Supporting Information

for Adv. Sci., DOI: 10.1002/advs.201700659

Oxygen-Vacancy Abundant Ultrafine Co$_3$O$_4$/Graphene Composites for High-Rate Supercapacitor Electrodes

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Keywords: ultrafine Co₃O₄ nanoparticles, graphene, laser irradiation, oxygen vacancies, supercapacitors
Part I: Supplementary Figures and Tables

Figure S1 UV-vis absorption spectrum of the porous Co$_3$O$_4$ nanorods.
Figure S2  TEM images of UCNG-10 (a), UCNG (b), UCNG-60 (c) under the same laser fluence (400 mJ pulse\(^{-1}\) cm\(^{-2}\)) with different irradiation time (10, 30, 60 min); TEM images of UCNG-200 (d), UCNG (e), and UCNG-600 (f) under the same irradiation time (30 min) with different laser fluence (200, 400, 600 mJ pulse\(^{-1}\) cm\(^{-2}\)). The figure S2b and the figure S2e are from the same sample (UCNG), but the scales are different.

Figure S3  (a) GCD curves of the Co\(_3\)O\(_4\) nanoparticles/graphene composites under same laser fluence with different irradiation time, (b) GCD curves of the Co\(_3\)O\(_4\) nanoparticles/graphene composites under same irradiation time with different laser fluence. The current density is 1 Ag\(^{-1}\).
**Table S1** Various Co₃O₄ nanoparticles/graphene composites prepared under different laser parameters.

| Conditions                  | 10 min   | 30 min   | 60 min   |
|-----------------------------|----------|----------|----------|
| 200 mJ pulse⁻¹ cm⁻²         | N/A      | UCNG-200 | N/A      |
| 400 mJ pulse⁻¹ cm⁻²         | UCNG-10  | UCNG     | UCNG-60  |
| 600 mJ pulse⁻¹ cm⁻²         | N/A      | UCNG-600 | N/A      |

**Table S2** The capacitance (capacity) of various Co₃O₄ nanoparticles/graphene composites prepared under different laser parameters.

| Materials   | UCNG-10 | UCNG-60 | UCNG | UCNG-200 | UCNG-600 |
|-------------|---------|---------|------|----------|----------|
| Capacitance (F/g) | 167.4   | 127.3   | 978.1| 320.5    | 101.2    |
| Capacity (mAh/g)  | 23.2    | 17.7    | 135.8| 44.5     | 14.1     |

A number of Co₃O₄ nanoparticles/graphene composites prepared under various laser parameters (Table S1) were surveyed to prove the proposed strategy in paper and optimize the preparation condition associated with excellent electrochemical properties for SCs electrodes applications.

Figure S2a-c reveals the morphology evolution of Co₃O₄ nanoparticles/graphene composites with different irradiation time (10, 30, 60 min) under the same laser fluence (400 mJ pulse⁻¹ cm⁻²). When the laser irradiation time is as short as 10 min, the porous Co₃O₄ nanorods have been fragmented into ultrafine Co₃O₄ nanoparticles, but only few particles are anchored on LG surface, as shown in Figure S2a. This is because the laser energy is enough to fragment the porous Co₃O₄ nanorods, but the laser irradiation time is too short to disperse and anchor the ultrafine Co₃O₄ nanoparticles on LG surface. When laser irradiation time increase to 30 min, all ultrafine Co₃O₄ nanoparticles are well dispersed on LG surface and no particles outside LG surface are found (Figure S2b). When the laser irradiation time further increase (60 min), the ultrafine Co₃O₄ nanoparticles on LG surface fuse together and form bigger spherical particles, as shown in Figure S2c.

Figure S2d-f reveals the morphology evolution of Co₃O₄ nanoparticles/graphene composites with different laser fluence (200, 400, 600 mJ pulse⁻¹ cm⁻²) for the same
irradiation time (30 min). As the applied laser energy density is 200 mJ pulse\(^{-1}\) cm\(^{-2}\), it is too low to fragment the porous Co\(_3\)O\(_4\) nanorods, as shown in Figure S2d. When the laser increase to 400 mJ pulse\(^{-1}\) cm\(^{-2}\), the porous Co\(_3\)O\(_4\) nanorod are completely fragmented into ultrafine Co\(_3\)O\(_4\) nanoparticles, as shown in Figure S2e. The ultrafine Co\(_3\)O\(_4\) nanoparticles merge and form bigger spherical particles under 600 mJ pulse\(^{-1}\) cm\(^{-2}\) laser energy density, which is high enough to melt the particles (Figure S2f). This indicates that lasers with proper irradiation time and fluence (400 mJ pulse\(^{-1}\) cm\(^{-2}\) of laser fluence and 30 min of irradiating time) are necessary to prepare ultrafine Co\(_3\)O\(_4\) nanoparticles/graphene composites.

Figure S3 shows the galvanostatic charge/discharge (GCD) curves of the various Co\(_3\)O\(_4\) nanoparticles/graphene composites at 1 A g\(^{-1}\). Among various Co\(_3\)O\(_4\) nanoparticles/graphene composites, the UCNG composites exhibit the highest specific capacitance (Table S2), further confirming the optimized preparation condition (400 mJ pulse\(^{-1}\) cm\(^{-2}\) of laser fluence and 30 min of irradiating time).
Figure S4 (a) SEM image, (b) enlarged SEM image, (c) TEM image, and (d) enlarged TEM image of the UCNG composites.

Figure S5 Size distribution of Co$_3$O$_4$ nanoparticles in the UCNG composites.
Figure S6 (a, b) TEM image of ultrafine Co$_3$O$_4$ nanoparticles on graphene sheets after laser irradiation. The neck formation (slight fusion) between adjacent Co$_3$O$_4$ particles may be mainly caused by laser melting. The neck was indicated by the red circle.
Figure S7 (a) TEM image and (b) zoom-in TEM image of porous Co$_3$O$_4$ nanorods (P-Co$_3$O$_4$) before laser irradiation.
The interaction between graphene and Co$_3$O$_4$ nanoparticles is further corroborated by XPS and Fourier transform infrared (FTIR) spectroscopy (Figure S8, S9).

High-resolution O1s XPS spectra was obtained in the LG (laser reduced graphene) and ultrafine Co$_3$O$_4$ nanoparticles/graphene (UCNG) composites. The O1s XPS spectrum of UCNG can be deconvoluted into four peaks (Figure S8a). The peak located at 530.1 eV is attributed to O-Co bonding configuration in Co$_3$O$_4$.\cite{1} The peak at 531.6 eV is related to C=O bonding configuration while the peak at 533.3 eV is due to the C-OH and/or C-O-C bonding.
configuration.\textsuperscript{[2, 3]} Another peak centered at 530.4 eV originates from the possible formation of a Co-O-C bond, exhibiting that Co$_3$O$_4$ was anchored on the graphene sheets by a Co-O-C.\textsuperscript{[2, 4]} Comparing with the peaks at binding energies of 531.5 and 532.7 eV in O 1s XPS spectrum of the LG (Figure S8b), the intensities of the O 1s peaks associated with C=O group and C-OH and/or C-O-C group in UCNG decreased dramatically, indicating that the oxygen-containing functional groups on LG have been substituted by cobalt ion in Co$_3$O$_4$, forming the Co-O-C bonds.

The FTIR spectra of the LG (laser reduced graphene) and ultrafine Co$_3$O$_4$ nanoparticles/graphene (UCNG) composites in the 400-2000 cm$^{-1}$ spectral region were shown in Figure S9. In the FTIR spectrum of the UCNG, the peaks at 562 and 661 cm$^{-1}$ are derived from the characteristic Co-O vibrations of the Co$_3$O$_4$ spinel lattice.\textsuperscript{[5]} The FTIR spectrum of LG shows the characteristic peaks at 1398, 1261, and 1099 cm$^{-1}$ are attributed to O-H deformation vibration, C-O vibration of the carboxy, and C-O-C vibration of the epoxy, respectively.\textsuperscript{[2, 6]} However, after the growth of Co$_3$O$_4$ nanoparticles, the peaks corresponding to the O-H and C-O-C groups at 1398 and 1099 cm$^{-1}$ almost disappear, while the intensity of C-OH group at 1261 cm$^{-1}$ significantly decrease. This result suggests that the epoxy C-O and hydroxyl O-H groups have been broken down to form a Co-O-C bond between graphene and Co$_3$O$_4$ nanoparticles.\textsuperscript{[4]}
Figure S10 XRD diffractograms of P-Co$_3$O$_4$ and LP-Co$_3$O$_4$.

Figure S11 Co 2p XPS spectrum for LP-Co$_3$O$_4$.

In the high-resolution Co 2p spectra (Figure 3b and Figure S11), the peaks observed at 780.0 and 795.5 eV for the P-Co$_3$O$_4$ (780.0 and 795.3 eV for the LP-Co$_3$O$_4$) can be assigned to the Co 2p$_{3/2}$ and Co 2p$_{1/2}$ spin-orbital peaks of Co$_3$O$_4$, respectively. Compared to the P-Co$_3$O$_4$, the Co 2p peaks of the LP-Co$_3$O$_4$ show two more obvious satellite peaks centered at about 786.6 and 802.8 eV, which are attributed to the Co$^{2+}$ oxidation state, indicating that a part of the Co$^{3+}$ ions was reduced to Co$^{2+}$ and formed oxygen vacancies.
Figure S12 (a) Room-temperature EPR spectra of UCNG composites and P-Co$_3$O$_4$. (b) Room-temperature EPR spectrum of LP-Co$_3$O$_4$. The signal intensity illustrates that both UCNG composites and LP-Co$_3$O$_4$ obtained under the laser irradiation possess higher oxygen vacancy concentration, while the P-Co$_3$O$_4$ exhibit very low oxygen vacancy concentrations, which agrees well with the XPS results.

Figure S13 Optical images of the mixture solution for GO and porous Co$_3$O$_4$ nanorods before (a) and after (b) laser irradiation. Upon laser irradiation, the yellow–brown color instantaneously turned black, indicating that GO could be rapidly reduced by laser irradiation.
**Figure S14** TEM image of LP-Co$_3$O$_4$. In the absence of GO, the LP-Co$_3$O$_4$ was prepared under same laser conditions as described in EXPERIMENTAL SECTION.

**Figure S15** Equivalent circuit for three-electrode configuration cell used in this work. The impedance characteristics were analyzed by the complex nonlinear least-squares (CNLS) fitting method on the basis of a Randles equivalent circuit, as shown Figure S15 (Supporting Information). $R_S$, $R_{CT}$, $C_{DL}$, $C_F$, and $W_o$ in the circuit represents solution resistance, charge-transfer resistance, double-layer capacitance, pseudocapacitance, and the finite-length Warburg diffusion element, respectively.
Figure S16 (a) TEM image and (b) HRTEM image of the UCNG composites after 20000 cycles.

Figure S17 (a) XRD diffractogram and (b) Raman spectrum of the UCNG composites after 20000 cycles.
Figure S18 Co 2p XPS spectrum for the UCNG composites after 20000 cycles.

Figure S19 (a) GCD curves at different current densities, (b) Ragone plot (power density vs energy density) of symmetric supercapacitors based on UCNG.

The power density (P) and energy density (E) of the ultrafine Co$_3$O$_4$ nanoparticles/graphene composites (UCNG) were tested by a classical two-electrode configuration in 2 M KOH aqueous electrolyte.

Specific capacitance of the UCNG in the symmetric supercapacitors (two-electrode configuration) were calculated from the galvanostatic charge–discharge (GCD) curves according to Eq. (1)

\[ C = \frac{2I\Delta t}{\Delta V m} \]  

(1)
where $C$ is the specific capacitance ($\text{F g}^{-1}$), $I$ is the current ($\text{A}$), $\Delta t$ is the discharge time ($\text{s}$), $m$ is the mass of one electrode ($\text{g}$), and $\Delta V$ is the operating potential window ($\text{V}$) during the discharge.

The potential range was set between 0 and 0.8 V.

The energy density ($E$) and power density ($P$) of the UCNG were calculated by using the following equations:

$$E = 0.5C (\Delta U)^2/3.6$$

$$P = E/\Delta t$$

where $E$ (Wh/kg) is the energy density, $C$ (F/g) is the specific capacitance, $\Delta U$ (V) was the SCs voltage window, $P$ (W/kg) is the power density, and $\Delta t$ (h) is the discharge time.

**Figure S20** TEM images of (a) Fe$_2$O$_3$/graphene and (b) MnO$_2$/graphene composites.

After laser irradiation, the Fe$_2$O$_3$ and MnO$_2$ precursors completely break up into ultrafine Fe$_2$O$_3$ and MnO$_2$ nanoparticles, and the ultrafine Fe$_2$O$_3$ nanoparticles and ultrafine MnO$_2$ nanoparticles were simultaneously anchored on graphene sheets.

For comparison, Fe$_2$O$_3$ and MnO$_2$ samples were prepared as given in previous reports (*Chem. Commun.* 2002, 764, *Adv. Funct. Mater.* 2013, 23, 4049). L-Fe$_2$O$_3$ and L-MnO$_2$ (Fe$_2$O$_3$/graphene and MnO$_2$/graphene composites) were fabricated using the as-prepared Fe$_2$O$_3$ and MnO$_2$ samples by laser irradiation reduction route.
Figure S21 (a) Narrow O 1s XPS spectra collected for untreated Fe$_2$O$_3$ and Fe$_2$O$_3$/graphene samples, (b) narrow Mn 3s XPS spectra collected for untreated MnO$_2$ and MnO$_2$/graphene samples.

For the O 1s XPS spectra of the untreated Fe$_2$O$_3$ and Fe$_2$O$_3$/graphene samples, two peaks can be obviously identified for both samples. The peak centered at about 530.2 eV is attributed to O-Fe bonding configuration in Fe$_2$O$_3$, while the peak located at 531.7 eV is related to the oxygen defects in the matrix of metal oxides (Adv. Mater. 2014, 26, 3148). In comparison with the untreated Fe$_2$O$_3$ sample, the higher intensity of the peak located at 531.7 eV for Fe$_2$O$_3$/graphene sample indicates that Fe$_2$O$_3$ in Fe$_2$O$_3$/graphene sample has more oxygen defects. For the Mn 3s XPS spectra of the untreated MnO$_2$ and MnO$_2$/graphene samples, the MnO$_2$/graphene sample shows larger energy separation ($\Delta E=5.6$ eV) when compared with untreated MnO$_2$ sample ($\Delta E=4.9$ eV). As previously reported (Nano Energy 2014, 8, 255), the multiplet splitting energy ($\Delta E$) increases linearly as the valence of Mn element decreases. This result further confirms that the MnO$_2$ in MnO$_2$/graphene sample is reduced by laser irradiation (Mn$^{4+}$ to Mn$^{3+}$/Mn$^{2+}$) and plentiful oxygen vacancies are induced into MnO$_2$. 
Figure S22 (a) Specific capacitance of Fe$_2$O$_3$/graphene composites, Fe$_2$O$_3$, and L-Fe$_2$O$_3$ electrodes calculated from GCD curves as a function of current densities, (b) Specific capacitance of MnO$_2$/graphene composites, MnO$_2$, and L-MnO$_2$ electrodes calculated from GCD curves as a function of current densities.

The electrochemical measurements of Fe$_2$O$_3$ based electrodes were tested using a three-electrode cell in 1 M Na$_2$SO$_4$ aqueous solution within a potential window from -1 to -0.3 V (vs. Ag/AgCl). The electrochemical measurements of MnO$_2$ based electrodes were tested using a three-electrode cell in 1 M Na$_2$SO$_4$ aqueous solution within a potential window from 0 to 1 V (vs. Ag/AgCl).
Figure S23 Atomic structures used to model the 001 surface
| Materials                        | Electrolyte | Measurement methods | $C_s / F g^{-1}$ ($I_s / A g^{-1}$) | Rate capability | Ref. |
|---------------------------------|-------------|---------------------|------------------------------------|-----------------|------|
| Mesoporous Co$_3$O$_4$ nanosheet | 2 M KOH     | 3-electrode         | 2735 (2)                           | 53.8%           | [7]  |
| 3D Graphene-Based Aerogel/Co$_3$O$_4$ | 6 M KOH     | 3-electrode         | 660 (0.5)                          | 75.8%           | [8]  |
| Co$_3$O$_4$/C-800               | 2 M KOH     | 3-electrode         | 201 (1)                            | 88%             | [9]  |
| RGO-Co$_3$O$_4$                 | 2 M KOH     | 3-electrode         | 458 (0.5)                          | 90.8%           | [10] |
| 3D Co$_3$O$_4$ twin-spheres     | 6 M KOH     | 3-electrode         | 781 (0.5)                          | 78.2%           | [11] |
| Reduced Mesoporous Co$_3$O$_4$  | 1 M KOH     | 3-electrode         | 977 (2)                            | 49.5%           | [12] |
| Nanowires                       |             |                     |                                    |                 |      |
| Co$_3$O$_4$/carbon              | 6 M KOH     | 3-electrode         | 555.2 (1)                          | 74.2%           | [13] |
| CNT@ Co$_3$O$_4$                | PVA-H$_2$SO$_4$ gel | 2-electrode | ~90 (~0.1) (~30 (~1.9) | 33.3% | [14] |
| Sub-3 nm Co$_3$O$_4$ Nanofilms  | 2 M KOH     | 3-electrode         | 1400 (1)                           | 91.1%           | [15] |
| Co$_3$O$_4$/Vertically aligned | PVA/KOH gel  | 2-electrode         | 580 (1)                            | 51.7%           | [16] |
| graphene                        |             |                     | 300 (10)                           | 33.8%           |      |
| Mesoporous Co$_3$O$_4$ Microtubules | 3 M KOH   | 3-electrode         | 130.5 (0.5)                        | 91.2%           | [17] |
| Needle-like Co$_3$O$_4$ /Graphene | 2 M KOH     | 3-electrode         | 157.7 (0.1)                        | 38.0%           | [18] |
| Co$_3$O$_4$ nanosheets          | 2 M KOH     | 3-electrode         | 176.8 (1)                          | 88.2%           | [19] |
| CoO/Co$_3$O$_4$                 | 3 M KOH     | 3-electrode         | 353 (10)                           | 78.3%           | [20] |
| Mesoporous Co$_3$O$_4$ nanowire | 6 M KOH     | 3-electrode         | 1160 (2)                           | 76.2%           | [21] |
| Macro-/Mesoporous Co$_3$O$_4$   | 2 M KOH     | 3-electrode         | 742.3 (0.5)                        | 54.4%           | [22] |
| Carbon Nanofibers/Co$_3$O$_4$   | 6 M KOH     | 3-electrode         | 586 (1)                            | 83.6%           | [23] |
|                | Current (mA) | Capacity (%) |
|----------------|-------------|--------------|
| Co$_3$O$_4$-CNFs1 | 196 (50)    | 33.4%        |
| Co$_3$O$_4$-CNFs2 | 270 (1)     | 83%          |
| Co$_3$O$_4$-CNFs3 | 225 (12)    | 79%          |
| Mesoporous Co$_3$O$_4$ Nanosheet | 6 M KOH | 3-electrode | [24] |
|                | 325 (1)     | 73%          |
|                | 256 (12)    |              |
| Mesoporous Co$_3$O$_4$ Nanosheet | 30 wt % KOH | 2-electrode | [25] |
|                | 552 (1)     | 73%          |
|                | 403 (12)    |              |
| UCNG           | 905 (1)     | 78%          |
|                | 705.9 (40)  |              |
|                | 978.1 (1)   | 93.7%        |
|                | 916.5 (10)  |              |
|                |              | This work    |
Table S4 Comparison of the rate capability of some advanced carbon materials in the literature.

| Materials                        | Electrolyte | Measurement methods | \( \frac{C}{F \text{ g}^{-1}} \) \((I/\text{A g}^{-1})\) | Rate capability | Ref. |
|----------------------------------|-------------|---------------------|---------------------------------|-----------------|-----|
| PCNS-G-4                         | 6 M KOH     | 3-electrode         | 300 (0.5)                       |                 |     |
|                                  | 6 M KOH     | 2-electrode         | 246 (10)                        | 82%             | [26]|
|                                  | 1 M TEABF4/AN | 2-electrode     | 189.2 (40)                      | 83%             |     |
|                                  |             |                     | 106 (1)                         |                 |     |
|                                  |             |                     | 85.9 (40)                       |                 |     |
| Shape-Tailorable Graphene        | PVA-Na_{2}SO_{4} gel | 2-electrode | From 50 mV/s to 5000 mV/s      | 53%             | [27]|
| Sheet-like porous carbon         | 6 M KOH     | 3-electrode         | N/A (~0.5)                      | ~75%            | [28]|
|                                  |             |                     | N/A (~120)                      |                 |     |
|                                  |             |                     | N/A (1)                         |                 |     |
|                                  |             |                     | N/A (20)                        |                 |     |
| B/O co-doped carbon nanofiber films | 1 M H_{2}SO_{4} | 2-electrode | 179.3 Fcm^{-3}(1)               | 88.6%           | [29]|
|                                  |             |                     | 158.9 Fcm^{-3}(10)              | 78.5%           |     |
|                                  |             |                     | 140.7 Fcm^{-3}(100)             |                 |     |
| GMCS–NH_{3}                      | 6 M KOH     | 2-electrode         | 29.6 (0.1)                      | 85%             | [30]|
|                                  |             |                     | 25.2 (25)                       |                 |     |
| Functionalized highly porous graphitic carbon fibers | 1 M H_{2}SO_{4} | 3-electrode | 175 (1)                         | 61%             | [31]|
|                                  |             |                     | 107 (60)                        |                 |     |
|                                  |             |                     | 96 (1)                          |                 |     |
|                                  |             |                     | 48 (120)                        |                 |     |
| Single-walled carbon nanotube aerogels | Ionic liquid | 2-electrode | ~50 (1)                         | ~50%            | [32]|
|                                  |             |                     | ~25 (60)                        |                 |     |
| N-doped porous carbon buildings  | 6 M KOH     | 3-electrode         | 347 (1)                         | 80%             | [33]|
|                                  |             |                     | 278 (50)                        |                 |     |
| UCNG                             | 2 M KOH     | 3-electrode         | 978.1 (1)                       | 93.7%           | This work |
|                                  |             |                     | 916.5 (10)                      |                 |     |
Part II: Computation details

Spin-polarized DFT calculations are performed using the Vienna Ab-initio Simulation Package (VASP)\textsuperscript{34, 35} with projector augmented wave (PAW) pseudopotentials\textsuperscript{36, 37} and the Perdew–Burke–Ernzerhof (PBE) exchange-correlation functional\textsuperscript{38}. The electron correlation was remedied by using the LDA+U approach\textsuperscript{39}, with U=3 eV for Co d-electrons, which has been shown to reproduce well the experimental structural parameters, heat of formation, and the band gap\textsuperscript{40}. The atomic structures and the coordinates (in VASP CONTCAR format) used to model the 001 surface are shown in Figure S22. We used 400 eV for the plane-wave cutoff, and fully relaxed the systems until the final force on each atom is less than 0.01 eV/Å. 5x5x1 k-points with Monkhorst-Pack sampling\textsuperscript{41} are used to relax the systems, and 21x21x1 k-points are used to calculate the DOS.

Perfect 001 surface

1.00000000000000

8.15000000000000  0.00000000000000  0.00000000000000

0.00000000000000  8.15000000000000  0.00000000000000

0.00000000000000  0.00000000000000  20.00000000000000

Co  O

Selective dynamics

Direct

0.0000977465099083  0.5002195250814268  0.4046075283703487  T  T  T

0.9887789284970135  0.1172518775171883  0.2038345628438449  T  T  T

0.5023683232493927  0.4970064977758497  0.1948311284579987  T  T  T

0.5981191429062633  0.4112613492843167  0.5834208901865452  T  T  T

0.4994081384111979  0.0002157725558973  0.4046575308906597  T  T  T

0.7499952269322563  0.7489403726926313  0.3085249846230553  T  T  T

0.7615181750500724  0.2348331599526917  0.509313763493010  T  T  T

0.1524737420928570  0.8390744881178236  0.1296150300278143  T  T  T

0.247827473410491  0.7538538382950532  0.5181560487454746  T  T  T

0.2507875740550901  0.2497860929084570  0.3084260482671633  T  T  T

0.6213815398808222  0.8750270753336469  0.559809327490712  T  T  T

0.8745798731743477  0.62909258710129  0.5579467360663486  T  T  T

0.116690677901602  0.380679505406624  0.559727763411512  T  T  T

0.3766462922020702  0.1268741391400638  0.559392459992850  T  T  T

0.633757473441674  0.869681385250530  0.1533943933350344  T  T  T

0.87583983625337  0.6211595507435916  0.1505026971404744  T  T  T

0.128937988617692  0.3627960270605897  0.153362505992955  T  T  T

0.373859504156335  0.1234631857084437  0.153645910943777  T  T  T

0.6230030374947546  0.6263949303774581  0.4577607184063979  T  T  T

0.37307456613330  0.8733507950506763  0.2547088164029816  T  T  T

0.6246269527868969  0.375498831195973  0.356196764292177  T  T  T

0.6230081195592660  0.1254905974306837  0.254564868712256  T  T  T

0.375092447047111  0.376739864773612  0.458508694446957  T  T  T

0.875047279849363  0.1250754521251665  0.3566314018900627  T  T  T

0.125655068917962  0.8470074632695442  0.350754889220629  T  T  T

0.1276060226569698  0.623835842588350  0.2554732034516576  T  T  T

0.875311329988458  0.8733023951612537  0.458564763965533  T  T  T

0.3750267250762676  0.625028342585774  0.5566723690779151  T  T  T

0.127218573927351  0.1247335457150355  0.4586827860075602  T  T  T

0.874831395504154  0.3768615338756121  0.2546209305935511  T  T  T

0.139799136418247  0.3628815773596390  0.4601332766779773  T  T  T

0.1141238925238781  0.6114342803956134  0.157358835506450  T  T  T

0.102644402643242  0.6090187997588109  0.5684331610285724  T  T  T

0.8926823328570848  0.6110836320945268  0.255675144873911  T  T  T
Selective dynamics

V0 1.000000000000000
8.1500000000000004 0.0000000000000000 0.0000000000000000
0.0000000000000000 0.0000000000000000 0.0000000000000000
0.0000000000000000 0.0000000000000000 0.0000000000000000

Co O 30 38

Selective dynamics

Direct

0.9961315508177506 0.5022073966592941 0.4061240366088458
0.9892873468152246 0.9984732850918974 0.1954250307667941
0.4984460259084455 0.4905060731025301 0.1937998797326471
0.5279761256679194 0.5248553944877552 0.5787047469174240
0.5000652184262829 0.9941360161212437 0.4085527026692972
0.7448105907904932 0.7511038088600444 0.3046935532599363
0.7479547955687909 0.2398637346428313 0.5198847542728373
0.271216941553294 0.7819255049899830 0.1341006686530100
0.2396301149278974 0.7489281450925560 0.5702561899584989
0.2515407136290335 0.2456874224497909 0.3068864749792716
0.5979855162582859 0.8764152325564893 0.5642119827907825
0.8833363680339446 0.6040775204115860 0.5641526858269259
0.1227819986432195 0.3740492162637636 0.5575205169702262
0.3713607194859895 0.1232770962040703 0.5581998620815393
0.6317992763160802 0.8529076894222946 0.1408608730751178
0.87380816345380970 0.622920141429832 0.155232153461649
0.1227007684187882 0.3725527576346650 0.1550621450072875
0.3501288155164559 0.127871752961711 0.1499728427386344
0.6240897394853600 0.6226214395761061 0.4592240941133200
0.3740697596016247 0.8775069873125975 0.2541410384956251
0.6247123779315586 0.3744122219471251 0.536482221904717
0.6223407962873736 0.1234430033169005 0.2582371181879364
0.3758207278870174 0.374475014775261 0.4567269811222090

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