h.c.); \]
\[ \{R_4, R_6\}; c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+ k_z + h.c.); \]

\[ R; \{R_2, R_4\}; c_1\sigma_0 + c_2\sigma_3k_z + [(\alpha_1k_x + \alpha_2k_y)\sigma_+ + h.c.]; \]

\[ X; \{R_2, R_4\}; c_1\sigma_0 + c_2\sigma_3k_z + [(\alpha_1k_x + \alpha_2k_y)\sigma_+ + h.c.]; \]

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Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_z + h.c.); \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_2 k_x + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_z^2) + h.c.]; \]
\[ \{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_z + h.c.); \]
\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_z + h.c.); \]
\[ \{R_4\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_2 k_x + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_z^2) + h.c.]; \]
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_z + h.c.); \]

\[ V; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_z + h.c.); \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_2 k_x + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_z^2) + h.c.]; \]
\[ \{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_z + h.c.); \]
\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_z + h.c.); \]
\[ \{R_4\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_2 k_x + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_z^2) + h.c.]; \]
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ k_z + h.c.); \]

\[ W; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y); \]
Accidental degeneracies on high symmetry line

\( \Delta: \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_4, R_6\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_4, R_6\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_4, R_6\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_4, R_6\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_+^2 + \alpha_2 k^2) + h.c.]; \)
\( \{R_6, R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_1 k_+ + h.c.); \)
Accidental degeneracies on high symmetry line

\[ L: \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + (\alpha_1 \sigma_4 k_y + h.c.); \]
\[ R_2, R_6; \sigma_0 (c_1 + c_2 k_y + c_3 k_z^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_y^2 + \alpha_2 k_y^2) + h.c.]; \]
\[ R_2, R_6; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_4 k_z + h.c.); \]
\[ R_4, R_6; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_4 k_z + h.c.); \]
\[ R_4, R_6; \sigma_0 (c_1 + c_2 k_y + c_3 k_z^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_y^2 + \alpha_2 k_y^2) + h.c.]; \]
\[ R_0, R_6; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_4 k_y + h.c.); \]
\[ R_2, R_4; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + (\alpha_1 \sigma_4 k_y + h.c.); \]
\[ R_0, R_4; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_4 k_y + h.c.); \]
\[ R_4, R_6; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_4 k_y + h.c.); \]
\[ R_2, R_4; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sum_{i=1}^2 \sigma_i (c_{i,1} k_y + c_{i,2} k_y); \]

\[ V: \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_4 k_y + h.c.); \]
\[ R_2, R_6; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_y^2 + \alpha_2 k_y^2) + h.c.]; \]
\[ R_2, R_6; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_4 k_y + h.c.); \]
\[ R_4, R_6; \sigma_0 (c_1 + c_2 k_y + c_3 k_z^2 + c_4 k_z^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_y^2 + \alpha_2 k_y^2) + h.c.]; \]
\[ R_0, R_6; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_4 k_y + h.c.); \]
\[ R_2, R_4; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sum_{i=1}^2 \sigma_i (c_{i,1} k_y + c_{i,2} k_y); \]

\[ W: \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sum_{i=1}^2 \sigma_i (c_{i,1} k_y + c_{i,2} k_y); \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_{k-} + h.c.) \];
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^2_z + \alpha_2 k^2_z) + h.c.] \];
\[ \{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z + \sigma_3 c_3 k_z + (\alpha_1 \sigma_{k+} + h.c.) \];
\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_{k-} + h.c.) \];
\[ \{R_4\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^2_z + \alpha_2 k^2_z) + h.c.] \];
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z + \sigma_3 c_3 k_z + (\alpha_1 \sigma_{k-} + h.c.) \];

\[ V; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_{k-} + h.c.) \];
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^2_z + \alpha_2 k^2_z) + h.c.] \];
\[ \{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_{k+} + h.c.) \];
\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_{k-} + h.c.) \];
\[ \{R_4\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2_z) + [\sigma_+ (\alpha_1 k^2_z + \alpha_2 k^2_z) + h.c.] \];
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z + \sigma_3 c_3 k_z + (\alpha_1 \sigma_{k-} + h.c.) \];

\[ W; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{i,1} k_x + c_{i,2} k_y) \];
SG 81
\[ \Gamma_q; \{ \text{S}^4_{4z}[000], \mathcal{T} \}; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{ R_2, R_8 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ M; \{ R_2, R_8 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ Z; \{ R_2, R_8 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ A; \{ R_2, R_8 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ R; \{ R_2, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_x + [(\alpha_1 k_x + \alpha_2 k_y) \sigma_x + \text{h.c.}] ; \]
\[ X; \{ R_2, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_x + [(\alpha_1 k_x + \alpha_2 k_y) \sigma_x + \text{h.c.}] ; \]
\[ \Lambda; \{ R_2, R_4 \}; \sigma_0 (c_1 + c_2 k_x) + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ V; \{ R_2, R_4 \}; \sigma_0 (c_1 + c_2 k_x) + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]

Accidental degeneracies on high symmetry line

\[ W; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_2 k_x + \sum_{i=1}^2 \sigma_i (c_{i1} k_x + c_{i2} k_y) ; \]

SG 82
\[ \Gamma_q^\prime; \{ \text{S}^4_{4z}[000], \mathcal{T} \}; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{ R_2, R_8 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ N; \{ R_2, R_2 \}; c_1 \sigma_0 + \sum_{i=1}^3 \sigma_i (c_{i1} k_x + c_{i2} k_y + c_{i3} k_z) ; \]
\[ X; \{ R_2, R_4 \}; c_1 \sigma_0 + c_2 c_3 k_x + [(\alpha_1 k_x + \alpha_2 k_y) \sigma_x + \text{h.c.}] ; \]
\[ Z; \{ R_2, R_8 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ \{ R_4, R_6 \}; c_1 \sigma_0 + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ \Lambda; \{ R_2, R_4 \}; \sigma_0 (c_1 + c_2 k_x) + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]
\[ V; \{ R_2, R_4 \}; \sigma_0 (c_1 + c_2 k_x) + (\alpha_1 \sigma_x k_x + \text{h.c.}) ; \]

Accidental degeneracies on high symmetry line

\[ W; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_2 k_x + \sum_{i=1}^2 \sigma_i (c_{i1} k_x + c_{i2} k_y) ; \]

SG 83
\[ \Gamma_q; \{ \text{C}^4_{4z}[000], \mathcal{I}[000], \mathcal{T} \}; \text{Centrosymmetric; with SOC} \]
Accidental degeneracies on high symmetry line

\[ \Gamma; \{ R_2, R_6 \}; \quad \gamma_{0,0} (c_1 + c_2 k_x) + \gamma_{3,0} c_3 k_x + \gamma_{1,0} (c_4 k_x + c_5 k_y) + \gamma_{2,3} (c_4 k_y - c_5 k_x); \]
\[ V; \{ R_2, R_6 \}; \quad \gamma_{0,0} (c_1 + c_2 k_x) + \gamma_{3,0} c_3 k_x + \gamma_{1,0} (c_4 k_x + c_5 k_y) + \gamma_{2,3} (c_4 k_y - c_5 k_x); \]

SG 84
\[ \Gamma; \{ C_2^+ \{ 00 \frac{1}{2} \}, \{ I \} \}; \quad T; \text{Centrosymmetric; with SOC} \]
\[ Z; \{ R_{19}, R_{20} \}; \quad c_1 \gamma_{0,0} + c_2 \gamma_{3,1} k_x + (\alpha_1 \gamma_{+1} k_x + \text{h.c.}); \]
\[ A; \{ R_{19}, R_{20} \}; \quad c_1 \gamma_{0,0} + c_2 \gamma_{3,1} k_x + (\alpha_1 \gamma_{+1} k_x + \text{h.c.}); \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{ R_2, R_6 \}; \quad \gamma_{0,0} (c_1 + c_2 k_x) + \gamma_{3,0} c_3 k_x + \gamma_{1,0} (c_4 k_x + c_5 k_y) + \gamma_{2,3} (c_4 k_y - c_5 k_x); \]
\[ V; \{ R_2, R_6 \}; \quad \gamma_{0,0} (c_1 + c_2 k_x) + \gamma_{3,0} c_3 k_x + \gamma_{1,0} (c_4 k_x + c_5 k_y) + \gamma_{2,3} (c_4 k_y - c_5 k_x); \]

SG 85
\[ \Gamma; \{ C_4^+ \{ \frac{1}{2} \frac{1}{2} \}, \{ I \} \}; \quad T; \text{Centrosymmetric; with SOC} \]
\[ M; \{ R_{19}, R_{20} \}; \quad c_1 \gamma_{0,0} + c_2 \gamma_{3,1} k_x + (\alpha_1 \gamma_{+1} k_x + \text{h.c.}); \]
\[ A; \{ R_{19}, R_{20} \}; \quad c_1 \gamma_{0,0} + c_2 \gamma_{3,1} k_x + (\alpha_1 \gamma_{+1} k_x + \text{h.c.}); \]
\[ R; \{ R_9, R_9 \}; \quad c_1 \gamma_{0,0} + c_2 \gamma_{0,2} k_x + \sum_{i=1}^{3} \gamma_{1,1} (c_{i,1} k_x + c_{i,2} k_y); \]
\[ X; \{ R_9, R_9 \}; \quad c_1 \gamma_{0,0} + c_2 \gamma_{0,2} k_x + \sum_{i=1}^{3} \gamma_{1,1} (c_{i,1} k_x + c_{i,2} k_y); \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{ R_2, R_8 \}; \quad \gamma_{0,0} (c_1 + c_2 k_x) + \gamma_{3,0} c_3 k_x + \gamma_{1,0} (c_4 k_x + c_5 k_y) + \gamma_{2,3} (c_4 k_y - c_5 k_x); \]
\[ V; \{ R_{10}, R_{12} \}; \quad \gamma_{0,0} (c_1 + c_2 k_x) + \gamma_{3,0} c_3 k_x + \gamma_{2,1} (c_4 k_x - c_5 k_y) - \gamma_{2,2} (c_4 k_y + c_5 k_x); \]
\[ W; \{ R_2, R_2 \}; \quad \gamma_{0,0} (c_1 + c_2 k_x) + \gamma_{3,0} c_3 k_x + \gamma_{1,0} (c_4 k_x + c_5 k_y) + \sum_{i=1}^{3} \gamma_{2,1} (c_{i,1} k_x + c_{i,2} k_y); \]

SG 86
\[ \Gamma; \{ C_2^+ \{ \frac{1}{2} \frac{1}{2} \}, \{ I \} \}; \quad T; \text{Centrosymmetric; with SOC} \]
\[ M; \{ R_{19}, R_{20} \}; \quad c_1 \gamma_{0,0} + c_2 \gamma_{3,1} k_x + (\alpha_1 \gamma_{+1} k_x + \text{h.c.}); \]
\[ Z; \{ R_{19}, R_{20} \}; \quad c_1 \gamma_{0,0} + c_2 \gamma_{3,1} k_x + (\alpha_1 \gamma_{+1} k_x + \text{h.c.}); \]
\[ R; \{ R_9, R_9 \}; \quad c_1 \gamma_{0,0} + c_2 \gamma_{0,2} k_x + \sum_{i=1}^{3} \gamma_{1,1} (c_{i,1} k_x + c_{i,2} k_y); \]
\[ X; \{ R_9, R_9 \}; \quad c_1 \gamma_{0,0} + c_2 \gamma_{0,2} k_x + \sum_{i=1}^{3} \gamma_{1,1} (c_{i,1} k_x + c_{i,2} k_y); \]
Accidental degeneracies on high symmetry line

\[ \Lambda: \{R_2, R_8\}, \{R_4, R_6\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \Gamma_{2,3} (c_6 k_y - c_7 k_z) ; \]
\[ V: \{R_{10}, R_{12}\}, \{R_{14}, R_{16}\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{2,1} (c_4 k_x - c_5 k_y) - \Gamma_{2,3} (c_6 k_y + c_7 k_z) ; \]
\[ W: \{R_2, R_4\}, \{R_4, R_4\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \sum_{i=1}^{5} \Gamma_{2,i} (c_{i,1} k_x + c_{i,2} k_y) ; \]

SG 87
\[ \Gamma_0: \{C_{4v}^{+}[000]\}, \{I[000]\}, T; \text{Centrosymmetric; with SOC} \]

Accidental degeneracies on high symmetry line

\[ \Lambda: \{R_2, R_8\}, \{R_4, R_6\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \Gamma_{2,3} (c_6 k_y - c_7 k_z) ; \]
\[ V: \{R_2, R_8\}, \{R_4, R_4\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \Gamma_{2,3} (c_6 k_y - c_7 k_z) ; \]

SG 88
\[ \Gamma_0: \{C_{4v}^{+}[000]\}, \{I[000]\}, T; \text{Centrosymmetric; with SOC} \]

Accidental degeneracies on high symmetry line

\[ \Lambda: \{R_2, R_8\}, \{R_4, R_6\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \Gamma_{2,3} (c_6 k_y - c_7 k_z) ; \]
\[ V: \{R_2, R_8\}, \{R_4, R_4\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \Gamma_{2,3} (c_6 k_y - c_7 k_z) ; \]
\[ W: \{R_2, R_2\}, \{R_4, R_4\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \sum_{i=1}^{5} \Gamma_{2,i} (c_{i,1} k_x + c_{i,2} k_y) ; \]

SG 89
\[ \Gamma_0: \{C_{4v}^{+}[000]\}, \{C_{2v}[000]\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma: \quad \{R_6\}; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]
\[ M: \quad \{R_6\}; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]
\[ Z: \quad \{R_6\}; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]
\[ A: \quad \{R_6\}; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]
\[ R: \quad \{R_5, R_8\}; \quad c_2 \sigma_3 k_z + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \]
\[ X: \quad \{R_5, R_8\}; \quad c_2 \sigma_3 k_z + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \]

\[ U: \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \]

\[ \Lambda: \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \left( e^{i \pi / 4} c_4 \sigma_1 k_x + h.c. \right); \]

\[ \{ R_2 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ \{ R_2 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ V: \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \left( e^{i \pi / 4} c_4 \sigma_1 k_x + h.c. \right); \]

\[ \{ R_2 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ \Sigma: \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z + c_3 k_z + c_4 k^2 + c_7 k^2_z) + \left[ \sigma_4 (\alpha_1 k^2_z + \alpha_2 k^2) + h.c. \right]; \]

\[ \Gamma_\delta: \{ C_{4\iota}^+ |000\}, \{ C_{2\iota} |1/2, 1/2 \}, T; Non-Centrosymmetric; with SOC \]

\[ \Gamma: \{ R_6 \}; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

\[ \{ R_7 \}; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

\[ M: \{ R_6 \}, \{ R_7 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,3} k_x - \Gamma_{0,2} k_y) + c_3 \Gamma_{3,1} k_z + \left[ \alpha_1 (k_x \Gamma_{4,0} + i k_y \Gamma_{4,1}) + h.c. \right]; \]

\[ Z: \{ R_6 \}; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

\[ \{ R_7 \}; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

\[ A: \{ R_6 \}, \{ R_7 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,3} k_x - \Gamma_{0,2} k_y) + c_3 \Gamma_{3,1} k_z + \left[ \alpha_1 (k_x \Gamma_{4,0} + i k_y \Gamma_{4,1}) + h.c. \right]; \]

\[ R: \{ R_6 \}, \{ R_6 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0; \]

\[ \{ R_7 \}, \{ R_8 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0; \]

\[ X: \{ R_6 \}, \{ R_6 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0; \]

\[ \{ R_7 \}, \{ R_8 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0; \]

\[ V: \{ R_6 \}, \{ R_6 \}; \quad c_2 (c_1 + c_2 k^2 + c_3 k^2_z + c_4 k_z) + (\alpha_1 \sigma_4 k_x k_y + h.c.); \]

\[ \{ R_7 \}, \{ R_8 \}; \quad c_2 (c_1 + c_2 k^2 + c_3 k^2_z + c_4 k_z) + (\alpha_1 \sigma_4 k_x k_y + h.c.); \]

\[ Y: \{ R_6 \}, \{ R_7 \}; \quad c_2 (c_1 + c_2 k^2 + c_3 k^2_z + c_4 k_z) + (\alpha_1 \sigma_4 k_x k_y + h.c.); \]

\[ T: \{ R_6 \}, \{ R_6 \}; \quad (c_2 k_x + c_1) + (c_3 \sigma_1 - c_2 \sigma_2) k_y; \]

\[ W: \{ R_2 \}, \{ R_4 \}; \quad c_2 (c_1 + c_2 k^2 + c_3 k^2_z + c_4 k_z) + (\alpha_1 \sigma_4 k_x k_y + h.c.); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \]

\[ U: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \]

\[ \Lambda: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left( e^{i \pi/4} c_4 \sigma_+ k_+ + h.c. \right); \]

\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_y^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_y^2) + \left[ \sigma_+ (c_1 k_+^2 + c_2 k_+^2) + h.c. \right]; \]

\[ \{ R_2 \}, \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left( e^{i \pi/4} c_4 \sigma_+ k_+ + h.c. \right); \]

\[ \{ R_4 \}, \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_y^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_y^2) + \left[ \sigma_+ (c_1 k_+^2 + c_2 k_+^2) + h.c. \right]; \]

\[ \{ R_4 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left( e^{i \pi/4} c_4 \sigma_+ k_+ + h.c. \right); \]

\[ \{ R_6 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_y^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_y^2) + \left[ \sigma_+ (c_1 k_+^2 + c_2 k_+^2) + h.c. \right]; \]

\[ V: \{ R_2, R_5 \}, \{ R_4, R_8 \} : \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \left\{ e^{i \pi/4} \left[ (c_4 \Gamma_{+,0} + ic_5 \Gamma_{+,3}) k_- + i k_+ (c_6 \Gamma_{+,1} + c_7 \Gamma_{+,2}) \right] + h.c. \right\}; \]

\[ \Sigma: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x + c_3 k_x + k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_x); \]

\[ S: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_x); \]
\section*{11. SG 91-100}

\begin{align*}
\Gamma; \{R_6\}; & \quad \sigma_2 (\sigma_1 k_x + \sigma_2 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \\
R_7; & \quad \sigma_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \\
M; R_6; & \quad \sigma_2 (\sigma_1 k_x + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \\
R_7; & \quad \sigma_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \\
Z; \{R_8, R_{10}\}; & \quad (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \\
\{R_9, R_{11}\}; & \quad (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \\
R_{14}; & \quad c_2 \sigma_3 k_z + c_3 \sigma_0; \\
A; \{R_8, R_{10}\}; & \quad (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \\
\{R_9, R_{11}\}; & \quad (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \\
R_{14}; & \quad c_2 \sigma_3 k_z + c_3 \sigma_0; \\
R; \{R_5, R_8\}; & \quad (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \\
\{R_7, R_9\}; & \quad (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \\
X; R_5; & \quad c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_3 \sigma_2 k_z + c_1 \sigma_0; \\
U; \{R_5, R_7\}; & \quad \sigma_0 (c_2 k_y + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \\
S; \{R_{12}, R_{16}\}; & \quad \sigma_0 [c_1 + c_2 (k_x + k_y)] + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \\
T; \{R_2, R_4\}; & \quad \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_z;
\end{align*}

Accidental degeneracies on high symmetry line

\begin{align*}
\Delta; \{R_2\}, \{R_4\}; & \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_9 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \\
\Lambda; \{R_2\}, \{R_4\}; & \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_9 k_y + \left(e^{i\pi/4}c_4 \sigma_1 k_x + h.c.;
\right) \\
\{R_2\}, \{R_5\}; & \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_9 k_y + \left(e^{i\pi/4}c_4 \sigma_1 k_x + h.c.;
\right) \\
\{R_2\}, \{R_6\}; & \quad \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2_2) + \sigma_3 (c_9 k_x + c_6 k^2 + c_7 k^2_2) + \left[\sigma_+ (\alpha_1 k^4_1 + \alpha_2 k^4_2) + h.c.;
\right) \\
\{R_2\}, \{R_8\}; & \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_9 k_y + \left(e^{i\pi/4}c_4 \sigma_1 k_x + h.c.;
\right) \\
\{R_4\}, \{R_6\}; & \quad \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2_2) + \sigma_3 (c_9 k_x + c_6 k^2 + c_7 k^2_2) + \left[\sigma_+ (\alpha_1 k^4_1 + \alpha_2 k^4_2) + h.c.;
\right) \\
\{R_6\}, \{R_8\}; & \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_9 k_y + \left(e^{i\pi/4}c_4 \sigma_1 k_x + h.c.;
\right) \\
\{R_2\}, \{R_4\}; & \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_9 k_y + \left(e^{i\pi/4}c_4 \sigma_1 k_x + h.c.;
\right) \\
\{R_2\}, \{R_8\}; & \quad \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2_2) + \sigma_3 (c_9 k_x + c_6 k^2 + c_7 k^2_2) + \left[\sigma_+ (\alpha_1 k^4_1 + \alpha_2 k^4_2) + h.c.;
\right) \\
\{R_4\}, \{R_8\}; & \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_9 k_y + \left(e^{i\pi/4}c_4 \sigma_1 k_x + h.c.;
\right) \\
\{R_2\}, \{R_6\}; & \quad \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k^2_2) + \sigma_3 (c_9 k_x + c_6 k^2 + c_7 k^2_2) + \left[\sigma_+ (\alpha_1 k^4_1 + \alpha_2 k^4_2) + h.c.;
\right) \\
\{R_4\}, \{R_6\}; & \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_9 k_y + \left(e^{i\pi/4}c_4 \sigma_1 k_x + h.c.;
\right) \\
\Sigma; \{R_2\}, \{R_4\}; & \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_x); \\
Y; \{R_2\}, \{R_4\}; & \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_y; \\
W; \{R_2\}, \{R_4\}; & \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_y; 
\end{align*}
\[ \Gamma; R_0; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]
\[ R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

\[ M; \{ R_6, R_7 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,3} k_z - \Gamma_{0,2} k_y) + c_3 \Gamma_{3,1} k_z + [\alpha_1 (k_z \Gamma_{1,0} + i k_y \Gamma_{1,1}) + h.c.]; \]

\[ Z; \{ R_8, R_{10} \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0; \]
\[ R_{14}; \quad c_2 \sigma_3 k_x + c_1 \sigma_0; \]

\[ A; \{ R_8, R_{11} \}; \quad \sigma_0 (c_1 + c_2 k^2 + c_3 k^2) + (\alpha_1 \sigma_1 k_z k_y k_z + h.c.); \]
\[ R_9, R_{10}; \quad \sigma_0 (c_1 + c_2 k^2 + c_3 k^2) + (\alpha_1 \sigma_1 k_z k_y k_z + h.c.); \]
\[ R_{12}, R_{12}; \quad \Gamma_{0,0} (c_1 + c_2 k^2 + c_3 k^2) + \sum_{i=1}^3 (c_{i,1} \Gamma_{1,2} k_z + c_{i,2} \Gamma_{1,3} k_y) + c_1 \Gamma_{0,1} (k_x^2 - k_y^2); \]

\[ R; \{ R_9, R_0 \}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{0,3} k_z + \sum_{i=1}^3 (c_{i,1} \Gamma_{1,1} k_y + c_{i,2} \Gamma_{1,2} k_z); \]

\[ X; \{ R_6, R_6 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0; \]
\[ R_7, R_8; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0; \]

\[ U; \{ R_6, R_7 \}; \quad \sigma_0 (c_2 k_y + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \]

\[ V; \{ R_6, R_6 \}; \quad \sigma_0 (c_1 + c_2 k^2 + c_3 k^2 + c_4 k_z) + (\alpha_1 \sigma_1 k_z k_y + h.c.); \]
\[ R_4, R_8; \quad \sigma_0 (c_1 + c_2 k^2 + c_3 k^2 + c_4 k_z) + (\alpha_1 \sigma_1 k_z k_y + h.c.); \]

\[ S; \{ R_{12}, R_{16} \}; \quad \sigma_0 (c_2 (k_z + k_y) + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \]

\[ Y; \{ R_6, R_7 \}; \quad \sigma_0 (c_2 k_z + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \]

\[ T; \{ R_5, R_5 \}; \quad \sigma_0 \left( c_1 + c_2 k_z + \sum_{i=x,y,z} c_i k_i^2 \right) + (\alpha_1 \sigma_1 + c_3 \sigma_3) k_y k_z + h.c.; \]
\[ R_8; \quad \sigma_0 \left( c_1 + c_2 k_z + \sum_{i=x,y,z} c_i k_i^2 \right) + (\alpha_1 \sigma_1 + c_3 \sigma_3) k_y k_z + h.c.; \]

\[ W; \{ R_2, R_4 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + \sigma_0 (c_3 k_z + c_1); \]

Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \]

\[ \Lambda; \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \left( e^{i\pi/4} c_4 \sigma_1 k_z + h.c. \right); \]
\[ \{ R_2 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + (\sigma_+ (\alpha_1 k^2_1 + \alpha_2 k^2_2) + h.c.); \]
\[ \{ R_2 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + (\sigma_+ (\alpha_1 k^2_1 + \alpha_2 k^2_2) + h.c.); \]

\[ \{ R_4 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + (\sigma_+ (\alpha_1 k^2_1 + \alpha_2 k^2_2) + h.c.); \]
\[ \{ R_4 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + (\sigma_+ (\alpha_1 k^2_1 + \alpha_2 k^2_2) + h.c.); \]

\[ \{ R_6 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2) + (\sigma_+ (\alpha_1 k^2_1 + \alpha_2 k^2_2) + h.c.); \]

\[ V; \{ R_2, R_6 \}, \{ R_4, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + \left( e^{i\pi/4} (c_4 \Gamma_{1,0} + i c_5 \Gamma_{1,3}) k_- + i k_+ (c_6 \Gamma_{1,1} + c_7 \Gamma_{1,2}) + h.c. \right); \]

\[ \Sigma; \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k_y) + \sigma_3 c_3 (k_z + k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 (k_y - k_z); \]

\[ T; \{ R_5, R_5 \}, \{ R_7, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} c_4 k_z + c_5 \Gamma_{2,0} k_y + \sum_{i=1}^3 (c_{i,1} \Gamma_{1,i} k_y + c_{i,2} \Gamma_{2,i} k_z); \]
Accidental degeneracies on high symmetry line

\( \Delta: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z ; \)

\( U: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z ; \)

\( \Lambda: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (\epsilon^{i \pi/4} c_4 \sigma_+ k_- + h.c.) ; \)

\( V: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (\epsilon^{i \pi/4} c_4 \sigma_+ k_- + h.c.) ; \)

\( \Sigma: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \sigma_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z) ; \)

\( S: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \sigma_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z) ; \)

\( Y: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \sigma_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z) ; \)

\( T: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_z) ; \)

\( W: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_x + c_5 \sigma_2 k_y ; \)
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + \sigma_3c_4k_y + c_4\sigma_1k_z + c_5\sigma_2k_z; \]

\[ U; \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + \sigma_3c_4k_y + c_4\sigma_1k_z + c_5\sigma_2k_z; \]

\[ \Lambda; \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_y) + \sigma_3c_4k_y + \left( e^{i\pi/4} c_4\sigma_1k_- + h.c. \right); \]

\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_4k_z + \left( e^{i\pi/4} c_4\sigma_1k_- + h.c. \right); \]

\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_4k_z + \left( e^{i\pi/4} c_4\sigma_1k_- + h.c. \right); \]

\[ \{R_4\}, \{R_8\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_4k_z + \left( e^{i\pi/4} c_4\sigma_1k_- + h.c. \right); \]

\[ \{R_4\}, \{R_8\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_4k_z + \left( e^{i\pi/4} c_4\sigma_1k_- + h.c. \right); \]

\[ V; \{R_2, R_6\}, \{R_4, R_8\}; \quad \Gamma_{0,0} (c_1 + c_2k_z) + \Gamma_{3,0}c_3k_z + \left( e^{i\pi/4} \left( c_4\Gamma_{1,0} + ic_5\Gamma_{1,3} \right) k_- + ik_+ \left( c_6\Gamma_{1,0} + c_7\Gamma_{1,2} \right) \right) + h.c.; \]

\[ \Sigma; \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_4k_y + \sigma_4c_5k_y + c_4\sigma_1k_z + c_5\sigma_2k_y + h.c.; \]

\[ S; \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_4k_y + \sigma_4c_5k_y + c_4\sigma_1k_z + c_5\sigma_2k_y + h.c.; \]
\( \Gamma_q; \{ C_{4}^{+} | 00 \}^{2}, \{ C_{2} | 000 \}, T \); Non-Centrosymmetric; with SOC

\[\begin{align*}
\Gamma: & \quad R_{6}: \quad c_{2} (\sigma_{1} k_{x} + \sigma_{3} k_{y}) - c_{3} \sigma_{2} k_{z} + c_{1} \sigma_{0}; \\
& \quad R_{7}: \quad c_{2} (\sigma_{1} k_{x} - \sigma_{3} k_{y}) - c_{3} \sigma_{2} k_{z} + c_{1} \sigma_{0}; \\
M: & \quad R_{6}: \quad c_{2} (\sigma_{1} k_{x} + \sigma_{3} k_{y}) - c_{3} \sigma_{2} k_{z} + c_{1} \sigma_{0}; \\
& \quad R_{7}: \quad c_{2} (\sigma_{1} k_{x} - \sigma_{3} k_{y}) - c_{3} \sigma_{2} k_{z} + c_{1} \sigma_{0}; \\
Z: & \quad \{ R_{8}, R_{10} \}: \quad (c_{2} \sigma_{1} + c_{3} \sigma_{2}) k_{z} + c_{1} \sigma_{0}; \\
& \quad \{ R_{9}, R_{11} \}: \quad (c_{2} \sigma_{1} - c_{3} \sigma_{2}) k_{z} + c_{1} \sigma_{0}; \\
& \quad R_{14}: \quad c_{2} \sigma_{3} k_{x} + c_{1} \sigma_{0}; \\
A: & \quad \{ R_{8}, R_{10} \}: \quad (c_{2} \sigma_{1} - c_{3} \sigma_{2}) k_{z} + c_{1} \sigma_{0}; \\
& \quad \{ R_{9}, R_{11} \}: \quad (c_{2} \sigma_{1} - c_{3} \sigma_{2}) k_{z} + c_{1} \sigma_{0}; \\
& \quad R_{14}: \quad c_{2} \sigma_{3} k_{x} + c_{1} \sigma_{0}; \\
X: & \quad R_{5}: \quad c_{2} \sigma_{3} k_{x} + c_{3} \sigma_{1} k_{y} - c_{4} \sigma_{2} k_{z} + c_{1} \sigma_{0}; \\
U: & \quad \{ R_{9}, R_{11} \}: \quad \sigma_{0} (c_{2} k_{y} + c_{1}) + (c_{3} \sigma_{1} - c_{4} \sigma_{2}) k_{z}; \\
S: & \quad \{ R_{10}, R_{14} \}: \quad \sigma_{0} (c_{2} k_{x} + c_{1}) + (c_{3} \sigma_{1} - c_{4} \sigma_{2}) k_{z}; \\
T: & \quad \{ R_{2}, R_{4} \}: \quad \sigma_{0} (c_{2} k_{x} + c_{1}) + (c_{3} \sigma_{1} - c_{4} \sigma_{2}) k_{z}; \\
\end{align*}\]
\( \Gamma; \{ C_4^v | 001 \}, \{ C_{2z} | 1/2 0 \}, \mathcal{T}; \text{Non-Centrosymmetric; with SOC} \)

\( \Gamma; \quad R_6; \quad c_2 (\sigma_1 k_z + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \)

\( R_7; \quad c_2 (\sigma_1 k_z - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \)

\( M; \{ R_6, R_7 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,3} k_z - \Gamma_{0,2} k_y) + c_3 \Gamma_{4,1} k_z + [\alpha_1 (k_z \Gamma_{+,0} + i k_y \Gamma_{+,-}) + h.c.]; \)

\( Z; \quad \{ R_6, R_{10} \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \)

\( \{ R_6, R_{11} \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_z + c_1 \sigma_0; \)

\( \{ R_7, R_{10} \}; \quad c_2 \sigma_3 k_z + c_1 \sigma_0; \)

\( A; \{ R_8, R_{11} \}; \quad \sigma_0 (c_1 + c_2 k^2 + c_3 k^2_z) + (\alpha_1 \sigma_1 k_x k_y k_z + h.c.); \)

\( \{ R_9, R_{12} \}; \quad \sigma_0 (c_1 + c_2 k^2 + c_3 k^2_z) + (\alpha_1 \sigma_1 k_x k_y k_z + h.c.); \)

\( \{ R_{12}, R_{13} \}; \quad \Gamma_{0,0} (c_1 + c_2 k^2 + c_3 k^2_z) + \sum_{i=1}^{3} (c_{1,i} \Gamma_{1,ik} k_z + c_{1,2} \Gamma_{1,ik} k_y) + c_4 \Gamma_{0,1} (k_x^2 - k_y^2); \)

\( R; \quad \{ R_9, R_0 \}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{0,3} k_z + \sum_{i=1}^{3} (c_{1,i} \Gamma_{1,ik} k_y + c_{1,2} \Gamma_{1,ik} k_z); \)

\( X; \quad \{ R_6, R_8 \}; \quad (c_2 \sigma_1 + c_3 \sigma_2) k_y + c_1 \sigma_0; \)

\( \{ R_7, R_8 \}; \quad (c_2 \sigma_1 + c_3 \sigma_2) k_y + c_1 \sigma_0; \)

\( U; \quad \{ R_6, R_7 \}; \quad c_0 (c_2 k_y + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \)

\( V; \quad \{ R_6, R_8 \}; \quad \sigma_0 (c_1 + c_2 k^2 + c_3 k^2_z) + (\alpha_1 \sigma_1 k_x k_y k_z + h.c.); \)

\( \{ R_4, R_8 \}; \quad \sigma_0 (c_1 + c_2 k^2 + c_3 k^2_z) + (\alpha_1 \sigma_1 k_x k_y k_z + h.c.); \)

\( S; \quad \{ R_{12}, R_{16} \}; \quad \sigma_0 [c_2 (k_x + k_y) + c_1] + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \)

\( Y; \quad \{ R_6, R_7 \}; \quad \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_y; \)

\( T; \quad \{ R_5, R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z + \sum_{i=1}^{3} c_i k^2_i) + [(\alpha_1 \sigma_1 + c_0 \sigma_3) k_y k_z + h.c.]; \)

\( \{ R_5, R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z + \sum_{i=1}^{3} c_i k^2_i) + [(\alpha_1 \sigma_1 + c_0 \sigma_3) k_y k_z + h.c.]; \)

\( W; \quad \{ R_2, R_4 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + \sigma_0 (c_3 k_z + c_1); \)

Accidental degeneracies on high symmetry line

\( \Delta; \quad \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 \sigma_1 k_z + c_5 \sigma_2 k_z; \)

\( \Lambda; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + \left( e^{i \pi/4} c_4 \sigma_1 k_z + h.c. \right); \)

\( \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_y + c_3 k^2 + c_4 k^2_y) + \sigma_3 (c_5 k_z + c_6 k^2 + c_7 k^2_y) + [\sigma_1 (\alpha_1 k^2_z + \alpha_2 k^2_y) + h.c.]; \)

\( \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z + \sigma_3 k_z + \left( e^{i \pi/4} c_4 \sigma_1 k_y + h.c. \right); \)

\( \{ R_4 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z + c_3 k^2 + c_4 k^2_z) + \sigma_3 (c_5 k_y + c_6 k^2 + c_7 k^2_z) + [\sigma_1 (\alpha_1 k^2_z + \alpha_2 k^2_y) + h.c.]; \)

\( \{ R_6 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x + \sigma_3 k_x + \left( e^{i \pi/4} c_4 \sigma_1 k_y + h.c. \right); \)

\( V; \quad \{ R_2, R_3 \}, \{ R_4, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_z + \left( e^{i \pi/4} \left[ c_4 \Gamma_{+,0} + i c_5 \Gamma_{+,3} \right] k_y + i k_+ (c_6 \Gamma_{+,1} + c_7 \Gamma_{+,2}) + h.c. \right); \)

\( \Sigma; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_5 (k_x + k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 (k_y - k_z); \)

\( T; \quad \{ R_5, R_3 \}, \{ R_7, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_z + c_4 \Gamma_{1,0} k_y + c_5 \Gamma_{2,0} k_y + \sum_{i=1}^{3} (c_{1,i} \Gamma_{1,ik} k_y + c_{1,2} \Gamma_{2,ik} k_z); \)
Γv: \{ C_{4v}^{+}[000], \{ C_{2v}[000] \}, T \}; Non-Centrosymmetric; with SOC

Γ;  
R6: \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0;
R7: \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0;
N; \{ R_2, R_3 \}: \sum_{i=1}^2 \sigma_i (c_{i1} k_x + c_{i2} k_z) + c_2 \sigma_3 k_y + c_1 \sigma_0;
X;  
R5: \quad c_3 \sigma_1 (k_x - k_y) + c_2 \sigma_3 (k_x + k_y) - c_4 \sigma_2 k_z + c_1 \sigma_0;
Z;  
R6: \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0;
R7: \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0;
P; \{ R_1, R_4 \}: \sum_{i=1}^2 \sigma_i (c_{i1} k_x k_y + c_{i2} k_z) + c_4 \sigma_3 (k_x^2 - k_y^2) + \sigma_0 (c_1 + c_2 k^2 + c_3 k_z^2);

Accidental degeneracies on high symmetry line

Λ: \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \left( e^{i\pi/4} c_4 \sigma_+ k_+ + h.c. \right);
\{ R_2 \}, \{ R_6 \}: \sigma_0 (c_1 + c_2 k_x + c_2 k_y + c_4 k_z^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_z^2) + h.c.];
\{ R_2 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \left( e^{i\pi/4} c_4 \sigma_\pm k_\pm + h.c. \right);
\{ R_4 \}, \{ R_6 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \left( e^{i\pi/4} c_4 \sigma_\pm k_\pm + h.c. \right);
\{ R_4 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_x + c_2 k_y + c_4 k_z^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_z^2) + h.c.];
\{ R_6 \}; \{ R_8 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \left( e^{i\pi/4} c_4 \sigma_+ k_+ + h.c. \right);

V: \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \left( e^{i\pi/4} c_4 \sigma_\pm k_\pm + h.c. \right);
\{ R_2 \}, \{ R_6 \}: \sigma_0 (c_1 + c_2 k_x + c_2 k_y + c_4 k_z^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_z^2) + h.c.];
\{ R_2 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \left( e^{i\pi/4} c_4 \sigma_\pm k_\pm + h.c. \right);
\{ R_4 \}, \{ R_6 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \left( e^{i\pi/4} c_4 \sigma_\pm k_\pm + h.c. \right);
\{ R_4 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_x + c_2 k_y + c_4 k_z^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_z^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_z^2) + h.c.];
\{ R_6 \}, \{ R_8 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \left( e^{i\pi/4} c_4 \sigma_+ k_+ + h.c. \right);

W; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sigma_3 c_3 (k_x + k_y) + c_5 \sigma_2 (k_y - k_x);
Σ; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sigma_3 c_3 k_y + c_6 \sigma_1 k_x;
F; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sigma_3 c_3 k_y + c_6 \sigma_1 k_x;
Q; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + \sum_{i=1}^2 \sigma_i (c_{i1} k_x + c_{i2} k_z);
\Delta; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 (k_y - k_x);
U; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 (k_y - k_x);
Y; \{ R_2 \}, \{ R_4 \}: \sigma_0 (c_1 + c_2 k_x - c_2 k_y) + \sigma_3 c_3 (k_x - k_y) + c_4 \sigma_1 (k_x + k_y) + c_5 \sigma_2 k_z;

SG 98
Γv; \{ C_{4v}^{+}[\frac{1}{2}, \frac{1}{2}], \{ C_{2v}[0, 1, \frac{1}{2}] \}, T \}; Non-Centrosymmetric; with SOC

Γ;  
R6: \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0;
R7: \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0;
N; \{ R_2, R_3 \}: \sum_{i=1}^2 \sigma_i (c_{i1} k_x + c_{i2} k_z) + c_2 \sigma_3 k_y + c_1 \sigma_0;
X;  
R5: \quad c_3 \sigma_1 (k_x - k_y) + c_2 \sigma_3 (k_x + k_y) - c_4 \sigma_2 k_z + c_1 \sigma_0;
Z;  
R6: \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0;
R7: \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0;
P; \{ R_1, R_4 \}: \sum_{i=1}^2 \sigma_i (c_{i1} k_x k_y + c_{i2} k_z) + c_4 \sigma_3 (k_x^2 - k_y^2) + \sigma_0 (c_1 + c_2 k^2 + c_3 k_z^2);
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left(e^{i\pi/4} c_4 \sigma_+ k_- + h.c.\right); \]
\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_y^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_y^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]
\[ \{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left(e^{i\pi/4} c_4 \sigma_+ k_- + h.c.\right); \]
\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + c_3 k_x + c_4 k_y) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_y^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]
\[ \{R_4\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left(e^{i\pi/4} c_4 \sigma_+ k_- + h.c.\right); \]
\[ \{R_5\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left(e^{i\pi/4} c_4 \sigma_+ k_- + h.c.\right); \]
\[ \{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_y^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_y^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]
\[ \{R_7\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x + c_3 k_x + c_4 k_y) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_y^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]
\[ \{R_7\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left(e^{i\pi/4} c_4 \sigma_+ k_- + h.c.\right); \]

\[ V; \{R_{10}\}, \{R_{12}\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left(e^{i\pi/4} c_4 \sigma_+ k_- + h.c.\right); \]
\[ \{R_{10}\}, \{R_{14}\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_y^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_y^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]
\[ \{R_{10}\}, \{R_{16}\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left(e^{i\pi/4} c_4 \sigma_+ k_- + h.c.\right); \]
\[ \{R_{12}\}, \{R_{14}\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left(e^{i\pi/4} c_4 \sigma_+ k_- + h.c.\right); \]
\[ \{R_{12}\}, \{R_{16}\}; \sigma_0 (c_1 + c_2 k_x + c_3 k^2 + c_4 k_y^2) + \sigma_3 (c_5 k_x + c_6 k^2 + c_7 k_y^2) + [\sigma_+ (\alpha_1 k_x^2 + \alpha_2 k_y^2) + h.c.]; \]
\[ \{R_{14}\}, \{R_{16}\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left(e^{i\pi/4} c_4 \sigma_+ k_- + h.c.\right); \]
\[ W; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 (k_x + k_y) + c_5 \sigma_2 (k_y - k_x); \]
\[ \Sigma; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 (k_y - k_x) + c_5 \sigma_1 (k_y + k_x); \]
\[ F; \{R_6\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_x + c_4 \sigma_2 (k_y - k_x) + c_5 \sigma_1 (k_y + k_x); \]
\[ Q; \{R_6\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sum_{i=1}^2 c_i (c_1 k_x + c_2 k_y); \]
\[ \Delta; \{R_6\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \sigma_4 c_4 k_y + c_5 c_1 (k_x + k_y); \]
\[ U; \{R_6\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + c_3 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 (k_x + k_y) + c_5 \sigma_2 (k_x - k_y); \]
\[ Y; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x - c_3 k_y) + \sigma_3 c_3 (k_x - k_y) + c_4 \sigma_1 (k_x + k_y) + c_5 \sigma_2 (k_x); \]

SG 99

\[ \Gamma; \{C_4^+|000\}, \{\sigma_y|000\}; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \quad R_6; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ \quad \quad \quad \quad R_7; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ M; \quad R_6; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ \quad \quad \quad \quad R_7; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ Z; \quad R_6; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ \quad \quad \quad \quad R_7; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ A; \quad R_6; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ \quad \quad \quad \quad R_7; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ R; \quad \quad \quad \quad R_5; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]
\[ X; \quad \quad \quad \quad R_5; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]
\[ \Delta; \quad R_6; \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x + \sigma_3 k_y); \]
\[ \quad \quad \quad \quad R_7; \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \]
\[ V; \quad \quad \quad \quad R_6; \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x + \sigma_3 k_y); \]
\[ \quad \quad \quad \quad R_7; \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \]
\[ W; \quad \quad \quad \quad R_6; \sigma_0 (c_3 k_x + c_1) + c_2 \sigma_1 k_x + c_3 \sigma_3 k_y; \]
Accidental degeneracies on high symmetry line

\( \Delta: \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z; \)
\( U: \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z; \)
\( \Lambda: \{ R_6 \}, \{ R_7 \} : \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{0,2} c_2 k_x + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_y + (c_4 \Gamma_{3,3} + c_5 \Gamma_{0,3}) k_y + [\alpha_1 (k_y \Gamma_{+,0} - i k_x \Gamma_{+,1} + h.c.)]; \)
\( V: \{ R_6 \}, \{ R_7 \} : \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{0,2} c_2 k_x + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_y + (c_4 \Gamma_{3,3} + c_5 \Gamma_{0,3}) k_y + [\alpha_1 (k_y \Gamma_{+,0} - i k_x \Gamma_{+,1} + h.c.)]; \)
\( \Sigma: \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 k_x + c_4 \sigma_2 (k_y - k_z); \)
\( S: \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 k_x + c_4 \sigma_2 (k_y - k_z); \)
\( Y: \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \)
\( T: \{ R_2 \}, \{ R_3 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \)

\( \Gamma_\eta: \{ C_2^\eta | 000 \}, \{ \sigma_0 \} | \frac{1}{2} \frac{1}{2} 0 \}, T; \) Non-Centrosymmetric; with SOC

\( \Gamma: \)
\( \{ R_6 \}; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \)
\( \quad R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \)
\( \{ R_6, R_7 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2} k_x + \Gamma_{3,3} k_y) + c_3 \Gamma_{3,0} k_x + [\alpha_1 (k_y \Gamma_{+,0} - i k_x \Gamma_{+,1} + h.c.)]; \)
\( Z: \{ R_6 \}; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \)
\( \quad R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \)
\( \{ R_7 \}, \{ R_8 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_x + c_1 \sigma_0; \)
\( \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_x + c_1 \sigma_0; \)
\( \{ R_8 \}, \{ R_9 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_x + c_1 \sigma_0; \)
\( \{ R_7, R_9 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_x + c_1 \sigma_0; \)
\( \{ R_6 \}, \{ R_7 \}; \quad \sigma_0 (c_0 k_x + c_1) + c_2 (\sigma_1 k_x + \sigma_3 k_y); \)
\( \quad R_7; \quad \sigma_0 (c_0 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \)
\( V: \{ R_6 \}; \quad \sigma_0 (c_0 k_x + c_1) + c_2 (\sigma_1 k_x + \sigma_3 k_y); \)
\( \quad R_7; \quad \sigma_0 (c_0 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \)
\( \{ R_8 \}, \{ R_7 \}; \quad \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_5 \sigma_2) k_y + c_4 \sigma_3 k_z; \)
\( \{ R_8 \}, \{ R_7 \}; \quad \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_5 \sigma_2) k_y + c_4 \sigma_3 k_z; \)

SG 100
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x; \]

\[ U: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x; \]

\[ \Lambda: \{R_6\}, \{R_7\}; \Gamma_{0,0} (c_2 k_z + c_1) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{0,3}) k_y + [\alpha_1 (k_2 \Gamma_{+0} - i k_y \Gamma_{+2}) + h.c.]; \]

\[ V: \{R_6\}, \{R_7\}; \Gamma_{0,0} (c_2 k_z + c_1) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{0,2} + c_5 \Gamma_{3,2}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{0,3}) k_y + [\alpha_1 (k_2 \Gamma_{+0} - i k_x \Gamma_{+1}) + h.c.]; \]

\[ \Sigma: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x); \]

\[ S: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x); \]

\[ W: \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_5\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_5\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]

\[ \{R_6\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]

\[ \{R_7\} , \{R_8\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) k_x; \]
12. SG 101-110

SG 101

Γ: \{C_{2v}^{+}|00\frac{1}{2}\}, \{\sigma_y|00\frac{1}{2}\}; T; Non-Centrosymmetric; with SOC

\[c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0;\]

\[\Gamma_0; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0;\]

\[M; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0;\]

\[T; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0;\]

\[Z; \{R_6, R_7\}; c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2} k_x + \Gamma_{3,3} k_y) + c_3 \Gamma_{3,0} k_x + [\alpha_1 (k_y \Gamma_{+0} - i k_x \Gamma_{+1}) + h.c.];\]

\[A; \{R_6, R_7\}; c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2} k_x + \Gamma_{3,3} k_y) + c_3 \Gamma_{3,0} k_x + [\alpha_1 (k_y \Gamma_{+0} - i k_x \Gamma_{+1}) + h.c.];\]

\[R; \{R_6, R_7\}; c_1 \Gamma_{0,0} + \sum_{i=1}^{3} (\Gamma_{1,2} k_x + c_1 \Gamma_{1,3} k_y + c_3 \Gamma_{4,0} k_x);\]

\[X; \{R_6\}; c_2 \sigma_1 k_x + c_2 \sigma_3 k_y + c_1 \sigma_0;\]

\[U; \{R_2, R_4\}; \sigma_0 (c_3 k_y + c_1) + (c_2 \sigma_1 + c_3 \sigma_2) k_y + c_3 \sigma_3 k_x;\]

\[L; \{R_6\}; c_2 (\sigma_1 k_x + \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1);\]

\[R_7; c_2 \sigma_1 k_x - \sigma_3 k_y + \sigma_0 (c_3 k_x + c_1);\]

\[V; \{R_6\}; c_2 (\sigma_1 k_x + \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1);\]

\[R_7; c_2 \sigma_1 k_x - \sigma_3 k_y + \sigma_0 (c_3 k_x + c_1);\]

\[T; \{R_2, R_4\}; \sigma_0 (c_3 k_x + c_1) + (c_2 \sigma_1 + c_3 \sigma_2) k_y + c_3 \sigma_3 k_x;\]

\[W; \{R_6\}; c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_3 k_x + c_1);\]

Accidental degeneracies on high symmetry line

\[\Delta; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x;\]

\[\Lambda; \{R_6\}, \{R_7\}; \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_3 k_x + (c_4 \Gamma_{0,1} + c_3 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_3 \Gamma_{0,3}) k_y + [\alpha_1 (k_y \Gamma_{+0} - i k_x \Gamma_{+1}) + h.c.];\]

\[V; \{R_6\}, \{R_7\}; \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_3 k_x + (c_4 \Gamma_{0,1} + c_3 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_3 \Gamma_{0,3}) k_y + [\alpha_1 (k_y \Gamma_{+0} - i k_x \Gamma_{+1}) + h.c.];\]

\[\Sigma; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x);\]

\[S; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x);\]

\[Y; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y;\]
\( \Gamma_q: \{ \Gamma^+_{1_{\mathbb{Z}}} \}, \{ \sigma_2 \} \}, \mathcal{T}; \) Non-Centrosymmetric; with SOC

\[ \Gamma; \quad R_6; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ M; \quad \{ R_6, R_7 \}; \quad c_1 \Gamma_0,0 + c_2 (\Gamma_0,2k_z + \Gamma_4,3k_y) + c_3 \Gamma_3,0k_x + [\alpha_1 (k_y \Gamma_{+,0} - ik_x \Gamma_{+,1}) + h.c.] ; \]
\[ Z; \quad \{ R_6, R_7 \}; \quad c_1 \Gamma_0,0 + c_2 (\Gamma_0,2k_z + \Gamma_4,3k_y) + c_3 \Gamma_3,0k_x + [\alpha_1 (k_y \Gamma_{+,0} - ik_x \Gamma_{+,1}) + h.c.] ; \]
\[ A; \quad R_6; \quad c_2 (\sigma_3 k_x - \sigma_1 k_y) + c_1 \sigma_0; \]
\[ R_7; \quad c_2 (\sigma_3 k_x + \sigma_1 k_y) + c_1 \sigma_0; \]
\[ R; \quad \{ R_5, R_6 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_y + c_1 \sigma_0 ; \]
\[ \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_y + c_1 \sigma_0 ; \]
\[ X; \quad \{ R_5, R_6 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0 ; \]
\[ \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0 ; \]
\[ U; \quad \{ R_2, R_4 \}; \quad \sigma_0 (c_3 k_x + c_1) + (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_4 \sigma_3 k_z ; \]
\[ \Lambda; \quad \{ R_6 \}; \quad \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x + \sigma_3 k_y) ; \]
\[ \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y) ; \]
\[ V; \quad \{ R_6 \}; \quad \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x + \sigma_3 k_y) ; \]
\[ \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y) ; \]
\[ \chi; \quad \{ R_5, R_7 \}; \quad \sigma_0 (c_3 k_x + c_1) + (c_3 \sigma_1 - c_5 \sigma_2) k_y + c_4 \sigma_3 k_z ; \]
\[ \Delta; \quad \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_z ; \]
\[ \Lambda; \quad \{ R_6 \}, \{ R_7 \}; \quad \Gamma_0,0 (c_3 k_x + c_1) + \Gamma_3,0 c_3 k_z + (c_4 \Gamma_0,1 + c_5 \Gamma_3,1) k_x + (c_4 \Gamma_3,3 + c_5 \Gamma_0,3) k_y + [\alpha_1 (k_x \Gamma_{+,0} - ik_y \Gamma_{+,2}) + h.c.] ; \]
\[ V; \quad \{ R_6 \}, \{ R_7 \}; \quad \Gamma_0,0 (c_3 k_x + c_1) + \Gamma_3,0 c_3 k_z + (c_4 \Gamma_0,2 + c_5 \Gamma_3,2) k_x + (c_4 \Gamma_3,3 + c_5 \Gamma_0,3) k_y + [\alpha_1 (k_x \Gamma_{+,0} - ik_y \Gamma_{+,1}) + h.c.] ; \]
\[ \Sigma; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_z + k_y) + c_4 \sigma_2 (k_y - k_z) ; \]
\[ S; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_z + k_y) + c_4 \sigma_2 (k_y - k_z) ; \]
\[ T; \quad \{ R_5 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y ; \]
\[ W; \quad \{ R_5 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_x ; \]
\[ \{ R_5 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_x ; \]
\[ \{ R_6 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z ; \]
\[ \{ R_6 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y ; \]
\[ \{ R_7 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_x ; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \quad \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x ; \]
\[ \Lambda; \quad \{ R_6 \}, \{ R_7 \}; \quad \Gamma_0,0 (c_3 k_x + c_1) + \Gamma_3,0 c_3 k_z + (c_4 \Gamma_0,1 + c_5 \Gamma_3,1) k_x + (c_4 \Gamma_3,3 + c_5 \Gamma_0,3) k_y + [\alpha_1 (k_x \Gamma_{+,0} - ik_y \Gamma_{+,2}) + h.c.] ; \]
\[ V; \quad \{ R_6 \}, \{ R_7 \}; \quad \Gamma_0,0 (c_3 k_x + c_1) + \Gamma_3,0 c_3 k_z + (c_4 \Gamma_0,2 + c_5 \Gamma_3,2) k_x + (c_4 \Gamma_3,3 + c_5 \Gamma_0,3) k_y + [\alpha_1 (k_x \Gamma_{+,0} - ik_y \Gamma_{+,1}) + h.c.] ; \]
\[ \Sigma; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_z + k_y) + c_4 \sigma_2 (k_y - k_z) ; \]
\[ S; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_z + k_y) + c_4 \sigma_2 (k_y - k_z) ; \]
\[ T; \quad \{ R_5 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y ; \]
\[ W; \quad \{ R_5 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_x ; \]
\( \Gamma; \) \( R_6; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \)
\( R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \)
\( M; \) \( R_6; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \)
\( R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \)
\( Z; \) \( \{R_6, R_6\}; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^{3} \{c_{i,1} [\Gamma_{1,1} (k_x - k_y) + \Gamma_{1,3} (k_x + k_y)] + c_{i,2} \Gamma_{1,0} k_z\}; \)
\( \{R_7, R_7\}; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^{3} \{c_{i,1} [\Gamma_{1,1} (k_x - k_y) - \Gamma_{1,3} (k_x + k_y)] + c_{i,2} \Gamma_{1,0} k_z\}; \)
\( A; \) \( \{R_6, R_6\}; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^{3} \{c_{i,1} [\Gamma_{1,1} (k_x - k_y) + \Gamma_{1,3} (k_x + k_y)] + c_{i,2} \Gamma_{1,0} k_z\}; \)
\( \{R_7, R_7\}; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^{3} \{c_{i,1} [\Gamma_{1,1} (k_x - k_y) - \Gamma_{1,3} (k_x + k_y)] + c_{i,2} \Gamma_{1,0} k_z\}; \)
\( R; \) \( \{R_6, R_6\}; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^{3} \{c_{i,1} \Gamma_{1,2} k_x + c_{i,2} \Gamma_{1,3} k_y + c_{i,3} \Gamma_{1,0} k_z\}; \)
\( X; \) \( R_5; \quad c_2 \sigma_1 k_x + c_3 \sigma_5 k_y + c_1 \sigma_0; \)
\( U; \) \( \{R_2, R_4\}; \quad \sigma_0 (c_3 k_y + c_1) + (c_2 \sigma_1 - c_5 \sigma_2) k_x + c_4 \sigma_3 k_z; \)
\( \Lambda; \) \( R_6; \quad \sigma_0 (c_3 k_y + c_1) + c_2 (\sigma_1 k_x + \sigma_3 k_y); \)
\( R_7; \quad \sigma_0 (c_3 k_y + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \)
\( V; \) \( R_6; \quad \sigma_0 (c_3 k_y + c_1) + c_2 (\sigma_1 k_x + \sigma_3 k_y); \)
\( R_7; \quad \sigma_0 (c_3 k_y + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \)
\( S; \) \( \{R_6, R_4\}; \quad [c_1 + c_2 (k_x + k_y)] \sigma_0 + (c_3 \sigma_1 - c_5 \sigma_2) (k_x - k_y) + c_4 \sigma_3 k_z; \)
\( T; \) \( \{R_6, R_4\}; \quad \sigma_0 (c_3 k_y + c_1) + (c_3 \sigma_1 - c_5 \sigma_2) k_y + c_4 \sigma_3 k_z; \)
\( W; \) \( R_5; \quad \sigma_0 (c_2 k_x + c_1) + c_3 \sigma_1 k_x + c_4 \sigma_5 k_y; \)

Accidental degeneracies on high symmetry line

\( \Delta; \) \( \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_5 k_y + c_4 \sigma_1 k_x; \)
\( \Lambda; \) \( \{R_6\}, \{R_4\}; \quad \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_5 k_x + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{0,3}) k_y + [\alpha_1 (k_x \Gamma_{0,0} - i k_y \Gamma_{3,0}) + h.c.] ; \)
\( V; \) \( \{R_6\}, \{R_4\}; \quad \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_5 k_x + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{0,3}) k_y + [\alpha_1 (k_x \Gamma_{0,0} - i k_y \Gamma_{3,0}) + h.c.] ; \)
\( \Sigma; \) \( \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x); \)
\( Y; \) \( \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \)

\( \Gamma; \) \{\( C_4^+ [000], [\sigma_y [00 \frac{1}{2}])\}; \) Non-Centrosymmetric; with SOC
\[ \Gamma : \{ R_5 \}, \{ R_6 \} : c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_6; \]
\[ R_7 : c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_6; \]
\[ M : \{ R_6, R_7 \} : c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2} k_x + \Gamma_{3,3} k_y) + c_3 \Gamma_{3,0} k_z + \{ \sigma_1 (k_y \Gamma_{+,0} - i k_z \Gamma_{+,1}) + h.c. \}; \]
\[ Z : \{ R_6, R_7 \} : c_1 \Gamma_{0,0} + \sum_{i=1}^{3} \{ \sigma_{i,1} [\Gamma_{1,1} (k_x - k_y) + \Gamma_{1,3} (k_x + k_y)] + c_{i,2} \Gamma_{1,0} k_z \}; \]
\[ A : \{ R_6, R_7 \} : c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2} k_x + \Gamma_{3,3} k_y) + c_3 \Gamma_{3,0} k_z + \{ \sigma_1 (k_x + k_y) \Gamma_{+,0} - i (k_x - k_y) \Gamma_{+,1} + h.c. \}; \]
\[ R : \{ R_5, R_6 \} : (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_z + c_1 \sigma_6; \]
\[ \{ R_7, R_8 \} : (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_3 \sigma_3 k_z + c_1 \sigma_6; \]
\[ X : \{ R_5, R_6 \} : (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_6; \]
\[ \{ R_7, R_8 \} : (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_6; \]
\[ U : \{ R_2, R_4 \} : \sigma_0 (c_2 k_x + c_1) + (c_2 \sigma_1 - c_4 \sigma_2) k_x + c_4 \sigma_3 k_z; \]
\[ \Delta : \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x; \]
\[ \Lambda : \{ R_6 \}, \{ R_7 \} : \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{3,0}) k_y + \{ \sigma_1 (k_x \Gamma_{+,0} - i k_y \Gamma_{+,2}) + h.c. \}; \]
\[ V : \{ R_6 \}, \{ R_7 \} : \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{0,2} + c_5 \Gamma_{3,2}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{3,0}) k_y + \{ \sigma_1 (k_y \Gamma_{+,0} - i k_x \Gamma_{+,1}) + h.c. \}; \]
\[ S : \{ R_2 \}, \{ R_4 \} : [c_1 + c_2 (k_x + k_y)] \sigma_0 + (c_3 \sigma_1 - c_5 \sigma_2) (k_x - k_y) + c_4 \sigma_3 k_z; \]
\[ Y : \{ R_5, R_6 \} : \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_5 \sigma_2) k_y + c_4 \sigma_3 k_z; \]

Accidental degeneracies on high symmetry line

\[ \Delta : \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x; \]
\[ \Lambda : \{ R_6 \}, \{ R_7 \} : \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{3,0}) k_y + \{ \sigma_1 (k_x \Gamma_{+,0} - i k_y \Gamma_{+,2}) + h.c. \}; \]
\[ V : \{ R_6 \}, \{ R_7 \} : \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{0,2} + c_5 \Gamma_{3,2}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{3,0}) k_y + \{ \sigma_1 (k_y \Gamma_{+,0} - i k_x \Gamma_{+,1}) + h.c. \}; \]
\[ S : \{ R_2 \}, \{ R_4 \} : [c_1 + c_2 (k_x + k_y)] \sigma_0 + (c_3 \sigma_1 - c_5 \sigma_2) (k_x - k_y) + c_4 \sigma_3 k_z; \]
\[ Y : \{ R_5, R_6 \} : \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_5 \sigma_2) k_y + c_4 \sigma_3 k_z; \]
\( \Gamma_q \); \( \{C_4^+[001], \{\sigma_y[000]\}\}; T \); Non-Centrosymmetric; with SOC

\[ \Gamma; \quad R_0; \quad c_2(\sigma_1k_x + \sigma_3k_y) + c_1\sigma_0; \]

\[ \Gamma; \quad R_1; \quad c_2(\sigma_1k_x - \sigma_3k_y) + c_1\sigma_0; \]

\[ M; \quad R_0; \quad c_2(\sigma_1k_x + \sigma_3k_y) + c_1\sigma_0; \]

\[ M; \quad R_1; \quad c_2(\sigma_1k_x - \sigma_3k_y) + c_1\sigma_0; \]

\[ Z; \quad \{R_0, R_1\}; \quad c_1[\Gamma_0.0 + c_2[\Gamma_0.2(k_x - k_y) + \Gamma_{3,3}(k_x + k_y)] + c_3\Gamma_{3,0}k_z + \{\alpha_1[(k_x + k_y)\Gamma_{+,0} - i(k_x - k_y)\Gamma_{+,1}] + h.c.\}]; \]

\[ A; \quad \{R_0, R_1\}; \quad c_1[\Gamma_0.0 + c_2[\Gamma_0.2(k_x - k_y) + \Gamma_{3,3}(k_x + k_y)] + c_3\Gamma_{3,0}k_z + \{\alpha_1[(k_x + k_y)\Gamma_{+,0} - i(k_x - k_y)\Gamma_{+,1}] + h.c.\}]; \]

\[ R; \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0; \]

\[ X; \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0; \]

\[ \Lambda; \quad R_0; \quad c_2(\sigma_1k_x + \sigma_3k_y) + \sigma_0(c_3k_z + c_1); \]

\[ \Lambda; \quad R_1; \quad c_2(\sigma_1k_x - \sigma_3k_y) + \sigma_0(c_3k_z + c_1); \]

\[ V; \quad R_5; \quad c_2(\sigma_1k_x + \sigma_3k_y) + \sigma_0(c_3k_z + c_1); \]

\[ V; \quad R_5; \quad c_2(\sigma_1k_x - \sigma_3k_y) + \sigma_0(c_3k_z + c_1); \]

\[ S; \quad \{R_2, R_4\}; \quad c_1 + c_2(k_x + k_y)\sigma_0 + (c_3\sigma_1 - c_3\sigma_2)(k_x - k_y) + c_4\sigma_3k_z; \]

\[ W; \quad R_5; \quad c_2\sigma_1k_x + c_3\sigma_3k_y + \sigma_0(c_4k_z + c_1); \]

Accidental degeneracies on high symmetry line

\[ \Delta; \quad \{R_2\}, \{R_4\}; \quad \sigma_0(c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_4k_z; \]

\[ U; \quad \{R_2\}, \{R_4\}; \quad \sigma_0(c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_4k_z; \]

\[ \Lambda; \quad \{R_0\}, \{R_2\}; \quad \Gamma_{0,0}(c_2k_z + c_1) + \Gamma_{3,0}c_3k_z + (c_4\Gamma_{0,1} + c_5\Gamma_{3,1})k_z + (c_4\Gamma_{3,3} + c_5\Gamma_{0,3})k_y + [\alpha_1(k_2\Gamma_{+,0} - ik_y\Gamma_{+,2}) + h.c.]; \]

\[ V; \quad \{R_0\}, \{R_2\}; \quad \Gamma_{0,0}(c_2k_z + c_1) + \Gamma_{3,0}c_3k_z + (c_4\Gamma_{0,1} + c_5\Gamma_{3,1})k_z + (c_4\Gamma_{3,3} + c_5\Gamma_{0,3})k_y + [\alpha_1(k_2\Gamma_{+,0} - ik_y\Gamma_{+,2}) + h.c.]; \]

\[ \Sigma; \quad \{R_2\}, \{R_4\}; \quad \sigma_0(c_1 + c_2k_z + c_2k_y) + \sigma_3c_3k_z + c_4\sigma_2k_y; \]

\[ \Upsilon; \quad \{R_2\}, \{R_4\}; \quad \sigma_0(c_1 + c_2k_z + c_3c_3k_z + c_4\sigma_2k_y); \]

\[ T; \quad \{R_2\}, \{R_4\}; \quad \sigma_0(c_1 + c_3k_z) + \sigma_3c_3k_z + c_4\sigma_2k_y; \]
\[ \Gamma; \quad \{ R_6 \}, \{ R_7 \}; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ M; \quad \{ R_6, R_7 \}; c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2} k_x + \Gamma_{3,3} k_y) + c_3 \Gamma_{3,0} k_z + [\alpha_1 (k_y \Gamma_{+,0} - i k_x \Gamma_{+,1}) + h.c.]; \]
\[ Z; \quad \{ R_6, R_7 \}; c_1 \Gamma_{0,0} + c_2 [\Gamma_{0,2} (k_x - k_y) + \Gamma_{3,3} (k_x + k_y)] + c_3 \Gamma_{3,0} k_z + [\alpha_1 [(k_x + k_y) \Gamma_{+,0} - i (k_x - k_y) \Gamma_{+,1}] + h.c.]; \]
\[ A; \quad \{ R_6, R_7 \}; c_1 \Gamma_{0,0} + \sum_{i=1}^{3} \{ c_1 [\Gamma_{i,1} (k_x - k_y) + \Gamma_{i,3} (k_x + k_y)] + c_2 \Gamma_{i,0} k_z \}; \]
\[ R_7, R_7; c_1 \Gamma_{0,0} + \sum_{i=1}^{3} \{ c_1 [\Gamma_{i,1} (k_x - k_y) - \Gamma_{i,3} (k_x + k_y)] + c_2 \Gamma_{i,0} k_z \}; \]
\[ R_7, R_8; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ \{ R_7, R_8 \}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ X; \quad \{ R_5, R_6 \}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ \{ R_7, R_8 \}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ \{ R_7, R_8 \}; (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]
\[ \{ R_6, R_6 \}; \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \]
\[ \{ R_7, R_7 \}; \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \]
\[ \{ R_6, R_6 \}; \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \]
\[ V; \quad \{ R_6, R_6 \}; \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \]
\[ \{ R_7, R_7 \}; \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \]
\[ \{ R_6, R_6 \}; \sigma_0 (c_3 k_x + c_1) + c_2 (\sigma_1 k_x - \sigma_3 k_y); \]
\[ S; \quad \{ R_2, R_4 \}; \sigma_0 (c_3 + c_2 (k_x - k_y)) + (c_3 \sigma_1 - c_5 \sigma_2) (k_x - k_y) + c_4 \sigma_3 k_x; \]
\[ Y; \quad \{ R_5, R_5 \}; \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_5 \sigma_2) k_y + c_4 \sigma_3 k_z; \]
\[ T; \quad \{ R_5, R_7 \}; \sigma_0 (c_2 k_x + c_1) + (c_3 \sigma_1 - c_5 \sigma_2) k_y + c_4 \sigma_3 k_z; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \quad \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_2 k_y + c_4 \sigma_1 k_x; \]
\[ U; \quad \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_2 k_y + c_4 \sigma_1 k_x; \]
\[ \Lambda; \quad \{ R_6 \}, \{ R_7 \}; \Gamma_{0,0} (c_3 k_x + c_1) + \Gamma_{3,0} c_2 k_z + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{0,3}) k_y + [\alpha_1 (k_y \Gamma_{+,0} - i k_x \Gamma_{+,1}) + h.c.]; \]
\[ V; \quad \{ R_6 \}, \{ R_7 \}; \Gamma_{0,0} (c_3 k_x + c_1) + \Gamma_{3,0} c_2 k_z + (c_4 \Gamma_{0,2} + c_5 \Gamma_{3,2}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{0,3}) k_y + [\alpha_1 (k_y \Gamma_{+,0} - i k_x \Gamma_{+,1}) + h.c.]; \]
\[ \Sigma; \quad \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x); \]
\[ W; \quad \{ R_5 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_x; \]
\[ \{ R_5 \}, \{ R_7 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z; \]
\[ \{ R_6 \}, \{ R_7 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z; \]
\[ \{ R_6 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{ R_7 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) k_x; \]
\[\Gamma^0; \{C_4^+\{000\}, \{\sigma_y\{000\}, T; Non-Centrosymmetric; with \text{SOC}\}
\]

\[\Gamma; \begin{align*}
R_6; & \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \\
R_7; & \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0;
\end{align*}
\]

\[N; \begin{align*}
\{R_2, R_4\} & \quad \sigma_3 (c_2 k_x + c_4 k_z) + (c_3 \sigma_1 - c_4 \sigma_2) k_y + c_1 \sigma_0; \\
R_5 & \quad c_2 \sigma_1 (k_x + k_y) + c_3 \sigma_3 (k_x - k_y) + c_1 \sigma_0;
\end{align*}
\]

\[Z; \begin{align*}
R_6; & \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_3 \sigma_0; \\
R_7; & \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_3 \sigma_0;
\end{align*}
\]

\[P; \begin{align*}
R_5 & \quad c_2 [\sigma_1 (k_x + k_y) + \sigma_3 (k_x - k_y)] + c_1 \sigma_0;
\end{align*}
\]

\[\Lambda; \begin{align*}
R_6 & \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1); \\
R_7 & \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1);
\end{align*}
\]

\[V; \begin{align*}
R_6 & \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1); \\
R_7 & \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1);
\end{align*}
\]

\[W; \begin{align*}
R_5 & \quad c_3 \sigma_1 (k_x + k_y) + c_2 \sigma_3 (k_x - k_y) + \sigma_0 (c_4 k_z + c_1);
\end{align*}
\]

\[\text{Accidental degeneracies on high symmetry line}
\]

\[\Lambda; \begin{align*}
\{R_6\} \cup \{R_5\} & \quad \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_2 k_x + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{0,3}) k_y + [\alpha_1 (k_x \Gamma_{r,+0} - ik_y \Gamma_{r,+2}) + \text{h.c.}]; \\
\{R_6\} \cup \{R_5\} & \quad \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_2 k_x + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_5 \Gamma_{0,3}) k_y + [\alpha_1 (k_x \Gamma_{r,+0} - ik_y \Gamma_{r,+2}) + \text{h.c.}];
\end{align*}
\]

\[\Sigma; \begin{align*}
\{R_2\} \cup \{R_3\} & \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \\
\{R_2\} \cup \{R_3\} & \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y;
\end{align*}
\]

\[\Delta; \begin{align*}
\{R_2\} \cup \{R_4\} & \quad \sigma_0 (c_1 + c_4 k_z + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x); \\
\{R_2\} \cup \{R_4\} & \quad \sigma_0 (c_1 + c_4 k_z + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x);
\end{align*}
\]

\[\text{SG 108}
\]

\[\Gamma^0; \{C_4^+\{000\}, \{\sigma_y\{1/2\}0\}, T; Non-Centrosymmetric; with \text{SOC}\}
\]

\[\Gamma; \begin{align*}
R_6; & \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \\
R_7; & \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0;
\end{align*}
\]

\[N; \begin{align*}
\{R_5, R_3\} & \quad c_1 \sigma_0 + \sum_{i=1}^{3} (c_i, 1 k_x + c_i, 2 k_z); \\
\{R_7, R_5\} & \quad c_1 \sigma_0 + \sum_{i=1}^{3} (c_i, 1 k_x + c_i, 2 k_z);
\end{align*}
\]

\[X; \begin{align*}
R_5 & \quad c_2 \sigma_1 (k_x + k_y) + c_3 \sigma_3 (k_x - k_y) + c_1 \sigma_0; \\
R_7 & \quad c_2 \sigma_1 (k_x + k_y) + c_3 \sigma_3 (k_x - k_y) + c_1 \sigma_0;
\end{align*}
\]

\[Z; \begin{align*}
R_6; & \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_3 \sigma_0; \\
R_7; & \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_3 \sigma_0;
\end{align*}
\]

\[P; \begin{align*}
\{R_5, R_3\} & \quad c_1 \Gamma_{0,0} + (c_2 \Gamma_{0,3} + c_3 \Gamma_{3,3}) (k_x - k_y) - (c_2 \Gamma_{0,1} - c_3 \Gamma_{3,1}) (k_x + k_y) \\
& \quad + c_4 \Gamma_{3,3} k_x + [\alpha_1 \Gamma_{3,1} (k_x + k_y) + \alpha_2 \Gamma_{3,3} (k_x - k_y) + \alpha_2 \Gamma_{3,3} (k_x + k_y) + \alpha_2 \Gamma_{3,3} (k_x - k_y) + \text{h.c.}];
\end{align*}
\]

\[\Lambda; \begin{align*}
R_6; & \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1); \\
R_7; & \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1);
\end{align*}
\]

\[V; \begin{align*}
R_6; & \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1); \\
R_7; & \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1);
\end{align*}
\]

\[W; \begin{align*}
R_5 & \quad c_2 \sigma_1 (k_x + k_y) + c_3 \sigma_3 (k_x - k_y) + \sigma_0 (c_4 k_z + c_1); \\
R_7 & \quad c_2 \sigma_1 (k_x + k_y) + c_3 \sigma_3 (k_x - k_y) + \sigma_0 (c_4 k_z + c_1);
\end{align*}
\]

\[Q; \begin{align*}
\{R_2, R_3\} & \quad \sigma_0 (c_2 k_y + c_1) + \sum_{i=1}^{3} (c_i, 1 k_x + c_i, 2 k_z);
\end{align*}
\]
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_6\}, \{R_7\} : \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_5 k_x + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_3 \Gamma_{0,3}) k_y + [\alpha_1 (k_x \Gamma_{+0} - i k_y \Gamma_{+2}) + h.c.]; \]

\[ V; \{R_6\}, \{R_7\} : \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_5 k_x + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_3 \Gamma_{0,3}) k_y + [\alpha_1 (k_x \Gamma_{+0} - i k_y \Gamma_{+2}) + h.c.]; \]

\[ \Sigma; \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \]

\[ F; \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \]

\[ \Delta; \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x); \]

\[ U; \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x); \]

\[ Y; \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_x - c_2 k_y) + \sigma_3 c_3 (k_x - k_y) + c_4 \sigma_1 (k_x + k_y); \]

\[ \Gamma; \{R_6\}, \{R_7\} : c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]

\[ R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]

\[ N; \{R_2, R_4\} ; \sigma_3 (c_2 k_x + c_4 k_z) + (c_3 \sigma_1 - c_5 \sigma_2) k_x + c_1 \sigma_0; \]

\[ X; \{R_3, R_5\} ; (c_2 \sigma_1 - c_4 \sigma_2) (k_x + k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \]

\[ \{R_2, R_4\} ; (c_2 \sigma_1 - c_4 \sigma_2) (k_x + k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \]

\[ Z; \{R_6, R_7\} ; c_1 \Gamma_{0,0} + c_2 [\Gamma_{0,2} (k_x - k_y) + \Gamma_{3,3} (k_x + k_y)] + c_3 \Gamma_{3,0} k_x + \{\alpha_1 [(k_x + k_y) \Gamma_{+,0} - i (k_x - k_y) \Gamma_{+,1}] + h.c. \}; \]

\[ P; \{R_{17}, R_{18}\} ; c_2 \sigma_3 k_x + c_1 \sigma_0; \]

\[ \Lambda; \{R_6\}, \{R_7\} ; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0 (c_3 k_x + c_1); \]

\[ R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0 (c_3 k_x + c_1); \]

\[ V; \{R_6\}, \{R_7\} ; c_2 [(\sigma_2 + \sigma_3) k_x + (\sigma_3 - \sigma_2) k_y] + c_1 \sigma_0 (c_3 k_x + c_1); \]

\[ R_7; \quad c_2 [(\sigma_3 - \sigma_2) k_x + (\sigma_2 + \sigma_3) k_y] + c_1 \sigma_0 (c_3 k_x + c_1); \]

\[ U; \{R_2, R_4\} ; [c_1 + c_2 (k_x + k_y)] \sigma_0 + (c_3 \sigma_1 - c_5 \sigma_2) (k_x - k_y) + c_4 \sigma_3 k_z; \]

\[ Y; \{R_3, R_5\} ; [c_1 + c_2 (k_x - k_y)] \sigma_0 + (c_3 \sigma_1 - c_5 \sigma_2) (k_x + k_y) + c_4 \sigma_3 k_z; \]

\[ \Gamma; \{C_{4z}^+ \} \{\sigma_0[000]\}, T; \text{Non-Centrosymmetric, with SOC} \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_6\}, \{R_7\} ; \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_5 k_x + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_3 \Gamma_{0,3}) k_y + [\alpha_1 (k_x \Gamma_{+0} - i k_y \Gamma_{+2}) + h.c.]; \]

\[ V; \{R_6\}, \{R_7\} ; \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} c_5 k_x + (c_4 \Gamma_{0,1} + c_5 \Gamma_{3,1}) k_x + (c_4 \Gamma_{3,3} + c_3 \Gamma_{0,3}) k_y + [\alpha_1 (k_x \Gamma_{+0} - i k_y \Gamma_{+2}) + h.c.]; \]

\[ W; \{R_5\}, \{R_6\} ; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) (k_x - k_y); \]

\[ \{R_5\}, \{R_7\} ; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) (k_x + k_y); \]

\[ \{R_6\}, \{R_7\} ; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]

\[ \{R_6\}, \{R_7\} ; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) (k_x - k_y); \]

\[ \{R_6\}, \{R_7\} ; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) (k_x + k_y); \]

\[ \{R_6\}, \{R_7\} ; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) (k_x - k_y); \]

\[ \{R_6\}, \{R_7\} ; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_5 \sigma_2) (k_x + k_y); \]

\[ \Sigma; \{R_2\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \]

\[ F; \{R_2\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \]

\[ \Delta; \{R_2\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x); \]
\[ \Gamma_\nu: \{ C_{44}^{\pm}, C_{44}^{\pm}, C_{44}^{\pm} \}, \{ \sigma_y, \Gamma_{\nu} \}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; ~ R_6: \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ N; \quad \{ R_5, R_3 \}: \quad c_1 \sigma_0 + \sum_{i=1}^3 (c_{1,1} k_x + c_{1,2} k_y); \quad \{ R_7, R_2 \}: \quad c_1 \sigma_0 + \sum_{i=1}^3 (c_{1,1} k_x + c_{1,2} k_y); \]
\[ X; \quad \{ R_5, R_3 \}: \quad (c_2 \sigma_1 - c_4 \sigma_2) (k_x + k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \quad \{ R_7, R_8 \}: \quad (c_2 \sigma_1 - c_4 \sigma_2) (k_x + k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \]
\[ Z; \quad \{ R_6, R_7 \}: \quad c_1 \Gamma_{0,0} + c_2 [\Gamma_{0,2} (k_x - k_y) + \Gamma_{3,3} (k_x + k_y)] + c_3 \Gamma_{3,0} k_z + \{ \alpha_1 [(k_x + k_y) \Gamma_{+0} - i (k_x - k_y) \Gamma_{+1}] + h.c. \}; \]
\[ P; \quad \{ R_{13, R_{14}} \}: \quad c_2 \sigma_3 k_z + c_1 \sigma_0; \quad \{ R_{17}, R_{15} \}: \quad (c_3 \sigma_1 - c_2 \sigma_2 + c_3 \sigma_3) k_x + c_1 \sigma_0; \quad \{ R_{18, R_{18}} \}: \quad (c_3 \sigma_1 - c_2 \sigma_2 + c_3 \sigma_3) k_x + c_1 \sigma_0; \]
\[ \Lambda; \quad R_6; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1); \quad R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1); \]
\[ V; \quad R_6; \quad c_2 [(\sigma_2 + \sigma_3) k_x + (\sigma_3 - \sigma_2) k_y] + \sigma_0 (c_3 k_x + c_1); \quad R_7; \quad c_2 [(\sigma_2 - \sigma_3) k_x + (\sigma_2 + \sigma_3) k_y] + \sigma_0 (c_3 k_x + c_1); \]
\[ Q; \quad \{ R_2, R_3 \}: \quad (c_1 + c_2 k_y) \sigma_0 + \sum_{i=1}^3 (c_{1,1} k_x + c_{1,2} k_y); \quad U; \quad \{ R_2, R_3 \}: \quad [c_1 + c_2 (k_x + k_y)] \sigma_0 + (c_3 \sigma_1 - c_2 \sigma_2) (k_x - k_y) + c_4 \sigma_3 k_z; \quad Y; \quad \{ R_5, R_7 \}: \quad [c_1 + c_2 (k_x - k_y)] \sigma_0 + (c_3 \sigma_1 - c_2 \sigma_2) (k_x + k_y) + c_4 \sigma_3 k_z; \]

**Accidental degeneracies on high symmetry line**

\[ \Lambda; \quad \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} (c_2 k_x + c_3 \Gamma_{3,1}) k_x + (c_3 \Gamma_{3,3} + c_3 \Gamma_{0,3}) k_y + [\alpha_1 (k_x \Gamma_{+0} - i k_y \Gamma_{+2}) + h.c.] + \frac{\alpha_1 k_x \Gamma_{+0} - i k_y \Gamma_{+2}}{h.c.}; \]
\[ V; \quad \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_2 k_x + c_1) + \Gamma_{3,0} (c_2 k_x + c_3 \Gamma_{3,1}) k_x + (c_3 \Gamma_{3,3} + c_3 \Gamma_{0,3}) k_y + [\alpha_1 (k_x \Gamma_{+0} - i k_y \Gamma_{+2}) + h.c.] + \frac{\alpha_1 k_x \Gamma_{+0} - i k_y \Gamma_{+2}}{h.c.}; \]
\[ W; \quad \{ R_5 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_2 \sigma_2) (k_x - k_y); \quad \{ R_5 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_2 \sigma_2) (k_x + k_y); \quad \{ R_5 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + (c_4 \sigma_1 + c_2 \sigma_2) (k_x + k_y); \quad \{ R_6 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]
\[ \Sigma; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \quad F; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \quad \Delta; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \]
\[ \Upsilon; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \]
\[ \Sigma; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x); \]
\[ \upsilon; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_x); \]
\[ \Upsilon; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y + c_5 \sigma_1 k_z; \]
\[ \Upsilon; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y + c_5 \sigma_1 k_z; \]
\[ T; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \]
\[ W; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z + c_5 \sigma_2 k_y; \]

SG 112

\[ \Gamma; \{ S_{1u}^+ [000], \{ C_{2u} [00\frac{1}{2}] \}; \] Non-Centrosymmetric; with SOC

\[ \Gamma; R_6; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ R_7; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ M; R_6; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ R_7; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ Z; \{ R_6, R_7 \}; c_1 \Gamma_{0,0} + c_2 [\Gamma_{0,2} (k_x - k_y) + \Gamma_{3,3} (k_x + k_y)] + [\alpha_1 \Gamma_{+,0} (k_x + k_y) - i \alpha_1 \Gamma_{+,1} (k_x - k_y) + \alpha_2 k_x \Gamma_{+,3} + h.c.]; \]
\[ A; \{ R_6, R_7 \}; c_1 \Gamma_{0,0} + c_2 [\Gamma_{0,2} (k_x - k_y) + \Gamma_{3,3} (k_x + k_y)] + [\alpha_1 \Gamma_{+,0} (k_x + k_y) - i \alpha_1 \Gamma_{+,1} (k_x - k_y) + \alpha_2 k_x \Gamma_{+,3} + h.c.]; \]
\[ R; R_5; c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \]
\[ X; R_5; c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \]
\[ N; R_5; c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + \sigma_0 (c_3 k_x + c_1); \]
\[ V; R_5; c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + \sigma_0 (c_3 k_x + c_1); \]
\[ S; \{ R_2, R_4 \}; [c_1 + c_2 (k_x + k_y)] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) (k_x - k_y) + c_5 \sigma_3 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_y) + c_3 c_4 k_y + c_4 (c_1 k_x + c_2 k_z); \]

\[ U: \{ R_2 \}, \{ R_1 \}; c_0 (c_1 + c_2 k_y) + c_3 c_4 k_y + c_4 (c_1 k_x + c_2 k_z); \]

\[ \Sigma: \{ R_2 \}, \{ R_1 \}; c_0 (c_1 + c_2 k_x + c_2 k_y) + c_3 c_3 (k_x + k_y) + c_4 (c_1 k_x + c_2 k_z); \]

\[ Y: \{ R_2 \}, \{ R_1 \}; c_0 (c_1 + c_2 k_x) + c_3 c_3 k_x + c_4 (c_1 k_x + c_2 k_z); \]

\[ T: \{ R_2 \}, \{ R_1 \}; c_0 (c_1 + c_2 k_x) + c_3 c_3 k_x + c_4 (c_1 k_x + c_2 k_z); \]

\[ W: \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_x) + c_3 c_3 k_x + c_4 (c_1 k_x + c_2 k_z); \]

SG 113

\[ \Gamma_4; \{ S'^1_{1} \}, \{ C_{2z} \}, \frac{1}{2} \Gamma_{0} \}, \mathcal{T}; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma: \quad R_6; \quad c_2 (c_1 k_x + c_3 k_y) + c_4 (c_1 k_x + c_2 k_z); \]

\[ R_7; \quad c_2 (c_1 k_x + c_3 k_y) + c_4 (c_1 k_x + c_2 k_z); \]

\[ M; \quad \{ R_2, R_4 \}; c_1 \Gamma_{0,0} - c_4 (\Gamma_{2,0} k_z + \Gamma_{1,1} k_y) + c_3 (\Gamma_{1,0} k_x - \Gamma_{2,1} k_y) + c_2 (\Gamma_{3,3} k_x - \Gamma_{0,2} k_y); \]

\[ Z; \quad R_6; \quad c_2 (c_1 k_x + c_3 k_y) + c_4 (c_1 k_x + c_2 k_z); \]

\[ R_7; \quad c_2 (c_1 k_x + c_3 k_y) + c_4 (c_1 k_x + c_2 k_z); \]

\[ A; \quad \{ R_2, R_4 \}; c_1 \Gamma_{0,0} - c_4 (\Gamma_{2,0} k_z + \Gamma_{1,1} k_y) + c_3 (\Gamma_{1,0} k_x - \Gamma_{2,1} k_y) + c_2 (\Gamma_{3,3} k_x - \Gamma_{0,2} k_y); \]

\[ R_6; \quad (c_2 c_1 - c_3 c_2) k_y + c_4 c_1; \]

\[ R_7; \quad (c_2 c_1 - c_3 c_2) k_y + c_4 c_1; \]

\[ X; \quad \{ R_2, R_4 \}; (c_2 c_1 - c_3 c_2) k_y + c_4 c_1; \]

\[ \{ R_2, R_6 \}; (c_2 c_1 - c_3 c_2) k_y + c_4 c_1; \]

\[ \{ R_2, R_4 \}; (c_2 c_1 - c_3 c_2) k_y + c_4 c_1; \]

\[ A; \quad R_6; \quad c_2 ([\sigma_3 - \sigma_1] k_x - (\sigma_1 + \sigma_3) k_y) + c_4 (c_3 k_x + c_1); \]

\[ V; \quad \{ R_2, R_4 \}; \Gamma_{0,0} (c_2 k_x + c_1) + c_3 [\Gamma_{1,1} (k_x + k_y) + \Gamma_{0,3} (k_x - k_y)] + \sum_{i=1}^{3} \{ c_1 \Gamma_{1,1} (k_x + k_y) - c_2 c_3 \Gamma_{1,3} (k_x - k_y); \]

\[ Y; \quad \{ R_2, R_4 \}; c_0 (c_2 k_x + c_1) + (c_3 c_1 - c_4 c_2) k_y; \]

\[ T; \quad \{ R_2, R_4 \}; c_0 (c_2 k_x + c_1) + (c_3 c_1 - c_4 c_2) k_y; \]

\[ W; \quad \{ R_2, R_4 \}; c_0 (c_2 k_x + c_1) + (c_3 c_1 - c_4 c_2) k_y; \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_y) + c_3 c_4 k_y + c_4 (c_1 k_x + c_2 k_z); \]

\[ U: \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_y) + c_3 c_4 k_y + c_4 (c_1 k_x + c_2 k_z); \]

\[ \Sigma: \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_x + c_2 k_y) + c_3 c_3 (k_x + k_y) + c_4 (c_1 k_x + c_2 k_z); \]

\[ S: \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_x + c_2 k_y) + c_3 c_3 (k_x + k_y) + c_4 (c_1 k_x + c_2 k_z); \]
\[ \Gamma_q \{ \tilde{S}^+_1[000], \tilde{C}_{2v}[\tilde{1} \tilde{1} \tilde{1} \tilde{1}] \}, T; \) Non-Centrosymmetric; with SOC \\

\[ \Gamma; \]

\[ R_6; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]

\[ R_7; \quad c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]

\[ M; \quad \{ R_6, R_7 \}; \quad c_1 \Gamma_{0,0} - c_4 (\Gamma_{2,0} k_x + \Gamma_{1,1} k_y) + c_3 (\Gamma_{1,0} k_x - \Gamma_{2,1} k_y) + c_2 (\Gamma_{3,3} k_x - \Gamma_{0,2} k_y); \]

\[ Z; \quad \{ R_6, R_7 \}; \quad c_1 \Gamma_{0,0} + c_2 [\Gamma_{0,2} (k_x - k_y) + \Gamma_{3,3} (k_x + k_y)] + [\alpha_1 \Gamma_{1,0} (k_x + k_y) - \alpha_2 \Gamma_{1,2} (k_x - k_y) + \alpha_3 \Gamma_{3,3} + h.c.]; \]

\[ A; \quad \{ R_6, R_7 \}; \quad c_1 \Gamma_{0,0} + \sum_{\ell=1}^{3} c_{1,\ell} [\Gamma_{1,1} (k_x - k_y) + \Gamma_{i,3} (k_x + k_y)]; \]

\[ R; \quad \{ R_5, R_6 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0; \]

\[ \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0; \]

\[ X; \quad \{ R_6, R_8 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0; \]

\[ \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_y + c_1 \sigma_0; \]

\[ \Delta; \quad \{ R_5 \}; \quad (c_1 + c_2 k_x) + c_3 \Gamma_{0,1} (k_x + k_y) + \sum_{\ell=1}^{3} c_{1,\ell} [\Gamma_{1,1} (k_x + k_y) - \Gamma_{2,1} (k_x - k_y)]; \]

\[ \Sigma; \quad \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_{3,2} (k_x - k_y) + c_4 \sigma_2 k_z; \]

\[ U; \quad \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_{3,2} (k_x - k_y) + c_4 \sigma_2 k_z; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \quad \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_{3,2} k_y + c_4 \sigma_2 k_x; \]

\[ \Sigma; \quad \{ R_2 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_{3,2} k_y + c_4 \sigma_2 k_x; \]

SG 115

\[ \Gamma_q \{ \tilde{S}^+_1[000], \tilde{C}_{2v}[000], T; \) Non-Centrosymmetric; with SOC \\

\[ \Gamma; \]

\[ R_6; \quad c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + c_1 \sigma_0; \]

\[ R_7; \quad c_2 [(\sigma_1 + \sigma_3) k_x + (\sigma_1 - \sigma_3) k_y] + c_1 \sigma_0; \]

\[ M; \quad \{ R_6 \}; \quad c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + c_1 \sigma_0; \]

\[ R_7; \quad c_2 [(\sigma_1 + \sigma_3) k_x + (\sigma_1 - \sigma_3) k_y] + c_1 \sigma_0; \]

\[ Z; \quad \{ R_6 \}; \quad c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + c_1 \sigma_0; \]

\[ R_7; \quad c_2 [(\sigma_1 + \sigma_3) k_x + (\sigma_1 - \sigma_3) k_y] + c_1 \sigma_0; \]

\[ A; \quad \{ R_6 \}; \quad c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + c_1 \sigma_0; \]

\[ R_7; \quad c_2 [(\sigma_1 + \sigma_3) k_x + (\sigma_1 - \sigma_3) k_y] + c_1 \sigma_0; \]

\[ R; \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]

\[ X; \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]

\[ \Lambda; \quad \{ R_5 \}; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1); \]

\[ V; \quad \{ R_5 \}; \quad c_2 (\sigma_1 k_x + \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1); \]

\[ W; \quad \{ R_5 \}; \quad c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + \sigma_0 (c_4 k_x + c_1); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_2k_z; \]
\[ U: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_2k_z; \]
\[ \Sigma: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_x + c_2k_y) + \sigma_3c_3 (k_x + k_y) + c_4\sigma_1k_z + c_5\sigma_2 (k_y - k_x); \]
\[ S: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_x + c_2k_y) + \sigma_3c_3 (k_x + k_y) + c_4\sigma_1k_z + c_5\sigma_2 (k_y - k_x); \]
\[ Y: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_1k_y; \]
\[ T: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_1k_y; \]

SG 116

\[ \Gamma_y: \{S^y_{1,0,0}\}, \{C_{2a},00^2_2\}, T; \] Non-Centrosymmetric; with SOC

\[ \Gamma: \]
\[ R_6: \quad c_2 [\sigma_3 - \sigma_1] k_x - (\sigma_1 + \sigma_3) k_y] + c_3\sigma_0; \]
\[ R_7: \quad c_2 [(\sigma_1 + \sigma_3) k_x + (\sigma_1 - \sigma_3) k_y] + c_3\sigma_0; \]
\[ M: \quad c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + c_3\sigma_0; \]
\[ R: \quad c_2 [(\sigma_1 + \sigma_3) k_x + (\sigma_1 - \sigma_3) k_y] + c_3\sigma_0; \]
\[ Z: \{R_6, R_7\}: c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2k_x} + \Gamma_{3,3k_y}) + [\sigma_1 (k_y \Gamma_{0,0} - i k_x \Gamma_{0,1})] + [\sigma_2 (\Gamma_{0,0} k_z + \Gamma_{0,1} k_y)]; \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_2k_z; \]
\[ \Sigma: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_x + c_2k_y) + \sigma_3c_3 (k_x + k_y) + c_4\sigma_1k_z + c_5\sigma_2 (k_y - k_x); \]
\[ S: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_x + c_2k_y) + \sigma_3c_3 (k_x + k_y) + c_4\sigma_1k_z + c_5\sigma_2 (k_y - k_x); \]
\[ Y: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_1k_y; \]
\[ \Gamma; \quad R_6: \quad c_2 [\langle \sigma_3 - \sigma_1 \rangle k_x - \langle \sigma_1 + \sigma_3 \rangle k_y] + c_1 \sigma_0; \]

\[ R_7; \quad c_2 [\langle \sigma_1 + \sigma_3 \rangle k_x + \langle \sigma_1 - \sigma_3 \rangle k_y] + c_1 \sigma_0; \]

\[ M; \quad \{ R_6, R_7 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2}k_x + \Gamma_{3,3}k_y) + [\lambda_1 (k_y \Gamma_{0,0} - ik_x \Gamma_{0,1}) + \alpha_2 k_x \Gamma_{0,3} + h.c.]; \]

\[ Z; \quad R_6; \quad c_2 [\langle \sigma_3 - \sigma_1 \rangle k_x - \langle \sigma_1 + \sigma_3 \rangle k_y] + c_1 \sigma_0; \]

\[ R_7; \quad c_2 [\langle \sigma_1 + \sigma_3 \rangle k_x + \langle \sigma_1 - \sigma_3 \rangle k_y] + c_1 \sigma_0; \]

\[ A; \quad \{ R_6, R_7 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2}k_x + \Gamma_{3,3}k_y) + [\lambda_1 (k_y \Gamma_{0,0} - ik_x \Gamma_{0,1}) + \alpha_2 k_x \Gamma_{0,3} + h.c.]; \]

\[ R; \quad \{ R_5, R_6 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ X; \quad \{ R_5, R_6 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_y + c_3 \sigma_3 k_z + c_1 \sigma_0; \]

\[ \Delta; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

\[ \{ R_3 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

\[ \Sigma; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

\[ \{ R_3 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

\[ \{ R_6 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

\[ \{ R_8 \}, \{ R_9 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

\[ \{ R_3 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

\[ \Sigma; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

\[ \{ R_3 \}, \{ R_5 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

\[ \{ R_6 \}, \{ R_7 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]

\[ \{ R_8 \}, \{ R_9 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 \sigma_3 k_z + c_4 \sigma_2 k_x; \]
Accidental degeneracies on high symmetry line

\[ \Delta : \{ R_5 \} , \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + c_3 c_4 k_y + c_4 \sigma_2 k_x; \]
\[ \Sigma : \{ R_5 \} , \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + c_3 c_4 (k_x + k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 (k_y - k_x); \]
\[ S : \{ R_7 \} , \{ R_1 \} : \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + c_3 c_4 (k_x + k_y) + c_4 \sigma_1 k_z + c_5 \sigma_2 (k_y - k_x); \]
\[ T : \{ R_6 \} , \{ R_1 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 c_4 k_y + c_4 \sigma_1 k_y; \]
\[ W : \{ R_6 \} , \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 c_4 k_y + (c_4 \sigma_2 + c_5 \sigma_2) k_y; \]
\[ \{ R_6 \} , \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + c_3 c_4 k_y + (c_4 \sigma_1 + c_5 \sigma_2) k_y; \]
\[ \{ R_6 \} , \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + s_3 c_4 k_y; \]
\[ \{ R_6 \} , \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + s_3 c_4 k_y; \]
\[ \{ R_6 \} , \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + s_3 c_4 k_y; \]
\[ \{ R_6 \} , \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + s_3 c_4 k_y; \]
\[ \{ R_6 \} , \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + s_3 c_4 k_y; \]
\[ \{ R_6 \} , \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + s_3 c_4 k_y; \]
\[ \{ R_6 \} , \{ R_5 \} : \sigma_0 (c_1 + c_2 k_x) + s_3 c_4 k_y; \]

[Page 1145]
Accidental degeneracies on high symmetry line

\[ W; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 c_2 k_z + c_4 \sigma_1 (k_x + k_y) + c_5 \sigma_2 (k_y - k_x)); \]

\[ \Sigma; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 c_2 k_z + c_4 \sigma_1 k_y); \]

\[ F; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 c_2 k_z + c_4 \sigma_1 k_y); \]

\[ \Delta; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_x); \]

\[ U; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_x); \]

\[ Y; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x - c_2 k_y) + \sigma_3 c_3 (k_x - k_y) + c_4 \sigma_1 (k_x + k_y) + c_5 \sigma_2 k_z; \]

SG 120

\[ \Gamma_\alpha^\nu; \{ S_\alpha^\nu \}[000], \{ C_{2\alpha} \}^{\nu \beta}; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \quad \begin{align*}
R_6; & \quad c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + c_1 \sigma_0; \\
R_7; & \quad c_2 [(\sigma_1 + \sigma_3) k_x + (\sigma_1 - \sigma_3) k_y] + c_1 \sigma_0; \\
N; & \quad \sum_{i=1}^3 (c_i, k_x + c_i, k_y) \sigma_i + c_1 \sigma_0; \\
R_5; & \quad \sum_{i=1}^3 (c_i, k_x + c_i, k_y) \sigma_i + c_1 \sigma_0; \\
X; & \quad c_3 \sigma_1 (k_x - k_y) + c_2 \sigma_3 (k_x + k_y) - c_4 \sigma_2 k_z + c_1 \sigma_0; \\
Z; & \quad c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + c_1 \sigma_0; \\
R_7; & \quad c_2 [(\sigma_1 + \sigma_3) k_x + (\sigma_1 - \sigma_3) k_y] + c_1 \sigma_0; \\
P; & \quad \{ R_2, R_6 \}; (c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0; \\
\{ R_4, R_8 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0; \\
\Lambda; & \quad R_5; \quad c_2 (\sigma_1 k_z + \sigma_3 k_y) + \sigma_0 (c_3 k_z + c_1); \\
V; & \quad R_5; \quad c_2 (\sigma_1 k_z + \sigma_3 k_y) + \sigma_0 (c_3 k_z + c_1); \\
Q; & \quad \{ R_2, R_2 \}; \quad \sigma_0 (c_2 k_y + c_1) + \sum_{i=1}^3 (c_i, k_x + c_i, k_y) \sigma_i; \\
\end{align*} \]

Accidental degeneracies on high symmetry line

\[ W; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_2 k_z + c_4 \sigma_1 (k_z + k_y) + c_5 \sigma_2 (k_y - k_x); \]

\[ \Sigma; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_2 k_z + c_4 \sigma_1 k_y; \]

\[ F; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_2 k_z + c_4 \sigma_1 k_y; \]

\[ \Delta; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_x); \]

\[ U; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 k_x + c_5 \sigma_2 (k_y - k_x); \]

\[ Y; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x - c_2 k_y) + \sigma_3 c_3 (k_x - k_y) + c_4 \sigma_1 (k_x + k_y) + c_5 \sigma_2 k_z; \]
SG 121

\[ \Gamma_i^q; \{ S_{4z}^+ | 000 \}, \{ C_{2x} | 000 \}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \]
\[ R_6; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ R_7; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ N; \{ R_2, R_4 \}; \sum_{i=1}^2 \sigma_i (c_{i,1} k_x + c_{i,2} k_z) + c_2 \sigma_3 k_y + c_1 \sigma_0; \]
\[ X; R_6; c_3 \sigma_1 (k_x + k_y) + c_2 \sigma_3 (k_x - k_y) + c_1 \sigma_0; \]
\[ Z; R_6; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ R_7; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ P; R_6; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ R_7; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ A; R_6; c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + \sigma_0 (c_3 k_x + c_1); \]
\[ V; R_6; c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + \sigma_0 (c_3 k_x + c_1); \]
\[ W; R_6; c_3 \sigma_1 (k_x + k_y) + c_2 \sigma_3 (k_x - k_y) + \sigma_0 (c_4 k_x + c_1); \]

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Accidental degeneracies on high symmetry line

\[ \Sigma; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ F; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_3 k_y + c_5 \sigma_1 k_z; \]
\[ Q; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sum_{i=1}^2 \sigma_i (c_{i,1} k_x + c_{i,2} k_z); \]
\[ \Delta; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_z); \]
\[ U; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_y - k_z); \]
\[ Y; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x - c_2 k_y) + \sigma_3 c_3 (k_x - k_y) + c_4 \sigma_1 (k_x + k_y); \]

SG 122

\[ \Gamma_i^q; \{ S_{4z}^+ | 000 \}, \{ C_{2x} | \frac{1}{3} \frac{1}{3} \frac{1}{3} \}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \]
\[ R_6; c_2 (\sigma_1 k_x + \sigma_3 k_y) + c_1 \sigma_0; \]
\[ R_7; c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ N; \{ R_2, R_4 \}; \sum_{i=1}^2 \sigma_i (c_{i,1} k_x + c_{i,2} k_z) + c_2 \sigma_3 k_y + c_1 \sigma_0; \]
\[ X; R_6, R_6; (c_2 \sigma_1 - c_4 \sigma_2) (k_x + k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \]
\[ \{ R_2, R_8 \}; (c_2 \sigma_1 - c_4 \sigma_2) (k_x + k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \]
\[ Z; \{ R_6, R_7 \}; c_1 \Gamma_{0,0} + c_2 [\Gamma_{0,2} (k_x - k_y) + \Gamma_{3,3} (k_x + k_y)] + [\alpha_1 \Gamma_{+,0} (k_x + k_y) - i \alpha_1 \Gamma_{-,1} (k_x - k_y) + \alpha_2 k_x \Gamma_{+,3} + h.c. ]; \]
\[ R_{20}; c_2 \sigma_3 k_x + c_1 \sigma_0; \]
\[ A; R_5; c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + \sigma_0 (c_3 k_x + c_1); \]
\[ V; R_5; c_2 [(\sigma_3 - \sigma_1) k_x - (\sigma_1 + \sigma_3) k_y] + \sigma_0 (c_3 k_x + c_1); \]
\[ U; \{ R_2, R_4 \}; (c_1 + c_2 (k_x + k_y)) \sigma_0 + (c_3 \sigma_1 - c_5 \sigma_2) (k_x - k_y) + c_4 \sigma_3 k_z; \]
\[ Y; \{ R_5, R_7 \}; (c_1 + c_2 (k_x - k_y)) \sigma_0 + (c_3 \sigma_1 - c_5 \sigma_2) (k_x + k_y) + c_4 \sigma_3 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_6\},\{R_4\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \sigma_1 c_4 k_y + \sigma_2 (k_x - k_y) ; \]

\[ \Gamma; \{R_5\},\{R_8\}; \quad \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + \Gamma_4 c_4 k_y + \Gamma_2,0 (k_x - k_y) ; \]

\[ \Sigma; \{R_4\},\{R_8\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \sigma_1 c_4 k_y + \sigma_2 (k_x - k_y) ; \]

\[ F; \{R_5\},\{R_7\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \sigma_1 c_4 k_y + \sigma_2 (k_x - k_y) ; \]

\[ Q; \{R_5\},\{R_2\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \sum_{i=1}^2 \sigma_i (c_i + c_i k_x) ; \]

\[ \Delta; \{R_2\},\{R_4\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \sigma_1 c_4 k_y + \sigma_2 (k_x - k_y) ; \]

SG 123
\[ \Gamma_\eta; \{C_{4v}^+|000\},\{C_{2z}|000\},\{I|000\},T; \text{Centrosymmetric; with SOC} \]

Accidental degeneracies on high symmetry line

\[ A; \{R_6\},\{R_7\}; \quad \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + \Gamma_4 (\Gamma_1,0 k_x + \Gamma_2,0 k_y) ; \]

\[ V; \{R_6\},\{R_7\}; \quad \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + \Gamma_4 (\Gamma_1,0 k_x + \Gamma_2,0 k_y) ; \]

SG 124
\[ \Gamma_\eta; \{C_{4v}^+|000\},\{C_{2z}|000\},\{I|000\},T; \text{Centrosymmetric; with SOC} \]

\[ Z; \{R_{10},R_{20}\}; \quad c_1 \Gamma_0,0 + c_2 [\Gamma_3,1 (k_x - k_y) + \Gamma_3,3 (k_x + k_y)] + \sum_{i=1}^2 c_i,1 \Gamma_i,0 k_x ; \]

\[ A; \{R_{10},R_{20}\}; \quad c_1 \Gamma_0,0 + c_2 [\Gamma_3,1 (k_x - k_y) + \Gamma_3,3 (k_x + k_y)] + \sum_{i=1}^2 c_i,1 \Gamma_i,0 k_x ; \]

\[ R; \{R_{13},R_{14}\}; \quad c_1 \Gamma_0,0 - c_4 \Gamma_0,2 k_x + c_2 \Gamma_3,1 k_y + k_x (c_3 \Gamma_1,1 - c_5 \Gamma_2,1) ; \]

Accidental degeneracies on high symmetry line

\[ U; \{R_5,R_9\},\{R_6,R_7\}; \quad \Gamma_0,0 (c_1 + c_2 k_y) + \Gamma_3,0 c_3 k_y + k_x (c_4 \Gamma_1,0 + c_5 \Gamma_2,3) + k_x (c_0 \Gamma_2,1 + c_7 \Gamma_2,2) ; \]

\[ A; \{R_6\},\{R_7\}; \quad \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + c_4 (\Gamma_1,0 k_x + \Gamma_2,0 k_y) ; \]

\[ V; \{R_6\},\{R_7\}; \quad \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + c_4 (\Gamma_1,0 k_x + \Gamma_2,0 k_y) ; \]

\[ S; \{R_5,R_9\},\{R_6,R_7\}; \quad \Gamma_0,0 (c_1 + c_2 k_x + c_2 k_y) + \Gamma_3,0 c_3 (k_x + k_y) + (c_4 \Gamma_1,0 + c_5 \Gamma_2,3) (k_x - k_y) + \Gamma_3,0 (c_0 \Gamma_2,1 + c_7 \Gamma_2,2) k_x ; \]

\[ T; \{R_5,R_9\},\{R_6,R_7\}; \quad \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + k_y (c_4 \Gamma_1,0 + c_5 \Gamma_2,3) + k_x (c_0 \Gamma_2,1 + c_7 \Gamma_2,2) ; \]
Accidental degeneracies on high symmetry line

\[\begin{align*}
\Lambda: \{R_0\}, \{R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_5 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \\
V: \{R_0\}, \{R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_5 k_z + c_4 (\Gamma_{2,1} k_x + \Gamma_{1,0} k_y); \\
Y: \{R_0, R_7\}, \{R_6, R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_5 k_z + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_x (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \\
T: \{R_0, R_7\}, \{R_6, R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_5 k_z + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \\
W: \{R_5, R_8\}, \{R_6, R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_5 k_z + k_x (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_y (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}); \\
\end{align*}\]

Accidental degeneracies on high symmetry line

\[\begin{align*}
U: \{R_0, R_7\}, \{R_6, R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_5 k_y + k_x (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_z (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}); \\
A: \{R_0\}, \{R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_5 k_x + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \\
V: \{R_0\}, \{R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_5 k_x + c_4 (\Gamma_{2,1} k_x + \Gamma_{1,0} k_y); \\
S: \{R_0, R_7\}, \{R_6, R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_x + c_2 k_y) + \Gamma_{3,0} c_5 (k_x + k_y) + (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) (k_x - k_y) + (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}) k_z; \\
Y: \{R_0, R_7\}, \{R_6, R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_5 k_x + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \\
W: \{R_5, R_8\}, \{R_6, R_7\}; & \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_5 k_x + k_x (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_y (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}); \\
\end{align*}\]
Accidental degeneracies on high symmetry line

\[\Gamma: \{R_0, R_7\}; \quad \Gamma_{00} (c_1 + c_2 k_z) + \Gamma_{10} c_1 k_x + c_4 \Gamma_{21} + c_5 \Gamma_{23} + k_y (c_6 \Gamma_{21} + c_7 \Gamma_{22})\]

\[W: \{R_0, R_8\}, \{R_6, R_7\}; \quad \Gamma_{00} (c_1 + c_2 k_z) + \Gamma_{30} c_3 k_z + k_x (c_4 \Gamma_{10} + c_5 \Gamma_{23}) + k_y (c_6 \Gamma_{21} + c_7 \Gamma_{22})\]

Accidental degeneracies on high symmetry line

\[U: \{R_5, R_8\}, \{R_6, R_7\}; \quad \Gamma_{00} (c_1 + c_2 k_y) + \Gamma_{30} c_3 k_y + k_x (c_4 \Gamma_{10} + c_5 \Gamma_{23}) + k_z (c_6 \Gamma_{21} + c_7 \Gamma_{22})\]

\[A: \{R_0, R_7\}; \quad \Gamma_{00} (c_1 + c_2 k_z) + \Gamma_{10} c_1 k_x + c_4 \Gamma_{21} + c_5 \Gamma_{23} + k_y (c_6 \Gamma_{21} + c_7 \Gamma_{22})\]

\[S: \{R_5, R_8\}, \{R_6, R_7\}; \quad \Gamma_{00} (c_1 + c_2 k_x + c_2 k_y) + \Gamma_{30} c_3 (k_z + k_y) + (c_4 \Gamma_{10} + c_5 \Gamma_{23}) (k_x - k_y) + (c_6 \Gamma_{21} + c_7 \Gamma_{22}) k_z\]

\[T: \{R_0, R_8\}, \{R_6, R_7\}; \quad \Gamma_{00} (c_1 + c_2 k_x) + \Gamma_{30} c_3 k_x + k_y (c_4 \Gamma_{21} + c_5 \Gamma_{22})\]

\[W: \{R_2, R_6\}, \{R_7, R_8\}; \quad \Gamma_{00} (c_1 + c_2 k_x) + \Gamma_{30} c_3 k_x + k_y (c_4 \Gamma_{10} + c_5 \Gamma_{23})\]

\[\Gamma: \{C_{12}^{x + \frac{1}{2}} | \frac{1}{2} \}, \{C_{2z}^{x + \frac{1}{2}} | \frac{1}{2} \}, \{I | 000 \}, \{\Gamma | 000 \}, T; \text{ Centrosymmetric; with SOC}\]

\[M: \{R_0, R_7\}; \quad (c_1 + c_2 k_z^2 + c_3 k_x^2) \Gamma_{00} + (c_4 \Gamma_{12} + c_5 \Gamma_{22}) k_y + c_6 (\Gamma_{32} k_x + \Gamma_{03} k_y) k_z;\]

\[\{R_20, R_21\}; \quad (c_1 + c_2 k_z^2 + c_3 k_x^2) \Gamma_{00} + (c_4 \Gamma_{12} + c_5 \Gamma_{22}) k_y + c_6 (\Gamma_{32} k_x + \Gamma_{03} k_y) k_z;\]

\[A: \{R_0, R_7\}; \quad (c_1 + c_2 k_z^2 + c_3 k_x^2) \Gamma_{00} + (c_4 \Gamma_{12} + c_5 \Gamma_{22}) k_y + c_6 (\Gamma_{32} k_x + \Gamma_{03} k_y) k_z;\]

\[R: \{R_13, R_{14}\}; \quad c_1 \Gamma_{00} + k_y (c_2 \Gamma_{11} - c_4 \Gamma_{21} + c_5 \Gamma_{23});\]

\[X: \{R_2, R_7\}; \quad c_1 \Gamma_{00} + k_y (c_2 \Gamma_{11} - c_4 \Gamma_{21} + c_5 \Gamma_{23});\]

\[V: \{R_0, R_7\}; \quad \Gamma_{00} (c_3 k_z + c_1) - c_2 (\Gamma_{32} k_x + \Gamma_{03} k_y);\]

\[Y: \{R_0, R_7\}; \quad (c_1 + c_2 k_x) \Gamma_{00} + c_3 \Gamma_{02} k_z + \sum_{i=1}^{3} c_i \Gamma_{13} k_y;\]

\[T: \{R_0, R_7\}; \quad (c_1 + c_2 k_x) \Gamma_{00} + c_3 \Gamma_{02} k_z + \sum_{i=1}^{3} c_i \Gamma_{13} k_y;\]
Accidental degeneracies on high symmetry line

A: \{R_6\}, \{R_7\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + c_4 (\Gamma_1,0 k_x + \Gamma_2,2 k_y);
Y: \{R_5, R_6\}, \{R_7, R_8\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + c_4 (\Gamma_2,1 + c_5 \Gamma_2,2);
T: \{R_5, R_6\}, \{R_7, R_8\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + c_4 (\Gamma_2,1 + c_5 \Gamma_2,2);

Accidental degeneracies on high symmetry line

U: \{R_5, R_6\}, \{R_6, R_7\}; \Gamma_0,0 (c_1 + c_2 k_y) + \Gamma_3,0 c_3 k_x + k_x (c_4 \Gamma_1,0 + c_5 \Gamma_2,3) + k_y (c_6 \Gamma_2,1 + c_7 \Gamma_2,2);
A: \{R_6\}, \{R_7\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + c_4 (\Gamma_1,0 k_x + \Gamma_2,2 k_y);
S: \{R_5, R_6\}, \{R_6, R_7\}; \Gamma_0,0 (c_1 + c_2 k_x + c_3 k_y) + \Gamma_3,0 c_3 (k_x + k_y) + (c_4 \Gamma_1,0 + c_5 \Gamma_2,3) (k_x - k_y) + (c_6 \Gamma_2,1 + c_7 \Gamma_2,2) k_z;
Y: \{R_5, R_6\}, \{R_6, R_7\}; \Gamma_0,0 (c_1 + c_2 k_x) + \Gamma_3,0 c_3 k_x + k_y (c_4 \Gamma_2,1 + c_5 \Gamma_2,2);
Accidental degeneracies on high symmetry line

\[ A: \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \]
\[ V: \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \]
\[ S: \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x + c_2 k_y) + \Gamma_{3,0} c_3 (k_x + k_y) + (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) (k_x - k_y) + (c_6 \Gamma_{1,0} + c_7 \Gamma_{2,3}) k_z; \]

Accidental degeneracies on high symmetry line

\[ U: \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_z (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}); \]
\[ A: \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \]
\[ V: \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \]
\[ T: \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + k_y (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_x (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}); \]

Accidental degeneracies on high symmetry line

\[ M: \{ R_9, R_20 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,3} k_x - \Gamma_{0,2} k_y) + c_3 \Gamma_{3,1} k_z; \]
\[ Z: \{ R_9, R_20 \}; \quad c_1 \Gamma_{0,0} + c_2 [\Gamma_{0,3} (k_x - k_y) - \Gamma_{0,2} (k_x + k_y)] + c_3 \Gamma_{3,1} k_z; \]
\[ A: \{ R_{21}, R_{22} \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,1} k_x + \Gamma_{3,3} k_y) + k_z (c_5 \Gamma_{1,0} - c_4 \Gamma_{2,0}); \]
\[ \{ R_{21}, R_{22} \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,1} k_x + \Gamma_{3,3} k_y) + k_z (c_5 \Gamma_{1,0} - c_4 \Gamma_{2,0}); \]
\[ R: \{ R_{13}, R_{14} \}; \quad c_1 \Gamma_{0,0} - c_4 \Gamma_{2,1} k_x + k_y (c_2 \Gamma_{1,1} - c_3 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_z; \]
\[ X: \{ R_{13}, R_{14} \}; \quad c_1 \Gamma_{0,0} - c_4 \Gamma_{2,1} k_x + k_y (c_2 \Gamma_{1,1} - c_3 \Gamma_{2,1}) + c_3 \Gamma_{3,1} k_z; \]
Accidental degeneracies on high symmetry line

\[ \Lambda;\{R_6\},\{R_7\}; \Gamma_{0,0}(c_1+c_2k_z) + \Gamma_{3,0}c_3k_z + c_4(\Gamma_{1,0}k_x + \Gamma_{2,2}k_y) ; \]
\[ V;\{R_6\},\{R_7\}; \Gamma_{0,0}(c_1+c_2k_z) + \Gamma_{3,0}c_3k_z + c_4(\Gamma_{2,1}k_x + \Gamma_{1,0}k_y) ; \]
\[ S;\{R_5, R_6\},\{R_7, R_8\}; \Gamma_{0,0}(c_1+c_2k_z + c_2k_y) + \Gamma_{3,0}c_3(k_z + k_y) + (c_4\Gamma_{2,1} + c_5\Gamma_{2,2})(k_x - k_y) + (c_6\Gamma_{1,0} + c_7\Gamma_{2,3})k_z ; \]
\[ Y;\{R_5, R_6\},\{R_7, R_8\}; \Gamma_{0,0}(c_1+c_2k_z + \Gamma_{3,0}c_3k_z + k_y(c_4\Gamma_{2,1} + c_5\Gamma_{2,2}) + k_x(c_6\Gamma_{2,3} + c_7\Gamma_{1,0}) ; \]
\[ T;\{R_5, R_8\},\{R_6, R_7\}; \Gamma_{0,0}(c_1+c_2k_z) + \Gamma_{3,0}c_3k_z + k_y(c_4\Gamma_{2,1} + c_5\Gamma_{2,2}) + k_x(c_6\Gamma_{2,3} + c_7\Gamma_{1,0}) ; \]
\[ W;\{R_5, R_8\},\{R_6, R_7\}; \Gamma_{0,0}(c_1+c_2k_z) + \Gamma_{3,0}c_3k_z + k_y(c_4\Gamma_{1,0} + c_5\Gamma_{2,3}) + k_y(c_6\Gamma_{2,1} + c_7\Gamma_{2,2}) ; \]

SG 134
\[ \Gamma_q; \{C^+_{4z}\frac{1}{2},\frac{3}{2}\}, \{C_{2z}\{000\}\}, \{I\frac{1}{2},\frac{3}{2}\}\}, T; Centrosymmetric; with SOC \]
\[ M; R_{19}; c_1\Gamma_{0,0} + c_2(\Gamma_{0,3}k_x - \Gamma_{0,2}k_y) + c_3\Gamma_{3,1}k_z ; \]
\[ Z; R_{19}; c_1\Gamma_{0,0} + c_2(\Gamma_{0,3}k_x - \Gamma_{0,2}k_y) + c_3\Gamma_{3,1}k_z ; \]
\[ R;\{R_{3, R_{14}}\}; c_1\Gamma_{0,0} + k_y(c_2\Gamma_{1,1} - c_3\Gamma_{2,1}) - c_5\Gamma_{0,2}k_y + c_4\Gamma_{1,1}k_z ; \]
\[ X;\{R_{13, R_{14}}\}; c_1\Gamma_{0,0} - c_4\Gamma_{0,2}k_x + k_y(c_2\Gamma_{1,1} - c_3\Gamma_{2,1}) + c_3\Gamma_{3,1}k_z ; \]

Accidental degeneracies on high symmetry line

\[ U;\{R_5, R_8\},\{R_6, R_7\}; \Gamma_{0,0}(c_1+c_2k_y) + \Gamma_{3,0}c_3k_y + k_x(c_4\Gamma_{1,0} + c_5\Gamma_{2,3}) + k_y(c_6\Gamma_{2,1} + c_7\Gamma_{2,2}) ; \]
\[ A;\{R_6\},\{R_7\}; \Gamma_{0,0}(c_1+c_2k_z) + \Gamma_{3,0}c_3k_z + c_4(\Gamma_{1,0}k_x + \Gamma_{2,2}k_y) ; \]
\[ V;\{R_6\},\{R_7\}; \Gamma_{0,0}(c_1+c_2k_z) + \Gamma_{3,0}c_3k_z + c_4(\Gamma_{2,1}k_x + \Gamma_{1,0}k_y) ; \]
\[ Y;\{R_5, R_6\},\{R_7, R_8\}; \Gamma_{0,0}(c_1+c_2k_z + \Gamma_{3,0}c_3k_z + k_y(c_4\Gamma_{2,1} + c_5\Gamma_{2,2}) + k_x(c_6\Gamma_{2,3} + c_7\Gamma_{1,0}) ; \]
\[ W;\{R_5, R_8\},\{R_6, R_7\}; \Gamma_{0,0}(c_1+c_2k_z) + \Gamma_{3,0}c_3k_z + k_y(c_4\Gamma_{1,0} + c_5\Gamma_{2,3}) + k_y(c_6\Gamma_{2,1} + c_7\Gamma_{2,2}) ; \]

SG 135
\[ \Gamma_q; \{C^+_{4z}\frac{1}{2},\frac{3}{2}\}, \{C_{2z}\{100\}\}, \{I\{000\}\}, T; Centrosymmetric; with SOC \]
\[ M;\{R_5, R_6\}; (c_1 + c_2k^2 + c_3k^2) \Gamma_{0,0} + (c_4\Gamma_{1,2} + c_5\Gamma_{2,2})k_xk_y + c_6(\Gamma_{3,2}k_x + \Gamma_{0,3}k_y)k_z ; \]
\[ \{R_{20, R_{21}}\}; (c_1 + c_2k^2 + c_3k^2) \Gamma_{0,0} + (c_4\Gamma_{1,2} + c_5\Gamma_{2,2})k_xk_y + c_6(\Gamma_{3,2}k_x + \Gamma_{0,3}k_y)k_z ; \]
\[ Z; R_{19}; c_1\Gamma_{0,0} + c_2[\Gamma_{0,3}(k_z - k_y) - \Gamma_{0,2}(k_x + k_y)] + c_3\Gamma_{3,1}k_z ; \]
\[ A;\{R_{13, R_{19}}\}; c_1Q_{0,0} + c_2(Q_{0,3}k_x + Q_{0,3}k_y) + \sum_{i=1}^{3}[c_{1,1}(Q_{1,2}k_x - Q_{1,3}k_y) + c_{1,2}Q_{1,3}k_z] ; \]
\[ R;\{R_{13, R_{14}}\}; c_1\Gamma_{0,0} + k_y(c_2\Gamma_{1,1} - c_3\Gamma_{2,1}) + c_3\Gamma_{3,1}k_z ; \]
\[ X;\{R_{13, R_{14}}\}; c_1\Gamma_{0,0} + k_y(c_2\Gamma_{1,1} - c_3\Gamma_{2,1}) + c_3\Gamma_{3,1}k_z ; \]

Accidental degeneracies on high symmetry line

\[ \Lambda;\{R_5\},\{R_7\}; \Gamma_{0,0}(c_1+c_2k_z) + \Gamma_{3,0}c_3k_z + c_4(\Gamma_{1,0}k_x + \Gamma_{2,2}k_y) ; \]
\[ S;\{R_5, R_6\},\{R_7, R_8\}; \Gamma_{0,0}(c_1+c_2k_z + c_2k_y) + \Gamma_{3,0}c_3(k_z + k_y) + (c_4\Gamma_{2,1} + c_5\Gamma_{2,2})(k_x - k_y) + (c_6\Gamma_{1,0} + c_7\Gamma_{2,3})k_z ; \]
\[ W;\{R_5, R_8\},\{R_6, R_7\}; \Gamma_{0,0}(c_1+c_2k_z) + \Gamma_{3,0}c_3k_z + k_y(c_4\Gamma_{1,0} + c_5\Gamma_{2,3}) + k_y(c_6\Gamma_{2,1} + c_7\Gamma_{2,2}) ; \]
\( \Gamma_q; \{C_{4v}^+|\frac{1}{2}, \frac{1}{2}\}, \{C_{2v}|\frac{1}{2}, \frac{1}{2}\}, \{I|00, \frac{1}{2}\}, T; \) Centrosymmetric; with SOC

\( M; \{R_6, R_7\}; \quad (c_1 + c_2 k_x^2 + c_3 k_y^2) \Gamma_{0,0} + (c_4 \Gamma_{1,2} + c_5 \Gamma_{2,2}) k_x k_y + c_6 (\Gamma_{3,2} k_x + \Gamma_{0,3} k_y) k_z; \)
\( \{R_{20}, R_{21}\}; \quad (c_1 + c_2 k_x^2 + c_3 k_y^2) \Gamma_{0,0} + (c_4 \Gamma_{1,2} + c_5 \Gamma_{2,2}) k_x k_y + c_6 (\Gamma_{3,2} k_x + \Gamma_{0,3} k_y) k_z; \)
\( Z; \ R_{19}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,3} k_x - \Gamma_{0,2} k_y) + c_3 \Gamma_{4,1} k_z; \)
\( A; \ R_{19}; \quad c_1 \Gamma_{0,0} - c_2 (\Gamma_{0,2} k_x + \Gamma_{0,3} k_y); \)
\( X; \ \{R_{13}, R_{14}\}; \quad c_1 \Gamma_{0,0} + k_y (c_2 \Gamma_{1,1} - c_3 \Gamma_{2,1}) + c_4 \Gamma_{3,1} k_z; \)
\( V; \ \{R_6, R_7\}; \quad (c_1 + c_2 k_x) \Gamma_{0,0} + c_3 (\Gamma_{3,2} k_x + \Gamma_{0,3} k_y); \)
\( Y; \ \{R_9, R_9\}; \quad (c_1 + c_2 k_x) \Gamma_{0,0} + c_3 \Gamma_{0,2} k_z + \sum_{i=1}^3 c_i \Gamma_{i,3} k_y; \)

Accidental degeneracies on high symmetry line

\( U; \ \{R_5, R_8\}, \{R_6, R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_x (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_z (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}); \)
\( A; \ \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \)
\( T; \ \{R_6, R_9\}, \{R_7, R_8\}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}); \)
\( W; \ \{R_5, R_6\}, \{R_7, R_8\}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_y + c_4 (\Gamma_{1,0} + \Gamma_{3,2}); \)

\( \Gamma_q; \{C_{4v}^+|00, \frac{1}{2}\}, \{C_{2v}|\frac{1}{2}, \frac{1}{2}\}, \{I|\frac{1}{2}, \frac{1}{2}\}, T; \) Centrosymmetric; with SOC

\( M; \ R_{19}; \quad c_1 \Gamma_{0,0} - c_2 (\Gamma_{0,2} k_x + \Gamma_{0,3} k_y); \)
\( Z; \ R_{19}; \quad c_1 \Gamma_{0,0} + c_2 [\Gamma_{0,3} (k_x - k_y) - \Gamma_{0,2} (k_x + k_y)] + c_3 \Gamma_{3,1} k_z; \)
\( A; \ \{R_{19}, R_{20}\}; \quad c_1 \Gamma_{0,0} + c_2 [\Gamma_{3,1} (k_x - k_y) + \Gamma_{3,3} (k_x + k_y)]; \)
\( \{R_{21}, R_{22}\}; \quad c_1 \Gamma_{0,0} + c_2 [\Gamma_{3,1} (k_x - k_y) + \Gamma_{3,3} (k_x + k_y)]; \)
\( R; \ \{R_{33}, R_{14}\}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + k_y (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}); \)
\( X; \ \{R_{13}, R_{14}\}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + k_y (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}); \)
\( V; \ \{R_6, R_7\}; \quad (c_1 + c_2 k_z) \Gamma_{0,0} + c_3 (\Gamma_{0,1} k_x + \Gamma_{0,3} k_y); \)
\( W; \ \{R_5, R_8\}; \quad (c_1 + c_2 k_z) \Gamma_{0,0} + c_3 \Gamma_{0,1} k_x + \sum_{i=1}^3 c_i \Gamma_{i,3} k_y; \)

Accidental degeneracies on high symmetry line

\( A; \ \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_x + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \)
\( S; \ \{R_5, R_6\}, \{R_7, R_8\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x + c_3 k_y) + \Gamma_{3,0} c_3 (k_x + k_y) + (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) (k_x - k_y) + (c_6 \Gamma_{1,0} + c_7 \Gamma_{2,3}) k_z; \)
\( Y; \ \{R_5, R_7\}, \{R_6, R_8\}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_x + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}); \)
\( T; \ \{R_5, R_7\}, \{R_6, R_8\}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_x + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}); \)
\( \Gamma_4; \{C_4^+|00\frac{1}{2}\}, \{C_{2z}|\frac{1}{2}\frac{1}{2}\frac{1}{2}\}, \{I|\frac{1}{2}\frac{1}{2}\}\}; T; \text{Centrosymmetric; with SOC} \)

\[
M; \quad R_{18}; \quad c_1 \Gamma_{0,0} - c_2 (\Gamma_{0,2} k_x + \Gamma_{0,3} k_y);
\]

\[
Z; \quad R_{19}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,3} k_y - \Gamma_{0,2} k_y) + c_3 \Gamma_{3,1} k_z;
\]

\[
A; \{R_6, R_7\}; \quad (c_1 + c_2 k_x^2 + c_3 k_y^2) \Gamma_{0,0} + (c_4 \Gamma_{1,2} + c_5 \Gamma_{2,2}) k_x k_y + c_6 (\Gamma_{3,2} k_x + \Gamma_{0,2} k_y) k_x;
\]

\[
\{R_{20}, R_{21}\}; \quad (c_1 + c_2 k_x^2 + c_3 k_y^2) \Gamma_{0,0} + (c_4 \Gamma_{1,2} + c_5 \Gamma_{2,2}) k_x k_y + c_6 (\Gamma_{3,2} k_x + \Gamma_{0,2} k_y) k_x;
\]

\[
R; \{R_6, R_7\}; \quad c_1 \Gamma_{0,0} + k_y (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1} + c_2 \Gamma_{3,1});
\]

\[
\{R_{10}, R_{10}\}; \quad c_1 \Gamma_{0,0} + k_y (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1} + c_2 \Gamma_{3,1});
\]

\[
X; \{R_{13}, R_{14}\}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + k_y (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1});
\]

\[
V; \{R_6, R_7\}; \quad (c_1 + c_2 k_x) \Gamma_{0,0} + c_3 (\Gamma_{0,1} k_x + \Gamma_{0,3} k_y);
\]

\[
T; \{R_6, R_7\}; \quad (c_1 + c_2 k_x) \Gamma_{0,0} + c_3 \Gamma_{0,3} k_x + \sum_{i=1}^{3} c_i \Gamma_{i,3} k_y;
\]

\[
W; \{R_6, R_7\}; \quad (c_1 + c_2 k_x) \Gamma_{0,0} + c_3 \Gamma_{0,1} k_x + \sum_{i=1}^{3} c_i \Gamma_{i,3} k_y;
\]

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Accidental degeneracies on high symmetry line

\[
U; \{R_5, R_5\}, \{R_6, R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_z (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) + k_x (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2});
\]

\[
A; \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_z + \Gamma_{2,2} k_y);
\]

\[
Y; \{R_5, R_7\}, \{R_6, R_8\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_z + \Gamma_{2,2} k_y);
\]

---

Accidental degeneracies on high symmetry line

\[
A; \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_z + \Gamma_{2,2} k_y);
\]

\[
V; \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y);
\]

---

Accidental degeneracies on high symmetry line

\[
N; \{R_8, R_9\}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_y + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1} k_x + c_{i,2} k_z);
\]

\[
P; \{R_6, R_7\}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,1} k_x + \Gamma_{0,3} k_y) + k_x (c_4 \Gamma_{1,2} + c_5 \Gamma_{2,2});
\]

---

Accidental degeneracies on high symmetry line

\[
A; \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_z + \Gamma_{2,2} k_y);
\]

\[
V; \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y);
\]

\[
Q; \{R_2, R_2\}, \{R_4, R_4\}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + \Gamma_{1,0} (c_4 k_x + c_5 k_z) + \sum_{i=1}^{3} \Gamma_{i,2} (c_{i,1} k_x + c_{i,2} k_z);
\]
SG 141

\[ \Gamma'_v; \{ C_{44}^+ [0 \frac{1}{2} 0], C_{2z} [\frac{1}{2} \frac{1}{2} 0], \{ I \frac{1}{2} \frac{1}{2} 0 \}, T; \text{Centrosymmetric; with SOC} \]  

\[ X; \{ R_{13}, R_{14} \}; c_1 \Gamma_0,0 + c_2 \Gamma_3,1 (k_x - k_y) + c_3 \Gamma_{3,1} (k_x + k_y) + \sum_{i=1}^{2} c_{i,1} \Gamma_{3,1} (k_x + k_y); \]
\[ Z; R_{19}; \quad c_1 \Gamma_0,0 + c_2 [\Gamma_0,3 (k_x - k_y) - \Gamma_0,2 (k_x + k_y)] + c_3 \Gamma_{3,1} k_z; \]

Accidental degeneracies on high symmetry line

\[ A; \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \]
\[ V; \{ R_{13} \}, \{ R_{14} \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_y - \Gamma_{2,2} k_x); \]
\[ W; \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) (k_x + k_y) + (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}) (k_x - k_y); \]
\[ U; \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x + c_3 k_y) + \Gamma_{3,0} c_3 (k_x + k_y) + (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) (k_x - k_y) + (c_6 \Gamma_{1,0} + c_7 \Gamma_{2,3}) k_z; \]
\[ Y; \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x + c_3 k_y) + \Gamma_{3,0} c_3 (k_x - k_y) + (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) (k_x + k_y) + (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}) k_z; \]

SG 142

\[ \Gamma'_v; \{ C_{44}^+ [\frac{1}{2} 00], C_{2z} [\frac{1}{2} \frac{1}{2} 0], \{ I \} [000], T; \text{Centrosymmetric; with SOC} \]  

\[ N; \{ R_{10}, R_{19} \}; c_1 \Gamma_0,0 + c_2 \Gamma_{0,2} k_y + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i1} k_x + c_{i2} k_z); \]
\[ X; \{ R_{13}, R_{14} \}; c_1 \Gamma_0,0 + \sum_{i=1}^{2} c_{i1} \Gamma_{1,1} (k_x + k_y) + c_2 \Gamma_{3,1} (k_x - k_y) + c_3 \Gamma_{0,2} k_z; \]
\[ Z; R_{19}; \quad c_1 \Gamma_0,0 + c_2 [\Gamma_{0,3} (k_x - k_y) - \Gamma_{0,2} (k_x + k_y)] + c_3 \Gamma_{3,1} k_z; \]
\[ P; \{ R_{19}, R_{19} \}; (c_1 + c_2 k^2 + c_3 k^2) \Gamma_{0,0} + c_4 \Gamma_{0,1} (k_x^2 - k_y^2) + \sum_{i=1}^{3} \Gamma_{1,2} (c_{i1} k_x k_y + c_{i2} k_z); \]

Accidental degeneracies on high symmetry line

\[ A; \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y); \]
\[ V; \{ R_{13} \}, \{ R_{14} \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_y - \Gamma_{2,2} k_x); \]
\[ W; \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) (k_x + k_y) + (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}) (k_x - k_y); \]
\[ Q; \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x + c_3 k_y) + \Gamma_{3,0} c_3 (k_x + k_y) + (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) (k_x - k_y) + (c_6 \Gamma_{1,0} + c_7 \Gamma_{2,3}) k_z; \]
\[ U; \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x + c_3 k_y) + \Gamma_{3,0} c_3 (k_x + k_y) + (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) (k_x + k_y) + (c_6 \Gamma_{2,1} + c_7 \Gamma_{2,2}) k_z; \]

SG 143

\[ \Gamma_h; \{ C_4^+ [000], T; \text{Non-Centrosymmetric; with SOC} \]  

\[ \Gamma; \{ R_{2}, R_{0} \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (a_1 \sigma_+ k_z + h.c.); \]
\[ R_{1}, R_{2}; \quad (c_1 + c_2 k^2 + c_3 k^2) \sigma_0 + \sum_{i=1}^{3} \sigma_i \left[ (c_{i1} + c_{i2} k^2 + c_{i3} k^2) k_z + c_{i4} k_x (k_x^2 - 3k_y^2) + c_{i5} k_y (3k_x^2 - k_y^2) \right]; \]
\[ M; \{ R_2, R_2 \}; c_1 \sigma_0 + \sum_{i=1}^{3} \sigma_i (c_{i1} k_x + c_{i2} k_y + c_{i3} k_z); \]
\[ A; \{ R_2, R_2 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (a_1 \sigma_+ k_z + h.c.); \]
\[ R_{1}, R_{2}; \quad (c_1 + c_2 k^2 + c_3 k^2) \sigma_0 + \sum_{i=1}^{3} \sigma_i \left[ (c_{i1} + c_{i2} k^2 + c_{i3} k^2) k_z + c_{i4} k_x (k_x^2 - 3k_y^2) + c_{i5} k_y (3k_x^2 - k_y^2) \right]; \]
\[ L; \{ R_2, R_2 \}; c_1 \sigma_0 + \sum_{i=1}^{3} \sigma_i (c_{i1} k_x + c_{i2} k_y + c_{i3} k_z); \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_z + \sigma_2 k_y) ; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_2 k_x + \sigma_1 k_y) + c_5 (\sigma_1 k_z - \sigma_2 k_y) ; \]
\[ \{R_4\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_z + \sigma_2 k_y) ; \]
\[ P; \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_z + \sigma_2 k_y) ; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_2 k_x + \sigma_1 k_y) + c_5 (\sigma_1 k_z - \sigma_2 k_y) ; \]
\[ \{R_4\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_z + \sigma_2 k_y) ; \]

\[ \Gamma_h; \{C_3^+\}^4[00\frac{1}{2}] ; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{R_2, R_6\}: c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_+ + h.c.) ; \]
\[ \{R_4, R_6\}: (c_1 + c_2 k^2 + c_3 k^2) \sigma_0 + \sum_{i=1}^3 \sigma_i [(c_{i,1} + c_{i,2} k^2 + c_{i,3} k^2) k_x + c_{i,4} k_x (k^2 - 3k^2_y) + c_{i,5} k_y (3k^2_x - k^2_y)] ; \]
\[ M; \{R_2, R_7\}: c_1 \sigma_0 + \sum_{i=1}^3 \sigma_i (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) ; \]
\[ A; \{R_2, R_7\}: c_1 \sigma_0 + c_2 \sigma_3 k_x + (\alpha_1 \sigma_+ k_+ + h.c.) ; \]
\[ \{R_4, R_7\}: (c_1 + c_2 k^2 + c_3 k^2) \sigma_0 + \sum_{i=1}^3 \sigma_i [(c_{i,1} + c_{i,2} k^2 + c_{i,3} k^2) k_x + c_{i,4} k_x (k^2 - 3k^2_y) + c_{i,5} k_y (3k^2_x - k^2_y)] ; \]
\[ L; \{R_2, R_7\}: c_1 \sigma_0 + \sum_{i=1}^3 \sigma_i (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) ; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_z + \sigma_2 k_y) ; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_2 k_x + \sigma_1 k_y) + c_5 (\sigma_1 k_z - \sigma_2 k_y) ; \]
\[ \{R_4\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_z + \sigma_2 k_y) ; \]
\[ P; \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_z + \sigma_2 k_y) ; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_2 k_x + \sigma_1 k_y) + c_5 (\sigma_1 k_z - \sigma_2 k_y) ; \]
\[ \{R_4\}, \{R_2\}: \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_z + \sigma_2 k_y) ; \]

SG 145
\[ \Gamma_h; \{C_3^+\}^4[00\frac{1}{2}] ; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{R_2, R_6\}: c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_+ + h.c.) ; \]
\[ \{R_4, R_6\}: (c_1 + c_2 k^2 + c_3 k^2) \sigma_0 + \sum_{i=1}^3 \sigma_i [(c_{i,1} + c_{i,2} k^2 + c_{i,3} k^2) k_x + c_{i,4} k_x (k^2 - 3k^2_y) + c_{i,5} k_y (3k^2_x - k^2_y)] ; \]
\[ M; \{R_2, R_7\}: c_1 \sigma_0 + \sum_{i=1}^3 \sigma_i (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) ; \]
\[ A; \{R_2, R_7\}: c_1 \sigma_0 + c_2 \sigma_3 k_x + (\alpha_1 \sigma_+ k_+ + h.c.) ; \]
\[ \{R_4, R_7\}: (c_1 + c_2 k^2 + c_3 k^2) \sigma_0 + \sum_{i=1}^3 \sigma_i [(c_{i,1} + c_{i,2} k^2 + c_{i,3} k^2) k_x + c_{i,4} k_x (k^2 - 3k^2_y) + c_{i,5} k_y (3k^2_x - k^2_y)] ; \]
\[ L; \{R_2, R_7\}: c_1 \sigma_0 + \sum_{i=1}^3 \sigma_i (c_{i,1} k_x + c_{i,2} k_y + c_{i,3} k_z) ; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y); \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_2 k_x + \sigma_1 k_y) + c_5 (\sigma_1 k_x - \sigma_2 k_y); \]
\[ \{ R_4 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y); \]
\[ P: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y); \]
\[ \{ R_2 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y); \]

SG 146
\[ \Gamma_{rh}; \{ C_4^+ |000 \}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma: \{ R_2, R_6 \} : c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_1, k_+ + h.c.); \]
\[ \{ R_4, R_6 \} : (c_1 + c_3 k^2 - c_5 k^2) \sigma_0 + \sum_{i=1}^{3} \sigma_i [c_{i,1} + c_{i,2} k^2 + c_{i,3} k^2] k_z + c_{i,4} k_x (k_z^2 - 3k_x^2) + c_{i,5} k_y (3k_z^2 - k_x^2)]; \]
\[ Z: \{ R_2, R_6 \} : c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_1, k_+ + h.c.); \]
\[ \{ R_4, R_6 \} : (c_1 + c_3 k^2 - c_5 k^2) \sigma_0 + \sum_{i=1}^{3} \sigma_i [c_{i,1} + c_{i,2} k^2 + c_{i,3} k^2] k_z + c_{i,4} k_x (k_z^2 - 3k_x^2) + c_{i,5} k_y (3k_z^2 - k_x^2)]; \]
\[ L: \{ R_2, R_2 \} : c_1 \sigma_0 + \sum_{i=1}^{3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y + c_{i,3} k_z); \]
\[ (a) F: \{ R_2, R_2 \} : c_1 \sigma_0 + \sum_{i=1}^{3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y + c_{i,3} k_z); \]
\[ (b) F: \{ R_2, R_2 \} : c_1 \sigma_0 + \sum_{i=1}^{3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y + c_{i,3} k_z); \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y); \]
\[ \{ R_2 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_2 k_x + \sigma_1 k_y) + c_5 (\sigma_1 k_x - \sigma_2 k_y); \]
\[ \{ R_4 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y); \]
\[ P: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y); \]
\[ \{ R_2 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_2 k_x + \sigma_1 k_y) + c_5 (\sigma_1 k_x - \sigma_2 k_y); \]
\[ \{ R_4 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y); \]

SG 147
\[ \Gamma_{h}; \{ S_6^+ |000 \}, \{ I|000 \}, T; \text{Centrosymmetric; with SOC} \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2 \}, \{ R_4 \} : \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_5 k_x + c_5 k_y) + \Gamma_{2,3} (c_4 k_y - c_5 k_x) + (\alpha_1 \Gamma_{2,4} k_- + h.c.); \]
\[ P: \{ R_2 \}, \{ R_4 \} : \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_5 k_x + c_5 k_y) + \Gamma_{2,3} (c_4 k_y - c_5 k_x) + (\alpha_1 \Gamma_{2,4} k_- + h.c.); \]

SG 148
\[ \Gamma_{rh}; \{ S_6^+ |000 \}, \{ I|000 \}, T; \text{Centrosymmetric; with SOC} \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_2, R_6\}, \{R_4, R_4\}; \Gamma_{0,0}^0 (c_1 + c_2 k_z) + \Gamma_{3,0}^1 (c_4 k_x + c_5 k_y) + \Gamma_{1,0}^3 (c_4 k_y - c_5 k_x) + (\alpha_1 \Gamma_{2,1} + k_z + h.c.); \]

\[ P; \{R_2, R_6\}, \{R_4, R_4\}; \Gamma_{0,0}^0 (c_1 + c_2 k_z) + \Gamma_{3,0}^1 (c_4 k_x + c_5 k_y) + \Gamma_{1,0}^3 (c_4 k_y - c_5 k_x) + (\alpha_1 \Gamma_{2,1} + k_z + h.c.); \]

SG 149

\[ \Gamma_h; \{C_3^+ [000]\}, \{C_3^- [000]\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + c_4 \sigma_3 k_x (k_y^2 - 3k_z^2) + \{ \sigma_+ [\alpha_1 k_y (k_y^2 - 3k_z^2) + k_z (\alpha_2 + \alpha_3 k^2 + \alpha_4 k_z^2)] + h.c. \}; \]

\[ R_6; \sigma_2 (\sigma_3 k_x + \sigma_1 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

\[ M; \{R_2, R_4\}; c_1 \sigma_0 + c_2 \sigma_3 k_x + \sum_{i=1}^2 \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

\[ A; \{R_2, R_4\}; (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + c_4 \sigma_3 k_x (k_y^2 - 3k_z^2) + \{ \sigma_+ [\alpha_1 k_y (k_y^2 - 3k_z^2) + k_z (\alpha_2 + \alpha_3 k^2 + \alpha_4 k_z^2)] + h.c. \}; \]

\[ R_6; \sigma_2 (\sigma_3 k_x + \sigma_1 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

\[ L; \{R_2, R_4\}; c_1 \sigma_0 + c_2 \sigma_3 k_x + \sum_{i=1}^2 \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

Accidental degeneracies on high symmetry line

\[ \Delta; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + \{ (i + \sqrt{3}) c_4 \sigma_4 k_z + h.c. \}; \]

\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + \{ (i - \sqrt{3}) c_4 \sigma_4 k_z + h.c. \}; \]

\[ \{R_4\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + \{ (i + \sqrt{3}) c_4 \sigma_4 k_z + h.c. \}; \]

\[ P; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + \{ (i + \sqrt{3}) c_4 \sigma_4 k_z + h.c. \}; \]

\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + \{ (i - \sqrt{3}) c_4 \sigma_4 k_z + h.c. \}; \]

\[ \{R_4\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + \{ (i + \sqrt{3}) c_4 \sigma_4 k_z + h.c. \}; \]

\[ \Sigma; \{R_2\}, \{R_2\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + \sum_{i=1}^2 \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

\[ R; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + \sum_{i=1}^2 \sigma_i (c_{i,1} k_y + c_{i,2} k_z); \]

SG 150

\[ \Gamma_h; \{C_3^+ [000]\}, \{C_3^- [000]\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{R_3, R_4\}; (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + c_4 \sigma_3 k_y (k_y^2 - 3k_z^2) + \{ \sigma_+ [\alpha_1 k_x (k_x^2 - 3k_z^2) + k_z (\alpha_2 + \alpha_3 k^2 + \alpha_4 k_z^2)] + h.c. \}; \]

\[ R_6; \sigma_2 (\sigma_3 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

\[ M; \{R_2, R_4\}; c_1 \sigma_0 + c_2 \sigma_3 k_y + \sum_{i=1}^2 \sigma_i (c_{i,1} k_x + c_{i,2} k_z); \]

\[ A; \{R_3, R_4\}; (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + c_4 \sigma_3 k_y (k_y^2 - 3k_z^2) + \{ \sigma_+ [\alpha_1 k_x (k_x^2 - 3k_z^2) + k_z (\alpha_2 + \alpha_3 k^2 + \alpha_4 k_z^2)] + h.c. \}; \]

\[ R_6; \sigma_2 (\sigma_3 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

\[ L; \{R_2, R_4\}; c_1 \sigma_0 + c_2 \sigma_3 k_y + \sum_{i=1}^2 \sigma_i (c_{i,1} k_x + c_{i,2} k_z); \]

\[ K; R_6; c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

\[ H; R_6; c_2 (\sigma_1 k_x - \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + \left[(1 - i\sqrt{3}) c_4 \sigma_4_{x\perp} + h.c\right]; \]

\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + \left[(1 + i\sqrt{3}) c_4 \sigma_4_{x\perp} + h.c\right]; \]

\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + \left[(1 - i\sqrt{3}) c_4 \sigma_4_{x\perp} + h.c\right]; \]

\[ P: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + c_4 (\sigma_1k_y - \sigma_2k_x) + c_5 (\sigma_1k_x - \sigma_2k_y); \]

\[ \{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + c_4 (\sigma_2k_x + \sigma_1k_y) + c_5 (\sigma_1k_x - \sigma_2k_y); \]

\[ \{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + c_4 (\sigma_1k_y - \sigma_2k_x) + c_5 (\sigma_1k_x + \sigma_2k_y); \]

\[ T: \{R_2\}, \{R_4\}; \sigma_0 \left[c_1 + c_2 \sqrt{3}k_x + k_y\right] + \sigma_3c_3 \left(\sqrt{3}k_x + k_y\right) + \sum_{i=1}^{2} \sigma_i \left[c_{i,1} (k_x - \sqrt{3}k_y) + c_{i,2}k_z\right]; \]

\[ S: \{R_2\}, \{R_4\}; \sigma_0 \left[c_1 + c_2 \sqrt{3}k_x + k_y\right] + \sigma_3c_3 \left(\sqrt{3}k_x + k_y\right) + \sum_{i=1}^{2} \sigma_i \left[c_{i,1} (k_x - \sqrt{3}k_y) + c_{i,2}k_z\right]; \]

\[ T': \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + \sum_{i=1}^{2} \sigma_i (c_{i,1}k_x + c_{i,2}k_z); \]

\[ S': \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + \sum_{i=1}^{2} \sigma_i (c_{i,1}k_x + c_{i,2}k_z); \]
Accidental degeneracies on high symmetry line

$$\Delta: \{R_2\}, \{R_4\}; \sigma_0(c_1 + c_2k_x) + 3c_3k_z + \left\{ (i + \sqrt{3}) c_4\sigma_4 k_y + h.c. \right\};$$
$$\{R_2\}, \{R_4\}; \sigma_0(c_1 + c_2k_x) + 3c_3k_z + \left\{ (i - \sqrt{3}) c_4\sigma_4 k_y + h.c. \right\};$$
$$\{R_4\}, \{R_6\}; \sigma_0(c_1 + c_2k_x) + 3c_3k_z + \left\{ (i + \sqrt{3}) c_4\sigma_4 k_y + h.c. \right\};$$

$$\Sigma: \{R_2\}, \{R_4\}; \sigma_0(c_1 + c_2k_x) + 3c_3k_z + \sum_{i=1}^2 \sigma_i(c_{i,1}k_y + c_{i,2}k_z);$$

$$R: \{R_2\}, \{R_8\}; \sigma_0(c_1 + c_2k_x) + 3c_3k_z + \sum_{i=1}^2 \sigma_i(c_{i,1}k_y + c_{i,2}k_z);$$

SG 152

$$\Gamma_h; \{C'_{2}\bar{h}|00\frac{1}{2}\}, \{C'_1|00\frac{1}{2}\}, T; \text{Non-Centrosymmetric; with SOC}$$

$$\Gamma; \{R_3, R_4\}; (c_1 + c_2k_x^2 + c_3k_z^2)\sigma_0 + c_4\sigma_3k_y(k_y^2 - 3k_z^2) + \left\{ \sigma_3 \left[ \alpha_1k_x(k_x^2 - 3k_y^2) + k_z(\alpha_2 + \alpha_3k_x' + \alpha_4k_z) \right] + h.c. \right\};$$
$$R_6; \quad c_2(\sigma_3k_x + \sigma_1k_y) - c_3\sigma_2k_x + c_1\sigma_0;$$

$$M; \{R_2, R_4\}; c_1\sigma_0 + c_2\sigma_3k_y + \sum_{i=1}^2 \sigma_i(c_{i,1}k_y + c_{i,2}k_z);$$

$$A; \{R_3, R_4\}; (c_1 + c_2k_x^2 + c_3k_z^2)\sigma_0 + c_4\sigma_3k_y(k_y^2 - 3k_z^2) + \left\{ \sigma_3 \left[ \alpha_1k_x(k_x^2 - 3k_y^2) + k_z(\alpha_2 + \alpha_3k_x' + \alpha_4k_z) \right] + h.c. \right\};$$
$$R_6; \quad c_2(\sigma_3k_x - \sigma_1k_y) - c_3\sigma_2k_x + c_1\sigma_0;$$

$$L; \{R_2, R_4\}; c_1\sigma_0 + c_2\sigma_3k_y + \sum_{i=1}^2 \sigma_i(c_{i,1}k_x + c_{i,2}k_z);$$

$$K; \{R_6\}; \quad c_2(\sigma_1k_x - \sigma_3k_y) - c_3\sigma_2k_x + c_1\sigma_0;$$

$$H; \{R_6\}; \quad c_2(\sigma_1k_x + \sigma_3k_y) - c_3\sigma_2k_x + c_1\sigma_0;$$
Accidental degeneracies on high symmetry line

\[\Delta: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + [(1 - i \sqrt{3}) c_4 \sigma_i k_z + h.c.];\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + [(1 + i \sqrt{3}) c_4 \sigma_i k_z + h.c.];\]
\[\{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + [(1 - i \sqrt{3}) c_4 \sigma_i k_z + h.c.];\]
\[P: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \alpha_1 k_y + \alpha_2 k_x + \alpha_3 k_y + c_4 (c_3, c_4);\]
\[\{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \alpha_1 k_y + \alpha_2 k_x + \alpha_3 k_y + c_4 (c_3, c_4);\]
\[\{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \alpha_1 k_y + \alpha_2 k_x + \alpha_3 k_y + c_4 (c_3, c_4);\]
\[T: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 (\sqrt{3} k_x + k_y)) + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x - \sqrt{3} k_y + c_{i,2} k_z);\]
\[S: \{R_2\}, \{R_12\}; \sigma_0 (c_1 + c_2 (\sqrt{3} k_x + k_y)) + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x - \sqrt{3} k_y + c_{i,2} k_z);\]
\[T': \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_z);\]
\[S': \{R_2\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_z);\]

\[\Gamma; \{C_3^2[00 \frac{1}{2}], C_3^2[00 \frac{1}{2}\bar{1}], T\}; \text{Non-Centrosymmetric; with SOC}\]
\[\Gamma: \{R_3, R_4\}; (c_1 + c_2 k_x + c_3 k_y) \sigma_0 + c_4 \sigma_4 k_x (k_y^2 - k_z^2) + \{ \sigma_3 [\alpha_4 k_y (k_y^2 - k_z^2) + k_z (\alpha_2 + \alpha_3 k_x + \alpha_4 k_z)] + h.c.\};\]
\[\{R_6\}; c_4 (\sigma_4 k_x + \sigma_1 k_y) - c_3 \sigma_3 k_x + c_1 \sigma_0;\]
\[M; \{R_2, R_4\}; c_1 \sigma_0 + c_2 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z);\]
\[A; \{R_3, R_4\}; (c_1 + c_2 k_x + c_3 k_y) \sigma_0 + c_4 \sigma_4 k_x (k_y^2 - k_z^2) + \{ \sigma_3 [\alpha_4 k_y (k_y^2 - k_z^2) + k_z (\alpha_2 + \alpha_3 k_x + \alpha_4 k_z)] + h.c.\};\]
\[\{R_6\}; c_4 (\sigma_4 k_x + \sigma_1 k_y) - c_3 \sigma_3 k_x + c_1 \sigma_0;\]
\[L; \{R_2, R_4\}; c_1 \sigma_0 + c_2 \sigma_3 k_x + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z);\]

Accidental degeneracies on high symmetry line

\[\Delta: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + [(i + \sqrt{3}) c_4 \sigma_i k_z + h.c.];\]
\[\{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + [(i - \sqrt{3}) c_4 \sigma_i k_z + h.c.];\]
\[\{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + [(i + \sqrt{3}) c_4 \sigma_i k_z + h.c.];\]
\[P: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + [(i + \sqrt{3}) c_4 \sigma_i k_z + h.c.];\]
\[\{R_2\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + [(i - \sqrt{3}) c_4 \sigma_i k_z + h.c.];\]
\[\{R_4\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + [(i + \sqrt{3}) c_4 \sigma_i k_z + h.c.];\]
\[\Sigma: \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z);\]
\[R; \{R_6\}, \{R_{12}\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_y + c_{i,2} k_z);\]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2, R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + [(1 - i \sqrt{3}) c_4 \sigma_3 k_- + h.c.]; \]

\[ \{R_2, R_6\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + [(1 + i \sqrt{3}) c_4 \sigma_3 k_- + h.c.]; \]

\[ \{R_4, R_6\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + [(1 - i \sqrt{3}) c_4 \sigma_3 k_- + h.c.]; \]

\[ P: \{R_2, R_4\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_y) + c_5 (\sigma_1 k_z + \sigma_2 k_z); \]

\[ \{R_2, R_6\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_2 k_x + \sigma_1 k_y) + c_5 (\sigma_1 k_z - \sigma_2 k_z); \]

\[ \{R_4, R_6\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_y) + c_5 (\sigma_1 k_z + \sigma_2 k_z); \]

\[ T: \{R_2, R_4\}; \quad \sigma_0 \left[ c_1 + c_2 (\sqrt{3}k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3}k_x + k_y) + \sum_{i=1}^{2} \sigma_i \left[ c_{i,1} (k_x - \sqrt{3}k_y) + c_{i,2} k_z \right]; \]

\[ S: \{R_2, R_6\}; \quad \sigma_0 \left[ c_1 + c_2 (\sqrt{3}k_x + k_y) \right] + \sigma_3 c_3 (\sqrt{3}k_x + k_y) + \sum_{i=1}^{2} \sigma_i \left[ c_{i,1} (k_x - \sqrt{3}k_y) + c_{i,2} k_z \right]; \]

\[ T': \{R_2, R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_z); \]

\[ S': \{R_2, R_6\}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_z); \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2k_z \right) + \sigma_3\sqrt{3}k_z + \left( i + \sqrt{3} \right) c_4\sigma_1k_x + h.c.; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2k_z \right) + \sigma_3\sqrt{3}k_z + \left( i - \sqrt{3} \right) c_4\sigma_1k_x + h.c.; \]
\[ \{R_4\}, \{R_6\}; \sigma_0 \left( c_1 + c_2k_z \right) + \sigma_3\sqrt{3}k_z + \left( i + \sqrt{3} \right) c_4\sigma_1k_x + h.c.; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2k_z \right) + \sigma_3\sqrt{3}k_z + \left( i - \sqrt{3} \right) c_4\sigma_1k_x + h.c.; \]
\[ \{R_4\}, \{R_6\}; \sigma_0 \left( c_1 + c_2k_z \right) + \sigma_3\sqrt{3}k_z + \left( i + \sqrt{3} \right) c_4\sigma_1k_x + h.c.; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2k_x \right) + \sigma_3c_3k_x + \left[ (i + \sqrt{3}) c_4\sigma_1k_x \right. + h.c.; \]
\[ \{R_4\}, \{R_6\}; \sigma_0 \left( c_1 + c_2k_x \right) + \sigma_3c_3k_x + \left[ (i - \sqrt{3}) c_4\sigma_1k_x \right. + h.c.; \]
\[ \{R_6\}; \sigma_0 \left( c_1 + c_2k_x \right) + \sigma_3c_3k_x + \left[ (i + \sqrt{3}) c_4\sigma_1k_x \right. + h.c.; \]
\[ \{R_4\}, \{R_6\}; \sigma_0 \left( c_1 + c_2k_x \right) + \sigma_3c_3k_x + \left[ (i - \sqrt{3}) c_4\sigma_1k_x \right. + h.c.; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2k_x \right) + \sigma_3c_3k_x + \sum_{i=1}^{2} \sigma_i \left( c_{i,1}k_y + c_{i,2}k_x \right); \]
\[ \{R_2\}, \{R_4\}; \sigma_0 \left( c_1 + c_2k_x \right) + \sigma_3c_3k_x + \sum_{i=1}^{2} \sigma_i \left( c_{i,1}k_y + c_{i,2}k_x \right); \]
\[ \{R_2\}, \{R_4\}; \sigma_0 \left[ c_1 + c_2 \left( k_x + \sqrt{3}k_y \right) \right] + \sigma_3c_3 \left( k_x - \sqrt{3}k_y \right) + \sum_{i=1}^{2} \sigma_i \left[ c_{i,1} \left( \sqrt{3}k_x - k_y \right) + c_{i,2}k_x \right]; \]
\[ \{R_2\}, \{R_4\}; \sigma_0 \left[ c_1 + c_2 \left( k_x - \sqrt{3}k_y \right) \right] + \sigma_3c_3 \left( k_x - \sqrt{3}k_y \right) + \sum_{i=1}^{2} \sigma_i \left[ c_{i,1} \left( \sqrt{3}k_x + k_y \right) + c_{i,2}k_x \right]; \]

SG 156

\[ \Gamma; \{C^0_3\mid000\}, \{\sigma_z\mid000\}, T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{R_3, R_4\}; c_2\sigma_3k_x + c_1\sigma_0; \]
\[ R_6; \quad c_2 \left( \sigma_2k_x + \sigma_1k_y \right) + c_1\sigma_0; \]
\[ M; \{R_2, R_4\}; \sigma_3 \left( c_2k_x + c_4k_z \right) + \left( c_3\sigma_1 - c_5\sigma_2 \right) k_y + c_1\sigma_0; \]
\[ A; \{R_3, R_4\}; c_2\sigma_3k_x + c_1\sigma_0; \]
\[ R_6; \quad c_2 \left( \sigma_2k_x + \sigma_1k_y \right) + c_1\sigma_0; \]
\[ L; \{R_2, R_4\}; \sigma_3 \left( c_2k_x + c_4k_z \right) + \left( c_3\sigma_1 - c_5\sigma_2 \right) k_y + c_1\sigma_0; \]
\[ \Delta; \{R_6\}; \quad c_2 \left( \sigma_3k_x + \sigma_1k_y \right) + \sigma_0 \left( c_3k_x + c_1 \right); \]

Accidental degeneracies on high symmetry line

\[ \Delta; \{R_5\}, \{R_4\}; \sigma_0 \left( c_1 + c_2k_z \right) + \sigma_3c_2k_z; \]
\[ \{R_3\}, \{R_6\}; \quad A_0 \left( c_1 + c_2k_z \right) + \left( \sqrt{3}A_5 + A_6 \right) c_3k_x + \left[ A_4c_4 + \left( \sqrt{3}A_8 - A_5 \right) c_5 - A_1c_6 \right] k_x - \left( A_6c_4 - 2A_7c_5 - A_2c_6 \right) k_y; \]
\[ \{R_4\}, \{R_6\}; \quad A_0 \left( c_1 + c_2k_z \right) + \left( \sqrt{3}A_5 + A_6 \right) c_3k_x + \left[ A_4c_4 + \left( \sqrt{3}A_8 - A_5 \right) c_5 - A_2c_6 \right] k_x + \left( A_4c_4 + 2A_7c_5 - A_1c_6 \right) k_y; \]
\[ U; \{R_2, R_4\}; \sigma_0 \left( c_1 + c_2k_z + c_3k_z \right) + \sigma_3 \left( c_4k_x + c_5k_z \right) + \left( c_6\sigma_1 + c_7\sigma_2 \right) k_y; \]
\[ P; \{R_2, R_4\}; \sigma_0 \left( c_1 + c_2k_z + c_3k_z \right) + \sigma_3 \left( c_4k_x + c_5k_z \right) + \left( c_6\sigma_1 + c_7\sigma_2 \right) k_y; \]
\[ \sigma_0 \left( c_1 + c_2k_z + c_3k_z \right) + \sigma_3 \left( c_4k_x + c_5k_z \right) + \left( c_6\sigma_1 + c_7\sigma_2 \right) k_y; \]
\[ \Sigma; \{R_2, R_4\}; \sigma_0 \left( c_1 + c_2k_z + c_3k_z \right) + \sigma_3 \left( c_4k_x + c_5k_z \right) + \left( c_6\sigma_1 + c_7\sigma_2 \right) k_y; \]
\[ R; \{R_2, R_4\}; \sigma_0 \left( c_1 + c_2k_z + c_3k_z \right) + \sigma_3 \left( c_4k_x + c_5k_z \right) + \left( c_6\sigma_1 + c_7\sigma_2 \right) k_y; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_3, R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]
\[ \{R_3, R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + (A_6 c_4 + 2 A_7 c_5 - A_2 c_6) k_x + [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] k_y; \]
\[ \{R_4, R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + (A_4 c_4 + 2 A_7 c_5 - A_1 c_6) k_x - [A_6 c_4 - (A_5 - \sqrt{3} A_8) c_5 - A_2 c_6] k_y; \]

\[ U: \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_y + c_3 k_x) + \sigma_3 (c_4 k_y + c_5 k_x) + (c_6 \sigma_1 + c_7 \sigma_2) k_x; \]
\[ P: \{R_3, R_4\}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x; \]
\[ \{R_3, R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + (A_6 c_4 + 2 A_7 c_5 - A_2 c_6) k_x + [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] k_y; \]
\[ \{R_4, R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_x + (A_4 c_4 + 2 A_7 c_5 - A_1 c_6) k_x - [A_6 c_4 - (A_5 - \sqrt{3} A_8) c_5 - A_2 c_6] k_y; \]

\[ T: \{R_2, R_4\}; \sigma_0 [c_1 + c_2 (\sqrt{3} k_x + k_y) + c_3 k_x] + \sigma_3 [c_4 (\sqrt{3} k_x + k_y) + c_5 k_x] + (c_6 \sigma_1 + c_7 \sigma_2) (k_x - \sqrt{3} k_y); \]
\[ S: \{R_2, R_4\}; \sigma_0 [c_1 + c_2 (\sqrt{3} k_x + k_y) + c_3 k_x] + \sigma_3 [c_4 (\sqrt{3} k_x + k_y) + c_5 k_x] + (c_6 \sigma_1 + c_7 \sigma_2) (k_x - \sqrt{3} k_y); \]

\[ T': \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_y + c_3 k_x) + \sigma_3 (c_4 k_y + c_5 k_x) + (c_6 \sigma_1 + c_7 \sigma_2) k_x; \]
\[ S': \{R_2, R_4\}; \sigma_0 (c_1 + c_2 k_y + c_3 k_x) + \sigma_3 (c_4 k_y + c_5 k_x) + (c_6 \sigma_1 + c_7 \sigma_2) k_x; \]
\( \Gamma; \{ R_3, R_4 \}; c_2 \sigma_3 k_x + c_1 \sigma_0;\)

\( R_6; \ c_2 (\sigma_3 k_x + \sigma_1 k_y) + c_1 \sigma_0;\)

\( M; \{ R_2, R_4 \}; \sigma_1 (c_2 k_x + c_4 k_z) + (c_3 \sigma_1 - c_2 \sigma_2) k_y + c_1 \sigma_0;\)

\( A; \{ R_1, R_1 \}; c_1 \sigma_0 + \sum_{i=1}^{3} c_{i,1} k_x \sigma_i;\)

\( \{ R_2, R_2 \}; c_1 \sigma_0 + \sum_{i=1}^{3} c_{i,1} k_x \sigma_i;\)

\( \{ R_5, R_5 \}; c_1 \Gamma_{0,0} + \sum_{i=1}^{3} [c_{i,1} (\Gamma_{i,3} k_x - \Gamma_{i,1} k_y) + c_{i,2} \Gamma_{i,0} k_z];\)

\( L; \{ R_1, R_1 \}; c_1 \sigma_0 + \sum_{i=1}^{3} [c_{i,1} k_x + c_{i,2} k_z] \sigma_i;\)

\( \{ R_3, R_3 \}; c_1 \sigma_0 + \sum_{i=1}^{3} [c_{i,1} k_x + c_{i,2} k_z] \sigma_i;\)

\( H; \{ R_2, R_2 \}; c_1 \sigma_0 + \sum_{i=1}^{3} c_{i,1} k_x \sigma_i;\)

\( \{ R_6, R_6 \}; c_1 \sigma_0 + \sum_{i=1}^{3} c_{i,1} k_x \sigma_i;\)

\( \Lambda; \{ R_2 \}; c_2 (\sigma_3 k_x + \sigma_1 k_y) + \sigma_0 (c_2 k_x + c_1);\)

\( S; \{ R_2, R_2 \}; [c_1 + c_2 (\sqrt{3} k_x + k_y)] \sigma_0 + \sum_{i=1}^{3} [c_{i,1} (k_x - \sqrt{3} k_y) + c_{i,2} k_z] \sigma_i;\)

\( S'; \{ R_2, R_2 \}; (c_1 + c_2 k_y) \sigma_0 + \sum_{i=1}^{3} [c_{i,1} k_x + c_{i,2} k_z] \sigma_i;\)

Accidental degeneracies on high symmetry line

\( \Delta; \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_2 k_z;\)

\( \{ R_3 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_2 + A_0) c_3 k_z + [A_4 c_4 + (\sqrt{3} A_4 - A_5) c_5 - A_1 c_6] k_x - (A_6 c_4 - 2A_7 c_5 - A_2 c_6) k_y;\)

\( \{ R_4 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_2 + A_0) c_3 k_z + [A_4 c_4 + (\sqrt{3} A_4 - A_5) c_5 - A_2 c_6] k_x + (A_4 c_4 + 2A_7 c_5 - A_1 c_6) k_y;\)

\( U; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_z) + \sigma_3 (c_4 k_x + c_5 k_z) + (c_0 \sigma_1 + c_2 \sigma_2) k_y;\)

\( P; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_z) + \sigma_3 (c_4 k_x + c_5 k_z) + (c_0 \sigma_1 - c_2 \sigma_2) k_y;\)

\( \Sigma; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_z) + \sigma_3 (c_4 k_x + c_5 k_z) + (c_0 \sigma_1 + c_2 \sigma_2) k_y;\)

\( R; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x + c_3 k_z) + \sigma_3 (c_4 k_x + c_5 k_z) + (c_0 \sigma_1 - c_2 \sigma_2) k_y;\)
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_3, R_4\}; c_0 (c_1 + c_2 k_x + \sigma_3 c_3 k_x) + c_3 c_4 k_z; \]
\[ \{R_3, R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z + (A_6 c_4 + 2 A_7 c_5 - A_2 c_8) k_x + [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] k_y; \]
\[ \{R_4, R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z + (A_6 c_4 + 2 A_7 c_5 - A_2 c_8) k_x - [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] k_y; \]
\[ \{R_4, R_5\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z + (A_6 c_4 + 2 A_7 c_5 - A_2 c_8) k_x - [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] k_y; \]
\[ \{R_4, R_6\}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z + (A_6 c_4 + 2 A_7 c_5 - A_2 c_8) k_x - [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] k_y; \]
\[ \{R_2, R_4\}; c_0 [c_1 + c_2 (\sqrt{3} k_x + k_y) + c_3 k_z] + \sigma_3 [c_1 (\sqrt{3} k_x + k_y) + c_3 k_z] + (c_0 \sigma_1 + c_7 \sigma_2) (k_x - \sqrt{3} k_y); \]
\[ \{R_2, R_4\}; c_0 [c_1 + c_2 (\sqrt{3} k_x + k_y) + c_3 k_z] + \sigma_3 [c_1 (\sqrt{3} k_x + k_y) + c_3 k_z] + (c_0 \sigma_1 + c_7 \sigma_2) (k_x - \sqrt{3} k_y); \]
\[ \{R_2, R_4\}; c_0 (c_1 + c_2 k_y + c_3 k_z) + \sigma_3 (c_1 k_y + c_3 k_z) + (c_0 \sigma_1 + c_7 \sigma_2) k_x; \]
\[ \{R_2, R_4\}; c_0 (c_1 + c_2 k_y + c_3 k_z) + \sigma_3 (c_1 k_y + c_3 k_z) + (c_0 \sigma_1 + c_7 \sigma_2) k_x; \]

SG 160

\[ \Gamma_{\nu}; \{C^+_3 |000\}, \{\sigma_{d1} |000\}, T; Non-Centrosymmetric; with SOC \]

\[ \Gamma: \{R_3, R_4\}; c_2 \sigma_3 k_x + c_1 \sigma_0; \]
\[ R_6: c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ Z: \{R_3, R_4\}; c_2 \sigma_3 k_x + c_1 \sigma_0; \]
\[ R_6: c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ L: \{R_2, R_4\}; c_1 \sigma_0 + \sigma_3 [c_2 (\sqrt{3} k_x + k_y) + c_3 k_z] + \sum_{i=1}^{2} c_i \sigma_i (k_x - \sqrt{3} k_y); \]
\[ (a) F: \{R_2, R_4\}; c_1 \sigma_0 + \sigma_3 [c_2 (\sqrt{3} k_x + k_y) + c_3 k_z] + \sum_{i=1}^{2} c_i \sigma_i (k_x + \sqrt{3} k_y); \]
\[ (b) F: \{R_2, R_4\}; c_1 \sigma_0 + \sigma_3 [c_2 (\sqrt{3} k_x - k_y) + c_3 k_z] + \sum_{i=1}^{2} c_i \sigma_i (k_x + \sqrt{3} k_y); \]
\[ \Lambda: R_6: c_2 (\sigma_1 k_x - \sigma_3 k_y) + \sigma_0 (c_3 k_z + c_1); \]
\[ P: R_6: c_2 (\sigma_1 k_x - \sigma_3 k_y) + \sigma_0 (c_3 k_z + c_1); \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z; \]

\[ \{R_3\}, \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + (A_6c_4 + 2A_7c_5 - A_2c_6) k_x + [A_4c_4 + (A_5 - \sqrt{3}A_8) c_5 - A_1c_6] k_y; \]

\[ \{R_4\}, \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + (A_4c_4 + 2A_7c_5 - A_1c_6) k_x - [A_6c_4 - (A_5 - \sqrt{3}A_8) c_5 - A_2c_6] k_y; \]

\[ P; \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z; \]

\[ \{R_3\}, \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + (A_6c_4 + 2A_7c_5 - A_2c_6) k_x + [A_4c_4 + (A_5 - \sqrt{3}A_8) c_5 - A_1c_6] k_y; \]

\[ \{R_4\}, \{R_6\}; A_0 (c_1 + c_2k_z) + (\sqrt{3}A_5 + A_8) c_3k_z + (A_4c_4 + 2A_7c_5 - A_1c_6) k_x - [A_6c_4 - (A_5 - \sqrt{3}A_8) c_5 - A_2c_6] k_y; \]
SG 161

Γ_h: \{C_4^+ [000] \}, \{σ_d1 [\frac{1}{2} \frac{1}{2} \frac{1}{2}] \}; T; Non-Centrosymmetric; with SOC

Γ:
\{R_3, R_4\}: c_2σ_3k_x + c_1σ_0;
\{R_6\}: c_2(σ_1k_x − σ_3k_y) + c_1σ_0;
Z:
\{R_1, R_1\}; (c_3σ_1 − c_4σ_2 + c_2σ_3)k_z + c_1σ_0;
\{R_2, R_2\}; (c_3σ_1 − c_4σ_2 + c_2σ_3)k_z + c_1σ_0;
\{R_5, R_5\}; c_1Γ_{0,0} + \sum_{i=1}^3 [c_{1,i} (Γ_{1,1}k_x + Γ_{1,1}k_y) + c_{1,2}Γ_{1,0}k_z] ;
L:
\{R_1, R_1\}; c_1σ_0 + \sum_{i=1}^3 [c_{1,i} (\sqrt{3}k_x + k_y) + c_{1,2}k_2] σ_i;
\{R_3, R_3\}; c_1σ_0 + \sum_{i=1}^3 [c_{1,i} (\sqrt{3}k_x + k_y) + c_{1,2}k_2] σ_i;

(a)F:\{R_2, R_4\}; c_1σ_0 + σ_3(c_2k_y + c_3k_z) + \sum_{i=1}^2 c_{1,i}σ_2k_2;
(b)F:\{R_2, R_4\}; c_1σ_0 + σ_3(c_2(\sqrt{3}k_x − k_y) + c_3k_2) + \sum_{i=1}^2 c_{1,i}σ_2k_2;
L:
\{R_1, R_1\}; c_1σ_0 + \sum_{i=1}^3 [c_{1,i} (\sqrt{3}k_x + k_y) + c_{1,2}k_2] σ_i;
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y) + c_5 (\Gamma_{2,1} k_x + \Gamma_{2,3} k_y); \]

\[ P: \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y) + c_5 (\Gamma_{2,1} k_x + \Gamma_{2,3} k_y); \]

\[ R: \{ R_5, R_7 \}, \{ R_7, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_z) + \sum_{i=1}^3 \Gamma_{2,i} (c_{i,1} k_y + c_{i,2} k_z); \]

SG 164
\[ \Gamma_h; \{ C_3^+ |000 \}, \{ C_3^+ |00 \}; \{ I|00 \}, T; \text{ Centrosymmetric}; \text{ with SOC} \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y) + c_5 (\Gamma_{2,1} k_y - \Gamma_{2,3} k_x); \]

\[ P: \{ R_2, R_6 \}, \{ R_4, R_4 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \Gamma_{2,3} (c_4 k_y - c_5 k_x) + (\alpha_1 \Gamma_{2,4} k_x + h.c.); \]

SG 165
\[ \Gamma_h; \{ C_3^+ |000 \}, \{ C_3^+ |00 \}; \{ I|00 \}, T; \text{ Centrosymmetric}; \text{ with SOC} \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_{10}, R_{10} \}; \quad (c_1 + c_2 k_x^2 + c_3 k_z^2) \Gamma_{0,0} + c_4 \Gamma_{0,3} k_y (k_x^2 - 3 k_y^2) + \sum_{i=1}^3 \Gamma_{1,2} \left[ (c_{1,1} + c_{2,2} k_x^2 + c_{3,3} k_z^2) k_x + c_{4,4} k_x (k_x^2 - 3 k_y^2) \right]; \]

\[ \{ R_1, R_1 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,1} k_y - \Gamma_{2,2} k_x) + k_z (c_3 \Gamma_{3,1} + c_4 \Gamma_{2,3}); \]

\[ L: \{ R_{10}, R_{10} \}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{0,3} k_y + \sum_{i=1}^3 \Gamma_{1,1} (c_{1,1} k_x + c_{1,3} k_z); \]

\[ H: \{ R_6, R_6 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{1,0} k_x - \Gamma_{2,2} k_y) + k_x (c_3 \Gamma_{1,2} + c_4 \Gamma_{2,2} + c_4 \Gamma_{3,2}); \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x + \Gamma_{2,2} k_y) + c_5 (\Gamma_{2,1} k_x + \Gamma_{2,3} k_y); \]

\[ P: \{ R_2, R_6 \}, \{ R_4, R_4 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \Gamma_{2,3} (c_4 k_y - c_5 k_x) + (\alpha_1 \Gamma_{2,4} k_x + h.c.); \]

\[ S: \{ R_5, R_5 \}, \{ R_7, R_7 \}; \quad \Gamma_{0,0} [c_1 + c_2 (\sqrt{3} k_x + k_y)] + \Gamma_{3,0} c_3 (\sqrt{3} k_x + k_y) + \Gamma_{1,0} [c_4 (k_x - \sqrt{3} k_y) + c_5 k_z] + \sum_{i=1}^3 \Gamma_{2,i} (c_{i,1} (\sqrt{3} k_y - k_x) - c_{i,2} k_z); \]

\[ S': \{ R_5, R_5 \}, \{ R_7, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + \Gamma_{1,0} (c_4 k_x + c_5 k_z) + \sum_{i=1}^3 \Gamma_{2,i} (c_{i,1} k_x + c_{i,2} k_z); \]

SG 166
\[ \Gamma_h; \{ C_3^+ |000 \}, \{ C_3^+ |00 \}; \{ I|00 \}, T; \text{ Centrosymmetric}; \text{ with SOC} \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_x - \Gamma_{1,0} k_y) + c_5 (\Gamma_{2,1} k_x + \Gamma_{2,3} k_y); \]

\[ P: \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{2,2} k_x - \Gamma_{1,0} k_y) + c_5 (\Gamma_{2,1} k_x + \Gamma_{2,3} k_y); \]
\[ Z: \{ R_{10}, R_{10}\} \times \{ (c_1 + c_2 k^2 + c_3 k_y^2) \Gamma_{0,0} + c_4 \Gamma_{0,3} k_x k_y (k_x^2 - 3k_y^2) + \sum_{i=1}^{3} \Gamma_{i,2} \left[ (c_{i,1} + c_{i,3} k^2 + c_{i,5} k_y^2) k_x + c_{i,4} k_y (k_y^2 - 3k_x^2) \right] \} ; \\
\{ R_{17}, R_{18}\} \times \{ c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,1} k_x + \Gamma_{0,2} k_y) + k_x (c_3 \Gamma_{1,1} + c_4 \Gamma_{2,1}) \} ; \\
L: \{ R_{10}, R_{10}\} \times \{ c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} (k_x - \sqrt{3} k_y) + \sum_{i=1}^{3} \Gamma_{i,1} [c_{i,1} (\sqrt{3} k_x + k_y) + c_{i,2} k_x] \} ; \\
\]

Accidental degeneracies on high symmetry line

\[ \Lambda: \{ R_3, R_4 \} \times \{ R_6 \} \times \{ \Gamma_0, 0 (c_1 + c_2 k_x) + \Gamma_3, 0 c_3 k_z + c_4 (\Gamma_{2,2} k_x - \Gamma_{1,0} k_y) + c_5 (\Gamma_{2,1} k_x + \Gamma_{2,3} k_y) ; \\
P: \{ R_3, R_4 \} \times \{ R_6 \} \times \{ \Gamma_0, 0 (c_1 + c_2 k_x) + \Gamma_3, 0 c_3 k_z + c_4 (\Gamma_{2,2} k_x - \Gamma_{1,0} k_y) + c_5 (\Gamma_{2,1} k_x + \Gamma_{2,3} k_y) ; \\
B: \{ R_5, R_5 \} \times \{ R_7, R_7 \} \times \{ \Gamma_0, 0 (c_1 + c_2 k_x) + \Gamma_3, 0 c_3 k_z + \Gamma_{1,0} (c_3 k_y + c_5 k_z) + \sum_{i=1}^{3} \Gamma_{i,1} (c_{i,1} k_y + c_{i,2} k_x) ; \\
Y: \{ R_3, R_5 \} \times \{ R_7, R_7 \} \times \{ \Gamma_0, 0 [c_1 + c_2 (k_x - \sqrt{3} k_y)] + \Gamma_{3,0} c_3 (k_x - \sqrt{3} k_y) + \Gamma_{1,0} [c_4 (\sqrt{3} k_x + k_y) + c_5 k_z] + \sum_{i=1}^{3} \Gamma_{i,1} [c_{i,1} (\sqrt{3} k_x + k_y) + c_{i,2} k_z] ; \\
\]

\[
\]

SG 168

\[ \Gamma_h: \{ C_0^+ [000] \}, T; Non-Centrosymmetric; with SOC \\
\]

\[ \Gamma: \{ R_2, R_{12} \} \times \{ c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_x + h.c.) ; \\
\{ R_4, R_{10} \} \times \{ c_1 + c_2 k^2 + c_3 k_y^2 \} \sigma_0 + (c_4 + c_5 k^2 + c_6 k_y^2) k_x \sigma_3 + [(\alpha_1 k_x^2 + \alpha_2 k_y^2) \sigma_+ + h.c.] ; \\
\{ R_6, R_8 \} \times \{ \Gamma_0, 0 \} \times \{ c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_x + h.c.) ; \\
M: \{ R_2, R_4 \} \times \{ c_1 \sigma_0 + c_2 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) ; \\
A: \{ R_2, R_{12} \} \times \{ c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_x + h.c.) ; \\
\{ R_4, R_{10} \} \times \{ c_1 + c_2 k^2 + c_3 k_y^2 \} \sigma_0 + (c_4 + c_5 k^2 + c_6 k_y^2) k_x \sigma_3 + [(\alpha_1 k_x^2 + \alpha_2 k_y^2) \sigma_+ + h.c.] ; \\
\{ R_6, R_8 \} \times \{ \Gamma_0, 0 \} \times \{ c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_x + h.c.) ; \\
L: \{ R_2, R_4 \} \times \{ c_1 \sigma_0 + c_2 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{i,1} k_x + c_{i,2} k_y) ; \\
K: \{ R_2, R_6 \} \times \{ c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_x + h.c.) ; \\
H: \{ R_2, R_6 \} \times \{ c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_+ k_x + h.c.) ; \\
\]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_2\}, \{R_{10}\} : c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1,i} k_z + c_{2,i} k^2 + c_{3,i} k_z^2) + (\alpha_1 \sigma_+ k_z^2 + h.c.) ;
\]

\[ \{R_2\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_+ + h.c.) ;
\]

\[ \{R_2\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z^{-} + h.c.) ;
\]

\[ \{R_2\}, \{R_6\} : c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1,i} k_z + c_{2,i} k^2 + c_{3,i} k_z^2) + (\alpha_1 \sigma_+ k_z^2 + h.c.) ;
\]

\[ \{R_2\}, \{R_{12}\} : c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{1,i} k_z (1 + c_{2,i} k^2 + c_{3,i} k_z^2) + c_{1,i} k^2 + c_{2,i} k_z^2] + [(\alpha_1 k_z^2 + \alpha_2 k_z^4) \sigma_+ + h.c.] ;
\]

\[ \{R_4\}, \{R_{10}\} : c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{1,i} k_z (1 + c_{2,i} k^2 + c_{3,i} k_z^2) + c_{1,i} k^2 + c_{2,i} k_z^2] + [(\alpha_1 k_z^2 + \alpha_2 k_z^4) \sigma_+ + h.c.] ;
\]

\[ \{R_4\}, \{R_6\} : c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1,i} k_z + c_{2,i} k^2 + c_{3,i} k_z^2) + (\alpha_1 \sigma_+ k_z^2 + h.c.) ;
\]

\[ \{R_6\}, \{R_{12}\} : c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{1,i} k_z (1 + c_{2,i} k^2 + c_{3,i} k_z^2) + c_{1,i} k^2 + c_{2,i} k_z^2] + [(\alpha_1 k_z^2 + \alpha_2 k_z^4) \sigma_+ + h.c.] ;
\]

\[ \{R_6\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z^{-} + h.c.) ;
\]

\[ \{R_8\}, \{R_{12}\} : c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{1,i} k_z (1 + c_{2,i} k^2 + c_{3,i} k_z^2) + c_{1,i} k^2 + c_{2,i} k_z^2] + [(\alpha_1 k_z^2 + \alpha_2 k_z^4) \sigma_+ + h.c.] ;
\]

\[ \{R_{10}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z^{-} + h.c.) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : c_1 \sigma_0 + c_2 \sigma_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_4\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_z) + c_5 (\sigma_1 k_x + \sigma_2 k_y) ;
\]

\[ \{R_{12}\}, \{R_6\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_2 k_y + \sigma_1 k_x) + c_5 (\sigma_1 k_x - \sigma_2 k_y) ;
\]

\[ \{R_{12}\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y) ;
\]

\[ \{R_{12}\}, \{R_6\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_8\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]

\[ \{R_{12}\}, \{R_{12}\} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{1,i} k_z + c_{2,i} k_y) ;
\]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_2 \}, \{ R_{10} \}; \ c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_z^2) + (\alpha_1 k_z + h.c.) ; \]

\[ \{ R_2 \}, \{ R_{12} \}; \ \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma_0 + h.c.) ; \]

\[ \{ R_2 \}, \{ R_4 \}; \ \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma_0 + h.c.) ; \]

\[ \{ R_2 \}, \{ R_6 \}; \ c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_z^2) + (\alpha_1 k_z + h.c.) ; \]

\[ \{ R_2 \}, \{ R_{10} \}; \ c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{i,1} k_z (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2] + [(\alpha_1 k_z^3 + \alpha_2 k_z^2) \sigma_0 + h.c.] ; \]

\[ \{ R_4 \}, \{ R_{10} \}; \ c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{i,1} k_z (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2] + [(\alpha_1 k_z^3 + \alpha_2 k_z^2) \sigma_0 + h.c.] ; \]

\[ \{ R_4 \}, \{ R_6 \}; \ c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{i,1} k_z (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2] + [(\alpha_1 k_z^3 + \alpha_2 k_z^2) \sigma_0 + h.c.] ; \]

\[ \{ R_6 \}; \ c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{i,1} k_z (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2] + [(\alpha_1 k_z^3 + \alpha_2 k_z^2) \sigma_0 + h.c.] ; \]

\[ \{ R_4 \}, \{ R_{12} \}; \ c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_z^2) + (\alpha_1 \sigma_0 k_z + h.c.) ; \]

\[ \{ R_4 \}, \{ R_6 \}; \ c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_z^2) + (\alpha_1 \sigma_0 k_z + h.c.) ; \]

\[ U; \{ R_2 \}, \{ R_4 \}; \ \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 \sigma_0 k_z + h.c.) ; \]

\[ P; \{ R_2 \}, \{ R_4 \}; \ \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y) ; \]

\[ \{ R_2 \}, \{ R_6 \}; \ \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_x - \sigma_2 k_y) + c_5 (\sigma_1 k_x + \sigma_2 k_y) ; \]

\[ \{ R_4 \}, \{ R_6 \}; \ \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y) ; \]

\[ \mathbf{SG} 170 \]

\[ \Gamma_h; \{ C_4^0 \}, \{ 00 \frac{1}{2} \}; T; \] Non-Centrosymmetric; with SOC

\[ \Gamma; \{ R_2, R_{12} \}; \ c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_0 k_z + h.c.) ; \]

\[ \{ R_4, R_{10} \}; \ (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + (c_4 + c_5 k^2 + c_6 k_z^2) k_z \sigma_3 + (\alpha_1 k_z^3 + \alpha_2 k_z^2) \sigma_0 + h.c. ; \]

\[ \{ R_6, R_8 \}; \ c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_0 k_z + h.c.) ; \]

\[ M; \{ R_2, R_4 \}; \ c_1 \sigma_0 + c_2 \sigma_3 k_z + \sum_{i=1}^2 \sigma_i (c_{i,1} k_z + c_{i,2} k_y) ; \]

\[ A; \{ R_4, R_1 \}; \ (c_3 \sigma_1 - c_4 \sigma_2 + c_5 \sigma_3) k_z + c_1 \sigma_0 ; \]

\[ \{ R_3, R_{11} \}; \ c_2 \sigma_3 k_z + c_1 \sigma_0 ; \]

\[ \{ R_5, R_9 \}; \ c_2 \sigma_3 k_z + c_1 \sigma_0 ; \]

\[ \{ R_7, R_7 \}; \ (c_3 \sigma_1 - c_4 \sigma_2 + c_5 \sigma_3) k_z + c_1 \sigma_0 ; \]

\[ L; \{ R_4, R_1 \}; \ (c_3 \sigma_1 - c_4 \sigma_2 + c_5 \sigma_3) k_z + c_1 \sigma_0 ; \]

\[ \{ R_9, R_9 \}; \ (c_3 \sigma_1 - c_4 \sigma_2 + c_5 \sigma_3) k_z + c_1 \sigma_0 ; \]

\[ K; \{ R_2, R_6 \}; \ c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_0 k_z + h.c.) ; \]

\[ H; \{ R_2, R_6 \}; \ c_2 \sigma_3 k_z + c_1 \sigma_0 ; \]

\[ \{ R_4, R_4 \}; \ (c_3 \sigma_1 - c_4 \sigma_2 + c_5 \sigma_3) k_z + c_1 \sigma_0 ; \]

\[ S; \{ R_2, R_2 \}; \ \sigma_0 (c_2 k_x + c_3 k_y + c_1) + \sum_{i=1}^3 c_1 \alpha \sigma_i k_z ; \]

\[ \{ R_2, R_2 \}; \ \sigma_0 (c_2 k_x + c_3 k_y + c_1) + \sum_{i=1}^3 c_1 \alpha \sigma_i k_z ; \]

\[ R; \{ R_2, R_2 \}; \ \sigma_0 (c_2 k_x + c_3 k_y + c_1) + \sum_{i=1}^3 c_1 \alpha \sigma_i k_z ; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2 \}, \{ R_{10} \}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_z^2) + (\alpha_1 \sigma_+ k_z^2 + h.c.); \]

\[ \{ R_2 \}, \{ R_{12} \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma_+ + h.c.); \]

\[ \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma_+ + h.c.); \]

\[ \{ R_2 \}, \{ R_6 \}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_z^2) + (\alpha_1 \sigma_+ k_z^2 + h.c.); \]

\[ \{ R_2 \}, \{ R_8 \}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{i,1} k_z (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2] + [(\alpha_1 k_z^3 + \alpha_2 k_z^4) \sigma_+ + h.c.]; \]

\[ \{ R_4 \}, \{ R_{10} \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma_+ + h.c.); \]

\[ \{ R_4 \}, \{ R_{12} \}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{i,1} k_z (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2] + [(\alpha_1 k_z^3 + \alpha_2 k_z^4) \sigma_+ + h.c.]; \]

\[ \{ R_6 \}, \{ R_{12} \}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{i,1} k_z (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2] + [(\alpha_1 k_z^3 + \alpha_2 k_z^4) \sigma_+ + h.c.]; \]

\[ \{ R_6 \}, \{ R_{10} \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma_+ + h.c.); \]

\[ \{ R_6 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma_+ + h.c.); \]

\[ \{ R_8 \}, \{ R_{12} \}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{i,1} k_z (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2] + [(\alpha_1 k_z^3 + \alpha_2 k_z^4) \sigma_+ + h.c.]; \]

\[ \{ R_6 \}, \{ R_{12} \}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{i,1} k_z (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2] + [(\alpha_1 k_z^3 + \alpha_2 k_z^4) \sigma_+ + h.c.]; \]

\[ \{ R_4 \}, \{ R_{10} \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma_+ + h.c.); \]

\[ \{ R_4 \}, \{ R_{12} \}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i [c_{i,1} k_z (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2] + [(\alpha_1 k_z^3 + \alpha_2 k_z^4) \sigma_+ + h.c.]; \]

\[ U; \{ R_2 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_i (c_{i,1} k_z + c_{i,2} k_y); \]

\[ P; \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y); \]

\[ \{ R_2 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x - \sigma_2 k_y); \]

\[ \{ R_4 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y); \]
\[\Gamma_h; \{C_h^0(00\frac{1}{2})\}, T; \text{Non-Centrosymmetric with SOC}\]

\[
\{R_4, R_{10}\}; \quad c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+k_x + c_3k_y)\sigma_3 + \left[(\alpha_1k_x^2 + \alpha_2k_y^2)\sigma_+ + \text{h.c.}\right];
\]

\[
\{R_6, R_8\}; \quad c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+k_x + c_3k_y)\sigma_3 + \left[(\alpha_1k_x^2 + \alpha_2k_y^2)\sigma_+ + \text{h.c.}\right];
\]

\[
M; \{R_2, R_4\}; \quad c_1\sigma_0 + c_2\sigma_3k_z + \sum_{i=1}^2 \sigma_i \left(c_i, k_x + c_i, k_y\right);
\]

\[
A; \{R_2, R_{12}\}; \quad c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+k_x + c_3k_y)\sigma_3 + \left[(\alpha_1k_x^2 + \alpha_2k_y^2)\sigma_+ + \text{h.c.}\right];
\]

\[
\{R_6, R_8\}; \quad c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+k_x + c_3k_y)\sigma_3 + \left[(\alpha_1k_x^2 + \alpha_2k_y^2)\sigma_+ + \text{h.c.}\right];
\]

\[
L; \{R_2, R_4\}; \quad c_1\sigma_0 + c_2\sigma_3k_z + \sum_{i=1}^2 \sigma_i \left(c_i, k_x + c_i, k_y\right);
\]

\[
K; \{R_2, R_{10}\}; \quad c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+k_x + c_3k_y)\sigma_3 + \left[(\alpha_1k_x^2 + \alpha_2k_y^2)\sigma_+ + \text{h.c.}\right];
\]

\[
H; \{R_2, R_6\}; \quad c_1\sigma_0 + c_2\sigma_3k_z + (\alpha_1\sigma_+k_x + c_3k_y)\sigma_3 + \left[(\alpha_1k_x^2 + \alpha_2k_y^2)\sigma_+ + \text{h.c.}\right];
\]

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**Accidental degeneracies on high symmetry line**

\[
\Delta; \{R_2\}, \{R_{10}\}; \quad c_1\sigma_0 + \sum_{i=0,3} \sigma_i \left(c_i, k_x + c_i, k^2 + c_i, k_x^2\right) + (\alpha_1k_x^2 + \text{h.c.});
\]

\[
\{R_2\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + (\alpha_1k_x\sigma_+ + \text{h.c.});
\]

\[
\{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + (\alpha_1k_x\sigma_+ + \text{h.c.});
\]

\[
\{R_2\}, \{R_6\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + (\alpha_1k_x\sigma_+ + \text{h.c.});
\]

\[
\{R_2\}, \{R_8\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + (\alpha_1k_x\sigma_+ + \text{h.c.});
\]

\[
\{R_2\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + (\alpha_1k_x\sigma_+ + \text{h.c.});
\]

\[
\{R_4\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + (\alpha_1k_x\sigma_+ + \text{h.c.});
\]

\[
\{R_6\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + (\alpha_1k_x\sigma_+ + \text{h.c.});
\]

\[
\{R_8\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + (\alpha_1k_x\sigma_+ + \text{h.c.});
\]

\[
U; \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + \sum_{i=1}^2 \sigma_i \left(c_i, k_x + c_i, k_y\right);
\]

\[
P; \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + c_4 \left(\sigma_1k_y - \sigma_2k_x\right) + c_5 \left(\sigma_1k_x + \sigma_2k_y\right);
\]

\[
\{R_2\}, \{R_6\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + c_4 \left(\sigma_2k_x + \sigma_1k_y\right) + c_5 \left(\sigma_1k_x - \sigma_2k_y\right);
\]

\[
\{R_4\}, \{R_6\}; \quad \sigma_0 (c_1 + c_2k_z) + \sigma_3c_3k_z + c_4 \left(\sigma_1k_y - \sigma_2k_x\right) + c_5 \left(\sigma_1k_x + \sigma_2k_y\right);
\]
$\Gamma_h: \{C_6^+[00\bar{2}], T\};$ Non-Centrosymmetric; with SOC

$\Gamma_r: \{R_2, R_{12}\}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma^_+ k_z + h.c.);$

$\{R_{10}\}; (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + (c_4 + c_5 k^2 + c_6 k_z^2) k_z \sigma_3 + \left[ (\alpha_1 k_z^3 + \alpha_2 k_z^3) \sigma^_+ + h.c. \right];$

$\{R_6, R_8\}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma^_+ k_z + h.c.);$

$M: \{R_2, R_{12}\}; c_1 \sigma_0 + c_2 \sigma_3 k_z + \sum_{i=1}^2 \sum_{i=1}^2 \sigma_i (c_{i,1} k_z + c_{i,2} k_y);$

$A: \{R_2, R_{12}\}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma^_+ k_z + h.c.);$

$\{R_{10}\}; (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + (c_4 + c_5 k^2 + c_6 k_z^2) k_z \sigma_3 + \left[ (\alpha_1 k_z^3 + \alpha_2 k_z^3) \sigma^_+ + h.c. \right];$

$\{R_6, R_8\}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma^_+ k_z + h.c.);$

$L: \{R_2, R_{12}\}; c_1 \sigma_0 + c_2 \sigma_3 k_z + \sum_{i=1}^2 \sum_{i=1}^2 \sigma_i (c_{i,1} k_z + c_{i,2} k_y);$

$K: \{R_2, R_{12}\}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma^_+ k_z + h.c.);$

$H: \{R_2, R_{12}\}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma^_+ k_z + h.c.);$

Accidental degeneracies on high symmetry line

$\Delta: \{R_2\}, \{R_{10}\}; c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_z^2) + (\alpha_1 \sigma^_+ k_z^2 + h.c.);$

$\{R_{12}\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma^_+ + h.c.);$

$\{R_{12}\}, \{R_6\}; \sigma_0 (c_1 + c_3 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma^_+ + h.c.);$

$\{R_2\}, \{R_{10}\}; c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_z^2) + (\alpha_1 \sigma^_+ k_z^2 + h.c.);$

$\{R_6\}, \{R_{12}\}; c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_z^2) + (\alpha_1 \sigma^_+ k_z^2 + h.c.);$

$\{R_2\}, \{R_{10}\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma^_+ + h.c.);$

$\{R_{12}\}, \{R_6\}; \sigma_0 (c_1 + c_3 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma^_+ + h.c.);$

$\{R_2\}, \{R_{10}\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma^_+ + h.c.);$

$\{R_{12}\}, \{R_6\}; \sigma_0 (c_1 + c_3 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_z \sigma^_+ + h.c.);$

$U: \{R_2\}, \{R_{12}\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y);$

$P: \{R_2\}, \{R_{12}\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y) + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y) + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y);$

$\{R_2\}, \{R_{10}\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y) + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y);$

$\{R_{12}\}, \{R_6\}; \sigma_0 (c_1 + c_3 k_z) + \sigma_3 c_3 k_z + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y) + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y);$

$\{R_2\}, \{R_{10}\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y) + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y);$

$\{R_{12}\}, \{R_6\}; \sigma_0 (c_1 + c_3 k_z) + \sigma_3 c_3 k_z + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y) + \sum_{i=0,3} \sigma_i (c_{i,1} k_z + c_{i,2} k_y);$
\[ \Gamma_h; \{ C^+[00\downarrow] \}; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \{ R_2, R_{12} \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_1 k_x + h.c.); \]
\[ \{ R_4, R_{10} \}; (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + (c_4 + c_5 k^2 + c_6 k_z^2) k_i \sigma_3 + \left[(\alpha_1 k_3^2 + \alpha_2 k_p^2) \sigma_+ + h.c. \right]; \]
\[ \{ R_6, R_8 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + (\alpha_1 \sigma_1 k_x + h.c.); \]
\[ M; \{ R_2, R_4 \}; c_1 \sigma_0 + c_2 \sigma_3 k_z + \sum_{i=1}^2 \sigma_i (c_1 i k_x + c_2 k_y) ; \]
\[ A; \{ R_1, R_5 \}; \sum_{i=1}^3 c_1 \sigma_1 i k_z + c_0 \sigma_0 ; \]
\[ \{ R_3, R_{11} \}; c_2 \sigma_3 k_z + c_1 \sigma_0 ; \]
\[ \{ R_5, R_9 \}; c_2 \sigma_3 k_z + c_1 \sigma_0 ; \]
\[ \{ R_7, R_9 \}; (c_1 \sigma_1 - c_4 \sigma_2 + c_3 \sigma_3) k_z + c_1 \sigma_0 ; \]
\[ L; \{ R_1, R_{11} \}; (c_1 \sigma_1 + c_4 \sigma_2 + c_2 \sigma_3) k_z + c_1 \sigma_0 ; \]
\[ \{ R_3, R_3 \}; (c_1 \sigma_1 - c_4 \sigma_2 + c_3 \sigma_3) k_z + c_1 \sigma_0 ; \]
\[ K; \{ R_2, R_6 \}; c_1 \sigma_0 + c_3 \sigma_3 k_z + (\alpha_1 \sigma_1 k_x + h.c.); \]
\[ H; \{ R_2, R_6 \}; c_2 \sigma_3 k_z + c_1 \sigma_0 ; \]
\[ \{ R_4, R_4 \}; (c_1 \sigma_1 - c_4 \sigma_2 + c_3 \sigma_3) k_z + c_1 \sigma_0 ; \]
\[ S; \{ R_2, R_{12} \}; \sigma_0 (c_1 c_2 k_z + c_3 k_y + c_1) + \sum_{i=1}^3 c_1 i \sigma_1 k_z ; \]
\[ S'; \{ R_2, R_{12} \}; \sigma_0 (c_1 k_x + c_2 k_y + c_1) + \sum_{i=1}^3 c_1 i \sigma_1 k_z ; \]
\[ R; \{ R_2, R_{12} \}; \sigma_0 (c_1 k_x + c_2 k_y + c_1) + \sum_{i=1}^3 c_1 i \sigma_1 k_z ; \]

**Accidental degeneracies on high symmetry line**

\[ \Delta; \{ R_2 \}, \{ R_{10} \}; c_1 \sigma_0 + \sum_{i=0,3} c_1 i k_z + c_1 i k_x^2 + c_1 i k_z^2 \right) + (\alpha_1 \sigma_1 k_x^2 + h.c.); \]
\[ \{ R_2 \}, \{ R_{12} \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]
\[ \{ R_2 \}, \{ R_5 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]
\[ \{ R_2 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]
\[ \{ R_4 \}, \{ R_{12} \}; \sigma_0 (c_1 i k_x + c_2 i k_x + c_3 i k_x + (\alpha_1 \sigma_1 k_x + h.c.); \]
\[ \{ R_6 \}, \{ R_{12} \}; \sigma_0 (c_1 i k_x + c_2 i k_x + c_3 i k_x + (\alpha_1 \sigma_1 k_x + h.c.); \]
\[ \{ R_8 \}, \{ R_{12} \}; \sigma_0 (c_1 i k_x + c_2 i k_x + c_3 i k_x + (\alpha_1 \sigma_1 k_x + h.c.); \]
\[ \{ R_2 \}, \{ R_{10} \}; c_1 \sigma_0 + \sum_{i=0,3} c_1 i k_z + c_1 i k_x^2 + c_1 i k_z^2 \] + (\alpha_1 \sigma_1 k_x^2 + h.c.); \]
\[ \{ R_4 \}, \{ R_{10} \}; c_1 \sigma_0 + \sum_{i=0,3} c_1 i k_z + c_1 i k_x^2 + c_1 i k_z^2 \] + (\alpha_1 \sigma_1 k_x^2 + h.c.); \]
\[ \{ R_6 \}, \{ R_{12} \}; c_1 \sigma_0 + \sum_{i=0,3} c_1 i k_z + c_1 i k_x^2 + c_1 i k_z^2 \] + (\alpha_1 \sigma_1 k_x^2 + h.c.); \]
\[ \{ R_8 \}, \{ R_{12} \}; c_1 \sigma_0 + \sum_{i=0,3} c_1 i k_z + c_1 i k_x^2 + c_1 i k_z^2 \] + (\alpha_1 \sigma_1 k_x^2 + h.c.); \]
\[ \{ R_2 \}, \{ R_{10} \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]
\[ \{ R_4 \}, \{ R_{10} \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]
\[ \{ R_6 \}, \{ R_{12} \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]
\[ \{ R_8 \}, \{ R_{12} \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (\alpha_1 k_x \sigma_+ + h.c.); \]
\[ \{ R_2 \}, \{ R_{10} \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + \sum_{i=1}^2 \sigma_1 (c_1 i k_x + c_2 k_y) ; \]
\[ P; \{ R_2 \}, \{ R_{12} \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_y + \sigma_2 k_x) ; \]
\[ \{ R_2 \}, \{ R_{10} \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_2 k_x + \sigma_1 k_y) + c_5 (\sigma_1 k_x - \sigma_2 k_y) ; \]
\[ \{ R_4 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 (\sigma_1 k_y - \sigma_2 k_x) + c_5 (\sigma_1 k_x + \sigma_2 k_y) ; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2, R_6 \}; \{ R_4 \}; A_0 \left( c_1 + c_2 k_x \right) + A_4 c_5 k_z + c_4 \left( A_3 - 2 A_2 + \sqrt{3} A_7 \right) + c_5 \left( A_2 - 2 A_3 + \sqrt{3} A_6 \right) k_z + c_4 \left( 2 A_6 + A_7 - \sqrt{3} A_3 \right) - c_5 \left( A_6 + 2 A_7 + \sqrt{3} A_2 \right) k_y; \]

\[ P: \{ R_2 \}; \{ R_4 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_4 c_5 k_z + c_4 \left( c_1 k_y - c_2 k_z \right) + c_5 \left( c_1 k_x + c_2 k_y \right); \]

\[ S: \{ R_2 \}; \{ R_4 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_4 \left( c_1 k_y + c_2 k_z \right) + c_4 \left( c_1 k_x + c_2 k_y \right) + c_5 \left( c_1 k_z - c_2 k_x \right); \]

\[ T': \{ R_2 \}; \{ R_4 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_4 \left( c_1 k_y + c_2 k_z \right) + c_4 \left( c_1 k_x + c_2 k_y \right) + c_5 \left( c_1 k_z + c_2 k_y \right); \]

\[ S': \{ R_2 \}; \{ R_4 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_4 \left( c_1 k_y + c_2 k_z \right) + c_4 \left( c_1 k_x + c_2 k_y \right) + c_5 \left( c_1 k_z + c_2 k_x \right); \]

\[ \Sigma: \{ R_2 \}; \{ R_4 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_4 \left( c_1 k_y + c_2 k_z \right) + c_4 \left( c_1 k_x + c_2 k_y \right) + c_5 \left( c_1 k_z + c_2 k_x \right); \]

\[ R: \{ R_2 \}; \{ R_4 \}; \sigma_0 \left( c_1 + c_2 k_x \right) + c_4 \left( c_1 k_y + c_2 k_z \right) + c_4 \left( c_1 k_x + c_2 k_y \right) + c_5 \left( c_1 k_z + c_2 k_x \right); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2, R_{12}\}, \{R_4, R_{10}\}; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \Gamma_{2,3} (c_2 k_y - c_3 k_z); \]
\[ \{R_2, R_{12}\}, \{R_6, R_8\}; c_i \Gamma_{0,0} + \sum_{i=0,3} \Gamma_{1,0} (c_{i1} k_x + c_{i2} k^2 + c_{i3} k_z) + \Gamma_{1,0} [2c_2 k_y k_x + c_3 (k_x^2 - k_y^2)] + \Gamma_{2,3} [c_2 (k_x^2 - k_y^2) + 2c_3 k_y k_x]; \]
\[ \{R_4, R_{10}\}, \{R_6, R_8\}; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \Gamma_{2,3} (c_2 k_y - c_3 k_z); \]

\[ P: \{R_2, R_6\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \Gamma_{1,0} (c_4 k_x + c_5 k_y) + \Gamma_{2,3} (c_2 k_y - c_3 k_z) + (\alpha_1 \Gamma_{2,4} k_- + h.c.); \]

\[ S: \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 k_x) + c_3 k_z + \Gamma_{3,0} (c_4 k_x + c_5 k_y) + k_x (c_6 \Gamma_{1,0} + \sum_{i=1}^3 c_{i1} \Gamma_{2,i}); \]
\[ S': \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 k_x) + c_3 k_z + \Gamma_{3,0} (c_4 k_x + c_5 k_y) + k_x (c_6 \Gamma_{1,0} + \sum_{i=1}^3 c_{i1} \Gamma_{2,i}); \]
\[ R: \{R_2, R_2\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 k_x) + c_3 k_z + \Gamma_{3,0} (c_4 k_x + c_5 k_y) + k_x (c_6 \Gamma_{1,0} + \sum_{i=1}^3 c_{i1} \Gamma_{2,i}); \]

SG 177

\[ \Gamma_h: \{C_0^* \{000\}, \{C_2^* \{000\}\}, T; \] Non-Centrosymmetric; with SOC

\[ \Gamma: \]
\[ R_7; (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + (c_4 + c_5 k^2 + c_6 k_z^2) k_x \sigma_3 + [(c_7 k_x^4 + c_8 k_z^3) \sigma_+ + h.c.]; \]
\[ R_6; c_2 (\sigma_1 k_x - \sigma_2 k_y) + c_3 \sigma_z k_z + c_1 \sigma_0; \]
\[ R_8; c_2 (\sigma_1 k_x + \sigma_2 k_y) + c_3 \sigma_z k_z + c_1 \sigma_0; \]
\[ M; R_5; c_2 \sigma_z k_z + c_3 \sigma_1 k_y - c_4 \sigma_2 k_x + c_1 \sigma_0; \]
\[ A; R_7; (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + (c_4 + c_5 k^2 + c_6 k_z^2) k_x \sigma_3 + [(c_7 k_x^4 + c_8 k_z^3) \sigma_+ + h.c.]; \]
\[ R_8; c_2 (\sigma_1 k_x - \sigma_2 k_y) + c_3 \sigma_z k_z + c_1 \sigma_0; \]
\[ R_9; c_2 (\sigma_1 k_x + \sigma_2 k_y) + c_3 \sigma_z k_z + c_1 \sigma_0; \]
\[ L; R_5; c_2 \sigma_z k_z + c_3 \sigma_1 k_y - c_4 \sigma_2 k_x + c_1 \sigma_0; \]
\[ K; R_6; c_2 (\sigma_1 k_z - \sigma_3 k_y) + c_3 \sigma_z k_z + c_1 \sigma_0; \]
\[ H; R_6; c_2 (\sigma_1 k_z - \sigma_3 k_y) + c_3 \sigma_z k_z + c_1 \sigma_0; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2\}, \{R_{10}\}; \] \[\sigma_0 + \sum_{i=0,3} \sigma_i \left( c_{1,i}k_z + c_{1,2}k^2 + c_{1,3}k_x^2 \right) \pm \left( 1 \mp i\sqrt{3} \right) c_2 \sigma_1 k_z^2 + h.c. \;
\]

\[ \{R_2\}, \{R_{12}\}; \] \[\sigma_0 \left( c_1 + c_2 k_y \right) + \sigma_3 c_3 k_x \pm \left( 1 - i\sqrt{3} \right) c_0 \sigma_0 k_z + h.c. \;
\]

\[ \{R_2\}, \{R_4\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_4 k_z \pm \left( 1 + i\sqrt{3} \right) c_0 \sigma_0 k_y + h.c. \;
\]

\[ \{R_2\}, \{R_6\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) \pm \left( 1 - i\sqrt{3} \right) c_2 \sigma_1 k_z^2 + h.c. \;
\]

\[ \{R_2\}, \{R_8\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + \left( 1 + i\sqrt{3} \right) c_0 \sigma_1 k_z + h.c. \;
\]

\[ \{R_4\}, \{R_{10}\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_4 k_z \pm \left( 1 - i\sqrt{3} \right) c_2 \sigma_1 k_z^2 + h.c. \;
\]

\[ \{R_4\}, \{R_{12}\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x \pm \left( 1 + i\sqrt{3} \right) c_0 \sigma_1 k_z + h.c. \;
\]

\[ \{R_4\}, \{R_6\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_4 k_z \pm \left( 1 + i\sqrt{3} \right) c_0 \sigma_1 k_z + h.c. \;
\]

\[ \{R_6\}, \{R_{10}\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) \pm \left( 1 - i\sqrt{3} \right) c_2 \sigma_1 k_z^2 + h.c. \;
\]

\[ \{R_6\}, \{R_{12}\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x \pm \left( 1 + i\sqrt{3} \right) c_0 \sigma_1 k_z + h.c. \;
\]

\[ \{R_0\}, \{R_{10}\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_4 k_z \pm \left( 1 + i\sqrt{3} \right) c_0 \sigma_1 k_y + h.c. \;
\]

\[ \{R_0\}, \{R_{12}\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x \pm \left( 1 - i\sqrt{3} \right) c_0 \sigma_1 k_y + h.c. \;
\]

\[ \{R_0\}, \{R_6\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_4 k_z \pm \left( 1 + i\sqrt{3} \right) c_0 \sigma_1 k_y + h.c. \;
\]

\[ U: \{R_2\}, \{R_4\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + \sigma_4 c_4 k_y \pm \sigma_5 \sigma_0 k_y; \]

\[ P: \{R_2\}, \{R_4\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + \sigma_4 \left[ \sigma_1 \left( k_x + \frac{k_y}{\sqrt{3}} \right) + \sigma_2 \left( k_y - \frac{k_x}{\sqrt{3}} \right) \right] ; \]

\[ \{R_2\}, \{R_6\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + \sigma_4 \left[ \sigma_1 \left( k_x + \frac{k_y}{\sqrt{3}} \right) - \sigma_2 \left( k_y - \frac{k_x}{\sqrt{3}} \right) \right] ; \]

\[ \{R_4\}, \{R_{10}\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + \sigma_4 \left[ \sigma_1 \left( k_x + \frac{k_y}{\sqrt{3}} \right) + \sigma_2 \left( k_y - \frac{k_x}{\sqrt{3}} \right) \right] ; \]

\[ T: \{R_2\}, \{R_4\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + \sigma_4 \left( \sqrt{3} k_x + k_y \right) - c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_0 \sigma_1 k_z ; \]

\[ S: \{R_2\}, \{R_4\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + \sigma_4 \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_0 \sigma_1 k_z ; \]

\[ T': \{R_2\}, \{R_4\}; \] \[\sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + \sigma_4 \sigma_0 k_y + c_1 \sigma_1 k_x + c_3 \sigma_0 k_z ; \]

\[ S': \{R_2\}, \{R_4\}; \] \[\sigma_0 \left( c_1 + c_2 k_y \right) + \sigma_3 c_3 k_y + c_1 \sigma_1 k_z + c_3 \sigma_0 k_x ; \]

\[ \Sigma: \{R_2\}, \{R_4\}; \] \[\sigma_0 \left( c_1 + c_2 k_x \right) + \sigma_3 c_3 k_x + c_2 \sigma_2 k_y + c_3 \sigma_0 k_z ; \]

\[ R: \{R_2\}, \{R_4\}; \] \[\sigma_0 \left( c_1 + c_2 k_x \right) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y + c_5 \sigma_1 k_z ; \]
Accidental degeneracies on high symmetry line

$$\Delta: \{R_2\}, \{R_{10}\}; \quad \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1,1} k_z + c_{1,2} k^2 + c_{1,3} k_z^2) + [(1 + i\sqrt{3}) c_{2,2} k_z^2 + h.c.];$$

$$\{R_2\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k^2) + \sigma_3 c_3 k_z + [(1 - i\sqrt{3}) c_{3,2} k_z + h.c.];$$

$$\{R_2\}, \{R_{14}\}; \quad \sigma_0 (c_1 + c_2 k^2) + \sigma_3 c_3 k_z + [(1 + i\sqrt{3}) c_{3,2} k_z^2 + h.c.];$$

$$\{R_2\}, \{R_{16}\}; \quad \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1,1} k_z + c_{1,2} k^2 + c_{1,3} k_z^2) + [(1 - i\sqrt{3}) c_{2,2} k_z + h.c.];$$

$$\{R_2\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z^2 + [(1 + i\sqrt{3}) c_{3,2} k_z^2 + h.c.];$$

$$\{R_2\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z^2 + [(1 - i\sqrt{3}) c_{3,2} k_z + h.c.];$$

$$U: \{R_{21}\}, \{R_{23}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_z + c_5 \sigma_2 k_y;$$

$$P: \{R_2\}, \{R_{14}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_z + c_5 \sigma_2 k_y;$$

$$T: \{R_2\}, \{R_{14}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_1 k_z + c_5 \sigma_2 k_y;$$

$$\Sigma: \{R_2\}, \{R_{14}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y + c_5 \sigma_1 k_z;$$
**Accidental degeneracies on high symmetry line**

\[ \Delta: \{R_2\}, \{R_{10}\}; \quad \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z) + [(1 + i\sqrt{3}) c_{2i} k^3_z + \text{h.c.}] ; \]

\[ \{R_2\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 - i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_2\}, \{R_6\}; \quad c_1 \sigma_1 + \sum_{i=0,3} \sigma_i (c_{1i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z) + [(1 - i\sqrt{3}) c_{2i} k^3_z + \text{h.c.}] ; \]

\[ \{R_2\}, \{R_{10}\}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z) + [(1 + i\sqrt{3}) c_{2i} k^3_z + \text{h.c.}] ; \]

\[ \{R_4\}, \{R_6\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_6\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 - i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_6\}, \{R_{12}\}; \quad c_1 \sigma_1 + \sum_{i=0,3} \sigma_i (c_{1i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z) + [(1 - i\sqrt{3}) c_{2i} k^3_z + \text{h.c.}] ; \]

\[ \{R_8\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_8\}, \{R_{12}\}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z) + [(1 + i\sqrt{3}) c_{2i} k^3_z + \text{h.c.}] ; \]

\[ \{R_{10}\}, \{R_{12}\}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z) + [(1 + i\sqrt{3}) c_{2i} k^3_z + \text{h.c.}] ; \]

\[ \{R_4\}, \{R_6\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_4\}, \{R_8\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 - i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_4\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_4\}, \{R_{12}\}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z) + [(1 + i\sqrt{3}) c_{2i} k^3_z + \text{h.c.}] ; \]

\[ \{R_2\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_2\}, \{R_4\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 - i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_2\}, \{R_6\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_2\}, \{R_8\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 - i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_2\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_2\}, \{R_{12}\}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i (c_{1i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z) + [(1 + i\sqrt{3}) c_{2i} k^3_z + \text{h.c.}] ; \]

\[ \{R_8\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{R_U\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{22} k^3_x + \text{h.c.}] ; \]

\[ \{P\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 \left( k_x + \frac{k_y}{\sqrt{3}} \right) + \sigma_2 \left( k_y - \frac{k_x}{\sqrt{3}} \right) ; \]

\[ \{R_2\}, \{R_6\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 \left( k_x + \frac{k_y}{\sqrt{3}} \right) - \sigma_2 \left( k_y - \frac{k_x}{\sqrt{3}} \right) ; \]

\[ \{R_2\}, \{R_8\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 \left( k_x + \frac{k_y}{\sqrt{3}} \right) + \sigma_2 \left( k_y - \frac{k_x}{\sqrt{3}} \right) ; \]

\[ \{R_2\}, \{R_{10}\}; \quad c_1 \sigma_0 + \sum_{i=0,3} \sigma_i \left( \sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left( \sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_x ; \]

\[ \{T\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y + c_5 \sigma_1 k_x ; \]

\[ \{\Sigma\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y + c_5 \sigma_1 k_x ; \]
Accidental degeneracies on high symmetry line

$$\Delta: \{ R_2 \}, \{ R_{10} \} : \sigma_0 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{2,i} k^2 + c_{3,i} k^2_z) + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_2 \}, \{ R_{12} \} : (c_1 + c_2 k^2 + c_3 k^2) \sigma_0 + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_2 \}, \{ R_8 \} : c_1 \sigma_0 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{2,i} k^2 + c_{3,i} k^2_z) + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_4 \}, \{ R_{10} \} : c_1 \sigma_0 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{2,i} k^2 + c_{3,i} k^2_z) + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_4 \}, \{ R_{12} \} : c_1 \sigma_0 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{2,i} k^2 + c_{3,i} k^2_z) + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_{10} \}, \{ R_{12} \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_6 \}, \{ R_{10} \} : c_1 \sigma_0 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{2,i} k^2 + c_{3,i} k^2_z) + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_6 \}, \{ R_{12} \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_6 \}, \{ R_8 \} : c_1 \sigma_0 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{2,i} k^2 + c_{3,i} k^2_z) + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_8 \}, \{ R_{10} \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_8 \}, \{ R_{12} \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
$$\{ R_{10} \}, \{ R_{12} \} : c_1 \sigma_0 + \sum_{i=0}^{3} \sigma_i (c_{1,i} k_x + c_{2,i} k^2 + c_{3,i} k^2_z) + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$

$$\{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$

$$P: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \left[ \sigma_1 \left( k_x + \frac{h \sqrt{3}}{2} \right) + \sigma_2 \left( k_y - \frac{h \sqrt{3}}{2} \right) \right];$$
$$\{ R_2 \}, \{ R_6 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \left[ \sigma_1 \left( k_x + \frac{h \sqrt{3}}{2} \right) - \sigma_2 \left( k_y - \frac{h \sqrt{3}}{2} \right) \right];$$
$$\{ R_6 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \left[ \sigma_1 \left( k_x + \frac{h \sqrt{3}}{2} \right) + \sigma_2 \left( k_y - \frac{h \sqrt{3}}{2} \right) \right];$$

$$T: \{ R_2 \}, \{ R_4 \} : c_1 \sigma_0 + \sum_{i=0}^{3} \sigma_i c_{1,i} \left( \sqrt{3} k_x + k_y \right) + \sum_{i=0}^{3} \sigma_i c_{2,i} \left( \sqrt{3} k_x - k_y \right) + \sum_{i=0}^{3} \sigma_i k_z;$$

$$S: \{ R_6 \}, \{ R_{12} \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$

$$T': \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$

$$S': \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$

$$\Sigma: \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$

$$R: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + \left[ (1 + i\sqrt{3}) c_2 \sigma_3 k^2_x + h.c. \right];$$
\[ \Gamma_h: \{C_6^0[00\bar{2}], C_2^0[000]\}; T; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; \quad R_\gamma: (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + (c_4 + c_5 k^2 + c_6 k_z^2) k_z \sigma_3 + [(c_7 k_x^4 + c_8 k_z^4) \sigma_+ + \text{h.c.}] ; \]
\[ R_6; \quad c_2 (\sigma_1 k_z - \sigma_2 k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \]
\[ R_0; \quad c_2 (\sigma_1 k_z + \sigma_2 k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \]
\[ M; \quad R_5; \quad c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \]
\[ A; \quad R_7; (c_1 + c_2 k^2 + c_3 k_z^2) \sigma_0 + (c_4 + c_5 k^2 + c_6 k_z^2) k_z \sigma_3 + [(c_7 k_x^4 + c_8 k_z^4) \sigma_+ + \text{h.c.}] ; \]
\[ R_8; \quad c_2 (\sigma_1 k_z - \sigma_2 k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \]
\[ R_0; \quad c_2 (\sigma_1 k_z + \sigma_2 k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \]
\[ L; \quad R_5; \quad c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \]
\[ K; \quad R_6; \quad c_2 (\sigma_1 k_z + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]
\[ H; \quad R_6; \quad c_2 (\sigma_1 k_z + \sigma_3 k_y) - c_3 \sigma_2 k_z + c_1 \sigma_0; \]

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Accidental degeneracies on high symmetry line

\[ \Delta; \quad \{R_2\}, \{R_{10}\}; \quad c_1 \sigma_0 + \sum_{i=3} \sigma_i (c_{i,1} k_x + c_{i,2} k^2 + c_{i,3} k_z^2) + [(1 + i\sqrt{3}) c_{2,2} \sigma_2 k_z^2 + \text{h.c.}] ; \]
\[ \{R_2\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + [(1 - i\sqrt{3}) c_0 \sigma_4 k_+ + \text{h.c.}] ; \]
\[ \{R_2\}, \{R_{14}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_0 \sigma_4 k_- + \text{h.c.}] ; \]
\[ \{R_2\}, \{R_8\}; \quad c_1 \sigma_0 + \sum_{i=3} \sigma_i c_{i,1} k_x (1 + c_{i,2} k^2 + c_{i,3} k_z^2) + c_{i,4} k^2 + c_{i,5} k_z^2 + [(c_{i,6} k_x^4 + c_{i,7} k_z^4) \sigma_+ + \text{h.c.}] ; \]
\[ \{R_4\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_0 \sigma_4 k_z + \text{h.c.}] ; \]
\[ \{R_0\}, \{R_{12}\}; \quad c_1 \sigma_0 + \sum_{i=3} \sigma_i (c_{i,1} k_x + c_{i,2} k^2 + c_{i,3} k_z^2) + [(1 + i\sqrt{3}) c_{2,2} \sigma_2 k_z^2 + \text{h.c.}] ; \]
\[ \{R_4\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + [(1 - i\sqrt{3}) c_0 \sigma_4 k_+ + \text{h.c.}] ; \]
\[ \{R_6\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + [(1 - i\sqrt{3}) c_0 \sigma_4 k_- + \text{h.c.}] ; \]
\[ \{R_8\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + [(1 - i\sqrt{3}) c_0 \sigma_4 k_- + \text{h.c.}] ; \]
\[ \{R_8\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + [(1 - i\sqrt{3}) c_{2,2} \sigma_2 k_z^2 + \text{h.c.}] ; \]
\[ \{R_8\}, \{R_{10}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_0 \sigma_4 k_z + \text{h.c.}] ; \]
\[ \{R_{10}\}, \{R_{12}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + [(1 + i\sqrt{3}) c_{2,2} \sigma_2 k_z^2 + \text{h.c.}] ; \]

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\[ U; \quad \{R_2\}, \{R_{4}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_1 \sigma_1 k_z + c_0 \sigma_2 k_y; \]
\[ P; \quad \{R_2\}, \{R_{4}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_1 (k_z + \frac{h_0}{k_z}) + \sigma_2 \left( k_y - \frac{k_0}{k_y} \right) ; \]
\[ \{R_2\}, \{R_{6}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_1 (k_z + \frac{h_0}{k_z}) + \sigma_2 \left( k_y - \frac{k_0}{k_y} \right) ; \]
\[ \{R_4\}, \{R_{6}\}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_1 (k_z + \frac{h_0}{k_z}) + \sigma_2 \left( k_y - \frac{k_0}{k_y} \right) ; \]

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\[ T; \quad \{R_2\}, \{R_{4}\}; \quad c_1 \sigma_0 + \sum_{i=3} \sigma_i c_{i,1} (\sqrt{3} k_z + k_0) + c_{2,2} \sigma_2 (\sqrt{3} k_y - k_0) + c_0 \sigma_1 k_z ; \]
\[ S; \quad \{R_2\}, \{R_{4}\}; \quad c_1 \sigma_0 + \sum_{i=3} \sigma_i c_{i,1} (\sqrt{3} k_z + k_0) + c_{2,2} \sigma_2 (\sqrt{3} k_y - k_0) + c_0 \sigma_1 k_z ; \]
\[ T'; \quad \{R_2\}, \{R_{4}\}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_x + c_1 \sigma_1 k_z + c_0 \sigma_2 k_y ; \]
\[ S'; \quad \{R_2\}, \{R_{4}\}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_x + c_1 \sigma_1 k_z + c_0 \sigma_2 k_y ; \]
\[ \Sigma; \quad \{R_2\}, \{R_{4}\}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_x + c_1 \sigma_1 k_z + c_0 \sigma_2 k_y ; \]
\[ R; \quad \{R_2\}, \{R_{4}\}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_x + c_1 \sigma_1 k_z + c_0 \sigma_2 k_y ; \]
\( \Gamma_h; \{ C_{2h}^1[00\bar{2}], C_{2h}^2[000] \}, T; \) Non-Centrosymmetric; with SOC

\[\begin{align*}
\Gamma; & \quad \{ R_7 \}; \quad (c_1 + c_2 k^2 + c_3 k^2_z) \sigma_0 + (c_4 + c_5 k^2 + c_6 k^2_z) k_x \sigma_3 + \left[(c_7 k_x^3 + c_8 k_z^3) \sigma_+ + \text{h.c.}\right]; \\
R_6; & \quad c_2 (\sigma_1 k_x - \sigma_2 k_y) + c_3 \sigma_3 k_x + c_4 \sigma_0; \\
R_5; & \quad c_2 (\sigma_1 k_x + \sigma_2 k_y) + c_3 \sigma_3 k_x + c_4 \sigma_0; \\
M; & \quad \{ R_7 \}; \quad c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \\
A; & \quad \{ R_{10}, R_{11} \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_z + c_1 \sigma_0; \\
& \quad \{ R_{12}, R_{13} \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_z + c_1 \sigma_0; \\
& \quad R_{14}; \quad c_2 \sigma_3 k_z + c_1 \sigma_0; \\
& \quad R_{15}; \quad c_2 \sigma_3 k_z + c_1 \sigma_0; \\
L; & \quad \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_z + c_1 \sigma_0; \\
K; & \quad R_6; \quad c_2 (\sigma_1 k_x - \sigma_2 k_y) - c_4 \sigma_2 k_z + c_1 \sigma_0; \\
H; & \quad \{ R_7, R_8 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) k_z + c_1 \sigma_0; \\
& \quad R_6; \quad c_1 \sigma_0 - c_2 \sigma_2 k_z; \\
S; & \quad \{ R_5, R_7 \}; \quad \sigma_0 \left[ c_2 \left( k_x + \frac{k_y}{\sqrt{3}} \right) + c_1 \right] + c_3 \sigma_1 k_z - c_4 \sigma_2 k_z; \\
S'; & \quad \{ R_5, R_7 \}; \quad \sigma_0 \left( c_2 k_y + c_1 \right) + (c_3 \sigma_1 - c_4 \sigma_2) k_z; \\
R; & \quad \{ R_2, R_4 \}; \quad \sigma_0 \left( c_2 k_x + c_1 \right) + (c_3 \sigma_1 - c_4 \sigma_2) k_z;
\end{align*}\]

Accidental degeneracies on high symmetry line

\[\begin{align*}
\Delta; & \quad \{ R_2 \}, \{ R_{10} \}; \quad c_1 \sigma_0 + \sum_{i,0,3} \sigma_i \left( c_{1,i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z \right) + \left[(1 + i\sqrt{3}) c_2 \sigma_4 k^2_z + \text{h.c.}\right]; \\
& \quad \{ R_2 \}, \{ R_{12} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 \sigma_2 k_z + \left[(1 - i\sqrt{3}) c_3 \sigma_4, k^2 + \text{h.c.}\right]; \\
& \quad \{ R_2 \}, \{ R_{14} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 \sigma_2 k_z + \left[(1 + i\sqrt{3}) c_3 \sigma_4, k^2 + \text{h.c.}\right]; \\
& \quad \{ R_6 \}, \{ R_8 \}; \quad c_1 \sigma_0 + \sum_{i,0,3} \sigma_i \left( c_{1,i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z \right) + \left[(1 - i\sqrt{3}) c_2 \sigma_4, k^2 + \text{h.c.}\right]; \\
& \quad \{ R_6 \}, \{ R_{10} \}; \quad c_1 \sigma_0 + \sum_{i,0,3} \sigma_i \left[ c_{1,i} k_x \left(1 + c_1 k^2 + c_{i,3} k^2_z \right) + c_4 \sigma_2 k^2 + c_{i,3} k^2_z \right] + \left[(c_3 k_x^3 + c_3 k_z^3) \sigma_+ + \text{h.c.}\right]; \\
& \quad \{ R_4 \}, \{ R_{12} \}; \quad c_1 \sigma_0 + \sum_{i,0,3} \sigma_i \left( c_{1,i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z \right) + \left[(1 + i\sqrt{3}) c_2 \sigma_4, k^2 + \text{h.c.}\right]; \\
& \quad \{ R_4 \}, \{ R_{14} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 \sigma_2 k_z + \left[(1 + i\sqrt{3}) c_3 \sigma_4, k^2 + \text{h.c.}\right]; \\
& \quad \{ R_8 \}, \{ R_{10} \}; \quad c_1 \sigma_0 + \sum_{i,0,3} \sigma_i \left( c_{1,i} k_x + c_{i,2} k^2 + c_{i,3} k^2_z \right) + \left[(1 - i\sqrt{3}) c_2 \sigma_4, k^2 + \text{h.c.}\right]; \\
& \quad \{ R_8 \}, \{ R_{12} \}; \quad c_1 \sigma_0 + \sum_{i,0,3} \sigma_i \left( c_{1,i} k_x \left(1 + c_1 k^2 + c_{i,3} k^2_z \right) + c_4 \sigma_2 k^2 + c_{i,3} k^2_z \right) + \left[(c_3 k_x^3 + c_3 k_z^3) \sigma_+ + \text{h.c.}\right]; \\
& \quad \{ R_8 \}, \{ R_{14} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 \sigma_2 k_z + \left[(1 + i\sqrt{3}) c_3 \sigma_4, k^2 + \text{h.c.}\right]; \\
& \quad \{ R_{10} \}, \{ R_{12} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 \sigma_2 k_z + \left[(1 + i\sqrt{3}) c_3 \sigma_4, k^2 + \text{h.c.}\right]; \\
& \quad \{ R_{10} \}, \{ R_{14} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 \sigma_2 k_z + \left[(1 + i\sqrt{3}) c_3 \sigma_4, k^2 + \text{h.c.}\right]; \\
U; & \quad \{ R_2 \}, \{ R_{12} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_z + c_5 \sigma_2 k_y; \\
P; & \quad \{ R_2 \}, \{ R_{14} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_z + c_5 \sigma_2 k_y; \\
& \quad \{ R_2 \}, \{ R_8 \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_z + c_5 \sigma_2 k_y; \\
& \quad \{ R_4 \}, \{ R_{12} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_z + c_5 \sigma_2 k_y; \\
T; & \quad \{ R_2 \}, \{ R_4 \}; \quad c_1 \sigma_0 + \sum_{i,0,3} \sigma_i c_{i,1} \left(\sqrt{3} k_x + k_y \right) + c_2 \sigma_2 \left(\sqrt{3} k_y - k_x \right) + c_3 \sigma_1 k_z; \\
T'; & \quad \{ R_2 \}, \{ R_{14} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_z + c_5 \sigma_2 k_z; \\
\Sigma; & \quad \{ R_2 \}, \{ R_{14} \}; \quad \sigma_0 \left( c_1 + c_2 k_z \right) + \sigma_3 c_3 k_x + c_4 \sigma_2 k_y + c_5 \sigma_1 k_z; 
\end{align*}\]
$\Gamma_h$: \{C_6^+{000}, \{\sigma_{d1}{000}\}; \bar{T}$; Non-Centrosymmetric; with SOC

$\Gamma$:  $R_7$: $c_1\sigma_0$;
  \begin{align*}
  R_8; & \; (c_2\sigma_2k_x + \sigma_1k_y) + c_1\sigma_0; \\
  R_9; & \; (c_2\sigma_1k_y - \sigma_2k_x) + c_1\sigma_0;
  \end{align*}

$M$:  $R_5; \; c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0$;

$A$:  $R_7$: $c_1\sigma_0$;
  \begin{align*}
  R_8; & \; (c_2\sigma_2k_x + \sigma_1k_y) + c_1\sigma_0; \\
  R_9; & \; (c_2\sigma_1k_y - \sigma_2k_x) + c_1\sigma_0;
  \end{align*}

$L$:  $R_5; \; c_2\sigma_1k_x + c_3\sigma_3k_y + c_1\sigma_0$;

$K$:  $R_6; \; (c_1\sigma_1k_x - \sigma_3k_y) + c_1\sigma_0$;

$H$:  $R_6; \; (c_1\sigma_1k_x - \sigma_3k_y) + c_1\sigma_0$;

$\Delta$:  $R_7; \; (c_1 + c_2k_x + c_3k^2 + c_4k_x^2 + c_5k_2k^2 + c_6k_x^2)\sigma_0 + [i(c_7k_3^2 + c_8k^2)\sigma_+ + h.c.]$;
  \begin{align*}
  R_8; & \; (c_2\sigma_2k_x + \sigma_1k_y) + c_0(c_3k_x + c_1); \\
  R_9; & \; (c_2\sigma_1k_y - \sigma_2k_x) + c_0(c_3k_x + c_1);
  \end{align*}

$U$:  $R_5; \; c_2\sigma_1k_x + c_3\sigma_3k_y + c_0(c_3k_x + c_1)$;

$P$:  $R_6; \; (c_1\sigma_1k_x - \sigma_3k_y) + c_0(c_3k_x + c_1)$;

Accidental degeneracies on high symmetry line

\begin{align*}
\Delta; & \; \{R_7\}, \{R_8\}: \Gamma_{0,0} (c_1 + c_2k_x) + \Gamma_{3,0}c_3k_x + c_4(\Gamma_{1,3}k_x - \Gamma_{2,0}k_y) + c_5(\Gamma_{2,3}k_x + \Gamma_{1,0}k_y) + \{i c_6(\Gamma_{0,+,+} - \Gamma_{3,+,+})k_+ + h.c.\}; \\
& \{R_7\}, \{R_9\}: \Gamma_{0,0} (c_1 + c_2k_x) + \Gamma_{3,0}c_3k_x + c_4(\Gamma_{1,3}k_x + \Gamma_{2,0}k_y) + c_5(\Gamma_{1,0}k_y - \Gamma_{2,3}k_x) + \{i c_6(\Gamma_{0,+,-} - \Gamma_{3,+,+})k_+ + h.c.\}; \\
& \{R_8\}, \{R_9\}: \Gamma_{0,0} (c_1 + c_2k_x) + \Gamma_{3,0}c_3k_x + \{i c_4(\Gamma_{0,+,+} - \Gamma_{3,+,+})k_+ - i c_5(\Gamma_{0,+,+} + \Gamma_{3,+,+})k_+ + h.c.\}; \\
\Delta; & \; \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x; \\
& \{R_3\}, \{R_6\}: A_0(c_1 + c_2k_x) + (\sqrt{3}A_1 + A_0) c_3k_x + (A_0c_4 + 2A_2c_5 - A_2c_6) k_x + \{A_4c_4 + (A_5 - \sqrt{3}A_8) c_5 - A_1c_6 \} k_y; \\
& \{R_4\}, \{R_6\}: A_0(c_1 + c_2k_x) + (\sqrt{3}A_1 + A_0) c_3k_x + (A_0c_4 + 2A_2c_5 - A_1c_6) k_x - \{A_4c_4 + (A_5 - \sqrt{3}A_8) c_5 - A_2c_6 \} k_y;
\end{align*}

$T$:  $\{R_2\}, \{R_4\}: \sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3c_3 (\sqrt{3}k_x + k_y) + c_4\sigma_1 (k_x - \sqrt{3}k_y)$;

$S$:  $\{R_2\}, \{R_4\}: \sigma_0 [c_1 + c_2 (\sqrt{3}k_x + k_y)] + \sigma_3c_3 (\sqrt{3}k_x + k_y) + c_4\sigma_1 (k_x - \sqrt{3}k_y)$;

$T'$:  $\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_x + c_4\sigma_2k_x$;

$S'$:  $\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_2k_y$;

$\Sigma$:  $\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_y) + \sigma_3c_3k_y + c_4\sigma_1k_y$;

$R$:  $\{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_1k_y$;
SG 184

Γ_h; \{C_0^+ [000], \{\sigma_{d1} |00\frac{1}{2}\}\}, T; Non-Centrosymmetric; with SOC

Γ; \quad R_7; \quad c_1 \sigma_0;
\quad R_8; \quad c_2 (\sigma_2 k_x + \sigma_1 k_y) + c_1 \sigma_0;
\quad R_9; \quad c_2 (\sigma_1 k_y - \sigma_2 k_x) + c_1 \sigma_0;
M; \quad R_5; \quad c_2 \sigma_1 k_x + c_2 \sigma_3 k_y + c_1 \sigma_0;

A; \quad \{R_7, R_7\}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,3} k_x + \Gamma_{3,1} k_y) + c_3 \Gamma_{3,0} k_z + [\alpha_1 k_x \Gamma_{+0} + \alpha_2 (k_x \Gamma_{+2} + k_y \Gamma_{+1}) + h.c.];
\quad \{R_8, R_8\}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,3} k_x - \Gamma_{3,1} k_y) + c_3 \Gamma_{3,0} k_z + [\alpha_1 k_x \Gamma_{+0} + \alpha_2 (k_x \Gamma_{-2} - k_y \Gamma_{+1}) + h.c.];
\quad \{R_9, R_9\}; \quad (c_1 + c_2 k_x^2 + c_3 k_z^2) \Gamma_{0,0} + \sum_{i=1}^3 [\Gamma_{i,0} k_x (c_{i,1} + c_{i,2} k_x^2 + c_{i,3} k_z^2) + c_{i,4} \Gamma_{i,1} k_y (k_y^2 - 3 k_x^2) + c_{i,5} \Gamma_{i,2} k_x (k_x^2 - 3 k_y^2)];

L; \quad \{R_9, R_9\}; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^3 (c_{i,1} \Gamma_{i,1} k_x + c_{i,2} \Gamma_{i,2} k_y + c_{i,3} \Gamma_{i,0} k_z);

K; \quad R_6; \quad c_2 (\sigma_1 k_x - \sigma_2 k_y) + c_1 \sigma_0;

H; \quad \{R_1, R_2\}; \quad c_2 \sigma_3 k_z + c_1 \sigma_0;
\quad \{R_3, R_5\}; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^3 (c_{i,1} (\Gamma_{i,1} k_x + \Gamma_{i,3} k_y) + c_{i,2} \Gamma_{i,0} k_z);

Δ; \quad R_7; \quad (c_1 + c_2 k_x + c_3 k_y + c_4 k_x^2 + c_5 k_y^2 + c_6 k_z^2) \sigma_0 + \left[ i (c_7 k_x^2 + c_8 k_y^2) \sigma_+ + h.c. \right];
\quad R_8; \quad c_2 (\sigma_2 k_x + \sigma_1 k_y) + \sigma_0 (c_5 k_x + c_1);
\quad R_9; \quad c_4 (\sigma_1 k_y - \sigma_2 k_x) + \sigma_0 (c_5 k_x + c_1);

U; \quad R_5; \quad c_3 \sigma_1 k_x + c_2 \sigma_3 k_y + \sigma_0 (c_5 k_x + c_1);
\quad R_6; \quad c_3 (\sigma_1 k_x - \sigma_2 k_y) + \sigma_0 (c_5 k_x + c_1);

S; \quad \{R_2, R_4\}; \quad \left[ c_1 + c_2 \left(\frac{k_x + k_y}{\sqrt{3}}\right) \right] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) (k_z - \sqrt{3} k_y) + c_5 \sigma_3 k_z;

S'; \quad \{R_2, R_4\}; \quad \sigma_0 (c_2 k_y + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_x + c_5 \sigma_3 k_z;

R; \quad \{R_2, R_4\}; \quad \sigma_0 (c_2 k_y + c_1) + (c_3 \sigma_1 - c_4 \sigma_2) k_y + c_4 \sigma_3 k_z;

Accidental degeneracies on high symmetry line

Δ; \quad \{R_7, R_8\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_2 k_x + c_4 (\Gamma_{1,3} k_x - \Gamma_{2,0} k_y) + c_5 (\Gamma_{2,3} k_x + \Gamma_{1,0} k_y) + [ic_6 (\Gamma_{0,+} - \Gamma_{3,+}) k_+ + h.c.];
\quad \{R_7, R_9\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_2 k_x + c_4 (\Gamma_{1,3} k_x + \Gamma_{2,0} k_y) + c_5 (\Gamma_{1,0} k_y - \Gamma_{2,3} k_x) + [ic_6 (\Gamma_{0,+} - \Gamma_{3,+}) k_- + h.c.];
\quad \{R_8, R_9\}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_2 k_x + [ic_4 (\Gamma_{0,+} - \Gamma_{3,+}) k_- - ic_5 (\Gamma_{0,+} + \Gamma_{3,+}) k_+ + h.c.];

P; \quad \{R_3, R_4\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z;
\quad \{R_3, R_6\}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z + (A_6 c_4 + 2 A_7 c_5 - A_2 c_6) k_x + [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] k_y;
\quad \{R_4, R_6\}; \quad A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_5 + A_8) c_3 k_z + (A_6 c_4 + 2 A_7 c_5 - A_1 c_6) k_x - [A_4 c_4 - (A_5 - \sqrt{3} A_8) c_5 - A_2 c_6] k_y;

T; \quad \{R_2, R_4\}; \quad \sigma_0 \left[c_1 + c_2 \left(\frac{\sqrt{3} k_z + k_y}{\sqrt{3}}\right)\right] + \sigma_3 c_3 \left(\sqrt{3} k_z + k_y\right) + c_4 \sigma_1 (k_x - \sqrt{3} k_y);

T'; \quad \{R_2, R_4\}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x;

Σ; \quad \{R_2, R_4\}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_y;
\[ \Gamma_h; \{ C_6^0 | 00 \frac{1}{2} \}, \{ \sigma_d | 000 \}, \mathcal{T}; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma; R_\gamma; \ c_1 \sigma_0; \]
\[ R_\delta; \ c_2 (\sigma_2 k_x + \sigma_1 k_y) + c_1 \sigma_0; \]
\[ R_\theta; \ c_2 (\sigma_1 k_y - \sigma_2 k_x) + c_1 \sigma_0; \]
\[ M; R_5; \ c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_1 \sigma_0; \]
\[ A; \{ R_{13}, R_{13} \}; \ (c_1 + c_2 k_x^2 + c_3 k_y^2) \Gamma_{0,0} + c_4 \Gamma_{1,0} k_y (k_x^2 - 3k_y^2) + \sum_{i=3}^5 [c_{1,1} \Gamma_{i,1} k_x + c_{1,2} \Gamma_{i,1} k_y (k_x^2 + 3k_y^2)] + \sum_{i=15} [c_{1,1} \Gamma_{i,1} k_x + c_{1,2} \Gamma_{i,1} k_y (k_x^2 + 3k_y^2)]; \]
\[ R_{14}, R_{15}; \ c_1 \Gamma_{0,0} + c_2 \Gamma_{3,1} k_x + \Gamma_{3,3} k_y + c_4 \Gamma_{1,0} k_x; \]
\[ L; \{ R_0, R_9 \}; \ c_1 \Gamma_{0,0} + c_2 \Gamma_{0,3} k_y + \sum_{i=1}^3 (c_{i,1} \Gamma_{i,1} k_x + c_{i,2} \Gamma_{i,1} k_y); \]
\[ K; R_6; \ c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_1 \sigma_0; \]
\[ H; \{ R_3, R_3 \}; \ (c_3 \sigma_1 - c_4 \sigma_2 + c_2 \sigma_3) k_x + c_1 \sigma_0; \]
\[ \{ R_4, R_4 \}; \ (c_3 \sigma_1 - c_4 \sigma_2 + c_2 \sigma_3) k_x + c_1 \sigma_0; \]
\[ \{ R_6, R_6 \}; \ c_1 \Gamma_{0,0} + c_2 \Gamma_{0,1} k_x - \Gamma_{0,3} k_y + \sum_{i=1}^3 c_{i,1} \Gamma_{i,1} k_x; \]
\[ \Delta; R_7; \ (c_1 + c_2 k_x + c_3 k_y^2 + c_4 k_x^2 + c_5 k_y^2 + c_6 k_x^2) \sigma_0 + [i (c_7 k_x^2 + c_8 k_y^2) \sigma_1 + h.c.]; \]
\[ R_8; \ c_2 (\sigma_2 k_x + \sigma_1 k_y) + c_0 (c_3 k_x + c_1); \]
\[ R_9; \ c_2 (\sigma_1 k_y - \sigma_2 k_x) + c_0 (c_3 k_x + c_1); \]
\[ U; R_5; \ c_2 \sigma_1 k_x + c_3 \sigma_3 k_y + c_0 (c_3 k_x + c_1); \]
\[ P; R_7; \ c_2 (\sigma_1 k_x - \sigma_3 k_y) + c_0 (c_3 k_x + c_1); \]
\[ S; \{ R_2, R_2 \}; \ c_0 (c_1 + c_2 (\sqrt{3} k_x + k_y)) + \sum_{i=1}^3 c_{i,1} \sigma_i k_x; \]
\[ \{ R_4, R_4 \}; \ c_0 (c_1 + c_2 (\sqrt{3} k_x + k_y)) + \sum_{i=1}^3 c_{i,1} \sigma_i k_x; \]
\[ S'; \{ R_2, R_2 \}; \ c_0 (c_1 + c_2 k_y) + \sum_{i=1}^3 c_{i,1} \Gamma_{i,1} k_x + [k_x (c_4 \Gamma_{1,1} + c_5 \Gamma_{2,0} + \alpha_1 \Gamma_{1,1}) + \sum_{i=0,3} (c_{i,1} \Gamma_{i,1} + \alpha_{i,1} \Gamma_{i,1}) k_x + h.c.]; \]
\[ \Sigma; \{ R_2, R_4 \}; \ c_0 (c_1 + c_2 k_x) + c_1 \sigma_3 k_x + c_4 \sigma_1 k_y; \]
\( \Gamma_h; \{ C_{0}^{+} [00\frac{1}{2}], \{ \sigma_{d1} [00\frac{1}{2}] \}, T; \) Non-Centrosymmetric; with SOC

\[
\begin{align*}
\Gamma; & \quad R_{\Gamma}; c_{1}\sigma_{0}; \\
R_{8}; & \quad c_{2}(\sigma_{2}k_{x} + \sigma_{1}k_{y}) + c_{1}\sigma_{0}; \\
R_{9}; & \quad c_{2}(\sigma_{1}k_{y} - \sigma_{2}k_{x}) + c_{1}\sigma_{0}; \\
M; & \quad R_{M}; c_{2}\sigma_{1}k_{x} + c_{3}\sigma_{3}k_{y} + c_{1}\sigma_{0}; \\
A; & \quad \{ R_{13}, R_{14} \}; (c_{1} + c_{2}k^{2} + c_{3}k_{y}^{2}) \Gamma_{0,0} + c_{4}\Gamma_{0,1}k_{x} (k_{x}^{2} - 3k_{y}^{2}) + \\
\sum_{i=1}^{3} \left[ \Gamma_{i,0}k_{x} (c_{i,1} + c_{i,2}k^{2} + c_{i,3}k_{y}^{2}) + c_{i,4}\Gamma_{i,2}k_{y} (k_{y}^{2} - 3k_{x}^{2}) \right]; \\
\{ R_{14}, R_{15} \}; c_{1}\Gamma_{0,0} + c_{2} (\Gamma_{3,3}k_{x} - \Gamma_{3,1}k_{y}) + c_{3}\Gamma_{3,0}k_{z}; \\
L; & \quad \{ R_{9}, R_{9} \}; c_{1}\Gamma_{0,0} + c_{2}\Gamma_{0,3}k_{x} + \sum_{i=1}^{3} (c_{1,i}\Gamma_{i,1}k_{y} + c_{1,2}\Gamma_{i,0}k_{z}); \\
K; & \quad R_{6}; c_{2}(\sigma_{1}k_{y} - \sigma_{2}k_{x}) + c_{1}\sigma_{0}; \\
H; & \quad \{ R_{1}, R_{2} \}; c_{2}\sigma_{3}k_{x} + c_{1}\sigma_{0}; \\
R_{5}; & \quad c_{1}\sigma_{0}; \\
\Delta; & \quad R_{\Delta}; (c_{1} + c_{2}k_{x} + c_{3}k_{y}^{2} + c_{4}k_{x}k_{y} + c_{5}k_{x}^{2}) \sigma_{0} + [i (c_{7}k_{x}^{2} + c_{8}k_{y}^{2}) \sigma_{0} + h.c.]; \\
R_{6}; & \quad c_{2}(\sigma_{2}k_{x} + \sigma_{1}k_{y}) + c_{0}(c_{3}k_{x} + c_{1}); \\
R_{9}; & \quad c_{2}(\sigma_{1}k_{y} - \sigma_{2}k_{x}) + c_{0}(c_{3}k_{y} + c_{1}); \\
U; & \quad R_{U}; c_{2}\sigma_{1}k_{x} + c_{3}\sigma_{3}k_{y} + c_{0}(c_{4}k_{x} + c_{1}); \\
P; & \quad R_{P}; c_{2}(\sigma_{1}k_{x} - \sigma_{3}k_{y}) + c_{0}(c_{3}k_{y} + c_{1}); \\
S; & \quad \{ R_{2}, R_{3} \}; \sigma_{0}(c_{2}(\sqrt{3}k_{x} + k_{y}) + c_{1}) + c_{3}\sigma_{3}k_{z}; \\
S'; & \quad \{ R_{2}, R_{4} \}; \sigma_{0}(c_{2}k_{y} + c_{1}) + c_{3}\sigma_{3}k_{z}; \\
R; & \quad \{ R_{2}, R_{2} \}; \sigma_{0}(c_{2}k_{x} + c_{1}) + (c_{4}\sigma_{1} + c_{5}\sigma_{2} + c_{6}\sigma_{3})k_{z}; \\
\{ R_{4}, R_{4} \}; \sigma_{0}(c_{2}k_{x} + c_{1}) + (c_{4}\sigma_{1} + c_{5}\sigma_{2} + c_{6}\sigma_{3})k_{z}; \\
\end{align*}
\]

Accidental degeneracies on high symmetry line

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\begin{align*}
\Delta; & \quad \{ R_{\Delta}, \{ R_{8} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + c_{4} (\Gamma_{1,3}k_{x} - \Gamma_{2,0}k_{y}) + c_{5} (\Gamma_{2,3}k_{x} + \Gamma_{1,0}k_{y}) + [ic_{6} (\Gamma_{0,1} - \Gamma_{3,1})k_{y} + h.c.]; \\
\{ R_{\Delta}, \{ R_{8} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + c_{4} (\Gamma_{1,3}k_{x} - \Gamma_{2,0}k_{y}) + c_{5} (\Gamma_{2,3}k_{x} + \Gamma_{1,0}k_{y}) + [ic_{6} (\Gamma_{0,1} - \Gamma_{3,1})k_{y} + h.c.]; \\
\{ R_{8}, \{ R_{9} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + [ic_{4} (\Gamma_{0,1} - \Gamma_{3,1})k_{y} - ic_{5} (\Gamma_{0,1} + \Gamma_{3,1})k_{x} + h.c.]; \\
P; & \quad \{ R_{3}, \{ R_{4} \}; \sigma_{0} (c_{1} + c_{2}k_{x}) + c_{3}\sigma_{3}k_{z}; \\
\{ R_{3}, \{ R_{6} \}; A_{0} (c_{1} + c_{2}k_{x}) + (\sqrt{3}A_{3} + A_{4})c_{3}k_{x} + (A_{6}c_{4} + 2A_{4}c_{5} - A_{4}c_{6}) k_{x} + [A_{4}c_{4} + (A_{3} - \sqrt{3}A_{4})c_{5} + A_{4}c_{6}k_{y}; \\
\{ R_{4}, \{ R_{6} \}; A_{0} (c_{1} + c_{2}k_{x}) + (\sqrt{3}A_{3} + A_{4})c_{3}k_{x} + (A_{6}c_{4} + 2A_{4}c_{5} - A_{4}c_{6}) k_{x} + [-A_{6}c_{4} + (A_{3} - \sqrt{3}A_{4})c_{5} - A_{4}c_{6}]k_{y}; \\
T; & \quad \{ R_{2}, \{ R_{4} \}; \sigma_{0} [c_{2} + c_{4} (\sqrt{3}k_{x} + k_{y})] + c_{3}\sigma_{3} (\sqrt{3}k_{x} + k_{y}) + c_{4}\sigma_{1} (k_{x} - \sqrt{3}k_{y}); \\
T'; & \quad \{ R_{2}, \{ R_{4} \}; \sigma_{0} (c_{1} + c_{2}k_{y}) + c_{3}\sigma_{3}k_{x} + c_{4}\sigma_{2}k_{z}; \\
\Sigma; & \quad \{ R_{2}, \{ R_{4} \}; \sigma_{0} (c_{1} + c_{2}k_{y}) + c_{3}\sigma_{3}k_{x} + c_{4}\sigma_{1}k_{y}; \\
R; & \quad \{ R_{2}, R_{2}; \{ R_{4}, R_{4} \}; \Gamma_{0,0} (c_{1} + c_{2}k_{x}) + \Gamma_{3,0}c_{3}k_{x} + [k_{y} (c_{4}\Gamma_{1,0} + c_{5}\Gamma_{2,3} + \alpha_{1}\Gamma_{2,1} + \sum_{i=0,3} (c_{i,1}\Gamma_{i,0} + c_{i,0}\Gamma_{i,1})k_{x} + h.c.] \\
\end{align*}
\]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z; \]
\[ \{ R_3 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_6) c_3 k_z + c_4 (A_2 k_y - A_1 k_z); \]
\[ \{ R_4 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + (\sqrt{3} A_5 + A_6) c_3 k_z + c_4 (A_2 k_y + A_1 k_z); \]
\[ U: \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_y; \]
\[ P: \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 [\sigma_1 (\sqrt{3} k_x - k_y) + \sigma_2 (k_x + \sqrt{3} k_y)]; \]
\[ \{ R_2 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 [\sigma_1 (\sqrt{3} k_x - k_y) - \sigma_2 (k_x + \sqrt{3} k_y)]; \]
\[ \{ R_4 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + c_4 [\sigma_1 (\sqrt{3} k_x - k_y) + \sigma_2 (k_x - \sqrt{3} k_y)]; \]
\[ T: \{ R_2 \}, \{ R_4 \}; \sigma_0 [c_1 + c_2 (\sqrt{3} k_x + k_y)] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_4 \sigma_2 k_z; \]
\[ S: \{ R_2 \}, \{ R_4 \}; \sigma_0 [c_1 + c_2 (\sqrt{3} k_x + k_y)] + \sigma_3 c_3 (\sqrt{3} k_x + k_y) + c_4 \sigma_2 k_z; \]
\[ T': \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_z; \]
\[ S': \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_6 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_3 k_x; \]
\[ \{ R_3 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_5) c_3 k_x + c_4 (A_2 k_y - A_1 k_x); \]
\[ \{ R_4 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_5) c_3 k_x + c_4 (A_2 k_x + A_1 k_y); \]
\[ U; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_3 k_x + c_4 c_4 k_y; \]
\[ P; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_3 k_x + c_4 \left[ \sigma_1 (\sqrt{3} k_x - k_y) + \sigma_2 (k_x + \sqrt{3} k_y) \right]; \]
\[ \{ R_2 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_3 k_x + c_4 \left[ \sigma_1 (\sqrt{3} k_x - k_y) - \sigma_2 (k_x + \sqrt{3} k_y) \right]; \]
\[ \{ R_4 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_3 k_x + c_4 \left[ \sigma_1 (\sqrt{3} k_x - k_y) + \sigma_2 (k_x + \sqrt{3} k_y) \right]; \]
\[ T; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 (\sqrt{3} k_x + k_y)) + c_3 c_3 (\sqrt{3} k_x + k_y) + c_4 c_2 k_x; \]
\[ T'; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + c_3 c_3 k_y + c_4 c_2 k_x; \]
\[ R; \{ R_5 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_3 k_x; \]
\[ \{ R_5 \}, \{ R_7 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_3 k_x + (c_4 c_1 + c_5 c_2) k_x; \]
\[ \{ R_6 \}, \{ R_7 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_3 k_x + (c_4 c_1 + c_5 c_2) k_y; \]
\[ \{ R_6 \}, \{ R_7 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_3 k_x + (c_4 c_1 + c_5 c_2) k_x; \]
\[ \{ R_7 \}, \{ R_8 \}; \sigma_0 (c_1 + c_2 k_x) + c_3 c_3 k_x; \]
\( \Gamma_h; \{ S^+_4 |000\}, \{ C''_{21} |000\}, \mathcal{T}; \) Non-Centrosymmetric; with SOC

\( \Gamma; \)
- \( R_\zeta; c_1 \sigma_0 - c_2 \sigma_2 k_z; \)
- \( R_8; c_1 \sigma_0; \)
- \( R_9; c_1 \sigma_0; \)

\( M; \)
- \( R_5; c_2 \sigma_3 k_x + c_3 \sigma_1 k_z + c_1 \sigma_0; \)

\( A; \)
- \( R_\zeta; c_1 \sigma_0 - c_2 \sigma_2 k_z; \)
- \( R_8; c_1 \sigma_0; \)
- \( R_9; c_1 \sigma_0; \)

\( L; \)
- \( R_5; c_2 \sigma_3 k_x + c_3 \sigma_1 k_z + c_1 \sigma_0; \)

\( K; \)
- \( R_\zeta; c_1 \sigma_0 - c_2 \sigma_2 k_z; \)
- \( R_8; c_1 \sigma_0; \)
- \( R_9; c_1 \sigma_0; \)

\( H; \)
- \( R_\zeta; c_1 \sigma_0 - c_2 \sigma_2 k_z; \)
- \( R_8; c_1 \sigma_0; \)
- \( R_9; c_1 \sigma_0; \)

\( \Delta; \)
- \( R_6; (c_1 + c_2 k_x + c_3 k^2 + c_4 k_z^2) \sigma_0 + c_5 \left[ 2 \sigma_1 k_x k_y + \sigma_3 (k_y^2 - k_z^2) \right] \);

\( P; \)
- \( R_6; c_2 (\sigma_1 k_x - \sigma_3 k_y) + \sigma_0 (c_3 k_x + c_1); \)

\( T; \)
- \( R_5; \sigma_0 c_6 (\sqrt{3} k_x + k_y) + c_1 + c_3 \sigma_3 (k_x - \sqrt{3} k_y) + c_4 \sigma_1 k_z; \)

\( S; \)
- \( R_5; \sigma_0 \left[ c_2 (\sqrt{3} k_x + k_y) + c_1 \right] + c_3 \sigma_3 (k_x - \sqrt{3} k_y) + c_4 \sigma_1 k_z; \)

\( T'; \)
- \( R_5; \sigma_0 (c_3 k_y + c_1) + c_2 \sigma_3 k_z + c_4 \sigma_1 k_z; \)

\( S'; \)
- \( R_5; \sigma_0 (c_3 k_y + c_1) + c_2 \sigma_3 k_z + c_4 \sigma_1 k_z; \)

---

Accidental degeneracies on high symmetry line

\( \Delta; \)
- \( \{ R_5 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z; \)
- \( \{ R_3 \}, \{ R_6 \} : A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_8) c_3 k_z + c_4 (A_2 k_y - A_1 k_z); \)
- \( \{ R_4 \}, \{ R_6 \} : A_0 (c_1 + c_3 k_x) + (\sqrt{3} A_2 + A_9) c_3 k_z + c_4 (A_2 k_y + A_3 k_y); \)

\( U; \)
- \( \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_z; \)

\( P; \)
- \( \{ R_3 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z; \)
- \( \{ R_3 \}, \{ R_6 \} : A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_8) c_3 k_z + (A_6 c_4 + 2 A_7 c_5 - A_2 c_6) k_z + [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] k_y; \)
- \( \{ R_4 \}, \{ R_6 \} : A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_2 + A_9) c_3 k_z + (A_4 c_4 + 2 A_7 c_5 - A_1 c_6) k_z - [A_0 c_4 - (A_5 - \sqrt{3} A_8) c_5 - A_2 c_6] k_y; \)

\( \Sigma; \)
- \( \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_z; \)

\( R; \)
- \( \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_z + c_4 \sigma_2 k_z; \)
\[ \Gamma_h; \{ S_3^+ | 000 \}, \{ C_{21}'' | 00 \frac{1}{2} \}; T; \text{Non-Centrosymmetric; with SOC} \]

\( \Gamma; R_7; c_1 \sigma_0 - c_2 \sigma_2 k_z; \)
\( R_8; c_1 \sigma_0; \)
\( R_9; c_1 \sigma_0; \)

\( M; R_5; c_2 \sigma_3 k_x + c_3 \sigma_1 k_z + c_1 \sigma_0; \)

\( A; \{ R_5, R_7 \}; \)
\( \{ R_6, R_8 \}; \)
\( \{ R_{11}, R_{12} \}; c_1 \Gamma_{0,0} + c_2 (\Gamma_{0,2} k_x + \Gamma_{3,1} k_y) + k_z (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}); \)

\( L; \{ R_5, R_6 \}; \)
\( \{ R_7, R_8 \}; \)

\( K; R_7; c_1 \sigma_0 - c_2 \sigma_2 k_z; \)
\( R_8; c_1 \sigma_0; \)
\( R_9; c_1 \sigma_0; \)

\( H; R_{11}; \)
\( R_{12}; \)

\( \Delta; R_5; \)
\( \{ R_4 \}; \)
\( \{ R_6 \}; \)
\( \{ R_7, R_8 \}; \)

\( P; R_6; \)

\( T; R_5; \)

\( T'; R_5; \)
\( \{ R_2, R_4 \}; \)

Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_3, R_4 \}; \]
\( \{ R_3 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_6) c_3 k_x + c_4 (A_2 k_y - A_1 k_z); \)
\( \{ R_4 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_6) c_3 k_x + c_4 (A_2 k_y + A_1 k_z); \)

\( U; \{ R_2, R_4 \}; \)

\( P; \{ R_2, R_4 \}; \)

\( S; \{ R_5, R_6 \}; \)
\( \{ R_5 \}, \{ R_7 \}; \)
\( \{ R_6 \}, \{ R_8 \}; \)

\( S'; \{ R_5, R_7 \}; \)
\( \{ R_6 \}, \{ R_8 \}; \)

\( \Sigma; \{ R_2, R_4 \}; \)

\[ \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z); \]

\[ \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z); \]

\[ \sigma_0 (c_1 + c_2 k_x + c_3 \sigma_1 k_y + c_4 \sigma_2 k_z); \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_7, R_8\} : \Gamma_{0,0}(c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4(\Gamma_{2,3} k_x + \Gamma_{1,0} k_y); \]

\[ \{R_7, R_8\} : \Gamma_{0,0}(c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4(\Gamma_{1,0} k_y - \Gamma_{2,3} k_x); \]

\[ \{R_8\}, \{R_9\} : \Gamma_{0,0}c_1 + \sum_{i=0,3} \Gamma_{1,0} (c_{i,1} k_x + c_{i,2} k^2 + c_{i,3} k_x^2) + c_2[\Gamma_{1,0}(k_y^2 - k_x^2) + 2\Gamma_{2,3} k_x k_y]; \]

\[ P: \{R_3, R_4\}, \{R_6\} : \Gamma_{0,0}(c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4(\Gamma_{2,3} k_x - \Gamma_{1,0} k_y) + c_5(\Gamma_{2,1} k_x + \Gamma_{2,3} k_y); \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{R_7, R_8\} : \Gamma_{0,0}(c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4(\Gamma_{2,3} k_x + \Gamma_{1,0} k_y); \]

\[ \{R_7, R_8\} : \Gamma_{0,0}(c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4(\Gamma_{1,0} k_y - \Gamma_{2,3} k_x); \]

\[ \{R_8\}, \{R_9\} : \Gamma_{0,0}c_1 + \sum_{i=0,3} \Gamma_{1,0} (c_{i,1} k_x + c_{i,2} k^2 + c_{i,3} k_x^2) + c_2[\Gamma_{1,0}(k_y^2 - k_x^2) + 2\Gamma_{2,3} k_x k_y]; \]

\[ P: \{R_3, R_4\}, \{R_6\} : \Gamma_{0,0}(c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4(\Gamma_{2,3} k_x - \Gamma_{1,0} k_y) + c_5(\Gamma_{2,1} k_x + \Gamma_{2,3} k_y); \]

\[ S: \{R_5, R_6\}, \{R_7, R_8\} : \Gamma_{0,0}c_1 + \sum_{i=0,3} \Gamma_{1,0} (c_{i,1} k_x + c_{i,2} k^2 + c_{i,3} k_x^2) + c_2[\Gamma_{1,0}(k_y^2 - k_x^2) + 2\Gamma_{2,3} k_x k_y]; \]

\[ S': \{R_5, R_6\}, \{R_7, R_8\} : \Gamma_{0,0}(c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4(\Gamma_{2,3} k_x - \Gamma_{1,0} k_y) + c_5(\Gamma_{2,1} k_x + \Gamma_{2,3} k_y); \]

\[ R: \{R_5, R_6\}, \{R_7, R_8\} : \Gamma_{0,0}(c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4(\Gamma_{2,3} k_x - \Gamma_{1,0} k_y) + c_5(\Gamma_{2,1} k_x + \Gamma_{2,3} k_y). \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_7 \}, \{ R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{2,3} k_x + \Gamma_{1,0} k_y) ; \\
\{ R_7 \}, \{ R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_y - \Gamma_{2,3} k_y) ; \\
\{ R_8 \}, \{ R_9 \}; \quad \Gamma_{0,0} c_1 + \sum_{i=0,3} \Gamma_{1,0} (c_1 k_i + c_2 k_i^2 + c_3 k_i^3) + c_2 \left[ \Gamma_{1,0} (k_y^2 - k_z^2) + 2\Gamma_{2,3} k_x k_y \right] ; \\
P: \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{2,3} k_x - \Gamma_{1,0} k_y) + c_5 (\Gamma_{2,1} k_x + \Gamma_{2,3} k_y) ; \\
R: \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + k_x (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) ; \\
\]

SG 194
\[
\Gamma_k; \{ C_6^+ [00\frac{1}{2}], C_2^- [00\frac{1}{2}] \}, \{ J[000] \}, T; \text{Centrosymmetric; with SOC} \\
\]
\[A: \{ R_{15}, R_{16} \}; \quad c_1 \Gamma_{0,0} + k_x (c_2 \Gamma_{1,3} - c_3 \Gamma_{2,3}) ; \\
\{ R_{24} \}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{3,3} k_z ; \\
L: \{ R_{13}, R_{14} \}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{3,3} k_y + k_z (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}) ; \\
R: \{ R_9, R_9 \}; \quad (c_1 + c_2 k_x) \Gamma_{0,0} + c_3 \Gamma_{0,1} k_y + \sum_{i=1}^3 c_i \Gamma_{i,3} k_z ; \\
\]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_7 \}, \{ R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{2,3} k_x + \Gamma_{1,0} k_y) ; \\
\{ R_7 \}, \{ R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{1,0} k_y - \Gamma_{2,3} k_y) ; \\
\{ R_8 \}, \{ R_9 \}; \quad \Gamma_{0,0} c_1 + \sum_{i=0,3} \Gamma_{1,0} (c_1 k_i + c_2 k_i^2 + c_3 k_i^3) + c_2 \left[ \Gamma_{1,0} (k_y^2 - k_z^2) + 2\Gamma_{2,3} k_x k_y \right] ; \\
P: \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_3 k_z + c_4 (\Gamma_{2,3} k_x - \Gamma_{1,0} k_y) + c_5 (\Gamma_{2,1} k_x + \Gamma_{2,3} k_y) ; \\
S: \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} c_1 + \sum_{i=0,3} \Gamma_{1,0} (c_1 k_i + c_2 k_i^2 + c_3 k_i^3) + c_2 \left[ \Gamma_{1,0} (k_y^2 - k_z^2) + 2\Gamma_{2,3} k_x k_y \right] ; \\
\]

SG 195
\[
\Gamma_k; \{ C_{33} [000] \}, \{ C_{24} [000] \}, \{ C_{24} [000] \}, T; \text{Non-Centrosymmetric; with SOC} \\
\]
\[\Gamma: \quad R_4; \quad c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) + c_1 \sigma_0 ; \\
\{ R_5, R_6 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,3} k_x - \Gamma_{0,2} k_y - \Gamma_{3,3} k_z) + \left[ \alpha_1 \left( k_x \Gamma_{+,-3} - e^{i\pi/6} k_y \Gamma_{+,-0} - e^{i\pi/3} k_z \Gamma_{+,-1} \right) \right] + h.c. ; \\
X: \quad R_5; \quad c_2 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0 ; \\
M: \quad R_5; \quad c_3 \sigma_3 k_x + c_3 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0 ; \\
R: \quad R_4; \quad c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) + c_1 \sigma_0 ; \\
\{ R_5, R_6 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,3} k_x - \Gamma_{0,2} k_y - \Gamma_{3,3} k_z) + \left[ \alpha_1 \left( k_x \Gamma_{+,-3} - e^{i\pi/6} k_y \Gamma_{+,-0} - e^{i\pi/3} k_z \Gamma_{+,-1} \right) \right] + h.c. ; \\
\]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z ; \\
\Delta: \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_y + \left( \alpha_1 \sigma_{+} q + h.c. \right) ; \\
\{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_y + \left( \alpha_1 \sigma_{-} q + h.c. \right) ; \\
\{ R_4 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_y + \left( \alpha_1 \sigma_{+} q + h.c. \right) ; \\
Z: \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z ; \\
T: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_y + c_4 \sigma_2 k_x + c_5 \sigma_1 k_y ; \\
\]
\[ \Gamma^i: \{ C_{2y}[000] \}, \{ C_{2y}[000] \}, \{ C_{2y}[000] \}, T \}; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma: \{ R_4 \}; \quad c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) + c_1 \sigma_0; \]

\[ \{ R_5, R_6 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,1} k_x - \Gamma_{0,2} k_y - \Gamma_{3,3} k_z) + \left[ \alpha_1 \left( k_x \Gamma_{+,-} - e^{i\pi/6} k_y \Gamma_{+,0} - e^{i\pi/3} k_z \Gamma_{+,1} \right) + \text{h.c.} \right]; \]

\[ X: \{ R_5 \}; \quad c_2 \sigma_3 k_x + c_0 \sigma_1 k_y - c_4 \sigma_2 k_z + c_1 \sigma_0; \]

\[ L: \{ R_2, R_3 \}; \quad c_1 \sigma_0 + c_2 \sigma_3 q_x + (\alpha_1 \sigma_4 q_+ + \text{h.c.}); \]

\[ \{ R_4, R_4 \}; \quad (c_1 + c_2 q^2 + c_3 q_z^2) \sigma_0 + \sum_{i=1}^{3} \left[ (c_{1,i} + c_{2,i} q^2 + c_{3,i} q_z^2) q_x + c_{4,i} \left( q_y^2 - 3 q_z^2 \right) q_y + c_{5,i} q_x \left( q_x^2 - 3 q_y^2 \right) \right] \sigma; \]

**Accidental degeneracies on high symmetry line**

\[ \Delta: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \]

\[ \Lambda: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_x + (\alpha_1 \sigma_4 q_+ + \text{h.c.}); \]

\[ \{ R_2 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_x + (\alpha_1 \sigma_4 q_+ + \text{h.c.}); \]

\[ \{ R_4 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_x + (\alpha_1 \sigma_4 q_+ + \text{h.c.}); \]

\[ Z: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]

\[ \Gamma^i: \{ C_{2y}[000] \}, \{ C_{2y}[000] \}, \{ C_{2y}[000] \}, T \}; \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma: \{ R_4 \}; \quad c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) + c_1 \sigma_0; \]

\[ \{ R_5, R_6 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,1} k_x - \Gamma_{0,2} k_y - \Gamma_{3,3} k_z) + \left[ \alpha_1 \left( k_x \Gamma_{+,-} - e^{i\pi/6} k_y \Gamma_{+,0} - e^{i\pi/3} k_z \Gamma_{+,1} \right) + \text{h.c.} \right]; \]

\[ H: \{ R_4 \}; \quad c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) + c_1 \sigma_0; \]

\[ \{ R_5, R_6 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,1} k_x - \Gamma_{0,2} k_y - \Gamma_{3,3} k_z) + \left[ \alpha_1 \left( k_x \Gamma_{+,-} - e^{i\pi/6} k_y \Gamma_{+,0} - e^{i\pi/3} k_z \Gamma_{+,1} \right) + \text{h.c.} \right]; \]

\[ P: \{ R_4 \}; \quad c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) + c_1 \sigma_0; \]

\[ R_5; \quad c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) + c_1 \sigma_0; \]

\[ R_6; \quad c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) + c_1 \sigma_0; \]

\[ N: \{ R_2, R_4 \}; \quad \sigma_2 (c_2 k_x + c_3 k_y) + \sigma_2 (c_2 k_x + c_3 k_y) + c_4 \sigma_3 k_z + c_1 \sigma_0; \]

**Accidental degeneracies on high symmetry line**

\[ \Delta: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 \sigma_1 k_x + c_5 \sigma_2 k_z; \]

\[ \Lambda: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_x + (\alpha_1 \sigma_4 q_+ + \text{h.c.}); \]

\[ \{ R_2 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_x + (\alpha_1 \sigma_4 q_+ + \text{h.c.}); \]

\[ \{ R_4 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_x + (\alpha_1 \sigma_4 q_+ + \text{h.c.}); \]

\[ D: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + c_4 \sigma_3 k_z + \sum_{i=1}^{2} \sigma_i (c_{1,i} k_x + c_{2,i} k_y); \]

\[ F: \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 p_x) + \sigma_3 c_3 p_x + (\alpha_1 \sigma_4 p_+ + \text{h.c.}); \]

\[ \{ R_2 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 p_x) + \sigma_3 c_3 p_x + (\alpha_1 \sigma_4 p_+ + \text{h.c.}); \]

\[ \{ R_4 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 p_x) + \sigma_3 c_3 p_x + (\alpha_1 \sigma_4 p_+ + \text{h.c.}); \]
Accidental degeneracies on high symmetry line

Accidental degeneracies on high symmetry line
\[ \Gamma_c; \{ C_{3y}^z \{ 000 \}, \{ C_{2x}^z \{ \frac{1}{2} 00 \} \}, \{ C_{2y}^z \{ 000 \} \}, \{ I \{ 000 \} \}; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; \{ R_{5}, R_{6} \}; \Gamma_0 \{ (c_2 k^2 + c_1) + c_3 \Gamma_{0,1} \left( \frac{\sqrt{3}}{2} k_x k_y - \frac{1 + \sqrt{3}}{2} k_x k_z + k_y k_z \right) + c_3 \Gamma_{0,1} \left( k_x k_y + k_z k_x + k_y k_z \right) + c_3 \Gamma_{0,1} \left( 1 + \frac{\sqrt{3}}{2} k_x k_y - \frac{\sqrt{3}}{2} k_x k_z - k_y k_z \right) + \left[ c_5 \left( 2 k_x^2 - k_y^2 - k_z^2 \right) + c_4 \left( k_x^2 - 2 k_y^2 + k_z^2 \right) \right] \Gamma_{1,2} + \sqrt{3} \Gamma_{2,2} \left( c_4 + c_5 \right) k_x^2 - c_5 k_y^2 - c_5 k_z^2 \}; \]

\[ \{ R_{12}, R_{13} \}; \Gamma_{0,0} \{ (c_2 k^2 + c_1) + c_3 \Gamma_{0,1} \left( \frac{\sqrt{3}}{2} k_x k_y - \frac{1 + \sqrt{3}}{2} k_x k_z + k_y k_z \right) + c_3 \Gamma_{0,1} \left( k_x k_y + k_z k_x + k_y k_z \right) + c_3 \Gamma_{0,1} \left( 1 + \frac{\sqrt{3}}{2} k_x k_y - \frac{\sqrt{3}}{2} k_x k_z - k_y k_z \right) + \left[ c_5 \left( 2 k_x^2 - k_y^2 - k_z^2 \right) + c_4 \left( k_x^2 - 2 k_y^2 + k_z^2 \right) \right] \Gamma_{1,2} + \sqrt{3} \Gamma_{2,2} \left( c_4 + c_5 \right) k_x^2 - c_5 k_y^2 - c_5 k_z^2 \}; \]

\[ R; \{ R_{5}, R_{6} \}; \Gamma_{0,0} \{ (c_2 k^2 + c_1) + c_3 \Gamma_{0,1} \left( \frac{\sqrt{3}}{2} k_x k_y - \frac{1 + \sqrt{3}}{2} k_x k_z + k_y k_z \right) + c_3 \Gamma_{0,1} \left( k_x k_y + k_z k_x + k_y k_z \right) + c_3 \Gamma_{0,1} \left( 1 + \frac{\sqrt{3}}{2} k_x k_y - \frac{\sqrt{3}}{2} k_x k_z - k_y k_z \right) + \left[ c_5 \left( 2 k_x^2 - k_y^2 - k_z^2 \right) + c_4 \left( k_x^2 - 2 k_y^2 + k_z^2 \right) \right] \Gamma_{1,2} + \sqrt{3} \Gamma_{2,2} \left( c_4 + c_5 \right) k_x^2 - c_5 k_y^2 - c_5 k_z^2 \}; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{ R_{2}, R_{6} \}, \{ R_{4}, R_{4} \}; \Gamma_{0,0} \{ (c_1 + c_2 q_x) + c_3 q_z + \Gamma_{3,0} c_3 q_z + \Gamma_{1,0} c_4 q_x + c_5 q_y \} + \Gamma_{2,3} \left( c_5 q_x - c_4 q_y \right) + \left( \alpha_1 \Gamma_{2,4} q_x + \text{h.c.} \right); \]
SG 201

Γc; \{C_{31}|000\}, \{C_{2x}|000\}, \{C_{2y}|000\}, \{I|\frac{1}{2} \frac{1}{2} \frac{1}{2}\}; T; Centrosymmetric; with SOC

\[ \Gamma; \{R_5, R_6\}; \Gamma_{0,0} (c_2 k^2 + c_1) + c_{3\Gamma_{0,1}} \left( \frac{\sqrt{3}}{2} k_x k_y - \frac{\sqrt{3}}{2} k_x k_z + k_y k_z \right) + c_{3\Gamma_{0,2}} \left( k_x k_y + k_x k_z + k_y k_z \right) + c_{3\Gamma_{3,2}} \left( \frac{1 + \sqrt{3}}{2} k_x k_y - \frac{1 + \sqrt{3}}{2} k_x k_z - k_y k_z \right) + \left[ c_5 (2k_y^2 - k_x^2 - k_z^2) + c_4 (k_x^2 - 2k_y^2 + k_z^2) \right] \Gamma_{1,2} + \sqrt{3} \Gamma_{2,2} \left( (c_4 + c_5) k_x^2 - c_4 k_y^2 - c_5 k_z^2 \right) ; \]

\[ \{R_{12}, R_{13}\}; \Gamma_{0,0} (c_2 k^2 + c_1) + c_{3\Gamma_{0,1}} \left( \frac{\sqrt{3}}{2} k_x k_y - \frac{\sqrt{3}}{2} k_x k_z + k_y k_z \right) + c_{3\Gamma_{0,3}} (k_x k_y + k_x k_z + k_y k_z) + c_{3\Gamma_{3,2}} \left( \frac{1 + \sqrt{3}}{2} k_x k_y - \frac{1 + \sqrt{3}}{2} k_x k_z - k_y k_z \right) + c_5 (2k_y^2 - k_x^2 - k_z^2) + c_4 (k_x^2 - 2k_y^2 + k_z^2) \Gamma_{1,2} + \sqrt{3} \Gamma_{2,2} \left( (c_4 + c_5) k_x^2 - c_4 k_y^2 - c_5 k_z^2 \right) ; \]

\[ X; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{3,1} k_x + k_y (c_3 \Gamma_{1,1} - c_4 \Gamma_{2,1}) + c_5 \Gamma_{0,2} k_z ; \]

\[ M; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} k_x + c_3 \Gamma_{3,1} k_y + k_z (c_4 \Gamma_{1,1} - c_5 \Gamma_{2,1}) ; \]

\[ R; \{R_5, R_6\}; \Gamma_{0,0} (c_2 k^2 + c_1) + c_{3\Gamma_{0,1}} \left( \frac{\sqrt{3}}{2} k_x k_y - \frac{\sqrt{3}}{2} k_x k_z + k_y k_z \right) + c_{3\Gamma_{0,2}} (k_x k_y + k_x k_z + k_y k_z) + c_{3\Gamma_{3,2}} \left( \frac{1 + \sqrt{3}}{2} k_x k_y - \frac{1 + \sqrt{3}}{2} k_x k_z - k_y k_z \right) + c_5 (2k_y^2 - k_x^2 - k_z^2) + c_4 (k_x^2 - 2k_y^2 + k_z^2) \Gamma_{1,2} + \sqrt{3} \Gamma_{2,2} \left( (c_4 + c_5) k_x^2 - c_4 k_y^2 - c_5 k_z^2 \right) ; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_2, R_6\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 q_x) + \Gamma_{3,0} c_3 q_x + \Gamma_{1,0} (c_4 q_x + c_5 q_y) + \Gamma_{2,3} (c_5 q_x - c_4 q_y) + (\alpha_1 \Gamma_{2,+} q_x + h.c.); \]

\[ Z; \{R_5, R_6\}, \{R_6, R_7\}; \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_y (c_1 \Gamma_{2,1} + c_2 \Gamma_{2,2}) + k_z (c_3 \Gamma_{2,3} + c_4 \Gamma_{1,0}); \]

SG 202

Γc; \{C_{31}|000\}, \{C_{2x}|000\}, \{C_{2y}|000\}, \{I|000\}; T; Centrosymmetric; with SOC

\[ \Gamma; \{R_5, R_6\}; \Gamma_{0,0} (c_2 k^2 + c_1) + c_{3\Gamma_{0,1}} \left( \frac{\sqrt{3}}{2} k_x k_y - \frac{\sqrt{3}}{2} k_x k_z + k_y k_z \right) + c_{3\Gamma_{0,2}} (k_x k_y + k_x k_z + k_y k_z) + c_{3\Gamma_{3,2}} \left( \frac{1 + \sqrt{3}}{2} k_x k_y - \frac{1 + \sqrt{3}}{2} k_x k_z - k_y k_z \right) + \left[ c_5 (2k_y^2 - k_x^2 - k_z^2) + c_4 (k_x^2 - 2k_y^2 + k_z^2) \right] \Gamma_{1,2} + \sqrt{3} \Gamma_{2,2} \left( (c_4 + c_5) k_x^2 - c_4 k_y^2 - c_5 k_z^2 \right) ; \]

\[ \{R_{12}, R_{13}\}; \Gamma_{0,0} (c_2 k^2 + c_1) + c_{3\Gamma_{0,1}} \left( \frac{\sqrt{3}}{2} k_x k_y - \frac{\sqrt{3}}{2} k_x k_z + k_y k_z \right) + c_{3\Gamma_{0,3}} (k_x k_y + k_x k_z + k_y k_z) + c_{3\Gamma_{3,2}} \left( \frac{1 + \sqrt{3}}{2} k_x k_y - \frac{1 + \sqrt{3}}{2} k_x k_z - k_y k_z \right) + c_5 (2k_y^2 - k_x^2 - k_z^2) + c_4 (k_x^2 - 2k_y^2 + k_z^2) \Gamma_{1,2} + \sqrt{3} \Gamma_{2,2} \left( (c_4 + c_5) k_x^2 - c_4 k_y^2 - c_5 k_z^2 \right) ; \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_2, R_6\}, \{R_4, R_4\}; \Gamma_{0,0} (c_1 + c_2 q_x) + \Gamma_{3,0} c_3 q_x + \Gamma_{1,0} (c_4 q_x + c_5 q_y) + \Gamma_{2,3} (c_5 q_x - c_4 q_y) + (\alpha_1 \Gamma_{2,+} q_x + h.c.); \]
Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_2, R_3\}, \{R_4, R_5\}; \Gamma_{0,0} (c_1 + c_2 q_x) + \Gamma_{3,0} c_3 q_x + \Gamma_{1,0} (c_4 q_x + c_5 q_y) + \Gamma_{2,3} (c_5 q_x + c_4 q_y) + (\alpha_1 \Gamma_{2,4} q_x + h.c.); \]
\[ \{R_3, R_4\}, \{R_5, R_6\}; \Gamma_{0,0} (c_1 + c_2 q_x) + \Gamma_{3,0} c_3 q_x + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_y (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \]

Accidental degeneracies on high symmetry line

\[ \Lambda; \{R_2, R_3\}, \{R_4, R_5\}; \Gamma_{0,0} (c_1 + c_2 q_x) + \Gamma_{3,0} c_3 q_x + \Gamma_{1,0} (c_4 q_x + c_5 q_y) + \Gamma_{2,3} (c_5 q_x - c_4 q_y) + \Gamma_{1,2} (c_1 + c_2 p_z); \]
\[ \{R_3, R_4\}, \{R_5, R_6\}; \Gamma_{0,0} (c_1 + c_2 q_x) + \Gamma_{3,0} c_3 q_x + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_y (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \]
\[ \Gamma_c; \{C_{3v}[000]\}, \{C_{2v}[\frac{1}{2}\pm 0]\}, \{C_{2h}[0\frac{1}{2}\pm \frac{1}{2}]\}, \{I[000]\}, \mathcal{T}; \text{Centrosymmetric with SOC} \]

\[ \Gamma; \{R_5, R_6\}; \Gamma_0,0 \left( c_2 k^2 + c_1 \right) + c_1 \Gamma_{0,1} \left( \sqrt{\frac{3}{2}} k_x k_y - \frac{1}{\sqrt{2}} k_z k_x + k_y k_z \right) + c_3 \Gamma_{0,3} \left( k_x k_y + k_x k_z + k_y k_z \right) + c_4 \Gamma_{3,2} \left( \sqrt{\frac{3}{2}} k_x k_y - \frac{1}{\sqrt{2}} k_z k_x - k_y k_z \right) + \left[ c_5 \left( 2k_x^2 - k_y^2 - k_z^2 \right) + c_6 \left( k_x^2 - 2k_y^2 + k_z^2 \right) \right] \Gamma_{1,2} + \sqrt{3} \Gamma_{2,2} \left[ (c_4 + c_5) k_y^2 - c_4 k_x^2 - c_5 k_y^2 \right] ; \]

\[ \{R_{12}, R_{13}\}; \Gamma_0,0 \left( c_2 k^2 + c_1 \right) + c_1 \Gamma_{0,1} \left( \sqrt{\frac{3}{2}} k_x k_y - \frac{1}{\sqrt{2}} k_z k_x + k_y k_z \right) + c_3 \Gamma_{0,3} \left( k_x k_y + k_x k_z + k_y k_z \right) + c_4 \Gamma_{3,2} \left( \sqrt{\frac{3}{2}} k_x k_y - \frac{1}{\sqrt{2}} k_z k_x - k_y k_z \right) + \left[ c_5 \left( 2k_x^2 - k_y^2 - k_z^2 \right) + c_6 \left( k_x^2 - 2k_y^2 + k_z^2 \right) \right] \Gamma_{1,2} + \sqrt{3} \Gamma_{2,2} \left[ (c_4 + c_5) k_y^2 - c_4 k_x^2 - c_5 k_y^2 \right] ; \]

\[ X; \{R_{13}, R_{14}\}; c_1 \Gamma_{0,0} + k_y \left( c_3 \Gamma_{1,1} - c_3 \Gamma_{2,1} + c_2 \Gamma_{3,1} \right) + c_3 \Gamma_{0,2} k_z ; \]

\[ M; \{R_9, R_9\}; c_1 \Gamma_{0,0} + k_y \left( c_3 \Gamma_{1,1} - c_3 \Gamma_{2,1} + c_2 \Gamma_{3,1} \right) + c_3 \Gamma_{0,2} k_z ; \]

\[ R; \{R_7, R_7\}; c_1 \Gamma_{0,0} + S_{0,0} \left( \frac{c_2 + c_3 + c_4}{3} \right) k^2 + \frac{1}{3} \left( c_3 \left( k_y^2 - k_z^2 \right) + c_2 \left( k_x^2 - k_z^2 \right) + c_4 \left( k_x^2 - k_y^2 \right) \right) + \left( c_3 \left( k_x^2 - k_z^2 - 2k_y^2 \right) + c_2 \left( k_x^2 - 2k_z^2 + k_y^2 \right) + c_4 \left( -2k_x^2 + k_z^2 + k_y^2 \right) \right) \Gamma_{0,8} + c_5 \left( S_{0,7} k_x k_y + S_{0,6} k_z k_z + S_{0,4} k_y k_z \right) + \sum_{i=1}^{3} c_1 \left( S_{3,3} k_x k_y - S_{1,3} k_z k_z + S_{1,1} k_y k_z \right) ; \]

\[ \{R_{14}, R_{14}\}; c_1 \Gamma_{0,0} + S_{0,0} \left( \frac{c_2 + c_3 + c_4}{3} \right) k^2 + \frac{1}{3} \left( c_3 \left( k_y^2 - k_z^2 \right) + c_2 \left( k_x^2 - k_z^2 \right) + c_4 \left( k_x^2 - k_y^2 \right) \right) + \left( c_3 \left( k_x^2 - k_z^2 - 2k_y^2 \right) + c_2 \left( k_x^2 - 2k_z^2 + k_y^2 \right) + c_4 \left( -2k_x^2 + k_z^2 + k_y^2 \right) \right) \Gamma_{0,8} + c_5 \left( S_{0,7} k_x k_y + S_{0,6} k_z k_z + S_{0,4} k_y k_z \right) + \sum_{i=1}^{3} c_1 \left( S_{3,3} k_x k_y - S_{1,3} k_z k_z + S_{1,1} k_y k_z \right) ; \]

\[ Z; \{R_9, R_9\}; \Gamma_0,0 \left( c_2 k_x + c_1 \right) + k_y \left( c_4 \Gamma_{1,3} - c_3 \Gamma_{2,3} + c_2 \Gamma_{3,3} \right) - c_5 \Gamma_{0,2} k_z ; \]

Accidental degeneracies on high symmetry line

\[ A; \{R_2, R_6\}, \{R_4, R_4\}; \Gamma_0,0 \left( c_1 + c_2 q_x \right) + \Gamma_3,0 c_3 q_x + \Gamma_{1,0} \left( c_4 q_x + c_5 q_y \right) + \Gamma_{2,3} \left( c_5 q_x - c_4 q_y \right) + \left( \alpha_1 \Gamma_{2,4} q_+ + h.c. \right) ; \]

\[ S; \{R_5, R_9\}, \{R_7, R_7\}; \Gamma_0,0 \left( c_1 + c_2 q_x \right) + \Gamma_3,0 c_3 q_x + \Gamma_0,0 \left( c_1 + c_2 q_x \right) + k_y \left( c_2 \Gamma_{1,0} + \sum_{i=1}^{3} c_3 \Gamma_{2,3} \right) ; \]

\[ T; \{R_6, R_6\}, \{R_8, R_8\}; \Gamma_0,0 \left( c_1 + c_2 q_x \right) + \Gamma_3,0 c_3 q_x + k_x \left( c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_3 \Gamma_{2,3} \right) ; \]

\[ \{R_6, R_6\}, \{R_9, R_9\}; \Gamma_0,0 \left( c_1 + c_2 q_x \right) + \Gamma_3,0 c_3 q_x + k_x \left( c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_3 \Gamma_{2,3} \right) ; \]

\[ \{R_7, R_7\}, \{R_9, R_9\}; \Gamma_0,0 \left( c_1 + c_2 q_x \right) + \Gamma_3,0 c_3 q_x + k_x \left( c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_3 \Gamma_{2,3} \right) ; \]

\[ \{R_8, R_8\}, \{R_9, R_9\}; \Gamma_0,0 \left( c_1 + c_2 q_x \right) + \Gamma_3,0 c_3 q_x + k_x \left( c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_3 \Gamma_{2,3} \right) ; \]

\[ Z'; \{R_5, R_6\}, \{R_7, R_7\}; \Gamma_0,0 \left( c_1 + c_2 q_y \right) + \Gamma_3,0 c_3 q_y + k_x \left( c_4 \Gamma_{1,0} + \sum_{i=1}^{3} c_3 \Gamma_{2,3} \right) ; \]
\[ \Gamma; \{ R_5, R_6 \}; \quad \Gamma_{0,0} (c_2 k^2 + c_1) + c_3 \Gamma_{0,1} \left( \sum_{j=1}^{\sqrt{3}} l_j k_j y_j - \frac{1 + i \sqrt{3}}{2} l_j x_j + k_j k_j \right) + c_3 \Gamma_{0,2} (k_j k_j + k_j k_j) + c_3 \Gamma_{0,3} (k_j k_j + k_j k_j + k_j k_j) + c_3 \Gamma_{3,2} \left( \frac{1 + i \sqrt{3}}{2} l_j k_j y_j - \frac{1 + i \sqrt{3}}{2} l_j x_j + k_j k_j \right) + c_3 \Gamma_{3,3} \left( k_j k_j + k_j k_j + k_j k_j + k_j k_j \right) \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_x + c_4 (\sigma_1 k_x - \sigma_2 k_z) ; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 c_1 + \sum_{i=0}^3 \sigma_i (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_y^2) + [\sigma_+ (c_2 k_y^2 - c_2 k_z^2 + i c_3 k_y k_z) + h.c.] ; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z) ; \]
\[ \{ R_4 \}, \{ R_4 \} : \sigma_0 c_1 + \sum_{i=0}^3 \sigma_i (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_y^2) + [\sigma_+ (c_2 k_y^2 - c_2 k_z^2 + i c_3 k_y k_z) + h.c.] ; \]
\[ \{ R_6 \}, \{ R_8 \} : \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z) ; \]
\[ \Sigma: \{ R_2 \}, \{ R_4 \} : \sigma_0 c_1 + \sum_{i=0}^3 \sigma_i c_{i,1} (k_x + k_y) + c_2 \sigma_1 (k_y - k_z) + c_3 \sigma_2 k_z ; \]
\[ \Lambda: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_z + (\alpha_1 \sigma_+ q_+ + h.c.) ; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_z + (\alpha_1 \sigma_+ q_+ + h.c.) ; \]
\[ \{ R_4 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_z + (\alpha_1 \sigma_+ q_+ + h.c.) ; \]
\[ S: \{ R_2 \}, \{ R_4 \} : \sigma_0 c_1 + \sum_{i=0}^3 \sigma_i c_{i,1} (k_x + k_z) + c_2 \sigma_1 (k_y - k_z) + c_3 \sigma_2 k_y ; \]
\[ Z: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z ; \]
\[ T: \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 [(\sigma_1 + \sigma_2) k_x + (\sigma_2 - \sigma_1) k_y] ; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 c_1 + \sum_{i=0}^3 \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_y^2) + [\sigma_+ (c_2 k_y k_x + i c_3 (k_z^2 - k_y^2)) + h.c.] ; \]
\[ \{ R_2 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 [(\sigma_1 - \sigma_2) k_x - (\sigma_1 + \sigma_2) k_y] ; \]
\[ \{ R_4 \}, \{ R_4 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 [(\sigma_1 + \sigma_2) k_x + (\sigma_2 - \sigma_1) k_y] ; \]
\[ \{ R_4 \}, \{ R_4 \} : \sigma_0 c_1 + \sum_{i=0}^3 \sigma_i (c_{i,1} k_z + c_{i,2} k^2 + c_{i,3} k_y^2) + [\sigma_+ (c_2 k_y k_x + i c_3 (k_z^2 - k_y^2)) + h.c.] ; \]
\[ \{ R_6 \}, \{ R_8 \} : \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_x + c_4 [(\sigma_1 + \sigma_2) k_z + (\sigma_2 - \sigma_1) k_y] ; \]

SG 208

\[ \Gamma_c: \{ C_{4v}^2 \{1 \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{3}{2} \} \}, \{ C_{3v} \{000 \} \}, \{ C_{2h} \{1 \frac{1}{2} \frac{1}{2} \frac{1}{2} \frac{3}{2} \} \} \times T; \text{ Non-Centrosymmetric; with SOC} \]

\[ \Gamma: \]
\[ R_4: c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) ; \]
\[ R_6: c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) ; \]
\[ R_5: c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) ; \]
\[ R_6: c_1 \sigma_0 + (c_2 \Gamma_{3,3} + c_3 \Gamma_{3,0}) k_z + (\left( \frac{\sqrt{3} \Gamma_{-1,1} + \Gamma_{1,3}}{2} \right) c_2 - c_3 \Gamma_{-1,0}) k_+ + h.c.] ; \]
\[ X: \]
\[ R_6: c_2 (\sigma_1 k_z - \sigma_3 k_x) + c_3 \sigma_2 k_y + c_1 \sigma_0 ; \]
\[ R_7: c_2 (\sigma_1 k_z + \sigma_3 k_x) + c_3 \sigma_2 k_y + c_1 \sigma_0 ; \]
\[ M: \]
\[ R_6: c_2 (\sigma_3 k_y - \sigma_1 k_z) - c_3 \sigma_2 k_y + c_1 \sigma_0 ; \]
\[ R_7: c_2 (\sigma_3 k_y + \sigma_1 k_z) - c_3 \sigma_2 k_y + c_1 \sigma_0 ; \]
\[ R: \]
\[ R_4: c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) ; \]
\[ R_5: c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) ; \]
\[ R_6: c_1 \sigma_0 + (c_2 \Gamma_{3,3} + c_3 \Gamma_{3,0}) k_z + (\left( \frac{\sqrt{3} \Gamma_{-1,1} + \Gamma_{1,3}}{2} \right) c_2 - c_3 \Gamma_{-1,0}) k_+ + h.c.] ; \]
Accidental degeneracies on high symmetry line

\[ \Delta: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]
\[ \{R_2\}, \{R_4\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_y + c_i k_x^2 + c_i k_z^2) + [\sigma_+ (c_2 k_y^2 - c_2 k_x^2 + i c_3 k_x k_z) + h.c.]; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]
\[ \{R_4\}, \{R_6\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_y + c_i k_x^2 + c_i k_z^2) + [\sigma_+ (c_2 k_y^2 - c_2 k_x^2 + i c_3 k_x k_z) + h.c.]; \]
\[ \{R_6\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]
\[ \Sigma: \{R_2\}, \{R_4\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_i,1 (k_x + k_y) + c_2 \sigma_1 (k_x - k_y) + c_3 \sigma_2 k_z; \]
\[ \Lambda: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_x + (\alpha_1 \sigma_+ q_+ + h.c.); \]
\[ \{R_2\}, \{R_6\}: \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_x + (\alpha_1 \sigma_+ q_+ + h.c.); \]
\[ \{R_4\}, \{R_6\}: \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_x + (\alpha_1 \sigma_+ q_+ + h.c.); \]
\[ S: \{R_4\}, \{R_6\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_i,1 (k_x + k_y) + c_2 \sigma_1 (k_x - k_y) + c_3 \sigma_2 k_z; \]
\[ Z: \{R_4\}, \{R_6\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]
\[ T: \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 [\sigma_1 \sigma_2 k_x + (\sigma_2 - \sigma_1) k_y]; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_i k_x^2 + c_i k_z^2) + [\sigma_+ [c_2 k_x k_y + ic_3 (k_x^2 - k_y^2)] + h.c.]; \]
\[ \{R_2\}, \{R_4\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 [\sigma_1 \sigma_2 k_x + (\sigma_2 - \sigma_1) k_y]; \]
\[ \{R_4\}, \{R_6\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 [\sigma_1 \sigma_2 k_x + (\sigma_2 - \sigma_1) k_y]; \]
\[ \{R_4\}, \{R_6\}: \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_i k_x + c_i k_x^2 + c_i k_z^2) + [\sigma_+ [c_2 k_x k_y + ic_3 (k_x^2 - k_y^2)] + h.c.]; \]
\[ \{R_6\}, \{R_8\}: \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 [\sigma_1 \sigma_2 k_x + (\sigma_2 - \sigma_1) k_y]; \]

SG 209

\[ \Gamma^e_x: \{C_{4v}^{+} \mid 000\}, \{C_{4v}^{+} \mid 000\}, \{C_{2v} \mid 000\}, T: \text{Non-Centrosymmetric; with SOC} \]

\[ \Gamma: \]
\[ \Gamma_4: \quad c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \]
\[ \Gamma_5: \quad c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \]
\[ \Gamma_6: \quad c_1 \Gamma_{0,0} + (c_2 \Gamma_{3,3} + c_3 \Gamma_{3,0}) k_x + \left(\frac{\sqrt{1+1+1}}{2} c_2 - c_3 \Gamma_{3,0} \right) k_x + h.c.; \]
\[ \Gamma_{11} : \quad c_2 (\sigma_3 k_y - \sigma_1 k_x) + c_3 \sigma_1 k_y + c_4 \sigma_0; \]
\[ \Gamma_{12} : \quad c_2 (\sigma_3 k_y - \sigma_1 k_x) + c_3 \sigma_1 k_y + c_4 \sigma_0; \]
\[ \Gamma_{13} : \quad c_1 + c_2 q_x^2 + c_3 q_x q_y q_y^2 - 3 q_x^2 - q_y^2; \]
\[ \Gamma_{14} : \quad \sigma_0 + c_1 \sigma_3 q_y q_y^2 - 3 q_y^2 + \left[ \alpha_1 q_x + \alpha_2 q_x (q_x^2 - 3 q_y^2) + \alpha_3 q_x (q_x^2 + q_y^2) + \alpha_4 q_x^2 \right] + h.c.; \]
\[ \Gamma_{15} : \quad c_1 \sigma_0 + c_2 \sigma_2 q_x + c_3 (\sigma_3 q_y - \sigma_1 q_x); \]
\[ \Gamma_{16} : \quad c_3 (k_y - k_z) = \Gamma_4; \]
\[ \Gamma_{17} : \quad c_3 \sigma_3 (k_y - k_z) - \sigma_1 (k_y + k_z) + c_3 \sigma_2 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Delta; \{R_2\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z) ; \]
\[ \{R_2\}, \{R_4\} ; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_y^2) + \left[ \sigma_+ (c_2 k_y^2 - c_2 k_y^2 + i c_3 k_z k_x) + h.c. \right] ; \]
\[ \{R_2\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_z - \sigma_2 k_x) ; \]
\[ \{R_4\}, \{R_4\} ; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_y^2) + \left[ \sigma_+ (c_2 k_y^2 - c_2 k_y^2 + i c_3 k_z k_x) + h.c. \right] ; \]
\[ \{R_6\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_z - \sigma_2 k_x) ; \]
\[ \Lambda; \{R_2\}, \{R_4\} ; \sigma_0 (c_1 + c_2 q_y) + \sigma_3 c_3 q_y + (\alpha_1 + q_y + h.c.) ; \]
\[ \{R_4\}, \{R_4\} ; \sigma_0 (c_1 + c_2 q_y) + \sigma_3 c_3 q_y + (\alpha_1 + q_y + h.c.) ; \]
\[ \Sigma; \{R_2\}, \{R_4\} ; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_y^2) + \left[ \sigma_+ (c_2 k_y^2 - c_2 k_y^2 + i c_3 k_z k_x) + h.c. \right] ; \]
\[ \{R_6\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_z - \sigma_2 k_x) ; \]
\[ \eta; \{R_2\}, \{R_4\} ; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_y^2) + \left[ \sigma_+ (c_2 k_y^2 - c_2 k_y^2 + i c_3 k_z k_x) + h.c. \right] ; \]
\[ \{R_6\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_z - \sigma_2 k_x) ; \]
\[ \Gamma; \{C_{12}^{+\{\{1,1,1\}}}, \{C_{31}^{\{000\}}, \{C_{20}^{\{1,1,1\}}}, T; \text{Non-Centrosymmetric with SOC} \]
\[ \{R_4\}; \ c_4 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) ; \]
\[ \{R_5\}; \ c_4 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z) ; \]
\[ \{R_6\}; \ c_4 \Gamma_{0,0} + (c_2^2 \Gamma_{3,3} + c_3 \Gamma_{3,0}) k_x + \left[ \left( \sqrt{\frac{\Gamma_{1,1} + \Gamma_{3,3} c_2}{2}} - c_3 \Gamma_{3,0} \right) k_x + h.c. \right] ; \]
\[ \{R_6\}; \ c_4 \sigma_0 + c_2 \sigma_2 k_y + c_1 \sigma_6 ; \]
\[ \{R_7\}; \ c_4 (\sigma_1 k_x - \sigma_3 k_y) ; \]
\[ \{R_1, R_3\}; \ c_1 + c_2 k^2 + c_3 k_x^2) \sigma_0 + c_4 \sigma_3 k_y k_x + \left[ \left( \alpha_1 k_x + \alpha_2 (k_y^2 - k_z^2) \right) \sigma_2 + h.c. \right] ; \]

Accidental degeneracies on high symmetry line

\[ \Delta; \{R_2\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z) ; \]
\[ \{R_2\}, \{R_4\} ; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_y^2) + \left[ \sigma_+ (c_2 k_y^2 - c_2 k_y^2 + i c_3 k_z k_x) + h.c. \right] ; \]
\[ \{R_2\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_z - \sigma_2 k_x) ; \]
\[ \{R_4\}, \{R_4\} ; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_y^2) + \left[ \sigma_+ (c_2 k_y^2 - c_2 k_y^2 + i c_3 k_z k_x) + h.c. \right] ; \]
\[ \{R_6\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_z - \sigma_2 k_x) ; \]
\[ \Lambda; \{R_2\}, \{R_4\} ; \sigma_0 (c_1 + c_2 q_y) + \sigma_3 c_3 q_y + (\alpha_1 + q_y + h.c.) ; \]
\[ \{R_4\}, \{R_4\} ; \sigma_0 (c_1 + c_2 q_y) + \sigma_3 c_3 q_y + (\alpha_1 + q_y + h.c.) ; \]
\[ \Sigma; \{R_2\}, \{R_4\} ; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_y^2) + \left[ \sigma_+ (c_2 k_y^2 - c_2 k_y^2 + i c_3 k_z k_x) + h.c. \right] ; \]
\[ \{R_6\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_z - \sigma_2 k_x) ; \]
\[ \eta; \{R_2\}, \{R_4\} ; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_y^2) + \left[ \sigma_+ (c_2 k_y^2 - c_2 k_y^2 + i c_3 k_z k_x) + h.c. \right] ; \]
\[ \{R_6\}, \{R_4\} ; \sigma_0 (c_1 + c_2 k_y) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_z - \sigma_2 k_x) ; \]
SG 211

\( \Gamma_v; \{ C_{4v}^+ | 000 \}, \{ C_{4v}^- | 000 \}, \{ C_{2v} \} | 000 \}, T; \) Non-Centrosymmetric; with SOC

\[ \Gamma; R_4; c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \]
\[ R_5; c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \]
\[ R_6; c_1 \Gamma_{0,0} + (c_2 \Gamma_{3,3} + c_3 \Gamma_{3,0}) k_x + \left( \frac{\sqrt{\Gamma_{-1} + \Gamma_{+3}}}{2} c_2 - c_3 \Gamma_{+0,0} \right) k_+ + h.c.; \]

\[ H; R_4; c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \]
\[ R_5; c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \]
\[ R_6; c_1 \Gamma_{0,0} + (c_2 \Gamma_{3,3} + c_3 \Gamma_{3,0}) k_x + \left( \frac{\sqrt{\Gamma_{-1} + \Gamma_{+3}}}{2} c_2 - c_3 \Gamma_{+0,0} \right) k_+ + h.c.; \]

\[ P; R_4; c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \]
\[ R_5; c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \]
\[ R_6; c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \]

\[ N; R_5; c_1 \sigma_0 + c_2 \sigma_3 (k_x + k_y) + c_3 \sigma_1 (k_x - k_y) + c_4 \sigma_2 k_z; \]

Accidental degeneracies on high symmetry line

\[ \Sigma; \{ R_2 \}, \{ R_4 \}; c_0 c_1 + \sum_{i=0}^{\alpha-3} c_i c_{i+1} (k_x + k_y) + c_2 \sigma_1 (k_x - k_y) + c_3 \sigma_2 k_z; \]
\[ \Delta; \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]
\[ \{ R_2 \}, \{ R_4 \}; c_0 c_1 + \sum_{i=0}^{\alpha-3} c_i (c_{i+1} k_y + c_{i+3} k_y^2 + c_{i+3} k_y^2) + \left[ \sigma_+ \left( c_2 k_x^2 - c_2 k_z^2 + i c_3 k_x k_z \right) + h.c. \right]; \]
\[ \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]
\[ \{ R_4 \}, \{ R_6 \}; c_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]
\[ \{ R_4 \}, \{ R_6 \}; c_0 c_1 + \sum_{i=0}^{\alpha-3} c_i (c_{i+1} k_y + c_{i+3} k_y^2 + c_{i+3} k_y^2) + \left[ \sigma_+ \left( c_2 k_x^2 - c_2 k_z^2 + i c_3 k_x k_z \right) + h.c. \right]; \]
\[ \{ R_6 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]
\[ \Lambda; \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + \left( \alpha_1 \sigma_+ q_+ + h.c. \right); \]
\[ \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_y) + c_3 \sigma_3 q_+ \left( \alpha_1 \sigma_+ q_+ + h.c. \right); \]
\[ \{ R_4 \}, \{ R_5 \}; c_0 (c_1 + c_2 q_+ \right) + c_3 \sigma_3 q_+ \left( \alpha_1 \sigma_+ q_+ + h.c. \right); \]
\[ \{ R_4 \}, \{ R_5 \}; c_0 (c_1 + c_2 q_+) + c_3 \sigma_3 q_+ \left( \alpha_1 \sigma_+ q_+ + h.c. \right); \]
\[ D; \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 k_y) + c_3 \sigma_3 k_y + \left( \alpha_1 \sigma_+ q_+ + h.c. \right); \]
\[ G; \{ R_2 \}, \{ R_4 \}; c_0 c_1 + \sum_{i=0}^{\alpha-3} c_i c_{i+1} (k_x - k_y) + c_2 \sigma_1 (k_x - k_y) + c_4 \sigma_2 k_z; \]
\[ F; \{ R_2 \}, \{ R_4 \}; c_0 (c_1 + c_2 p_+) + c_3 \sigma_3 p_+ \left( \alpha_1 \sigma_+ p_- + h.c. \right); \]
$\Gamma_c; \{ C_4^+; \frac{3}{4} \frac{3}{4} \frac{1}{4} \}; \{ C_{31}; \frac{0}{0} \frac{0}{0} \}; \{ C_{2b}; \frac{1}{4} \frac{1}{4} \frac{1}{4} \}; T; \text{Non-Centrosymmetric; with SOC}$

\[ \begin{align*}
\Gamma: & \quad R_4; \quad c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \\
& \quad R_5; \quad c_1 \sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \\
& \quad R_8; \quad c_1 \Gamma_{0,0} + (c_2 \Gamma_{3,3} + c_3 \Gamma_{3,0}) k_z + \left( \frac{\sqrt{\Gamma_{2,0} + \Gamma_{1,3}}}{2} c_2 - c_3 \Gamma_{1,0} \right) k_+ + h.c.; \\
X: & \quad \{ R_8, R_{10} \}; \quad c_1 \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_y; \\
& \quad \{ R_9, R_{11} \}; \quad c_1 \sigma_0 + (c_2 \sigma_1 + c_3 \sigma_2) k_y; \\
& \quad R_{14}; \quad c_1 \sigma_0 + c_2 \sigma_3 k_y; \\
M: & \quad \{ R_6, R_7 \}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,3} k_x + \Gamma_{0,2} k_y) + c_3 \Gamma_{3,1} k_z + [c_1 (i k_2 \Gamma_{+,0} + k_2 \Gamma_{+,1}) + h.c.; \\
R: & \quad \{ R_3, R_4 \}; \quad (c_1 + c_2 k^2) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_x k_y k_z; \\
& \quad R_8; \quad (c_1 + c_2 k^2) \sigma_0 + c_3 \sigma_3 k_y k_z; \\
& \quad \{ R_{13}, R_{14} \}; \quad c_1 S_{0,0} + c_2 (S_{0,2} k_x + S_{0,3} k_y - S_{0,1} k_z) + \sum_{i=1}^{2} c_{i,1} (S_{i,0} k_x - S_{i,7} k_y + S_{i,4} k_z); \\
S: & \quad \{ R_0, R_{14} \}; \quad (c_1 + c_2 k_x + c_2 k_y) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \\
Z: & \quad \{ R_5, R_7 \}; \quad (c_1 + c_2 k_x) \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) k_y; \\
T: & \quad \{ R_{10}, R_{14} \}; \quad (c_1 + c_2 k_x + c_3 k^2 + c_4 k_2^2) \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_x k_y; \\
& \quad \{ R_{12}, R_{16} \}; \quad (c_1 + c_2 k_x + c_3 k^2 + c_4 k_2^2) \sigma_0 + (c_5 \sigma_1 + c_6 \sigma_2) k_x k_y; \\
\end{align*} \]

Accidental degeneracies on high symmetry line

\[ \begin{align*}
\Delta: & \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \\
& \quad \{ R_2 \}, \{ R_6 \}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_1 (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_2^2) + [\sigma_1 (c_2 k_2^2 - c_2 k_2^2 + ic_3 k_x k_z) + h.c.]; \\
& \quad \{ R_2 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \\
& \quad \{ R_4 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \\
& \quad \{ R_4 \}, \{ R_8 \}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_1 (c_{i,1} k_y + c_{i,2} k^2 + c_{i,3} k_2^2) + [\sigma_1 (c_2 k_2^2 - c_2 k_2^2 + ic_3 k_x k_z) + h.c.]; \\
& \quad \{ R_6 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \\
\Sigma: & \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 c_1 + \sum_{i=0,3} \sigma_1 (c_{i,1} k_y + k_x + c_2 \sigma_1 (k_x - k_y) + c_3 \sigma_2 k_z; \\
\Lambda: & \quad \{ R_2 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + (\sigma_1 \sigma_4 q_4 + h.c.); \\
& \quad \{ R_2 \}, \{ R_8 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + (\sigma_1 \sigma_4 q_4 + h.c.); \\
& \quad \{ R_4 \}, \{ R_6 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_y + (\sigma_1 \sigma_4 q_4 + h.c.); \\
T: & \quad \{ R_{10}, R_{14} \}, \{ R_{12}, R_{16} \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_z + \left( [c_4 \Gamma_{2,0} + c_5 \Gamma_{1,3} - \alpha_1 \Gamma_{2,1} (k_x + k_y) + (c_4 \Gamma_{1,0} - c_5 \Gamma_{2,3} + \alpha_1 \Gamma_{1,4}) (k_x - k_y) + h.c.]; \right. \\
\end{align*} \]
\( \Gamma_c; \{ C_{4v}^{1+}\{4\} \}, \{ C_{3v}^{1}\{000\}, \{ C_{2v}^{3+}\{4\} \}; T; \) Non-Centrosymmetric; with SOC

\[
\begin{align*}
\Gamma: & \quad R_4: \quad c_1\sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \\
R_5: & \quad c_1\sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \\
R_8: & \quad c_1\Gamma_0,0 + (c_2\Gamma_{3,3} + c_3\Gamma_{3,0}) k_z + \left[ \left( \sqrt{\frac{\Gamma_{-1,1} + \Gamma_{1,3}}{2}}^2 c_2 - c_1\Gamma_{4,0,0} \right) \right] k_z + h.c.; \\
X: & \quad \{ R_8, R_{10}\}; \quad c_1\sigma_0 + (c_2\sigma_1 + c_3\sigma_2) k_y; \\
\{ R_9, R_{11}\}; \quad c_1\sigma_0 + (c_2\sigma_1 + c_3\sigma_2) k_y; \\
R_{14}: & \quad c_1\sigma_0 + c_2\sigma_3 k_y; \\
M: & \quad \{ R_6, R_7\}; \quad c_1\Gamma_{0,0} + c_2 (\Gamma_{3,3} k_x + \Gamma_{0,2} k_y) + c_3\Gamma_{3,1} k_z + \left[ (\alpha_1 (i k_x \Gamma_{4,0,0} + k_y \Gamma_{4,1,1})) + h.c. \right]; \\
R: & \quad \{ R_3, R_4\}; \quad \{ c_1 + c_2 k^2 \}\sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_x k_y; \\
R_4: & \quad (c_1 + c_2 k^2)\sigma_0 + c_3\sigma_3 k_x k_y; \\
\{ R_{13}, R_{14}\}; \quad c_1 S_{0,0} + c_2 (S_{0,2} k_x + S_{0,3} k_y - S_{0,1} k_z) + \sum_{i=1}^2 c_1 S_{i,6} (S_{i,6} k_x - S_{i,7} k_y + S_{i,4} k_z); \\
S: & \quad \{ R_2, R_{16}\}; \quad (c_1 + c_2 k^2 + c_3 k^2)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_y; \\
T: & \quad \{ R_5, R_7\}; \quad (c_1 + c_2 k^2)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_y; \\
\{ R_{10}, R_{11}\}; \quad (c_1 + c_2 k^2 + c_3 k^2)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_y; \\
\{ R_{12}, R_{16}\}; \quad (c_1 + c_2 k^2 + c_3 k^2)\sigma_0 + (c_3\sigma_1 + c_4\sigma_2) k_y; \\
\end{align*}
\]

Accidental degeneracies on high symmetry line

\[
\Delta: \quad \{ R_2\} \cdot \{ R_4\}; \quad \sigma_0 (c_1 + c_2 k^2) + c_3 c_4 k_x + c_4 (\sigma_1 k_x - \sigma_2 k_z); \\
\{ R_2\} \cdot \{ R_6\}; \quad \sigma_0 + (c_1 + c_2 k^2 + c_3 k^2) + \left[ (\sigma_4 c_2 c_2 - c_2 k^2 + i c_3 k_x k_z) + h.c. \right]; \\
\{ R_2\} \cdot \{ R_8\}; \quad \sigma_0 (c_1 + c_2 k^2) + c_3 c_4 k_x + c_4 (\sigma_1 k_x - \sigma_2 k_z); \\
\{ R_4\} \cdot \{ R_6\}; \quad \sigma_0 + (c_1 + c_2 k^2 + c_3 k^2) + \left[ (\sigma_4 c_2 c_2 - c_2 k^2 + i c_3 k_x k_z) + h.c. \right]; \\
\{ R_4\} \cdot \{ R_8\}; \quad \sigma_0 (c_1 + c_2 k^2) + c_3 c_4 k_x + c_4 (\sigma_1 k_x - \sigma_2 k_z); \\
\Sigma: \quad \{ R_2\} \cdot \{ R_4\}; \quad \sigma_0 (c_1 + c_2 k^2) + c_3 c_4 k_x + c_4 (\sigma_1 k_x - \sigma_2 k_z); \\
\{ R_2\} \cdot \{ R_6\}; \quad \sigma_0 (c_1 + c_2 k^2) + c_3 c_4 k_x + c_4 (\sigma_1 k_x - \sigma_2 k_z); \\
\{ R_4\} \cdot \{ R_6\}; \quad \sigma_0 (c_1 + c_2 k^2) + c_3 c_4 k_x + c_4 (\sigma_1 k_x - \sigma_2 k_z); \\
\Lambda: \quad \{ R_2\} \cdot \{ R_8\}; \quad \sigma_0 (c_1 + c_2 k^2) + c_3 c_4 k_x + (c_1 + c_2 k^2) + h.c. \right]; \\
\{ R_2\} \cdot \{ R_{10}\}; \quad \sigma_0 (c_1 + c_2 k^2) + c_3 c_4 k_x + (c_1 + c_2 k^2) + h.c. \right]; \\
\{ R_2\} \cdot \{ R_{16}\}; \quad \sigma_0 (c_1 + c_2 k^2) + c_3 c_4 k_x + (c_1 + c_2 k^2) + h.c. \right]; \\
T: \quad \{ R_{10}, R_{14}\} \cdot \{ R_{12}, R_{16}\}; \quad \Gamma_{0,0} (c_1 + c_2 k^2) + \Gamma_{1,0} c_4 k_z + \left[ (c_1 \Gamma_{2,0} + c_3 \Gamma_{1,3} + \alpha_1 \Gamma_{2,1}) (k_x + k_y) + (c_4 \Gamma_{1,0} - c_5 \Gamma_{2,3} + \alpha_1 \Gamma_{1,4}) (k_x - k_y) + h.c. \right];
\]

SG 214

\( \Gamma_c; \{ C_{4v}^{1+}\{0\} \}, \{ C_{3v}^{1}\{000\}, \{ C_{2v}^{3+}\{2\} \}; T; \) Non-Centrosymmetric; with SOC

\[
\begin{align*}
\Gamma: & \quad R_4: \quad c_1\sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \\
R_5: & \quad c_1\sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \\
R_8: & \quad c_1\Gamma_0,0 + (c_2\Gamma_{3,3} + c_3\Gamma_{3,0}) k_z + \left[ \left( \sqrt{\frac{\Gamma_{-1,1} + \Gamma_{1,3}}{2}}^2 c_2 - c_1\Gamma_{4,0,0} \right) \right] k_z + h.c.; \\
H: & \quad \{ R_4\}; \quad c_1\sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \\
R_5: & \quad c_1\sigma_0 + c_2 (\sigma_1 k_x - \sigma_2 k_y - \sigma_3 k_z); \\
R_8: & \quad c_1\Gamma_0,0 + (c_2\Gamma_{3,3} + c_3\Gamma_{3,0}) k_z + \left[ \left( \sqrt{\frac{\Gamma_{-1,1} + \Gamma_{1,3}}{2}}^2 c_2 - c_1\Gamma_{4,0,0} \right) \right] k_z + h.c.; \\
P: & \quad \{ R_7\}; \quad c_1 A_0 + c_2 (A_1 k_x - A_2 k_y + A_3 k_z) + A_4 c_3 k_x + c_4 (A_6 k_y + A_7 k_z); \\
N: & \quad \{ R_5\}; \quad c_1\sigma_0 + c_2\sigma_1 (k_x - k_y) + c_3\sigma_2 (k_x - k_y) + c_4\sigma_3 k_z;
\end{align*}
\]
Accidental degeneracies on high symmetry line

\[ \Sigma; \{ R_2 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i c_{i,1} (k_x + k_y) + c_2 \sigma_1 (k_x - k_y) + c_3 \sigma_2 k_z; \]

\[ \Delta; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]

\[ \{ R_2 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_1 k_x + c_2 k^2 + c_3 k_y^2) + [\sigma_2 c_2 k_x^2 - c_2 k_x^2 + i c_3 k_x k_z] + h.c.; \]

\[ \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]

\[ \{ R_4 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]

\[ \{ R_4 \}, \{ R_3 \}; \sigma_0 c_1 + \sum_{i=0,3} \sigma_i (c_1 k_x + c_2 k^2 + c_3 k_y^2) + [\sigma_2 c_2 k_x^2 - c_2 k_x^2 + i c_3 k_x k_z] + h.c.; \]

\[ \{ R_0 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + c_4 (\sigma_1 k_x - \sigma_2 k_z); \]

\[ \Lambda; \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + (a_1 \sigma_1 q_+ + h.c.); \]

\[ \{ R_0 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + (a_1 \sigma_1 q_+ + h.c.); \]

\[ \{ R_4 \}, \{ R_0 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + a_1 \sigma_1 q_+ + h.c.; \]

\[ \{ R_5 \}, \{ R_0 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + a_1 \sigma_1 q_+ + h.c.; \]

\[ D; \{ R_5 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + a_1 \sigma_1 (k_x - k_y) + c_5 \sigma_2 (k_x + k_y); \]

\[ \{ R_7 \}, \{ R_0 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + a_1 \sigma_1 (k_x - k_y) + c_5 \sigma_2 (k_x + k_y); \]

\[ F; \{ R_7 \}, \{ R_1 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + a_1 \sigma_1 (k_x - k_y) + c_5 \sigma_2 (k_x + k_y); \]

\[ \{ R_0 \}, \{ R_1 \}; \sigma_0 (c_1 + c_2 k_y) + \sigma_2 c_3 k_y + a_1 \sigma_1 (k_x - k_y) + c_5 \sigma_2 (k_x + k_y); \]

SG 215

\[ \Gamma; \{ S_{3z}^{\pm} \{000, \{C_{3x}^{\pm} \{000, \{\sigma_{1h} \{000, T; \text{Non-Centrosymmetric with SOC} \}
\]

\[ \Gamma; \{ R_4 \}; (c_1 + c_2 k^2 \sigma_0 + c_3 [\sigma_1 k_x (k_x^2 - k_y^2) + \sigma_2 k_y (k_y^2 - k_x^2)] + \sigma_3 k_x (k_x^2 - k_y^2)]; \]

\[ \Gamma; \{ R_5 \}; (c_1 + c_2 k^2 \sigma_0 + c_3 [\sigma_1 k_x (k_x^2 - k_y^2) + \sigma_2 k_y (k_y^2 - k_x^2)] + \sigma_3 k_x (k_x^2 - k_y^2)]; \]

\[ \Gamma; \{ R_6 \}; c_1 \Gamma_{0,0} + c_2 \left[ \left( \Gamma_{1,1} - \sqrt{3} \Gamma_{1,3} \right) k_x - \left( \Gamma_{2,1} + \sqrt{3} \Gamma_{2,3} \right) k_y + 2 \Gamma_{3,1} k_z \right]; \]

\[ \Lambda; \{ R_6 \}; c_2 (\sigma_1 k_x + \sigma_1 k_y) + c_3 \sigma_0; \]

\[ \Lambda; \{ R_7 \}; c_2 (\sigma_1 k_x - \sigma_1 k_y) + c_3 \sigma_0; \]

\[ \Lambda; \{ R_8 \}; c_2 (\sigma_1 k_x + \sigma_1 k_y) + c_3 \sigma_0; \]

\[ \Lambda; \{ R_9 \}; c_2 (\sigma_1 k_x - \sigma_1 k_y) + c_3 \sigma_0; \]

\[ \Delta; \{ R_5 \}; (c_1 + c_2 k^2 \sigma_0 + c_3 [k_x + k_y] \sigma_3) - (k_x - k_y) \sigma_1; \]

\[ \Lambda; \{ R_6 \}; c_2 (\sigma_1 k_x + \sigma_1 k_y) + c_3 (k_x + k_y) \sigma_0 + c_5 (k_y - k_x) - \frac{c_5 k_x + k_y - 2 k_z}{2 \sqrt{3}}; \]

\[ T; \{ R_5 \}; c_2 (\sigma_1 k_x + \sigma_1 k_y) + c_3 (k_x + k_y) \sigma_3 + (k_x - k_y) \sigma_1; \]

Accidental degeneracies on high symmetry line

\[ \Sigma; \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + c_2 \sigma_3 (k_x + k_y) + c_4 \sigma_1 (k_x - k_y); \]

\[ \Lambda; \{ R_3 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_2 \sigma_3 c_1 k_x; \]

\[ \{ R_3 \}, \{ R_4 \}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_4) c_2 k_x + (A_6 c_4 + 2 A_7 c_5 - A_2 c_6) q_y + [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] q_z; \]

\[ \{ R_4 \}, \{ R_6 \}; A_0 (c_1 + c_2 k_x) + (\sqrt{3} A_3 + A_4) c_2 k_x - [A_6 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_2 c_6] q_z + (A_4 c_4 + 2 A_7 c_5 - A_1 c_6) q_y; \]

\[ S; \{ R_2 \}, \{ R_3 \}; \sigma_0 (c_1 + c_2 k_x) + c_2 \sigma_3 c_1 k_x + c_4 \sigma_2 (k_x + k_y) + c_5 \sigma_2 (k_x - k_y); \]

\[ Z; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2 k_x) + c_2 \sigma_3 c_1 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z; \]
Accidental degeneracies on high symmetry line

\[ \Lambda: \{ R_3, R_4 \} : \sigma_0 (c_1 + c_2 q_y) + \sigma_2 c_3 q_z; \]
\[ \{ R_3, R_4 \} : A_0 (c_1 + c_2 q_y) + (\sqrt{3}A_5 + A_8) c_3 q_x + (A_6 c_4 + 2A_7 c_5 - A_2 c_6) q_y + [A_4 c_4 + (A_5 - \sqrt{3}A_8) c_5 - A_1 c_6] q_z; \]
\[ \{ R_4, R_5 \} : A_0 (c_1 + c_2 q_y) + (\sqrt{3}A_5 + A_8) c_3 q_x - [A_6 c_4 - (A_5 - \sqrt{3}A_8) c_5 - A_2 c_6] q_y + (A_4 c_4 + 2A_7 c_5 - A_1 c_6) q_y; \]
\[ \Sigma: \{ R_2, R_3 \} : \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 (k_x - k_y); \]
\[ \{ R_2, R_3 \} : \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 (k_x - k_y); \]
\[ \{ R_2, R_4 \} : \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 (k_x - k_y); \]
\[ \{ R_2, R_5 \} : c_2 \left[ \sigma_1 (k_y - k_x) + \frac{(k_x + k_y - 2k_z)}{\sqrt{3}} \right] + c_1 \sigma_0; \]

\[ \Gamma = R_4: (c_1 + c_2 k^2) \sigma_0 + c_4 \left[ \sigma_1 k_x (k_y^2 - k_x^2) + \sigma_2 k_y (k_x^2 - k_y^2) + \sigma_3 k_z (k_y^2 - k_z^2) \right]; \]
\[ \Gamma = R_5: (c_1 + c_2 k^2) \sigma_0 + c_4 \left[ \sigma_1 k_x (k_y^2 - k_x^2) + \sigma_2 k_y (k_x^2 - k_y^2) + \sigma_3 k_z (k_y^2 - k_z^2) \right]; \]
\[ \Gamma = R_8: c_1 \Gamma_{0,0} + c_2 \left[ \left( \Gamma_{1,1} - \sqrt{3} \Gamma_{1,3} \right) k_x - \left( \Gamma_{2,1} + \sqrt{3} \Gamma_{2,3} \right) k_y + 2 \Gamma_{3,1} k_z \right]; \]

\[ \\]
Accidental degeneracies on high symmetry line

\[ \Sigma; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2k_x + c_2k_y) + \sigma_3c_3 (k_x + k_y) + c_4\sigma_1 (k_x - k_y); \]

\[ \Lambda; \{ R_3 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2q_x) + \sigma_3c_3q_y; \]
\[ \{ R_8 \}, \{ R_6 \}; A_0 (c_1 + c_2q_x) \pm (\sqrt{3}A_5 + A_8) c_3q_y + (A_6c_4 + 2A_7c_5 - A_2c_6) q_y + [A_4c_4 + (A_5 - \sqrt{3}A_3) c_5 - A_1c_6] q_y; \]
\[ \{ R_3 \}, \{ R_6 \}; A_0 (c_1 + c_2q_x) \pm (\sqrt{3}A_5 + A_8) c_3q_y - [A_6c_4 + (A_5 - \sqrt{3}A_3) c_5 - A_2c_6] q_y + (A_4c_4 + 2A_7c_5 - A_1c_6) q_y; \]

\[ \{ R_9 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2k_x - c_2k_y) + \sigma_3c_3 (k_x - k_y) + c_4\sigma_1 (k_x + k_y); \]

\[ F; \{ R_3 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2p_x) + \sigma_3c_3p_y; \]
\[ \{ R_3 \}, \{ R_6 \}; A_0 (c_1 + c_2p_x) \pm (\sqrt{3}A_5 + A_8) c_3p_y + (A_6c_4 + 2A_7c_5 - A_2c_6) (\sqrt{3}p_y - p_y) + [A_4c_4 + (A_5 - \sqrt{3}A_3) c_5 - A_1c_6] (p_x + \sqrt{3}p_y); \]
\[ \{ R_4 \}, \{ R_6 \}; A_0 (c_1 + c_2p_x) \pm (\sqrt{3}A_5 + A_8) c_3p_y + (A_6c_4 + 2A_7c_5 - A_2c_6) (\sqrt{3}p_y - p_y) - [A_6c_4 + (A_5 - \sqrt{3}A_3) c_5 - A_2c_6] (p_x + \sqrt{3}p_y); \]

SG 218

\[ \Gamma_c; \{ S_{4\alpha} \} | \frac{1}{2} + \frac{1}{2} \};, \{ C_{3\alpha} | 000 \}, \{ \sigma_{ab} | \frac{1}{2} \frac{1}{2} \};, T; Non-Centrosymmetric; with \ SOC \]

\[ \Gamma; \quad R_4; \quad (c_1 + c_2k^2) \sigma_0 + c_3 \left[ \sigma_1k_x (k_y^2 - k_z^2) + \sigma_2k_y (k_x^2 - k_z^2) + \sigma_3k_z (k_x^2 - k_y^2) \right]; \]
\[ R_5; \quad (c_1 + c_2k^2) \sigma_0 + c_3 \left[ \sigma_1k_x (k_y^2 - k_z^2) + \sigma_2k_y (k_x^2 - k_z^2) + \sigma_3k_z (k_x^2 - k_y^2) \right]; \]
\[ R_6; \quad c_1\Gamma_{0,0} + c_2 \left[ \left( \Gamma_{1,1} - \sqrt{3}\Gamma_{1,3} \right) k_x - \left( \Gamma_{2,1} + \sqrt{3}\Gamma_{2,3} \right) k_y + 2\Gamma_{3,1}k_z \right]; \]

\[ X; \{ R_6, R_7 \}; \quad c_1\Gamma_{0,0} + \left( c_2 \Gamma_{0,2} + c_3 \Gamma_{1,1} \right) (k_x + k_z) + (c_2\Gamma_{3,3} + c_3\Gamma_{1,0} - c_4\Gamma_{2,0}) (k_x - k_z) + (c_5\Gamma_{1,3} + c_6\Gamma_{2,2}) \]
\[ M; \quad R_6; \quad c_2 (\sigma_1k_y + \sigma_3k_y) + c_1\sigma_0; \]
\[ R_7; \quad c_2 (\sigma_1k_x - \sigma_3k_y) + c_1\sigma_0; \]

\[ R; \quad \{ R_6, R_7 \}; \quad c_1\Gamma_{0,0} + c_2 \left( \Gamma_{1,0}q_x + \Gamma_{2,3}q_y + \Gamma_{2,1}q_z \right) + c_3 \left[ \left( \sqrt{3}\Gamma_{1,0} - \Gamma_{2,0} \right) q_x + \left( \Gamma_{1,3} + \sqrt{3}\Gamma_{2,3} \right) q_y + \left( \Gamma_{1,1} + \sqrt{3}\Gamma_{2,1} \right) q_z \right]; \]
\[ \{ R_{15}, R_{12} \}; \quad c_1Q_{0,0,0} + \sqrt{2} (2c_2Q_{3,1,3} - c_3Q_{2,2,3} + 2c_4Q_{1,1,3} - c_5Q_{2,2,3} - c_6Q_{2,2,3} - 2c_7Q_{2,1,3}) k_x + \\
\[ c_2 \left( \sqrt{3}Q_{2,3,2} + Q_{3,1,1} \right) + c_3Q_{3,2,1} + c_4 \left( \sqrt{3}Q_{1,3,2} + Q_{1,1,1} \right) + c_5Q_{2,2,1} + c_6Q_{1,2,1} - c_7 \left( \sqrt{3}Q_{2,3,2} + Q_{1,1,1} \right) \left( k_x - k_y \right) + \\
\[ c_2 \left( \sqrt{3}Q_{3,0,3} - Q_{2,1,0} \right) + c_3Q_{3,1,0} + c_4 \left( \sqrt{3}Q_{1,0,3} - Q_{2,0,0} \right) + c_5Q_{2,1,0} + c_6Q_{1,1,0} - c_7 \left( \sqrt{3}Q_{2,0,3} - Q_{2,2,0} \right) \left( k_x + k_y \right); \]

\[ \Delta; \quad R_5; \quad c_2 \left[ \left( \sigma_3 - \sigma_1 \right) k_x + \left( \sigma_1 + \sigma_3 \right) k_z \right] + \sigma_0 \left( c_4k_y + c_1 \right); \]

\[ \Lambda; \quad R_6; \quad \left[ c_1 + c_2 \left( k_x + k_y + k_z \right) \right] \left( \sigma_0 + c_3\sigma_1 \right) \left( k_y - k_z \right) - \frac{c_3\sigma_3 \left( k_x + k_y + k_z \right)}{\sqrt{3}}; \]

\[ S; \quad \{ R_2, R_4 \}; \quad \left[ c_1 + c_2 \left( k_x + k_z \right) \right] \sigma_0 + \left( c_0\sigma_1 - c_0\sigma_2 \right) \left( k_x - k_z \right) + c_5\sigma_3k_y; \]

\[ T; \quad R_5; \quad c_2 \left[ \left( \sigma_3 - \sigma_1 \right) k_x + \left( \sigma_1 + \sigma_3 \right) k_y \right] + \sigma_0 \left( c_4k_z + c_1 \right); \]

Accidental degeneracies on high symmetry line

\[ \Sigma; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2k_x + c_2k_y) + \sigma_3c_3 (k_x + k_y) + c_4\sigma_1 (k_x - k_y); \]

\[ \Lambda; \{ R_3 \}, \{ R_6 \}; \sigma_0 (c_1 + c_2q_x) + \sigma_3c_3q_y; \]
\[ \{ R_3 \}, \{ R_6 \}; A_0 (c_1 + c_2q_x) \pm (\sqrt{3}A_5 + A_8) c_3q_y + (A_6c_4 + 2A_7c_5 - A_2c_6) q_y + [A_4c_4 + (A_5 - \sqrt{3}A_3) c_5 - A_1c_6] q_y; \]
\[ \{ R_4 \}, \{ R_6 \}; A_0 (c_1 + c_2q_x) \pm (\sqrt{3}A_5 + A_8) c_3q_y - [A_6c_4 + (A_5 - \sqrt{3}A_3) c_5 - A_2c_6] q_y + (A_4c_4 + 2A_7c_5 - A_1c_6) q_y; \]

\[ Z; \{ R_2 \}, \{ R_4 \}; \sigma_0 (c_1 + c_2k_x) + \sigma_3c_3k_x + c_4\sigma_1k_y + c_5\sigma_2k_z; \]
\( \Gamma_1: \{ S_{4z} | \frac{1}{2}, \frac{1}{2} \}, \{ C_{3z} | 000 \}, \{ \sigma_{2b} | \frac{1}{2}, \frac{1}{2} \} \); T; Non-Centrosymmetric; with SOC

\( \Gamma; \\begin{align*}
R_4; & \quad (c_1 + c_2 k_x^2) \sigma_0 + c_3 [\sigma_1 k_x (k_y^2 - k_z^2) + \sigma_2 k_y (k_x^2 - k_z^2) + \sigma_3 k_z (k_x^2 - k_y^2)] \\
R_5; & \quad (c_1 + c_2 k_x^2) \sigma_0 + c_3 [\sigma_1 k_x (k_y^2 - k_z^2) + \sigma_2 k_y (k_x^2 - k_z^2) + \sigma_3 k_z (k_x^2 - k_y^2)] \\
R_6; & \quad c_1 \Gamma_{0,0} + c_2 [\Gamma_{1,-1} - \sqrt{3} \Gamma_{3,1}] k_x - (\Gamma_{2,1} + \sqrt{3} \Gamma_{2,3}) k_y + 2 \Gamma_{3,1} k_z \\
X; & \quad R_6; \quad c_2 (\sigma_1 k_x - \sigma_2 k_z) + c_1 \sigma_0; \\
R_7; & \quad c_2 (\sigma_1 k_x + \sigma_2 k_z) + c_1 \sigma_0; \\
L; & \quad \{ R_2, R_1 \}; \quad (c_3 \sigma_1 - c_4 \sigma_2 + c_2 \sigma_3) q_x + c_1 \sigma_0; \\
& \quad \{ R_2, R_2 \}; \quad (c_3 \sigma_1 - c_4 \sigma_2 + c_2 \sigma_3) q_x + c_1 \sigma_0; \\
& \quad \{ R_5, R_6 \}; \quad c_1 \Gamma_{0,0} + \sum_{i=1}^{3} [c_{i,1} \Gamma_{0,0} q_x + c_{i,2} (\Gamma_{1,3} q_x - \Gamma_{1,1} q_y)]; \\
W; & \quad \{ R_2, R_5 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0; \\
& \quad \{ R_4, R_8 \}; \quad (c_2 \sigma_1 - c_3 \sigma_2) k_x + c_1 \sigma_0; \\
\Delta; & \quad R_5; \quad c_2 [(\sigma_3 - \sigma_1) k_x + (\sigma_1 + \sigma_3) k_z] + c_0 (c_3 k_y + c_1); \\
\Lambda; & \quad R_6; \quad [c_1 + c_2 (k_x + k_y + k_z)] \sigma_0 + c_3 \sigma_1 (k_y - k_z) - \frac{c_3 \sigma_2 (k_x + k_y - 2k_z)}{\sqrt{3}}; \\
Q; & \quad \{ R_2, R_2 \}; \quad [c_1 + c_2 (k_y - k_z)] \sigma_0 + \sum_{i=1}^{3} [c_{i,1} k_x + c_{i,2} (k_y + k_z)] \sigma_i.
\end{align*} \)

Accidental degeneracies on high symmetry line

\( \Lambda; \quad \{ R_3 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 q_x) + \sigma_3 c_3 q_x; \\
& \quad \{ R_3 \}, \{ R_6 \}; \quad A_0 (c_1 + c_2 q_x) + (\sqrt{3} A_5 + A_8) c_3 q_x + (A_6 c_4 + 2 A_7 c_5 - A_2 c_6) q_y + [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] q_z; \\
& \quad \{ R_4 \}, \{ R_6 \}; \quad A_0 (c_1 + c_2 q_x) + (\sqrt{3} A_5 + A_8) c_3 q_x - [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_2 c_6] q_y + (A_4 c_4 + 2 A_7 c_5 - A_1 c_6) q_z; \\
\Sigma; \quad \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 (k_x - k_y); \\
S; \quad \{ R_2 \}, \{ R_3 \}; \quad \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_2 (k_x - k_y); \\
Z; \quad \{ R_2 \}, \{ R_4 \}; \quad \sigma_0 (c_1 + c_2 k_x) + \sigma_3 c_3 k_x + c_4 \sigma_1 k_y + c_5 \sigma_2 k_z;
\)

SG 220

\( \Gamma_2: \{ S_{4z} | \frac{1}{2}, \frac{1}{2} \}, \{ C_{3z} | 000 \}, \{ \sigma_{2b} | \frac{1}{2}, \frac{1}{2} \} \); T; Non-Centrosymmetric; with SOC

\( \Gamma; \\begin{align*}
R_4; & \quad (c_1 + c_2 k_y^2) \sigma_0 + c_3 [\sigma_1 k_x (k_y^2 - k_z^2) + \sigma_2 k_y (k_x^2 - k_z^2) + \sigma_3 k_z (k_x^2 - k_y^2)] \\
R_5; & \quad (c_1 + c_2 k_y^2) \sigma_0 + c_3 [\sigma_1 k_x (k_y^2 - k_z^2) + \sigma_2 k_y (k_x^2 - k_z^2) + \sigma_3 k_z (k_x^2 - k_y^2)] \\
R_6; & \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{1,0} q_x + \Gamma_{2,3} q_y + \Gamma_{2,1} q_z) + c_3 \left[(\sqrt{3} \Gamma_{1,0} - \Gamma_{2,0}) q_x + (\Gamma_{1,3} + \sqrt{3} \Gamma_{2,3}) q_y + (\Gamma_{1,1} + \sqrt{3} \Gamma_{2,1}) q_z \right]; \\
R_{15}, \{ R_{15} \}; & \quad c_2 [\sqrt{3} Q_{3,3,2} + Q_{3,1,1}] + c_3 Q_{4,2,1} + c_4 (\sqrt{3} Q_{3,4,2} + Q_{1,1,1}) + c_5 Q_{2,2,1} + c_6 Q_{2,1,2} + c_7 (\sqrt{3} Q_{2,3,2} + Q_{2,1,1}) (k_x - k_y); \\
R_{21}; & \quad (c_1 + c_2 k_x^2) \sigma_0 + c_3 \sigma_1 (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3} c_4 \sigma_2 (k_y^2 - k_z^2); \\
R_{27}; & \quad c_2 (A_0 k_x + A_4 k_y - A_7 k_z) + A_0 c_1; \\
R_{28}; & \quad c_2 (A_0 k_x + A_4 k_y - A_7 k_z) + A_0 c_1; \\
N; \quad \{ R_3, R_9 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) (k_x + k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \\
& \quad \{ R_7, R_9 \}; \quad (c_2 \sigma_1 - c_4 \sigma_2) (k_x + k_y) + c_3 \sigma_3 k_x + c_1 \sigma_0; \\
\Delta; \quad R_5; \quad c_2 [(\sigma_1 + \sigma_3) k_x + (\sigma_1 - \sigma_3) k_z] + c_0 (c_3 k_y + c_1); \\
N; \quad R_6; \quad [c_1 + c_2 (k_x + k_y + k_z)] \sigma_0 + \sqrt{3} c_4 \sigma_1 (k_y - k_z) - c_3 \sigma_3 (k_x + k_y - 2k_z); \\
G; \quad \{ R_2, R_4 \}; \quad [c_1 + c_2 (k_x - k_y)] \sigma_0 + (c_3 \sigma_1 + c_4 \sigma_2) (k_x + k_y) + c_5 \sigma_3 k_z; \\
F; \quad R_{12}; \quad [c_1 + c_2 (k_x - k_y + k_z)] \sigma_0 + \sqrt{3} c_4 \sigma_1 (k_y + k_z) + c_3 \sigma_3 (k_x + k_y - 2k_z); 
\end{align*} \)
Accidental degeneracies on high symmetry line

\(\Sigma; \{R_2\}, \{R_4\}; \sigma_0 (c_1 + c_2 k_x + c_2 k_y) + \sigma_3 c_3 (k_x + k_y) + c_4 \sigma_1 (k_x - k_y);\)

\(\Lambda; \{R_3\}, \{R_4\}; \sigma_0 (c_1 + c_2 q_z) + \sigma_3 c_3 q_z;\)

\(\{R_3\}, \{R_6\}; A_0 (1 + c_2 q_z) + (\sqrt{3} A_5 + A_8) c_3 q_z + (A_6 c_4 + 2 A_7 c_5 - A_2 c_6) q_y + [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] q_x;\)

\(\{R_4\}, \{R_6\}; A_0 (1 + c_2 q_z) + (\sqrt{3} A_5 + A_8) c_3 q_z - [A_6 c_4 - (A_5 - \sqrt{3} A_8) c_5 - A_2 c_6] q_x + (A_4 c_4 + 2 A_7 c_5 - A_1 c_6) q_y;\)

\(D; \{R_5\}, \{R_6\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z;\)

\(\{R_5\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_1 \sigma_1 + c_3 \sigma_2) (k_x - k_y);\)

\(\{R_5\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) (k_x - k_y);\)

\(\{R_6\}, \{R_7\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_1 \sigma_1 + c_3 \sigma_2) (k_x + k_y);\)

\(\{R_6\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z + (c_4 \sigma_1 + c_5 \sigma_2) (k_x - k_y);\)

\(\{R_7\}, \{R_8\}; \sigma_0 (c_1 + c_2 k_z) + \sigma_3 c_3 k_z;\)

\(F; \{R_9\}, \{R_{10}\}; \sigma_0 (c_1 + c_2 p_z) + \sigma_3 c_3 p_z;\)

\(\{R_9\}, \{R_{12}\}; A_0 (c_1 + c_2 p_z) + (\sqrt{3} A_5 + A_8) c_3 p_z + (A_6 c_4 + 2 A_7 c_5 - A_2 c_6) (\sqrt{3} p_x - p_y) + [A_4 c_4 + (A_5 - \sqrt{3} A_8) c_5 - A_1 c_6] (p_x + \sqrt{3} p_y);\)

\(\{R_{10}\}, \{R_{12}\}; A_0 (c_1 + c_2 p_z) + (\sqrt{3} A_5 + A_8) c_3 p_z + (A_4 c_4 + 2 A_7 c_5 - A_1 c_6) (\sqrt{3} p_x - p_y) - [A_6 c_4 - (A_5 - \sqrt{3} A_8) c_5 - A_2 c_6] (p_x + \sqrt{3} p_y);\)
SG 221

\[ \Gamma_c: \{ C_{4v}^{+}[000], C_{4v}^{-}[000], C_{2v}[000], I[000], T \}; \] Centrosymmetric; with SOC

\[ \Gamma; \quad R_8: \quad (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 \left[ k_x \Gamma_{1,0} (k_y + k_z) + \Gamma_{2,1} k_x (k_z - k_y) - \sqrt{2} \Gamma_{2,3} k_y k_x \right] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3} \Gamma_{2,2} (k_x^2 - k_y^2) \right]; \]

\[ R_{16}: (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 \left[ k_x \Gamma_{1,0} (k_y + k_z) + \Gamma_{2,1} k_x (k_z - k_y) - \sqrt{2} \Gamma_{2,3} k_y k_x \right] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3} \Gamma_{2,2} (k_x^2 - k_y^2) \right]; \]

\[ R; \quad R_{16}: (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 \left[ k_x \Gamma_{1,0} (k_y + k_z) + \Gamma_{2,1} k_x (k_z - k_y) - \sqrt{2} \Gamma_{2,3} k_y k_x \right] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3} \Gamma_{2,2} (k_x^2 - k_y^2) \right]; \]

\[ T; \{ R_6, R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4 \left( \Gamma_{1,0} k_x + \Gamma_{2,2} k_y \right); \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 \left( \Gamma_{1,0} k_x + \Gamma_{2,2} k_y \right); \]

\[ \Lambda: \{ R_5, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 q_y) + \Gamma_{3,0} c_3 q_y + c_4 \left( \Gamma_{2,2} q_y - \Gamma_{1,0} q_x \right) + c_5 \left( \Gamma_{2,3} q_x + \Gamma_{2,1} q_y \right); \]

\[ T; \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + c_4 \left( \Gamma_{1,0} k_x + \Gamma_{2,2} k_y \right); \]

SG 222

\[ \Gamma_c: \{ C_{4v}^{+}[000], C_{4v}^{-}[000], C_{2v}[000], I[000], T \}; \] Centrosymmetric; with SOC

\[ \Gamma; \quad R_8: \quad (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 \left[ k_x \Gamma_{1,0} (k_y + k_z) + \Gamma_{2,1} k_x (k_z - k_y) - \sqrt{2} \Gamma_{2,3} k_y k_x \right] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3} \Gamma_{2,2} (k_x^2 - k_y^2) \right]; \]

\[ R_{16}: (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 \left[ k_x \Gamma_{1,0} (k_y + k_z) + \Gamma_{2,1} k_x (k_z - k_y) - \sqrt{2} \Gamma_{2,3} k_y k_x \right] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3} \Gamma_{2,2} (k_x^2 - k_y^2) \right]; \]

\[ X; \{ R_{19}, R_{20} \}; \quad c_1 \Gamma_{0,0} + c_2 \left( \Gamma_{3,1} k_x + \Gamma_{3,3} k_z \right) + k_y \left( c_3 \Gamma_{1,0} + c_4 \Gamma_{2,0} \right); \]

\[ \{ R_{21}, R_{22} \}; \quad c_1 \Gamma_{0,0} + c_2 \left( \Gamma_{3,1} k_x + \Gamma_{3,3} k_z \right) + k_y \left( c_3 \Gamma_{1,0} + c_4 \Gamma_{2,0} \right); \]

\[ M; \quad c_1 \Gamma_{0,0} + c_2 \left( \Gamma_{3,1} k_z - \Gamma_{3,3} k_x \right) + k_y \left( c_3 \Gamma_{1,0} + c_4 \Gamma_{2,0} \right); \]

\[ R; \quad R_{18}: \quad c_1 \Gamma_{0,0} + c_2 \left( \Gamma_{3,1} k_z - \Gamma_{3,3} k_x \right) + k_y \left( c_3 \Gamma_{1,0} + c_4 \Gamma_{2,0} \right); \]

\[ \{ R_{21}, R_{22} \}; \quad c_1 Q_{0,0,0} - 2 c_2 Q_{1,1,3} k_x + (c_3 Q_{1,1,3} + c_4 Q_{2,1,3}) k_y + c_5 Q_{1,1,0} - c_5 Q_{2,2,0} k_y + c_5 Q_{1,1,0} - c_5 Q_{2,2,0} k_y; \]

\[ \left( c_2 k_x \left( \sqrt{3} Q_{0,2,+} + Q_{1,1,+} \right) - i c_2 k_y \left( \sqrt{3} Q_{0,2,+} - Q_{0,1,+} \right) - c_5 k_x Q_{1,1,+,} - c_5 k_y Q_{2,2,+,} + h.c. \right); \]

Accidental degeneracies on high symmetry line

\[ \Delta: \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 \left( \Gamma_{1,0} k_x + \Gamma_{2,2} k_y \right); \]

\[ \Lambda: \{ R_5, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 q_y) + \Gamma_{3,0} c_3 q_y + c_4 \left( \Gamma_{2,2} q_y - \Gamma_{1,0} q_x \right) + c_5 \left( \Gamma_{2,3} q_x + \Gamma_{2,1} q_y \right); \]

\[ S; \{ R_5, R_8 \}, \{ R_6, R_7 \}; \quad \Gamma_{0,0} c_1 + \sum_{i=0,3} \Gamma_{0,0} c_1 \left( k_x + k_z \right) + \left( c_2 \Gamma_{1,0} + c_3 \Gamma_{2,3} \right) (k_x - k_y) + \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,3} \right) k_y; \]

\[ Z; \{ R_5, R_6 \}, \{ R_6, R_7 \}; \quad \Gamma_{0,0} c_1 + c_2 k_x + \Gamma_{3,0} c_k k_x + k_y \left( c_4 \Gamma_{2,1} + c_5 \Gamma_{2,3} \right) + k_z \left( c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0} \right); \]

\[ T; \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_k k_x + c_4 \left( \Gamma_{1,0} k_y - \Gamma_{2,1} k_y \right); \]
\[ \Gamma_c: \{C_{4v}^i, \frac{1}{2} \frac{1}{2} \frac{1}{2}\}, \{C_{3v}^i, 000\}, \{C_{2h}^i, \frac{1}{2} \frac{1}{2} \frac{1}{2}\}, \{I(000)\}, T; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; \quad R_6; \quad (c_1 + c_2 k_y^2) \Gamma_{0,0} + c_3 \left[ k_z \Gamma_{1,1} (k_y + k_z) + \Gamma_{2,1} k_x (k_z - k_y) - \sqrt{2} \Gamma_{2,3} k_y k_x \right] + c_4 \left[ \Gamma_{1,0} \left( 2k_x^2 - k_y^2 - k_z^2 \right) + \sqrt{3} \Gamma_{2,2} (k_x^2 - k_y^2) \right]; \]

\[ R_{16}; \quad (c_1 + c_2 k_y^2) \Gamma_{0,0} + c_3 \left[ k_z \Gamma_{1,1} (k_y + k_z) + \Gamma_{2,1} k_x (k_z - k_y) - \sqrt{2} \Gamma_{2,3} k_y k_x \right] + c_4 \left[ \Gamma_{1,0} \left( 2k_x^2 - k_y^2 - k_z^2 \right) + \sqrt{3} \Gamma_{2,2} (k_x^2 - k_y^2) \right]; \]

\[ X; \quad R_{19}; \quad c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} (k_x + k_z) + \Gamma_{0,3} (k_y - k_x) + c_3 \Gamma_{3,1} k_y; \]

\[ R; \quad R_{18}; \quad c_1 \Gamma_{0,0} + c_2 (\Gamma_{3,1} k_x - \Gamma_{3,2} k_y + \Gamma_{3,3} k_z); \]

\[ \{R_{21}, R_{22}\}; \quad c_1 Q_{0,0,0} - 2c_2 Q_{1,1,2} k_x + (c_1 Q_{1,1,3} + c_2 Q_{2,1,3}) k_x + (c_4 Q_{1,1,0} - c_5 Q_{2,1,0}) k_y + \left[ c_2 k_x \left( \sqrt{3} Q_{0,2,1} + Q_{1,1,1} \right) - ic_k y \left( \sqrt{3} Q_{0,2,1} - Q_{0,1,1} \right) - c_3 k_x Q_{1,1,1} + c_4 k_y Q_{2,1,1} + h.c. \right]; \]

\[ \Delta; \quad \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 (\Gamma_{2,2} k_x + \Gamma_{1,0} k_z); \]

\[ \Lambda; \quad \{R_5, R_4\}, \{R_6\}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 (\Gamma_{2,2} k_x + \Gamma_{1,0} k_z) + c_5 (\Gamma_{2,3} k_y + \Gamma_{2,3} k_z); \]

\[ S; \quad \{R_5, R_6\}, \{R_7, R_8\}; \quad \Gamma_{0,0} c_1 + \sum_{i=0,3} \Gamma_{1,0} (k_x + k_z) + (c_2 \Gamma_{1,0} + c_3 \Gamma_{2,3}) k_y + (c_4 \Gamma_{1,1} + c_5 \Gamma_{2,3}) (k_z - k_x); \]

\[ T; \quad \{R_{13}\}, \{R_{14}\}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 (\Gamma_{1,0} k_y - \Gamma_{2,2} k_x); \]

\[ \text{Accidental degeneracies on high symmetry line} \]

\[ \Delta; \quad \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 (\Gamma_{2,2} k_x + \Gamma_{1,0} k_z); \]

\[ \Lambda; \quad \{R_5, R_4\}, \{R_6\}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 (\Gamma_{2,2} k_x + \Gamma_{1,0} k_z) + c_5 (\Gamma_{2,3} k_y + \Gamma_{2,3} k_z); \]

\[ Z; \quad \{R_5, R_6, R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + k_y (c_4 \Gamma_{1,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}); \]

\[ T; \quad \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 (\Gamma_{1,0} k_y - \Gamma_{2,1} k_z); \]

\[ \text{Accidental degeneracies on high symmetry line} \]
\[ \Gamma'_i; \{ C_{1m}^i [000], C_{3m}^i [000], C_{2m}^i [000], I [000], T \}; \text{Centrosymmetric; with SOC} \]

\[ \Gamma \] \( R_8 \): \( (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 [k_x \Gamma_{1,0}(k_y + k_z) + \Gamma_{2,1} k_x(k_z - k_y) - \sqrt{2}\Gamma_{2,3} k_y k_z] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3}\Gamma_{2,2} (k_x^2 - k_y^2) \right] \);

\[ R_{16} \]: \( (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 [k_x \Gamma_{1,0}(k_y + k_z) + \Gamma_{2,1} k_x(k_z - k_y) - \sqrt{2}\Gamma_{2,3} k_y k_z] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3}\Gamma_{2,2} (k_x^2 - k_y^2) \right] \);

Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_0 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 (\Gamma_{2,2} k_x + \Gamma_{1,0} k_z) \);

\[ \Lambda; \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 q_x) + \Gamma_{3,0} c_3 q_x + c_4 (\Gamma_{2,2} q_y - \Gamma_{1,0} q_x) + c_5 (\Gamma_{2,3} q_x + \Gamma_{2,1} q_y) \);

\[ \text{SG 226} \]

\[ \Gamma'_i; \{ C_{4m}^i [000], C_{3m}^i [000], C_{2m}^i [000], I [\frac{1}{2} \frac{1}{2} \frac{1}{2}], T \}; \text{Centrosymmetric; with SOC} \]

\[ \Gamma \] \( R_8 \): \( (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 [k_x \Gamma_{1,0}(k_y + k_z) + \Gamma_{2,1} k_x(k_z - k_y) - \sqrt{2}\Gamma_{2,3} k_y k_z] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3}\Gamma_{2,2} (k_x^2 - k_y^2) \right] \);

\[ R_{16} \]: \( (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 [k_x \Gamma_{1,0}(k_y + k_z) + \Gamma_{2,1} k_x(k_z - k_y) - \sqrt{2}\Gamma_{2,3} k_y k_z] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3}\Gamma_{2,2} (k_x^2 - k_y^2) \right] \);

Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_0 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 (\Gamma_{2,2} k_x + \Gamma_{1,0} k_z) \);

\[ \Lambda; \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 q_x) + \Gamma_{3,0} c_3 q_x + c_4 (\Gamma_{2,2} q_y - \Gamma_{1,0} q_x) + c_5 (\Gamma_{2,3} q_x + \Gamma_{2,1} q_y) \);

\[ \text{SG 227} \]

\[ \Gamma'_i; \{ C_{4m}^i [\frac{1}{2} \frac{1}{2} \frac{1}{2}], C_{3m}^i [000], C_{2m}^i [\frac{1}{2} \frac{1}{2} \frac{1}{2}], I [\frac{1}{2} \frac{1}{2} \frac{1}{2}], T \}; \text{Centrosymmetric; with SOC} \]

\[ \Gamma \] \( R_8 \): \( (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 [k_x \Gamma_{1,0}(k_y + k_z) + \Gamma_{2,1} k_x(k_z - k_y) - \sqrt{2}\Gamma_{2,3} k_y k_z] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3}\Gamma_{2,2} (k_x^2 - k_y^2) \right] \);

\[ R_{16} \]: \( (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 [k_x \Gamma_{1,0}(k_y + k_z) + \Gamma_{2,1} k_x(k_z - k_y) - \sqrt{2}\Gamma_{2,3} k_y k_z] + c_4 \left[ \Gamma_{3,0} (2k_x^2 - k_y^2 - k_z^2) + \sqrt{3}\Gamma_{2,2} (k_x^2 - k_y^2) \right] \);

Accidental degeneracies on high symmetry line

\[ \Delta; \{ R_0 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 (\Gamma_{2,2} k_x + \Gamma_{1,0} k_z) \);

\[ \Lambda; \{ R_3, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 q_x) + \Gamma_{3,0} c_3 q_x + c_4 (\Gamma_{2,2} q_y - \Gamma_{1,0} q_x) + c_5 (\Gamma_{2,3} q_x + \Gamma_{2,1} q_y) \);

\[ Z; \{ R_5, R_7 \}, \{ R_6, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_x) + \Gamma_{3,0} c_3 k_x + k_y (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) + k_z (c_6 \Gamma_{2,3} + c_7 \Gamma_{1,0}) \);
Accidental degeneracies on high symmetry line

\[\Delta: \{R_6\}, \{R_7\}; \quad \Gamma_{0,0} (c_1 + c_2 k_0^2) + \Gamma_{3,0} c_3 k_0 + \Gamma_{4,0} c_4 (\Gamma_{2,2} k_0 + \Gamma_{1,0} k_z);\]

\[\Lambda: \{R_3, R_4\}, \{R_6\}; \quad \Gamma_{0,0} (c_1 + c_2 q_y) + \Gamma_{3,0} c_3 q_y + \Gamma_{4,0} c_4 (\Gamma_{2,2} q_y - \Gamma_{1,0} q_x) + c_5 (\Gamma_{2,2} q_x + \Gamma_{2,1} q_y);\]

\[\Sigma: \{R_5, R_7\}, \{R_6, R_9\}; \quad \Gamma_{0,0} (c_1 + c_2 k_0^2) + \Gamma_{3,0} c_3 k_0 + \Gamma_{4,0} c_4 (\Gamma_{2,2} k_0 + \Gamma_{1,0} k_z);\]

\[\Omega: \{R_{10}, R_{14}\}, \{R_{14, R_{14}}\}; \quad \Gamma_{0,0} c_1 + \sum_{i=0,1} \Gamma_{1,0} c_1 (k_0 - k_2) + \Gamma_{1,1} [c_2 k_0 + c_3 (k_0 + k_2)] + \sum_{i=1} \Gamma_{2,1} [c_1 k_0 + c_1,1 (k_0 + k_2)];\]
\[ \Gamma_v: \{ C_{4v}^+ | 00 \frac{1}{2} \}, \{ C_{4v}^- | 000 \}, \{ C_{2v} + \frac{1}{2} \} \}; \{ I | 000 \}; T; \text{Centrosymmetric; with SOC} \]

\[ \Gamma; \ R_6: \]
\[ (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 \left[ k_y \Gamma_{1,0} (k_y + k_z) + \Gamma_{2,1} k_z (k_z - k_y) - \sqrt{2} \Gamma_{2,3} k_y k_z \right] + c_4 \left[ \Gamma_{3,0} \left( 2 k_y - k_z - k_y \right) + \sqrt{3} \Gamma_{2,2} \left( k_y - k_z \right) \right]; \]
\[ \Gamma_{16}: \]
\[ (c_1 + c_2 k^2) \Gamma_{0,0} + c_3 \left[ k_z \Gamma_{1,0} (k_y + k_z) + \Gamma_{2,1} k_x (k_x - k_y) - \sqrt{2} \Gamma_{2,3} k_y k_z \right] + c_4 \left[ \Gamma_{3,0} \left( 2 k_x - k_y - k_y \right) + \sqrt{3} \Gamma_{2,2} \left( k_x - k_y \right) \right]; \]
\[ H; \ R_{18}: \]
\[ c_1 \Gamma_{0,0} + c_2 \left( -\Gamma_{3,2} k_x + \Gamma_{3,1} k_y + \Gamma_{3,3} k_z \right); \]
\[ \{ R_{21}, R_{22} \}; \]
\[ c_1 \Gamma_{0,0} + c_2 \left[ (\sqrt{3} Q_{0,1,2} - 3 Q_{2,2,2}) k_x + \sqrt{3} \left( 2 Q_{3,1,3} k_z - Q_{3,1,1} k_y \right) - 3 Q_{0,2,1} k_y \right] + c_3 \left( Q_{1,1,0} k_z + Q_{2,1,1} k_y - Q_{2,1,3} k_z \right) + c_4 \left( Q_{2,2,0} k_y - Q_{1,1,3} k_y + Q_{1,1,1} k_z \right); \]
\[ \{ R_{27}, R_{28} \}; \]
\[ c_1 \Gamma_{0,0} + c_2 \left( S_{0,6} k_x + S_{0,4} k_y - S_{0,7} k_z \right) + c_3 \left( S_{1,2} k_x - S_{1,1} k_y + S_{1,3} k_z \right) + c_4 \left( S_{2,2} k_y - S_{2,1} k_y + S_{2,3} k_z \right); \]
\[ N; \{ R_{13}, R_{14} \}; \]
\[ c_1 \Gamma_{0,0} + c_2 \Gamma_{0,2} (k_x - k_y) + c_3 \Gamma_{1,1} + c_4 \Gamma_{2,1} (k_x + k_y) + c_5 \Gamma_{3,1} k_z; \]

\section*{Accidental degeneracies on high symmetry line}

\[ \Delta: \{ R_6 \}, \{ R_7 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_y) + \Gamma_{3,0} c_3 k_y + c_4 \Gamma_{2,2} k_x + \Gamma_{1,0} k_z; \]
\[ \Lambda: \{ R_5, R_4 \}, \{ R_6 \}; \quad \Gamma_{0,0} (c_1 + c_2 q_x) + \Gamma_{3,0} c_3 q_x + c_4 \Gamma_{2,2} q_y - \Gamma_{1,0} q_z + c_5 \left( \Gamma_{2,3} q_x + \Gamma_{2,1} q_y \right); \]
\[ D: \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} (c_1 + c_2 k_z) + \Gamma_{3,0} c_4 k_z + (c_4 \Gamma_{1,0} + c_5 \Gamma_{2,3}) (k_y - k_y) + (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) (k_x + k_y); \]
\[ G: \{ R_5, R_6 \}, \{ R_7, R_8 \}; \quad \Gamma_{0,0} c_1 + \sum_{i=0,3} \Gamma_{i,0} c_{i,1} (k_z - k_y) + (c_2 \Gamma_{1,0} + c_3 \Gamma_{2,3}) (k_x + k_y) + (c_4 \Gamma_{2,1} + c_5 \Gamma_{2,2}) k_z; \]
\[ F: \{ R_5, R_{10} \}, \{ R_{12} \}; \quad \Gamma_{0,0} (c_1 + c_2 p_z) + \Gamma_{3,0} c_3 p_z + (c_4 \Gamma_{2,2} + c_5 \Gamma_{2,1}) (\sqrt{3} p_x - p_y) - (c_4 \Gamma_{1,0} - c_5 \Gamma_{2,3}) (p_z + \sqrt{3} p_y); \]
