From Photon to Oganesson: Lie Algebra Realization of the Standard Model Extending over the Periodic Table

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Abstract. As reported in a series of previous PIRT conferences, a direct SU(3) structural realization of the Standard Model has been developed based upon Marius Sophus Lie’s original Norwegian Ph.D. thesis Over en Classe Geometriske Transformationer from 1871 (and thus due for a most deserved 150-year anniversary). It elucidates how “the theory of main tangential curves can be brought back to that of rounded curves”, anticipating a coherent linear representation of the elementary particles instead of the rotational chosen since they were considered point-like and amorphous when they many years later entered the stage. Under these premises the Standard Model has built a magnificent, undoubtedly true but congested multiparticle system whereas the Lie continuous transformation element, the partial derivative ‘straight line of length equal to zero’ outlines an isotropic vector matrix lattice of crystallographic Killing root space diagram A3 form which from the Nucleon and inwards can backtrack the Standard Model geometrically, as well as continue outward iterating to a space-filling solid state R×SO(3) wave-packet complex tessellating the whole periodic table with electron shells and subshells, isotope spectrum, neutron captures, radiative channels, oxidation states, molecular binding sites etc. in successive layers also including the Lanthanides in the sixth period and the Actinides in the seventh, in which now the concluding Oganesson has been reached in perfectly well-built saturated noble gas shape and condition.

1. Introduction
Developed since the early 70.ies and consolidated by the confirmation of the Higg’s field and mechanism in 2012, the Standard Model has reached canonical status and power “to describe the most basic building blocks of the universe” [1] (Figure 1a) and their “greatest equation ever written down” [2] (Figure 1b). However, although mathematically coherent and self-consistent this still “in

![Figure 1: Total Standard Model block diagram and equation](Both Wikipedia)
fact...predicts very little about the forces and particles whose behaviour it describes, and information on force strengths, particle mass and so on must be input from experimental measurements” [3]. It is an annoying dilemma, and intensive research is going on, not to replace the mother equation but to amend it. Especially David Tong has emphasized that “if we study the grand equation more there are other patterns that emerge...we should go back to the drawing board and start thinking about different ideas...things like condensed matter physics or quantum information theory” [2].

I have since many years followed a related structural trail based upon Marius Sophus Lie’s Norwegian Ph. D. thesis Over en Classe geometriske Transformationer from 1871 [4,5], in which he originally, in plain language in order to reach the public and the dissertation committee, carefully presented his continuous infinitesimal transformations and their ties with differential equations and spherical geometry. He got excellent marks and praise in the defense but in fact “not one...had understood a single word of it” [6], so the thesis soon went down to oblivion in both linguistic and physical isolation in the faculty archives until a hundred years later I managed to get a photocopy of it from the Oslo University library (and translated it to English [5]). I realized what a treasure it is, essentially advancing from the very bottom ground “the nature of Cartesian geometry” [4,5], whose fundamental condition is that “the extension in length, width, and depth which constitutes the space occupied by a body, is exactly the same as that which constitutes the body...consequently, there cannot exist a space separate from body, since all spatial extension simply is body” [7].

2. Methods
The Eigenelement of extension is the straight line [8], which is thus a physical structure spanning Euclidean space both as an infinite, basically cubic lattice and its coordinate axes, which remain central in any magnitude down to the limit level where it as the infinitesimal generator of itself ends up in a Lie neighborhood of eight Cartesian segments which determines mirror symmetry to all inclusions and exchanges. Furthermore, “Descartes has among the unlimited manifold of possible coordinate systems chosen a definite one” with “x, y, z...as parameters” [4,5], by which in this connection the Lie groups and transformations in them are bound to Euclidean space. And finally, “Cartesian geometry...translates any geometric theorem into an algebraic one and thus...of the geometry of space a representation of the algebra of three variable quantities”, so that Lie groups and their own “reciprocal” algebras share structural element, which in infinitesimal transformations amounts to, “instead of the point, the collection of...imaginary straight lines whose length equals zero”, that is, the partial derivatives, where “x, y, z are perceived as parameters, dx, dy, dz on the other hand as direction-cosines” [Ib.]: It is perfectly arranged for an ordinary space realization of the smallest things in a mutually “tangential...curve net” (Figure 2a), where ”the Plücker line geometry can be transformed into a sphere geometry” by its “straight lines of length equal to zero turning...into the sphere’s rectilinear generatrices” [Ib.] (= infinitesimal generators in present terminology). Their $A_2$ root diagram over the complex field is duplicated when they join with the central Cartesian coordinate axes in real space to an $A_2$ root form hybrid (Figure 2a) in whose lattice (Figure 2b-d) the infinitesimal continuous transformations

![Image](image_url)

**Figure 2.** a,b) Cellular automaton hybrid for SU(3), SU(2), U(1) transformations in real space c,d) 90-180° and 60-120° root vector trains e) Cartesian segment lattice cell with major semiaxis projections
are carried out by successively each other “touching” [Ib.] steps of the root vector elements or over the surface of their projections.

3. Results

This “particularly remarkable transformation” system with its “equations that map the two spaces into each other” projects an “infinitesimal sphere” [Ib.] as a differentiable manifold in mutual tangential reciprocity with its Lie neighbourhood. The continuous further transformations there preserving e.g. symmetry and gauge form the respective Lie group as well as algebra. In the elementary particles it is precisely the spherical transformations that replicate the natural events as well as the Standard Model.

3.1. The baryons

Just as in reality, where the transformations occur in response to some reciprocal impact, a virtual “Game of Lie” Cellular Automaton [9] trial can be launched from the Nucleon’s dual origin (Figure 2) as either a Neutron from the inner product volume element of the x, y, z cubical infinitesimal generators or a Proton from that of the spherical infinitesimal generators spanning a practically equal-sized volume and commutating in the horizontal plane. The stage is set for stepwise lattice transformations projecting symmetry- and volume-preserving ellipsoids and spheroids from the unit sphere identity. This has been described and illustrated in previous reports [10-21] so is here only exemplified by the basic u,d,s supermultiplet baryons (Figures 2 e, 3) and their major semiaxis steps in the lattice with the resulting shape alterations shown in Figure 4 and the masses in Table 1 as calculated according to the quark

![Figure 3](image1.png)

**Figure 3.** Lateral, frontal and horizontal cross-section projection of major semiaxis of the nucleon, \(\Lambda^0, \Sigma^+, \Delta^{++}, \Xi^0, \Sigma(1385)^0\) and \(\Lambda(1405)^0\) from folding out in successive unit SU(3) root vector steps along the existing charged or neutral \(\pi\) channels from end- and focal points of preceding states

![Figure 4](image2.png)

**Figure 4.** Basic eightfold way multiplet shapes

| Major semiaxis | Minor semiaxis | Mass        |
|---------------|---------------|-------------|
| \(q^0\)       | \(q^0\)       | Calculated  |
| \(\Sigma^+\)  | \(\Sigma^+\)  | Observed    |
| \(\Delta^{++}\) | \(\Delta^{++}\) | Calculated  |
| \(\Xi^0\)     | \(\Xi^0\)     | Calculated  |
| \(\Sigma(1385)^0\) | \(\Sigma(1385)^0\) | Calculated  |
| \(\Lambda(1405)^0\) | \(\Lambda(1405)^0\) | Calculated  |

* Minor semiaxis changed in the transformation (6).

**Table 1.** Table of same with resulting masses.
pressure formula from the minor semiaxis contraction in inverse proportionality to the radius of the unit Proton. All of this has been thoroughly described in earlier papers for all observed u,d,s baryons in extensive and exact correspondence with recorded states and their masses, charge levels and angular momenta [1b.] so will not be repeated here. The sphere-ellipsoid/spheroid transformation scheme in effect holds a number of interconnecting subgroups, e.g. spatial channel/flavor orientations alluded to in Figure 4, and moreover offers commutating separate degrees of freedom for the charm and bottom quark classes as well [16,17], and this will be described more in detail to further clarify the model.

While (the majority of) the u,d,s baryons are symmetrical and centrally related the charm baryons result from the much rarer instances when a high-energy e.g. collision hits directly on a minor semiaxis endpoint of a Proton or Neutron (or other state), compressing only this but leaving the second minor semiaxis unchanged = 1 in the case of a Nucleon impact, and squeezing out the new major semiaxis like a protuberance from the surface. In Figure 5 directly showing this by the projections of \( \Lambda_c^+, \Sigma_c^{+++0}, \Xi_c^+ \) and \( \Xi_c^0 \) along their numerous channels, this in \( \Lambda_c^+ \) leads to the new endpoint from which the length of the major semiaxis back to the origin is \( 2\sqrt{\frac{1}{6}} \) (Figure 5a), and when one of the minor semiaxes through the basis remains unit to preserve gauge reduces the length of the other to \( \sqrt{\frac{1}{6}} \), the mass according to the quark pressure formula will be \( 1/1/6 \times 0.93827 \approx 2.30 \) versus real 2.29 GeV.

In \( \Sigma_c^{+++0} \), shown from the Proton surface point (Figure 5 b) the major semiaxis in all varieties is \( 7/12 \) \( \{(4.5/12)^2 + 1.7^2 + 0.5^2\}^{1/2} \) in \( \Sigma_c^{++} \); \( \{1^2 + (6/12)^2\}^{1/2} \) in \( \Sigma_c^+ \) and \( \{2^2 + (0.5/12)^2 + 0.5^2\}^{1/2} \) in \( \Sigma_c^0 \) with mass \( = 1/1/7 \times 0.93827 \approx 2.48 \) versus observed 2.45 GeV in all charge states.

In the same way, Figure 5c,d (enlargeable in the screen) summarizes the plentiful channel spectrum and stages of \( \Xi_c^- \) and \( \Xi_c^0 \). Three modes between the observed starting points and terminations are shown, all leading to a major semiaxis length of \( 7/12 \) and consequential mass value \( 7/12 \times 0.93827 \) GeV = 2.48 GeV, in fine agreement with the observed 2.47 GeV in all states. In Figure 7b, an observed \( \Xi \pi^-\pi^+ \) channel of \( \Xi_c^+ \) and two alternatives of \( \Xi_c^0 \) are outlined. The \( \Xi \pi^-\pi^+ \) channel is interesting because there have been reports of two peaks of \( \Xi_c^+ \), one at 2.47 GeV and the other 75 MeV lower, which fits well with the 2.394 GeV obtained from the \( (1.804^2 + 1.804^2)^{1/2} \) \( \approx 6.51^{1/2} \) channel. The other two for \( \Xi_c^0 \) end up at \( 7^{1/2} \) and 7.02\(^{1/2} \) with mass 2.48 and 2.485 respectively.

![Figure 5](image)

**Figure 5.** a) The \( \Lambda_c^+ \), b) \( \Sigma_c^{+++0} \), and c,d) \( \Xi_c^- \) and \( \Xi_c^0 \) charm baryon resonances and their channels

Also \( \Omega_c^0 \) can be replicated but is not shown here. It is to be noted that only the ground states of the charmed hadrons and not their ‘charmonium’ excited states or extra-Nucleon origins are included in the graphs. However, these can be traced by the same “flavor symmetry” transformations as those of the ordinary \( \Lambda, \Sigma \) baryon/hyperon/resonance series, whereby “the \( \Lambda_c \) and \( \Sigma_c \) spectra look much like the \( \Lambda \) and \( \Sigma \) spectra” and “the \( \Xi_c \) and \( \Omega_c \) spectra ought to be richer than the \( \Xi \) and \( \Omega \) spectra” [22,23].

The bottom baryons and their distinct degree of freedom of volume-preserving transformations occur by combining two charm major semiaxes to a correspondingly thinned and mass-increased disc, or cap, or torus. The highest observed mass number state is \( \Omega_b^0 \) at 6.07 GeV, obtained by a \( 6^{1/2} \times 7^{1/2} \) (being the major semiaxis of \( \Lambda_b^+ \) respective \( \Sigma_c^{+++0} \) and \( \Xi_c^0 \)) \( \times 0.93827 \approx 6.08 \) GeV slightly elliptic disc. When instead a round disc is incorporating the major semiaxis of \( \Lambda_b^+ \), the mass from the compressed minor semiaxis (or/and equivalently from the surface area against the Higgs mechanism) will be \( 1/1/6 \) times the Proton mass \( = 6 \times 0.93827 \) GeV \( \approx 5.63 \) GeV, which is identical with the 5.62 GeV of \( \Lambda_b^0 \). In other respects, too, like the decay modes and the ‘bottomonium’ spectrum [1b.], the coincidences are extensive. There are also a few bottom baryon states between the \( \Lambda_b^0 \) and \( \Omega_b^0 \) (i.e. \( \Sigma_b^{00} \) and \( \Xi_b^{00} \)) and all with a mass around 5.8 GeV. And there are many corresponding asymmetric disc/cap configuration candidates, e.g. a combination of axes \( 6^{1/2} \) and \( 6.5^{1/2} \), giving a mass value of 5.86 GeV, and where the
half-integer axis step comes naturally from the root vector lattice, too. There is no need, therefor, to illustrate the bottom baryons. And the peaking top is not a transformation but a jet in the quark-gluon blowout crescendo.

3.2. The mesons
The mesons appear as transient difference vortices between forming as well as decaying hadrons including themselves to such a multitude that they outnumber the quark-antiquark combination over the Standard Model flavor range. There are also unflavored mesons, so a more realistic classification is offered by the Lie product group SU(2) × U(1) of their geometrical constitution by which their mass can be approximated as the symmetric area times the antisymmetric tightness between the interchanging particles in the transformation lattice. This has also been reported in further detail before [10-21] so is here only summarized for some basic u,d,s mesons in Figure 6 and Table 2.

Table 2. Computed and observed ground meson masses.

| Meson | Calculated | Observed |
|-------|------------|----------|
| π⁺   | 135.4      | 135.0    |
| π⁻   | 139.9      | 139.6    |
| K⁺   | 492.0      | 492.7    |
| K⁻   | 497.6      | 497.67   |
| K⁺   | 547.33     | 548.8 ± 0.6 |
| ρ(770) | 766.1     | 768.3 ± 0.5 |
| ω(780) | 781.9     | 781.95 ± 0.14 |

3.2.1. The D mesons
In Figure 7 it is next turned to the charm mesons, starting with D⁺ and D⁰. In D⁺ (D⁻ obtained by reflection) three varieties are discerned (Figure 7 a-c); the longest sequences span a horizontal side length = 4, and in the charged direction = 1, or a length of 2 in both. The distance to the next D⁺ on either side is 0.5. The product mass is thus 1 x 1/0.5 = 0.93827 GeV = 2 x 0.93827 GeV = 1.87 (1.877) GeV, which complies very well with the recorded 1.87 (1.869) GeV. In D⁰ and its antiparticle this simple plan persists as shown in Figure 7 d. Further example are given by the relatively stable charmed mesons D_s⁺ and D_s*⁺. In the former (D_s⁻ obtained by charge conjugation), the channels K⁺K⁻π⁺ and K⁻K⁺π⁻ establish a t isospin semiaxis of length 2 with the other axis of the weak isospin plane = 3 (Figure 7 e). The distance to the next such plane is 0.51/2 and the mass is 3/2 x 2/2 x 0.51/2 x 0.93827 GeV = 1.99 GeV versus the measured 1.97 GeV. The D_s*⁺ isodoublet (Figure 7f) has mass 2.11 GeV and a sole D_s⁻ − γ mode to a straight vector of length = 1 within an unaltered electromagnetic charge plane which gives a weak isospin plane length = 3. The other sides retain this length so the surface area of the SU(2) plane is 3/2 x 3/2, and the distance in the unilateral γ direction to the neighbor = 1. The mass is then 1.5 x 1.5 x 0.93827 GeV = 2.11 GeV.

Figure 7. a - c) The D⁺ and D⁰ charmed mesons and their channels e,f) D_s⁺ and D_s*⁺. Also the prototype B⁺ and B⁰ bottom mesons are retrieved as shown in Figure 8 a, b. There is a close relation to the D mesons by which almost directly or by single pion steps forging the SU(2) plane major
semiaxis into the radius of a round or elliptic disc, as sketched at very reduced scale in the \( D^0 - \pi^+ \) mode for \( B^+ \) (\( B^0 \) by charge conjugation) in Figure 8 a. It produces a pion semiaxis of length 1 and a \( D^0 \) vector of length 4, spanning an area of \( 1 \times 4 \). The distance to adjacent \( B^0 \) states is \( 0.5^{1/2} \) and combined mass expression \( 4 \times 1/(0.5^{1/2}) \times 0.93827 \text{ GeV} \approx 5.30 \text{ GeV} \) in comparison with actual value of \( 5.28 \text{ GeV} \). In \( B^0 \), three varieties are shown (Figure 8 b). In the \( D^0/\bar{D}^0 \pi^+ \pi^-\) modes the elliptic semiaxes are \( 0.5^{1/2} \) and 4, and 1 and \( 2(2^{1/2}) \), and the distance to the neighbors = 0.5. The resulting mass is \( 0.5^{1/2} \times 4 \times 1/0.5 = 0.5^{1/2} \times 8 \times 0.93827 \), and \( 1 \times 2(2^{1/2}) \times 1/0.5 = 4(2^{1/2}) \times 0.93827 \text{ GeV} \), respectively; which in both cases, like in the \( A_c \) channel \( = 5.30 \text{ GeV} \) versus the real 5.28 GeV. The antiparticle is a degeneracy in the horizontal plane and caused by one semiaxis = 4 and the other = 1, or both = 2, and distance to the neighbor = \( 0.5^{1/2} \), with mass = \( 4 \times 2^{1/2} \times 0.93827 = 5.30 \text{ GeV} \), too.

In this connection also the \( W \) (Figure 8c) and \( Z \) (Figure 8d) gauge vector bosons can be briefly mentioned as the stack of respectively charged and neutral channel vectors contained and released in a colliding e.g. proton/antiproton at what could be called the total ionization energy of the state. In \( W^\pm \) this is 80.4 GeV and as earlier reported \([16, 17]\) the fact is that when one makes an addition of the mass value of all its vectors (Figure 8c) it amounts to \( 2 \times [36 \times 0.93827 + (10 \times 2^{1/2}) \times 0.93827] \text{ GeV} \approx 80.8 \text{ GeV} \). In \( Z \), the result is also within per mille precision; \( 2 \times [44 + (6 \times 2^{1/2})] \times 0.93827 \approx 90.5 \text{ versus the observed } 91.2 \text{ GeV} \) (Figure 8d).

And dealing with the exotic aspects of the Standard Model also the gluon octet can be mimicked when coming out in three-jet ejections into the quark-gluon plasma from “break-up vertices” \([24]\) of particles literally rupturing in ultrahigh energy collisions. It is tempting to see these events happening in the triangular outer corners of the bursting particle’s eight Cartesian segments to that effect (Figure 8e). And at still higher energies, the whole particle/antiparticle fire ball may be smashed flat so gushing out in a double perpendicular jet the rapidly fragmenting top quark from the sides?

3.3. The leptons

Figure 9a gives an overview of the Muon and Tau leptons plus Photon and Neutrino events and Figure 9b summarizes electron processes which are extra-Nucleon and thus although included in the Standard
Joining the $90\text{°}$ inclined vectors (Figure 2c) over the surface of or inside the nucleon leads to a single (Figure 9a), duplicated (Figure 9b) or helical (Figure 9c) orbit, whose spherically projected length in all alternatives $= (2\pi \times 2^{1/2})$ and resulting mass in antisymmetric proportionality to the unit radius of the proton $= 1/(2\pi \times 2^{3/2}) \times 938.27 = 1/(2\pi \times 2^{1/2}) \times 938.27 = 105.59 \text{ MeV}$ in comparison with the measured $\mu^+$ mass of 105.66 MeV. A linking of the 60-120° root vectors (Figures 2c, 9d, e) which would correspond to the electron (positron by inversion) doesn’t lead to an orbit but to a three-pronged closed (Figure 9d) or helical (Figure 9e) propeller-like loop inside the nucleon but leaves no mass there since passing. Instead the three-pronged propeller blades strikingly simulate the Tau, which although classified as a lepton really is governed by the SU(2) part of the weak force $SU(2) \times U(1)$ algebra, that is, the mass is directly related to the 938.27 MeV $= 0.93827 \text{ GeV}$ of the unit Proton equatorial plane of differential area = 1. The area of each Tau blade can be calculated to $1/2^{9/2} \times 2^{3/2} = 1$, and there are three blades so the mass would come out as $3 \times 0.93827 \approx 1.79 \text{ GeV}$. This compares very well with the recorded $\tau$ mass of $1.78 \text{ GeV}$ and also in other respects, like multitude of production and decay modes, the correspondences are extensive but for matters of brevity only mentioned here as is the case for the remaining leptons; in Figure 9f the Photon (though a boson in the Standard Model) in the decay of $\pi^0$, and an Electron Antineutrino and Muon Neutrino in the decay of a Muon to an Electron. Both the Photon and the Antineutrino/Neutrino respectively zigzag and straight trajectories are of infinite length with resulting antisymmetric $U(1)$ mass value zero.

Stepping out of the Nucleon domain (Figures 2e, 9g), the root vector lattice as described in the PIRT-19 conference proceedings [21] takes a space-filling one octahedron-two tetrahedrons isotropic vector matrix (IVM) route where the problem of finding a continuous non-overcrossing path is solved by the chaperon stacking of enveloping space segments as structural wave-packets in palindromic Bohr orbital order to flat-bottom floor modules complemented with a flat-roofed cap to a bilayer, effectively cubical compartment in which like in a ribosome conveyor belt [20] the space-filling geodesics can be hierarchically continued in the global IVM network. Not iterating the detailed description in the previous report [Ib.], a suite of illustrations from it (Figure 10) may recapitulate the process and how the stashing can be used by the combined wave-packet or by its separate constituents in the form of a Neutron and an Electron respectively, filling equal space portions and how this and its combinations allow the reproduction of the elements and their isotopes, here up till 4Beryllium.

**Figure 10.** Suite of greatly size-reduced depictions (enlargeable in the screen) of the extra-Nucleon extension of the Standard Model, including the Electron (and Positron by inversion) and Photon and Neutrino production (from breaking-up of wall/lattice sequences). Note two varieties of module stashing; one without central hole (e.g. in Protium, $^1\text{He}_3$) an one with one forming a tunnel (from Deuterium and onwards) and that in this case the inertial relation between the unit hub and the total wave length ($153 \times 12$) is $1/1836$, that is, the electron/proton mass ratio. The Lego-type building blocks are fine-grained, which in larger assemblies gets blurred even when colors referring to those of the noble gases in raising order is applied to enliven the labor.

Now is only to continue the procedure, which in the previous report had reached Krypton [Ib.] From the third period the fine-grained, Lego-type building blocks used in the first (Figure 10) and second period were replaced by simplified ‘Duplo’ bricks [25] but after the third period these were modified to ‘Triplo’ shape, giving better reproduction of marginal layering, binding site variation and space-filling. Like in the elementary particle transformations, computer animation would be most helpful and valuable. This is supported by Figure 11, recapitulating the third and fourth period in Lego-style and Duplo execution plus the introduction of Triplo bricks.
Figure 11. a) Second period in space-filling Lego-style and Duplo reproduction. The binding sites and the saturation of the concluding noble gas are evident. Note symmetric reactivity of Carbon, halogen binding site of Fluorine, and saturation of Neon. b) Duplo reproduction of third period with neutron (grey blocks) excess in stable isotopes c) Construction of ‘Triplo’ blocks

In the previous PIRT conference the fourth period was reported in Duplo style, and is here updated in Triplo notation in size-reduced figures that can be enlarged in the screen. Like in the previous presentation, (slow) neutron capture setting in from Iron are marked by red arrows in observed beta decay channels. The central parts of the isotope range are also shown from Iron and onwards.

Figure 12. Triplo reproduction of fourth period plus comparison with the standard periodic system. The marginal layering of the present system is discerned, and likewise the absence of a gap in the initial periods.

The fifth period is new and here reproduced in Triplo design. As in all periods the first one or two neutron captures go to the outer shell, then to the flanking and in the terminal states successively returning to saturate the outer.

Figure 13. The fifth period with marginal accretion/superposition and observed neutron capture beta decay channels in central parts of the isotope spectrum. The settling of subshells is suggested. Full saturation of Xenon by terminal filling of four alpha blocks in outer layer is also seen.

The marginal growth and accompanying increase of the neutron excess and its implied design function is illustrated both for the fifth and sixth period below
Figure 14. Marginal growth of periodic table in fifth and sixth period

In the sixth period, the lanthanides are incorporated. They show similar properties since mainly their subshells are loaded. One can follow this in the diagram as also the saturation process to Radon.

Figure 15. Sixth Period including the Lanthanides. Also alpha decay between Radium and Radon is shown. Many atoms, e.g. Francium are extremely rare and unstable. The highest stable states are Lead and Bismuth between the isotopes of which there are many beta decays. Otherwise the slow Neutron capture process largely stops here to be replaced by downward alpha decay from rapid Neutron capture processes in higher states.

The seventh period includes the actinides and leads to Oganesson.
With Oganesson the goal is reached. It also forms the perfect full periodic table. It has one higher isotope, Oganesson 295, and that may start an eight period which can be outlined from information in the palindromic Bohr orbital distribution of the atoms.

Figure 16. Seventh period culminating with Oganesson. All the atoms in the seventh period are unstable but some Uranium isotopes are long-living. The actinides are included and like the lanthanides mostly engaged in subshell saturation.

Figure 17. Oganesson and its 295 isotope which may start an eight period with its first, still not confirmed element Ununentium. Projections of full eight period are also shown.

The Bohr palindromic orbital model is not exhausted by the seventh period but has capacity for one more 32-period and a dwindling tail. And nothing is new and the wave-packet with a parallelepped
encasement around an internal coil is reminiscent both of ancient concepts and tilings as well as modern Clifford algebra trivectors and their operations which also have an internal twist.

Figure 18. The Bohr palindromic orbital distribution of the number of atoms in the periods is not exhausted with the seventh, but can lodge more. And finally noting that nothing is new under the sun.

4. Discussion
I think that the results are significant and also strongly supporting as well as supported by the Standard Model because showing such remarkable correspondences over the whole range of their mutual comprise and organization. The difference lies in the approach; the Standard Model dealing with primary particles and their mathematical identity as points while the partial derivative “straight line of length equal to zero” [4,5] provides a differential realization of the Lie SU(3) × SU(2) × U(1) product group and algebra which both share at the very core. The transformation between straight and round expands as a phase transition between the inner surface of the Euclidean cube and the outer surface of the perfect sphere as suggested by Figure 8e where one can imagine the attraction from the dark mass of this when inducing in the interstice the leap to an IVM continuation.

In that quantum jump also the spatial frame changes from a unit cube to a parallelepiped of height $2^{1/2}$ (Figure 2e) and that might give a clue to the so far not identified counterpart of the Higgs’ field and mechanism. This has a proportionality constant of just $2^{1/2}$ and is a scalar, and it is tempting to speculate that stepping out in a new geometry could bring about such effects. However, these are not explained in the Standard Model either so there is a correspondence in that regard as well.

While the Standard Model deals with external objects the present plan would seem to resolve the dilemma that “humanity’s best attempts at the ultimate explanation of matter and energy, space and time…suffer from a fundamental weakness…the strings move in a spacetime whose shape has been chosen from the beginning, as if they were actors on a previously constructed stage. A truly fundamental theory…would build the stage itself” [26]. The straight line generates itself as the Eigenvector of the absolute contrast to nothingness, namely extension [7,8], and that it is existentially as well as physically spanning its own infinite space is not a problem but gives a natural explanation of the seemingly increasing acceleration and the utter paradox of an outer border of the Universe. As mentioned in another context, “The immanent endlessness of the straight line as a state rather than a distance brings a relativistic perspective also on the everywhere observer-centered expanding universe impression, which is founded upon radiation from around reaching recording. But in a truly infinite cosmos all emissions from ever so strong sources will be successively absorbed and subjected to relativistic gravitational influences under their way, so that in the long run only some near-exhausted and cumulatively bent and thereby increasingly redshifted photons will remain for the farthest away spectator who is in fact, like we, just on the outermost border as well as in the very midst of a vanishing ray-bubble of the All” [In manuscript].

References
[1] DOE Explains The Standard Model of Particle Physics
[2] Tong D 2019 Quantum Fields: The Real Building Blocks of the Universe
[3] Shears T 2013 The Standard Model Philosophical Transactions of the Royal Society
[4] Lie M S 1871 Over en Classe geometriske Transformationer (Kristiania (now Oslo) University: Ph.D. Thesis)
[5] Stubhaug A 2003 The mathematician Sophus Lie. It was the Audacity of My Thinking (Berlin: Heidelberg Springer Verlag)
[6] Grassmann H 1844 and 1878 Die Ausdehnungslehre von 1844 oder die Lineale Ausdehnungslehre Leipzig Otto Wigand
[7] Gardner M 1970 Mathematical Games: The fantastic combinations of John Conway's new solitaire game "Life" Scientific American 223 120
[8] Trell E 1983 Representation of particle masses in hadronic SU(3) transformation diagram Acta Phys. Austriaca 55 97
[9] Trell E 1990 Geometrical reproduction of (u, d, s) baryon, meson, and lepton transformation symmetries, masses, and channels Hadronic J. 13 277
[10] Trell E 1991 On rotational symmetry and real geometrical representations of the elementary particles with special reference to the N and Δ Series Phys. Essays 4 272
[11] Trell E 1992 Real forms of the elementary particles with a report of the Σ resonances Phys. Essays 5 362
[12] Trell E 1998 The eightfold eightfold way: Application of Lie’s true geometriske transformationer to the elementary elementary particles Algebras Groups and Geometries 15 447
[13] Trell E 1998 The eightfold eightfold way: Application of Lie’s true geometriske transformationer to the elementary elementary particles Algebras Groups and Geometries 15 447
[14] Trell E 2008 Elementary particle spectroscopy in regular solid rewrite AIP Conference Proceedings 1051 127
[15] Trell E 2013 3–d realization of τ, and c and b hadrons in endogenous parity with standard model Afr. J. Phys. 3 24
[16] Trell E 2013 Digital outline of elementary particles via a root space diagram approach J. Comput.Meth.Sci.Eng. 13 245
[17] Trell E 2014 Lie, Santilli, and nanotechnology: From the elementary particles to the periodic table of the elements AIP Conference Proceedings 1637 1100
[18] Trell E, Edeagu S and Animalu A 2017 Geometric Lie Algebra in Matter, Arts and Mathematics with Incubation of the Periodic System of the Elements AIP Conference Proceedings 1798 020162
[19] Trell E, Akpojotor G, Edeagu S and Animalu A 2019 Structural wave-packet tessellation of the periodic table and atomic constitution in real R^3xSO(3) configuration space J. Phys.: Conference Series 1251 012047
[20] Trell E 2020 A Space-Frame Periodic Table Representation System Testing Relativity in Nucleosynthesis of the Elements J. Phys.: Conference Series 1557 012006
[21] Beringer J et al 2012 Charmed baryons Particle Data Group 86 010001 245
[22] Beringer J et al 2012 Baryon list Particle Data Group 86 010001 1
[23] Ferreres-Sóle S and Sjöstrand T 2018 The Space-Time Structure of Hadronization in the Lund Model (arXiv:1808.04619v2 [hep-ph])
[24] Portegeis Zwart S 2018 Computational astrophysics for the future Science 36 979
[25] Cho A 2002 Constructing Spacetime – No Strings Attached Science 298 1166