ATLAS OF ATOMIC NUCLEAR STRUCTURES

Stoyan Sarg

The Atlas of Atomic Nuclear Structures (ANS) is one of the major output results of the Basic Structures of Matter – Supergravitation Unified Theory (BSM-SG), based on an alternative concept of the physical vacuum. The atlas of ANS illustrates the material structure of the elementary particles and atomic nuclei as they are revealed in BSM-SG. While they exhibit the same interaction energies as the Quantum Mechanical models, they are not point-like structures. The atlas also provides information about the spatial arrangement of the protons and neutrons in the atomic nuclei, atoms and molecules. The Z-number trend of the nuclear build-up follows a shell structure that complies strictly with the row-column pattern of the Periodic table, while obeying the Hund's rules and Pauli exclusion principle. The nuclear structures of the stable isotopes exhibit a higher degree of symmetry. The trend of faster increase of the number of neutrons in comparison to the protons in heavier elements and their spatial positions play a role in redistribution of the repulsive Coulomb forces between protons. The proposed physical models could find applications in different fields, such as the chemistry, nanotechnology, biomolecules and deeper understanding of the nuclear stability and reactions.

1. S. Sarg © 2001, "Atlas of Atomic Nuclear Structures", monograph

Archived in the National Library of Canada (April 2002)
http://www.nlc-bnc.ca/amicus/index-e.html
(AMICUS No. 27106037)
Canadiana: 2002007655X
ISBN: 0973051515
Classification:
LC Class no.: QC794.6*
Dewey: 530.14/2 21

2. S. Sarg, "Atlas of Atomic Nuclear Structures According to the Basic Structures of Matter Theory, Journal of Theoretics, Extensive papers, 2003.
http: www.journaloftheoretics.com

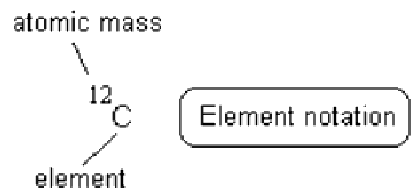
Tables of contents

Table 1: Page location of the elements

Z	Page		Z	Page
1 - 2	II-1		53 - 56	II-11
3 - 7	II-2		57 - 61	II-12
8 - 13	II-3		62 - 67	II-13
14 - 18	II-4		68 - 72	II-14
19 - 24	II-5		73 -78	II-15
24 - 29	II-6		79 - 84	II-16
30 - 35	II-7		85 - 89	II-17
36 - 40	II-8		90 - 95	II-18
41 - 46	II-9		96 - 101	II-19
47 - 52	II-10		102-103	II-20

Notes: The symbols used for notation of the protons and neutrons and their connections in the atomic nucleus are given in Page II-).

Notations:
Z- number of protons in the nucleus
N - number of neutrons in the nucleus



Note: BSM-SG Periodic Table of Atomic Nuclei is included at the end (300dpi resolution). Higher resolution Periodic Table is available upon request.

References:

[1]. S. Sarg, *Basic Structures of Matter Supergravitation Unified Theory*, monograph, ISBN 9781412083874, Amazon.com, also in http://collection.nlc-bnc.ca/amicus/index-e.html (AMICUS No. 27105955) LC Class no.: QC794.6*; Dewey: 530.14/2 21, (first edition, 2002); second edition, 2005)
[2]. S. Sarg, New approach for building of unified theory about the Universe and some results, http://lanl.arxiv.org/abs/physics/0205052 (2002)
[3]. S. Sarg, Brief introduction to BSM theory and derived atomic models, Journal of Theoretics, (2003). http://www.journaloftheoretics.com/Links/Papers/Sarg.pdf
[4]. S. Sarg, A Physical Model of the Electron According to the Basic Structures of Matter Hypothesis, Physics Essays (An international journal dedicated to fundamental questions in Physics), v. 16, No. 2, 180-195, (2003), viXra:1104.0051
[5] Basic Structures of Matter - Supergravitation Unified Theory Based on an Alternative Concept of the Physical Vacuum, viXra:1104.0046

Introduction

The Atlas of Atomic Nuclear Structures (ANS) is one of the major output results of the Basic Structures of Matter - Supergravitation Unified Theory (BSM-SG), based on an alternative concept of the physical vacuum. While the physical structures of the elementary particles obtained by analysis according to the BSM-SG theory exhibit the same interaction energies as the Quantum Mechanical models, they allow unveiling the spatial configurations of the atomic nuclei, atoms and molecules. The unveiled structural features of the atomic nuclei provide explanation about the particular angular positions of the chemical bonds. Such features are in good agreement with the VSEPR model used in the chemistry. Other intrinsic features defined by the structural composition of the nuclei provide strong evidence that the proposed models are real physical atomic structures. The arguments for this claim are presented in the BSM-SG theory and more particularly in Chapter 8. The proposed physical models allows understanding the stability of the isotopes and the radioactivity. The nuclear models could be useful in different fields, such as chemistry, nanotechnology, biomolecules and deeper understanding of the nuclear reactions.

The atlas of ANS contains two parts. Part I illustrates the geometry and the internal structure of the basic atomic particles, built of helical structures. (The helical structures are building blocks of all elementary particles. Their type and classification are shown in §2.7, Chapter 2 of BSM). Part II illustrates the three dimensional atomic nuclear structures of the elements in a range of $1 < Z < 103$, where Z is the number of protons in the nucleus. Only the stable isotopes given in the Periodic table are shown. In order to simplify the complex views of the nuclei they are shown as plane projections of symbols. For this purpose two types of symbols are used: symbols for hadron (nucleon) particles (proton, neutron and He nucleus) and symbols for the type of the nuclear bonding of the nucleons. The symbolic views contain the necessary information for presenting the real three-dimensional structures of the atomic nuclei by different sectional views. This is demonstrated in page 21 of the atlas, where nuclear sectional views of some selected elements are shown.

The rules according to which the protons and neutrons are arranged in shells in the nuclei are discussed in Chapter 8 of BSM-SG. The trend of consecutive nuclear building by Z-number follows a shell structure that complies strictly with the row-column pattern of the Periodic table. The periodic law of Mendeleev appears to reflect not only the Z-number, but also the shell structure of the atomic nuclei. The latter becomes apparent in the BSM-SG analysis. The protons (also deuterons) shells get stable completion at column 18 (noble gases). The separate rows of the Lanthanides and the Actinides are characterised by a consecutive grow and completion of different shells. The nuclear structures of all stable elements (isotopes) possess a clearly identifiable polar axis of rotational symmetry. One or more He nuclear structures are always positioned along this axis. The most abundant sub-nuclear compositions are deuterons, tritium and protons. The strong SG forces hold them together, while the proximity E-fields play a role for their orientations. The identified different types of bonds are shown in the atlas by symbolic notations. For more details, see Chapter 8 of BSM-SG. In the same Chapter, the conditions for instability of the short-lived isotopes are also discussed. They are partly apparent from the Atlas drawings - especially for the alpha decay. The stability limit for elements with a high Z-number is apparent from the nuclear shelf completion overal shape. The strong SG forces falls fast with the distance.

The electronic orbits are not shown in the nuclear drawings, but their positions are defined by the spatial positions of the nucleons. The Hund's rules and the Pauli exclusion principle are both identifiable features related to the available positions and mutual orientations of the quantum orbits. The quantum velocity of the orbiting and oscillating electron, defines the length trace of any quantum orbit (see §3.12, Chapter 3; §7.7, Chapter 7 of BSM-SG)

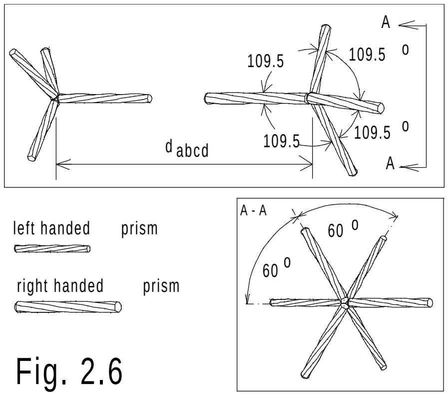
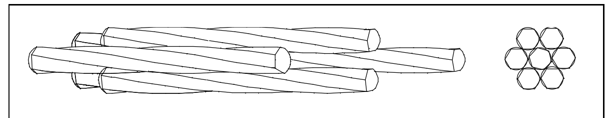
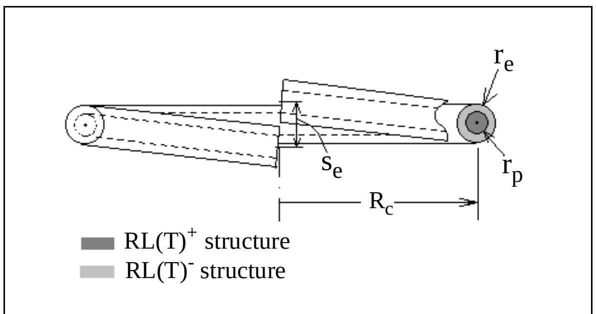


Fig. 2.6

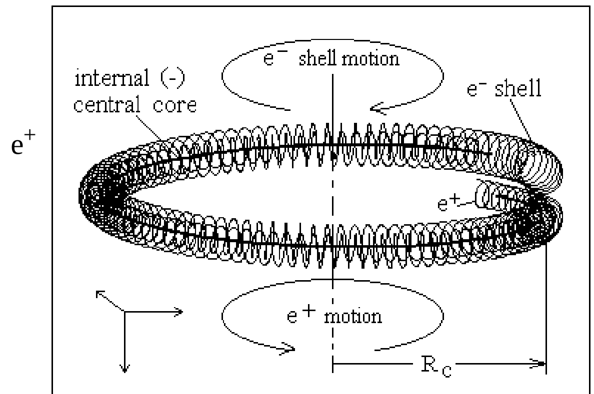


Core node from prisms of same type
(building element of the helical structure)
Note: The twisted prisms model is used

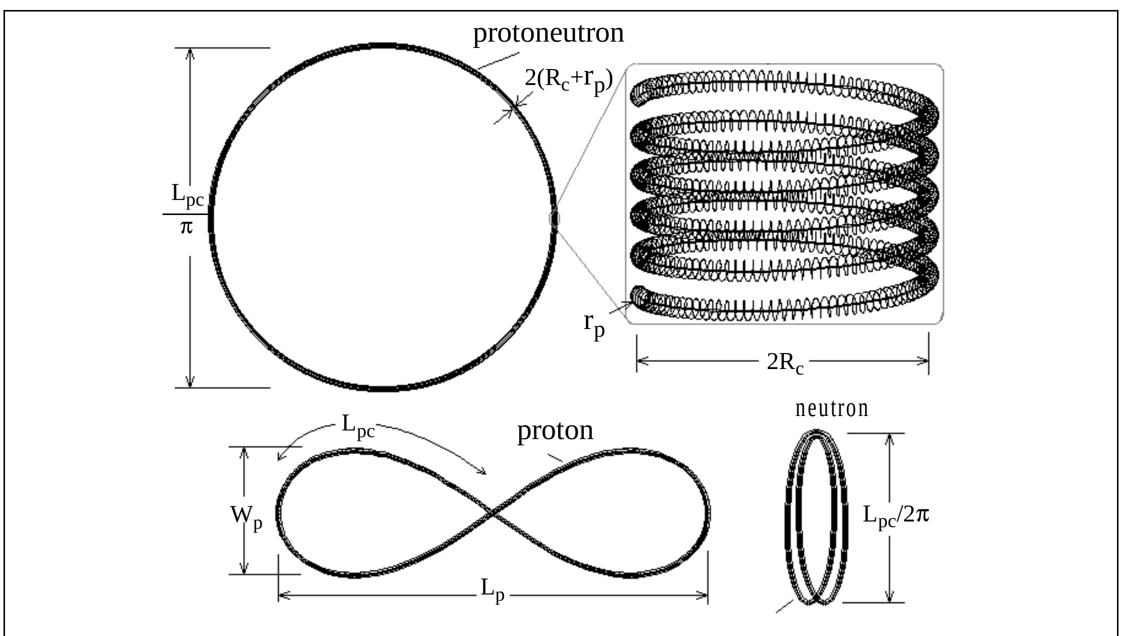
Fig. 2.8.B



Electron structure geometrical parameters



Oscillating electron



Shape and envelope structure of proton and neutron

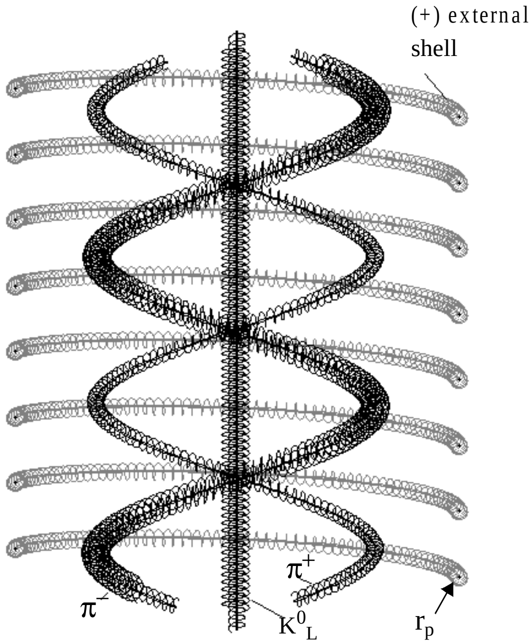


Fig. 2.15.B. Axial sectional view of proton (neutron) showing the external positive shell (envelope) and the internal elementary particles - pions and kaon. All of them are formed by helical structures possessing internal RL structures (not shown).

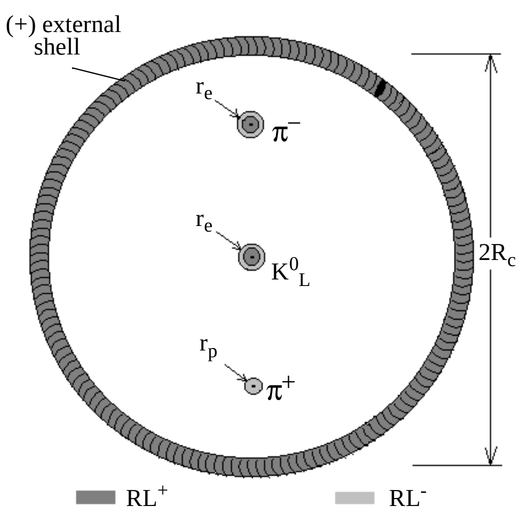


Fig. 2.15.A. Radial sectional view of a proton (neutron) core with internal elementary particles and their internal RL structures. The RL structures are not twisted for the kaon, partly twisted for the pions and fully twisted for the external shell.

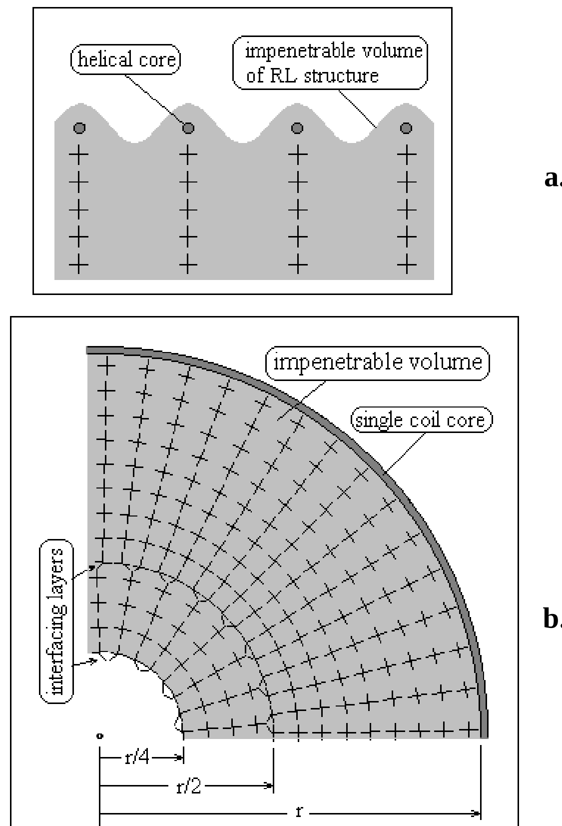


Fig. 2.16 Axial (a) and radial (b) section geometry of the internal RL structure of FOHS (not twisted). The real number of radial layers is large since the prism's length is much smaller than the boundary radius *r*.

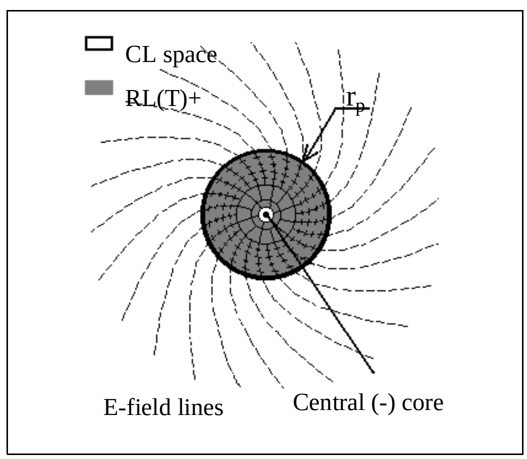
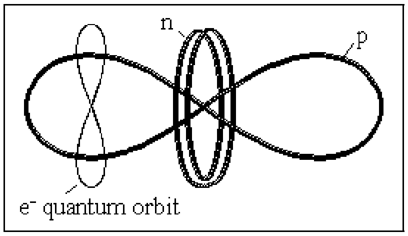
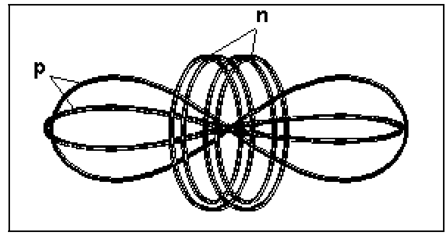


Fig. 2.29.E. Radial section of positive FOHS with twisted internal $RL(T)^+$ structure generating E-field in CL space. The radial section of the FOHS envelope core and the central core is formed of 7 prisms. r_p - is a radius of the FOHS envelope.

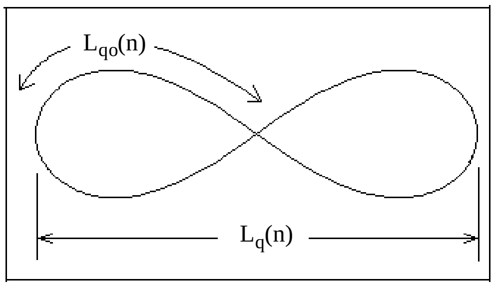


Deuteron with Balmer series orbital

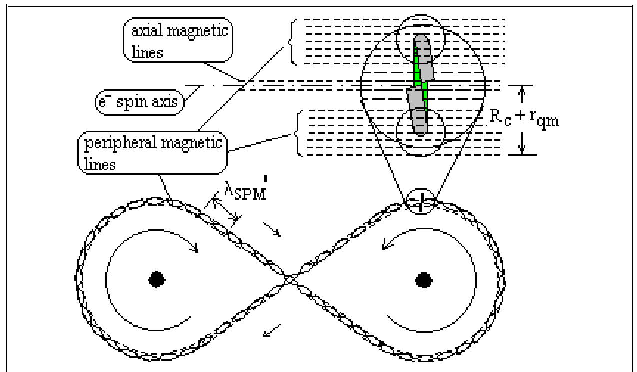


He nucleus

p - proton; n - neutron; e⁻ - electron



Simple quantum orbit (n - is the subharmonic number)



Electron orbit in Balmer series

Idealized shape of stable (quantum) orbit defined by the quantum magnetic line conditions. The peripheral and axial magnetic lines are generated by the screw-like confined motion of the electron in CL space (see §7.7 in Chapter 7 of BSM)

The equation of the quantum orbit trace length, L_{qo} is derived in §3.12.3 (Chapter 3 of BSM).

$$L_{qo}(n) = \frac{2\pi a_o}{n} = \frac{\lambda_c}{\alpha n} \qquad (3.43.i)$$

where: n is the subharmonic number of the quantum orbit; λ_c - is the Compton wavelength; α - is the fine structure constant; $2\pi a_o$ - is the length of the boundary orbit (a_o - is the Bohr model radius)

The shape of the orbit is defined by the proximity E-field of the proton. The most abundant quantum orbit has a shape of Hippoped curve with a parameter $a = \sqrt{3}$. Orbits of such shapes serve also as electronic bonds connecting the atoms in molecules (see Chapter 9 of BSM).

The trace length L_{qo} and the long axis length L_q of the possible simple quantum orbits (formed by single quantum loops) are given in Table 1.

The estimated distance between the CL nodes in abcd axis is: $d_{abcd} \approx 0.549 \times 10^{-20}$ (m).

Table 1:

n	L_{qo} [A]	L_q [A]	e^- energy [eV]
1	3.3249	1.3626	13.6
2	1.6625	0.6813	3.4
3	1.1083	0.4542	1.51
4	0.8312	0.3406	0.85
5	0.665	0.2725	0.544
6	0.5541	0.2271	0.3779

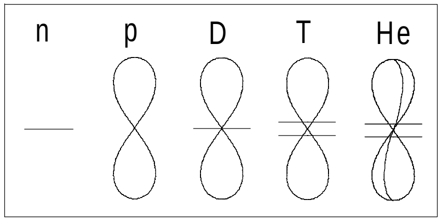
The calculated geometrical parameters of the stable atomic particles: proton, neutron, electron and positron are given in **Table 2**. The last reference column points to the BSM chapters, related to the calculations and cross validations of these parameters.

Table 2:

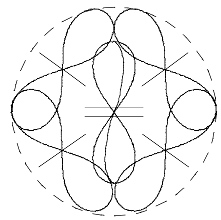
Parameter	Value	Description	Calculations and cross validations in:
L_{PC}	1.6277 (A)	proton (neutron) core length	Chapters 5 and 6
L_P	0.667 (A)	proton length	Chapters 6, 7, 8, 9
W_P	0.19253 (A)	proton (neutron) width	Chapters 6, 7 ,8 ,9
r_e	8.8428E-15 (m)	small radius of electron	Chapters 3, 4, 6
s_e	1.7706E-14 (m)	electron(positron) step	Chapter 3
r_p	5.8952E-15 (m)	small radius of positron	Chapters 3, 4, 6
$2(R_c + r_p)$	7.8411E-13 (m)	thickness of proton (neutron)	Chapters 6, 7, 8, 9

Notes:
(1) $R_c = 3.86159 \times 10^{-13}$ (m) - is the Compton radius of the electron.
(2) $1A = 10 \times 10^{-10}$ (m) - is the Amstrong unit for length

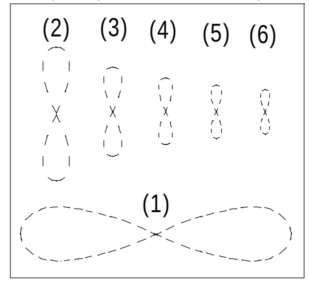
Shape symbols of nuclear atomic structures



Polar section of Ar nucleus

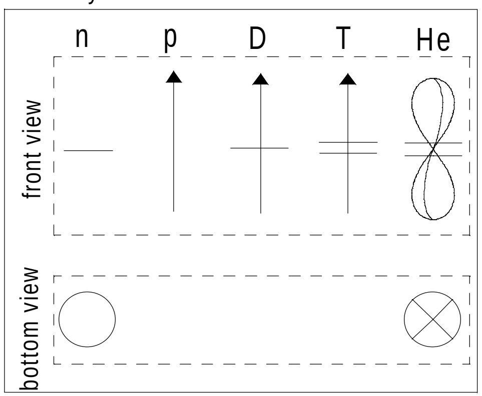


Simple quantum orbits (QOs)

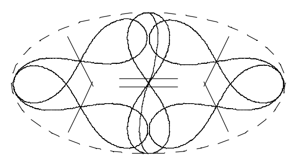


(1) first harmonic QO (13.6 eV)
(2) second subharmonic QO (3.4 eV)
(3) third subharmonic QO (1.51 eV)
(4) fourth subharmonic QO (0.85 eV)
(5) fifth subharmonic QO (0.544 eV)
(6) sixth subharmonic QO (0.377 eV)

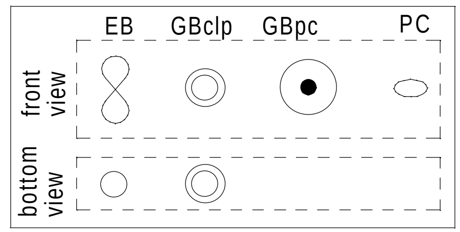
Sketch symbols of nuclear atomic structures



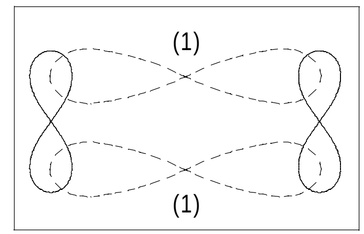
Polar section of Ar nucleus embedded in a heavier nucleus



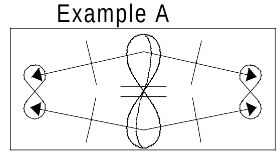
Connection symbols



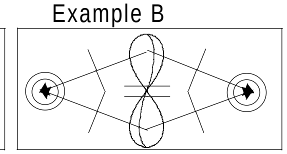
H2 ortho molecule



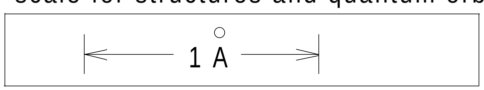
Example A



Example B

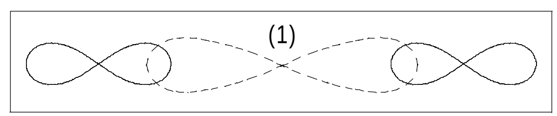


scale for structures and quantum orbits



Example A: Two pairs of Ds connected by EB bonds
Example B: Two pairs of Ds conncted by GBclp bonds

H2 para molecule (two electrons share a common orbit)

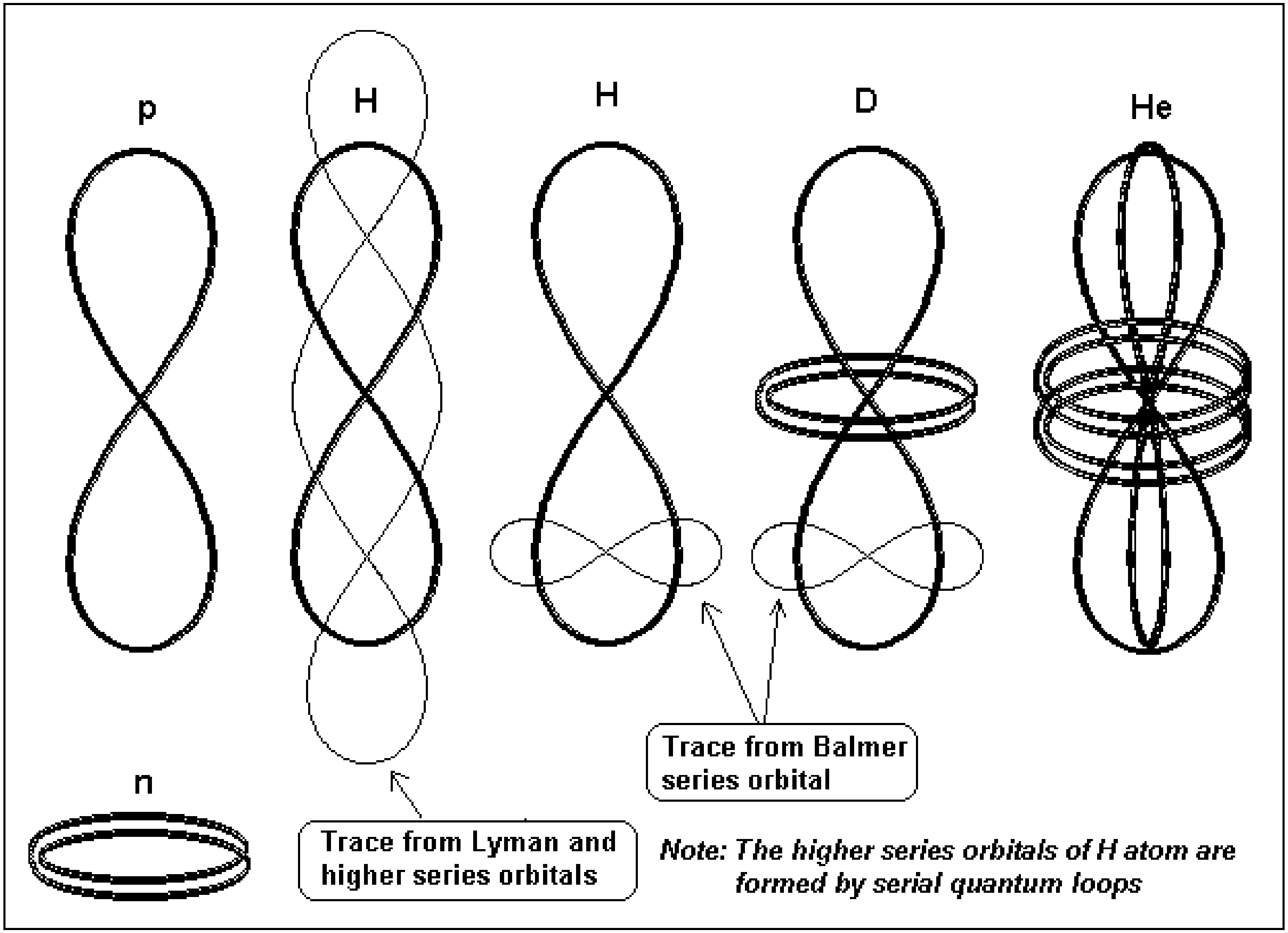


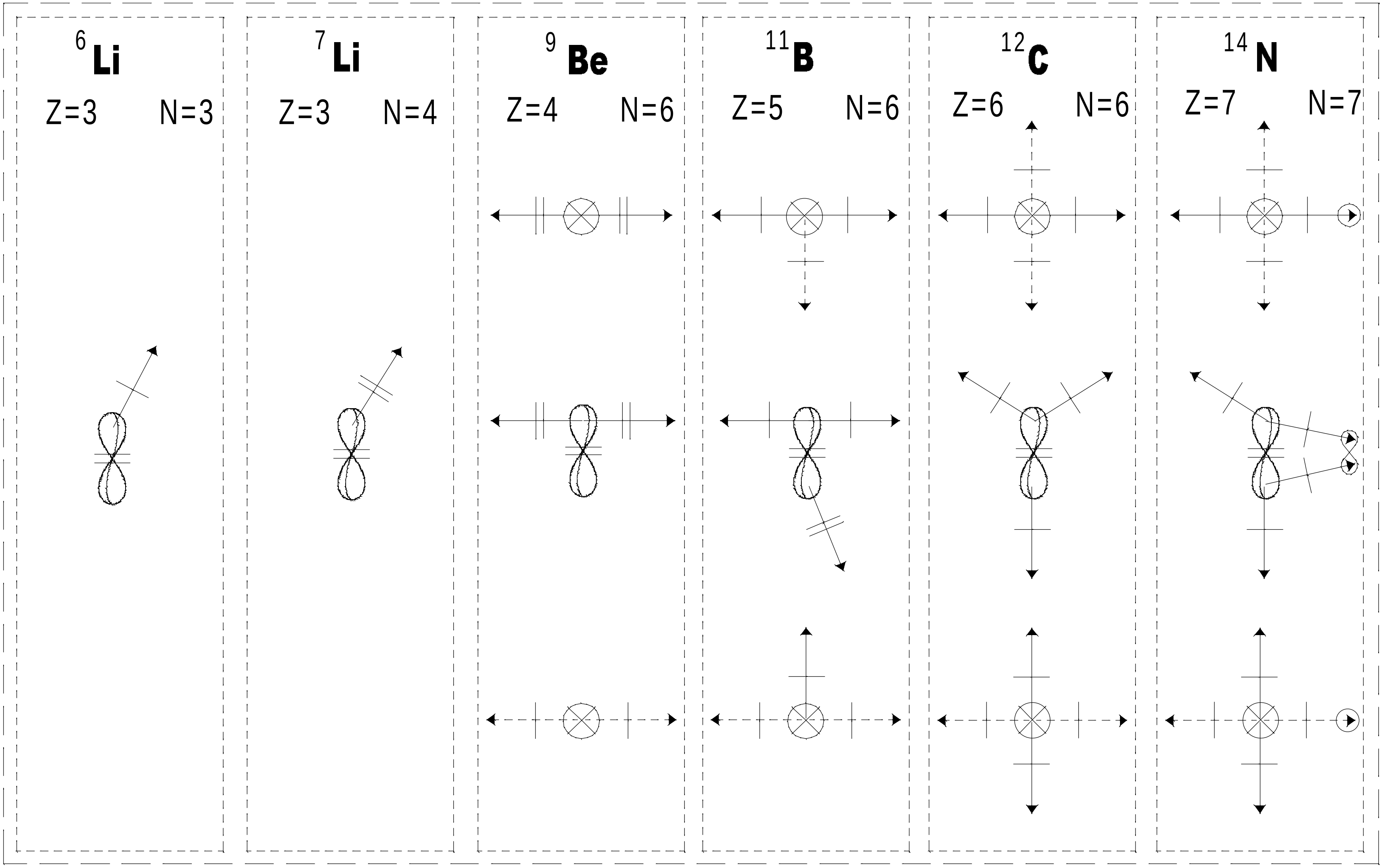
Note: QOs for para and ortho states of H2 are normal to the proton's quasiplanes

Notations:

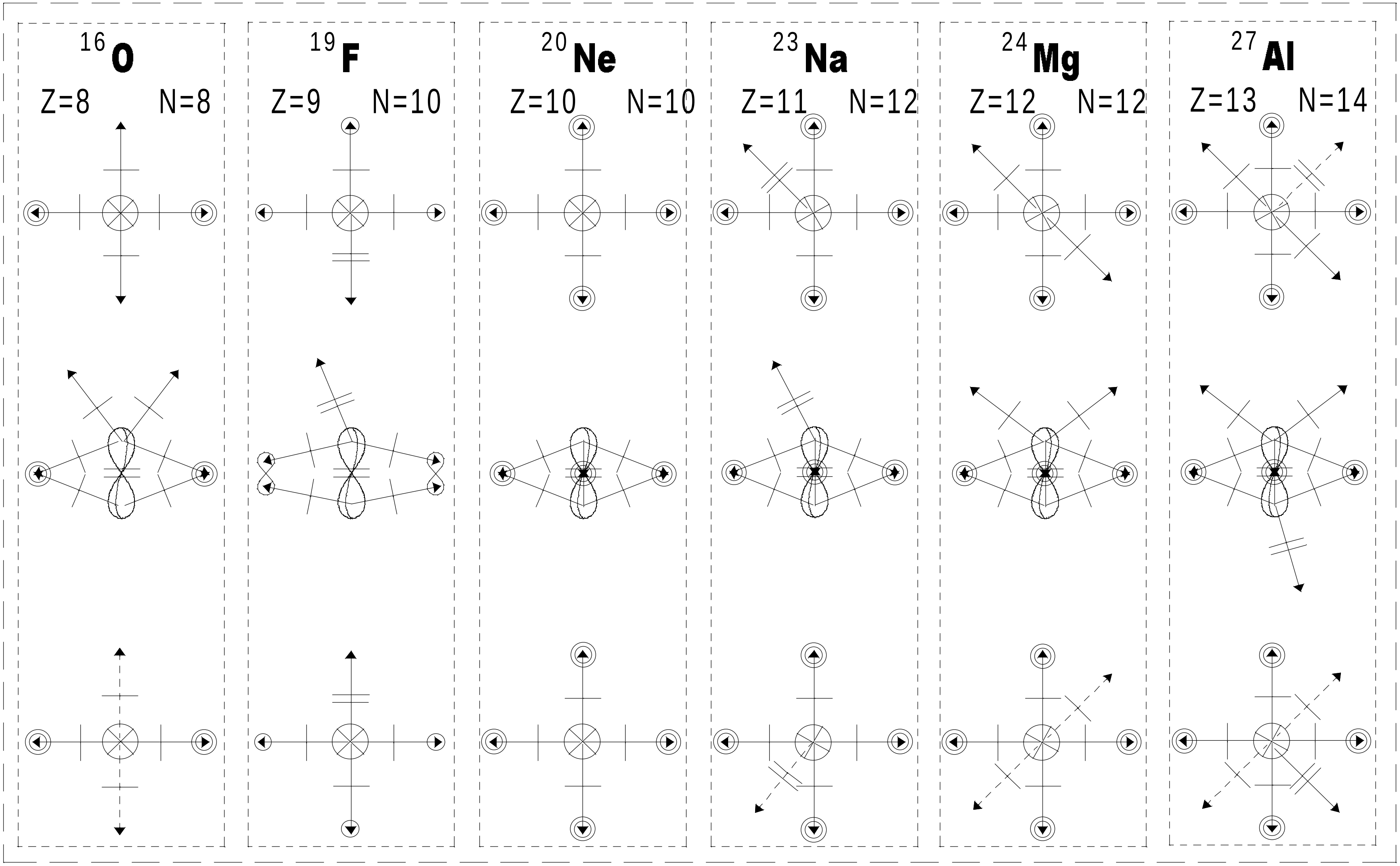
n - neutron
p - proton
D - deuteron
T - Tritii
He - Helium
Ar - Argon

EB - electronic bond (weak)
GB - (intrinsic) gravitational bond (strong)
GBclp - (proton) club proximity GB
GBpc - polar clamped GB
PC - polar connection or clamp for Ar polar GB

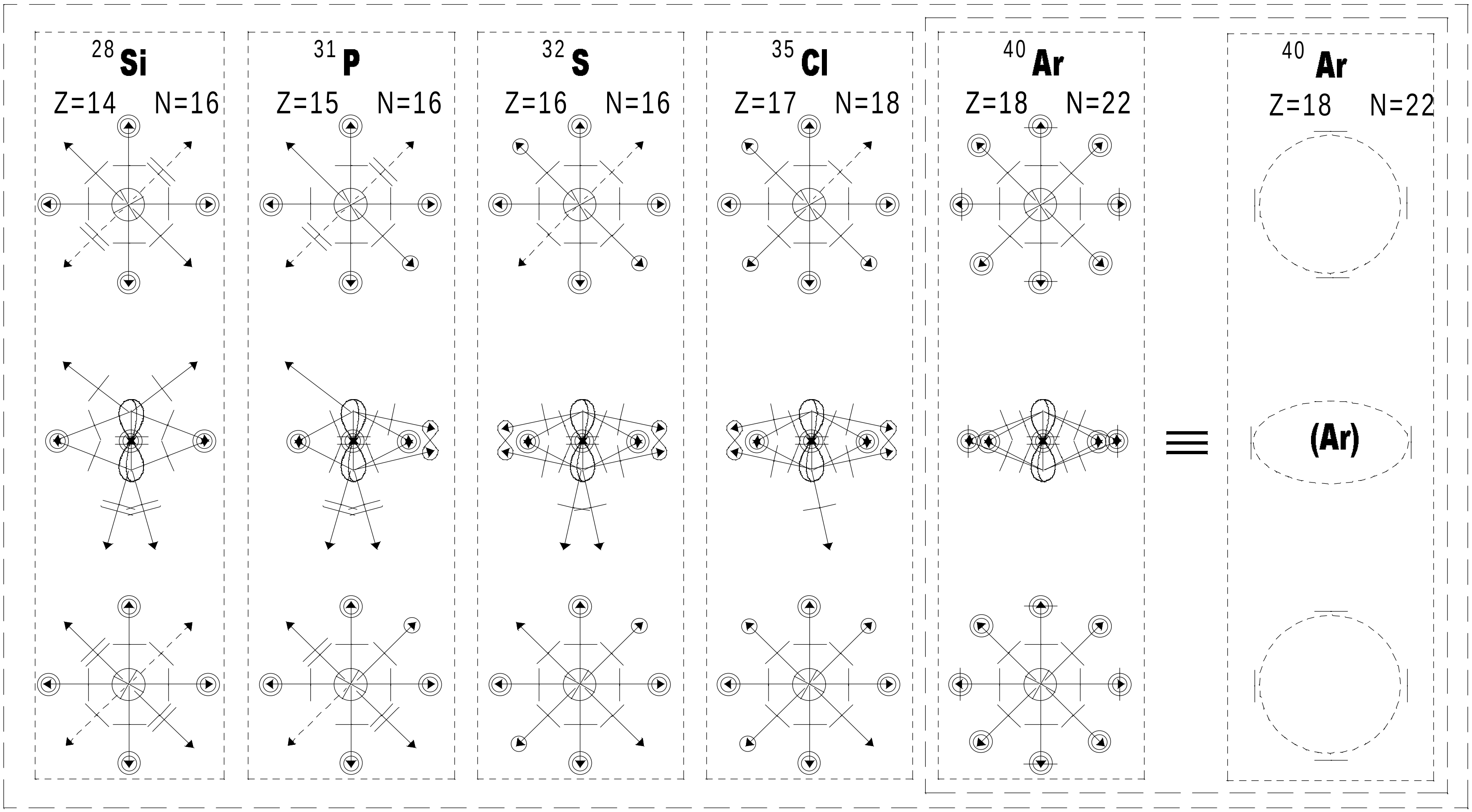

p
H
H
D
He
n
Trace from Lyman and higher series orbitals
Trace from Balmer series orbital
Note: The higher series orbitals of H atom are formed by serial quantum loops



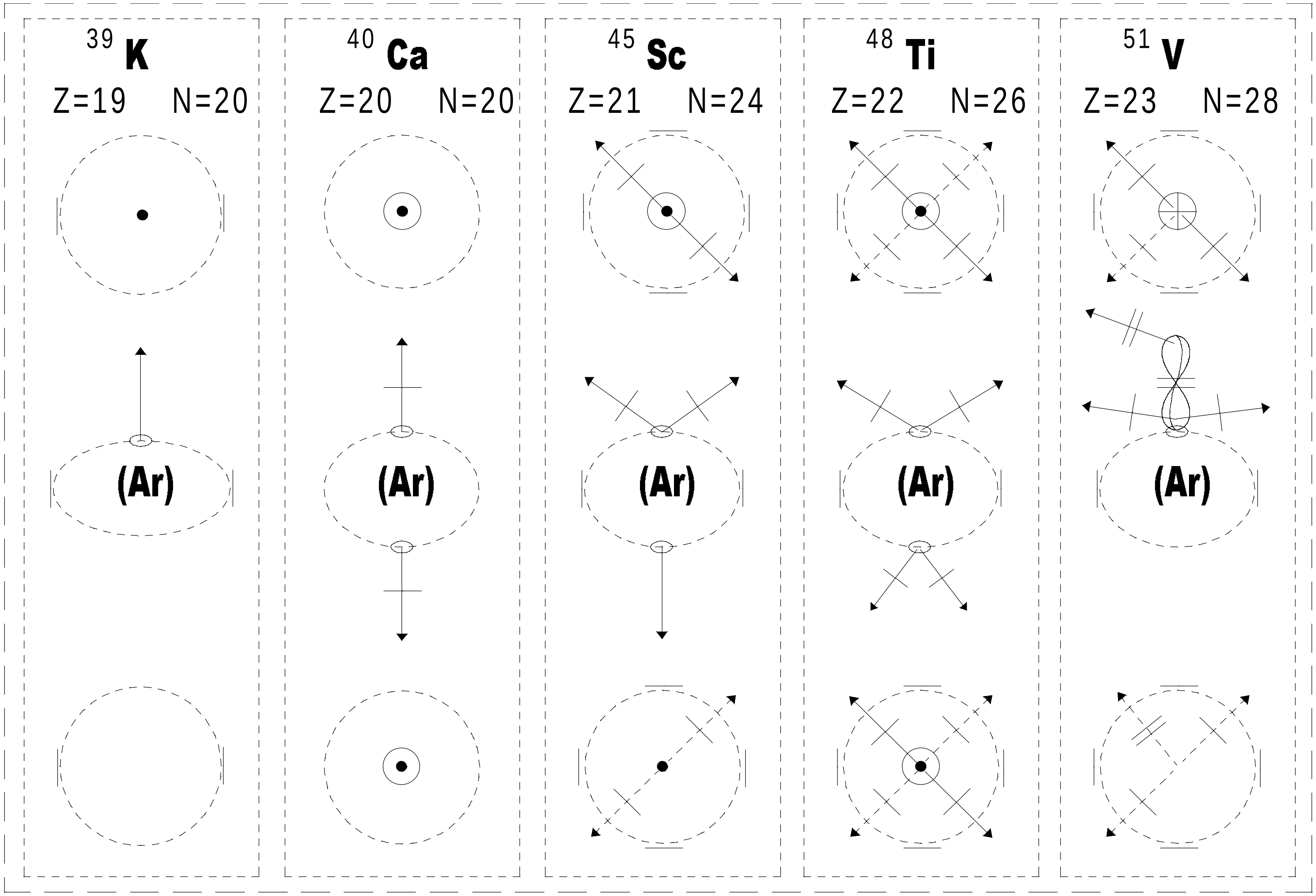
^{6}Li
Z=3 N=3
^{7}Li
Z=3 N=4
^{9}Be
Z=4 N=6
^{11}B
Z=5 N=6
^{12}C
Z=6 N=6
^{14}N
Z=7 N=7

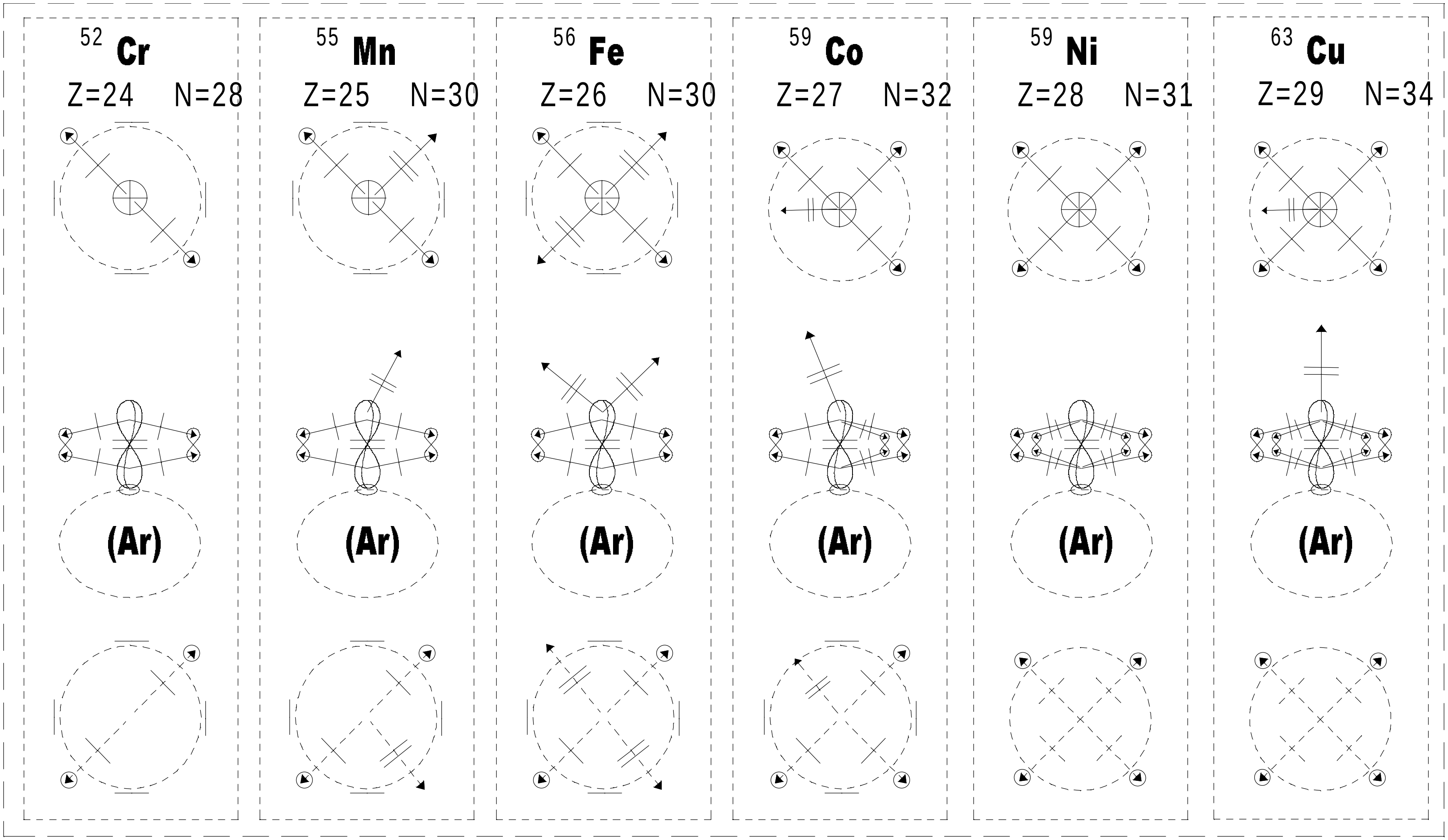


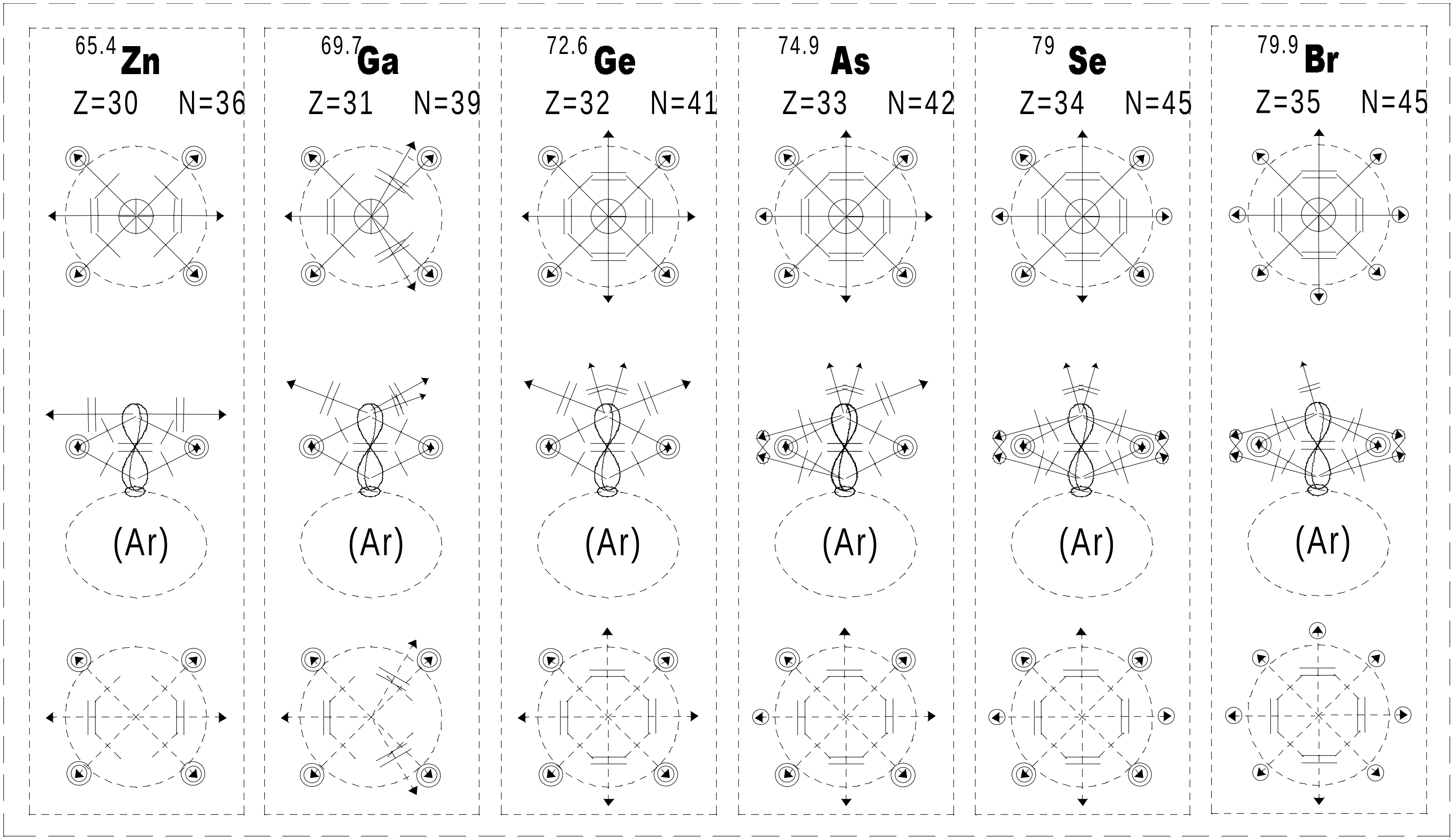
16 O
Z=8 N=8
19 F
Z=9 N=10
20 Ne
Z=10 N=10
23 Na
Z=11 N=12
24 Mg
Z=12 N=12
27 Al
Z=13 N=14



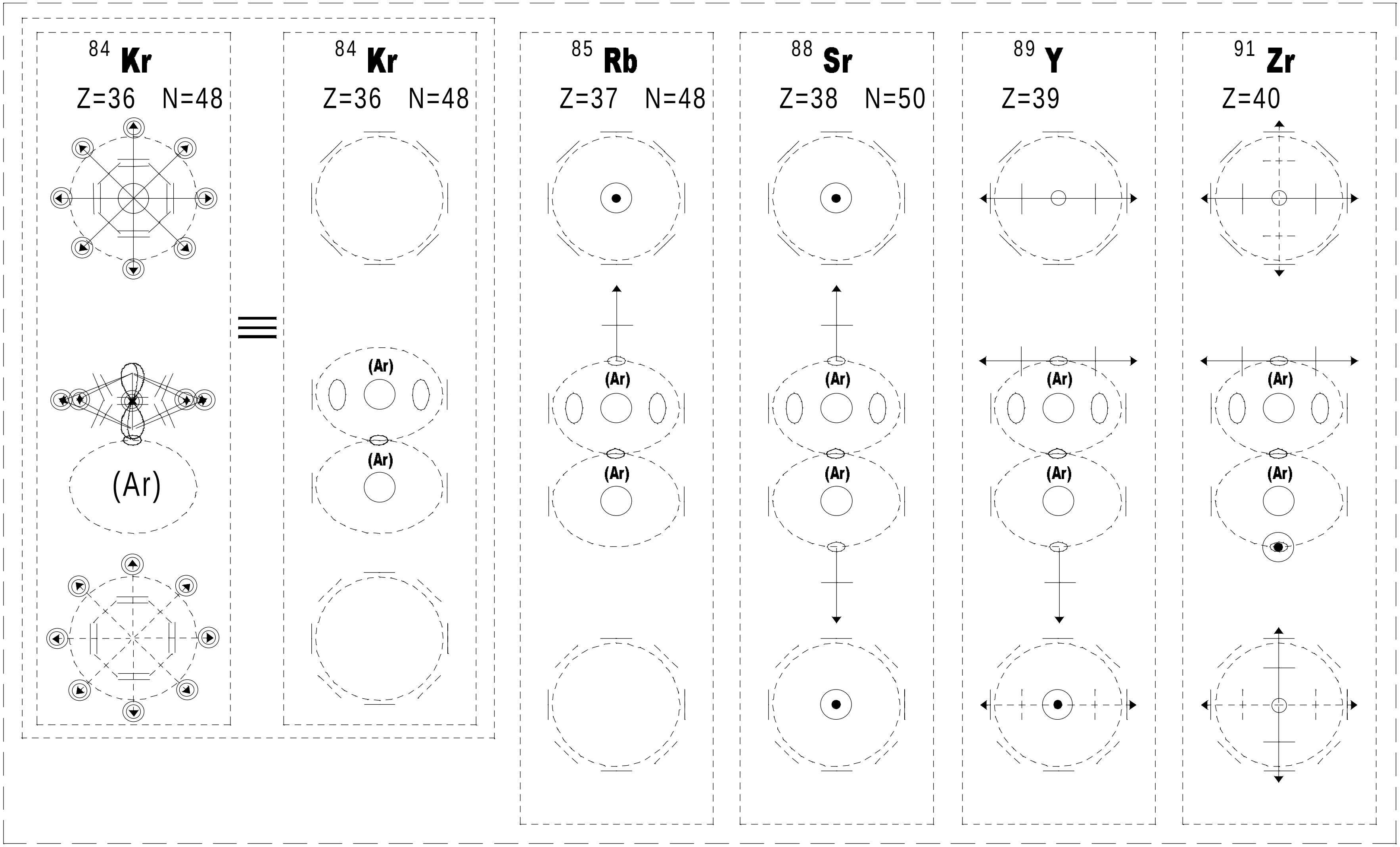
28 Si
Z=14 N=16
31 P
Z=15 N=16
32 S
Z=16 N=16
35 Cl
Z=17 N=18
40 Ar
Z=18 N=22
40 Ar
Z=18 N=22
(Ar)

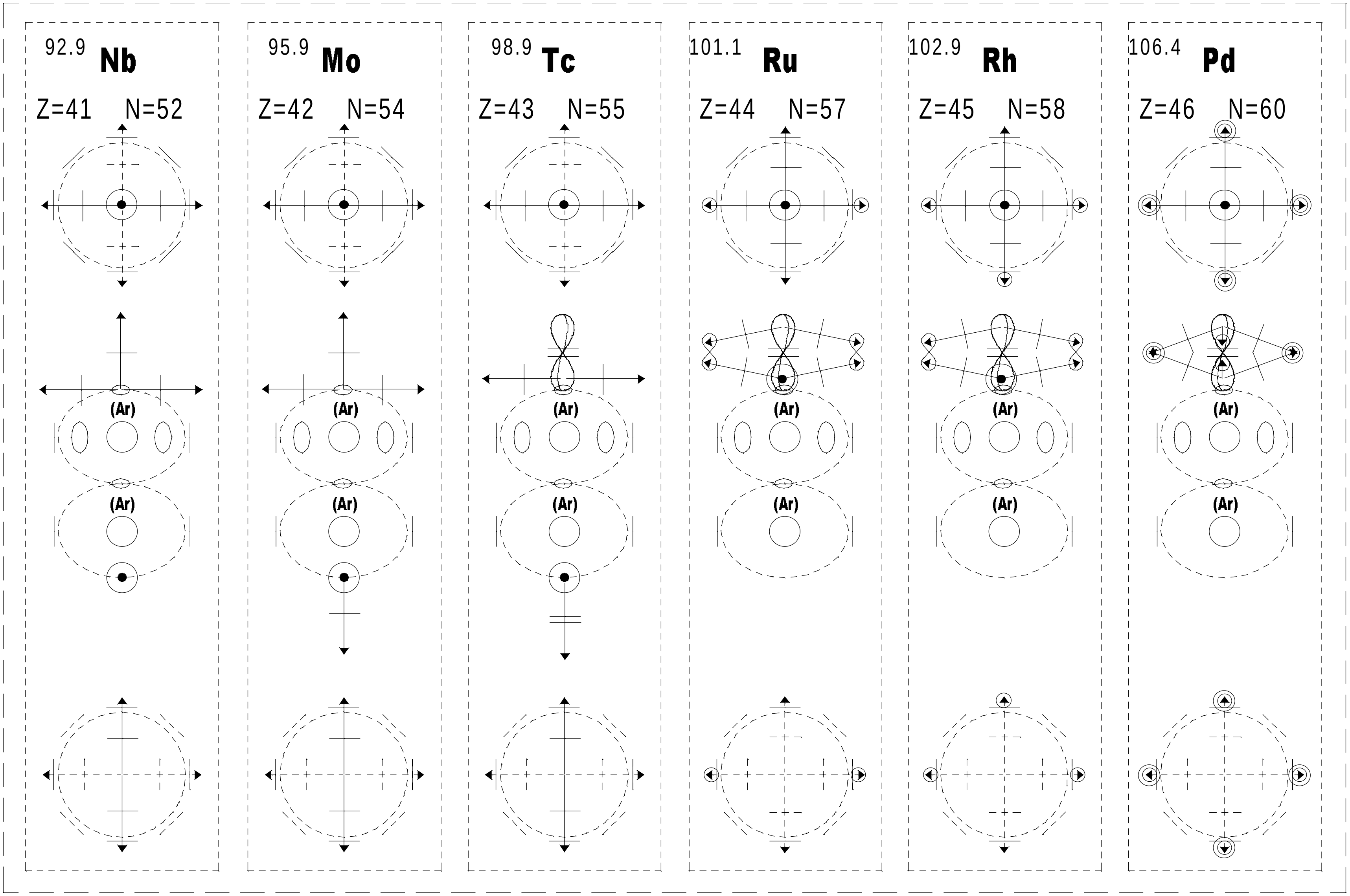

39 K
Z=19 N=20
(Ar)
40 Ca
Z=20 N=20
(Ar)
45 Sc
Z=21 N=24
(Ar)
48 Ti
Z=22 N=26
(Ar)
51 V
Z=23 N=28
(Ar)

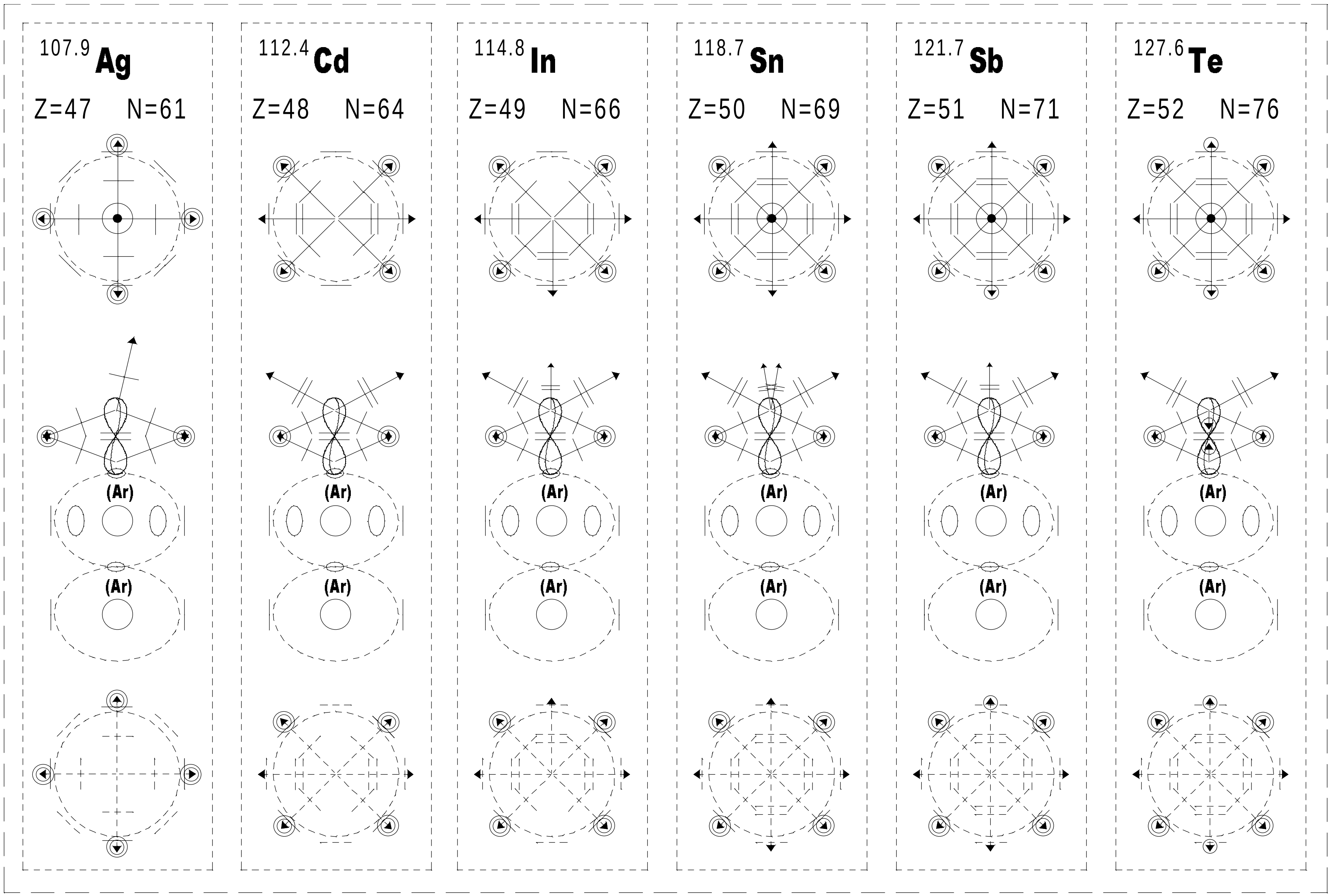

52 Cr
Z=24 N=28
(Ar)
55 Mn
Z=25 N=30
(Ar)
56 Fe
Z=26 N=30
(Ar)
59 Co
Z=27 N=32
(Ar)
59 Ni
Z=28 N=31
(Ar)
63 Cu
Z=29 N=34
(Ar)

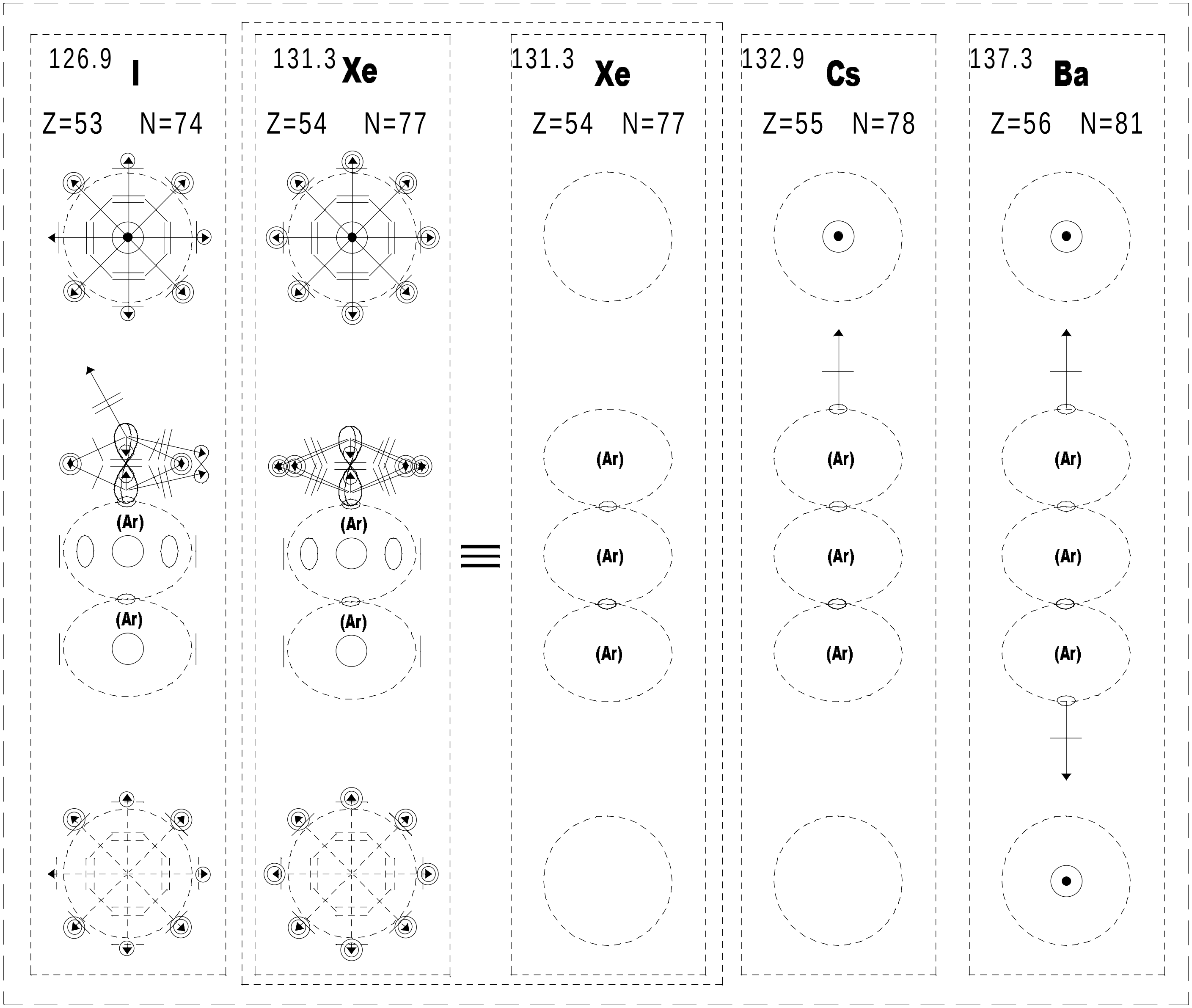


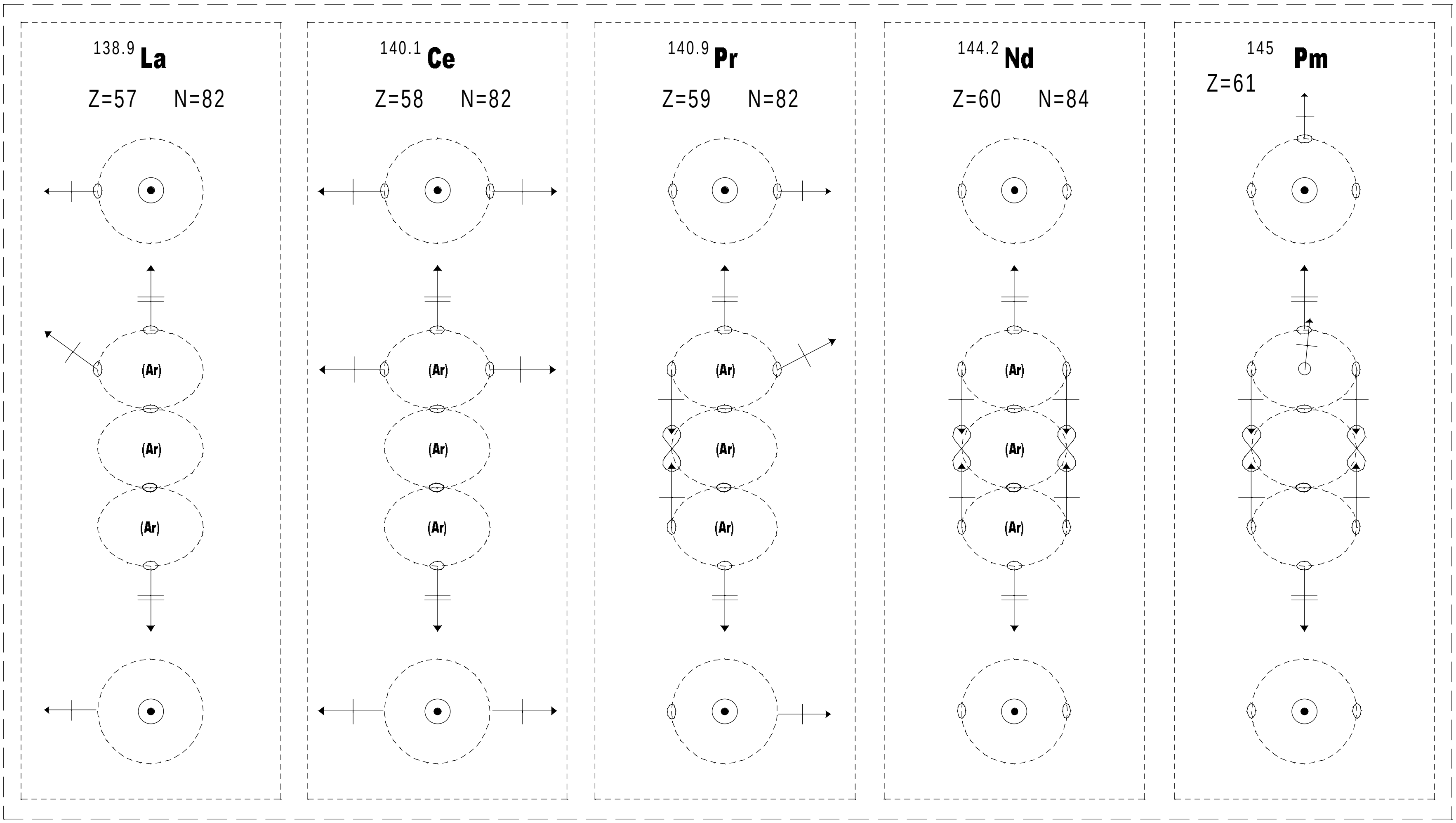
65.4 Zn
Z=30 N=36
(Ar)
69.7 Ga
Z=31 N=39
(Ar)
72.6 Ge
Z=32 N=41
(Ar)
74.9 As
Z=33 N=42
(Ar)
79 Se
Z=34 N=45
(Ar)
79.9 Br
Z=35 N=45
(Ar)


84 Kr
Z=36 N=48
(Ar)
84 Kr
Z=36 N=48
(Ar)
(Ar)
85 Rb
Z=37 N=48
(Ar)
(Ar)
88 Sr
Z=38 N=50
(Ar)
(Ar)
89 Y
Z=39
(Ar)
(Ar)
91 Zr
Z=40
(Ar)
(Ar)

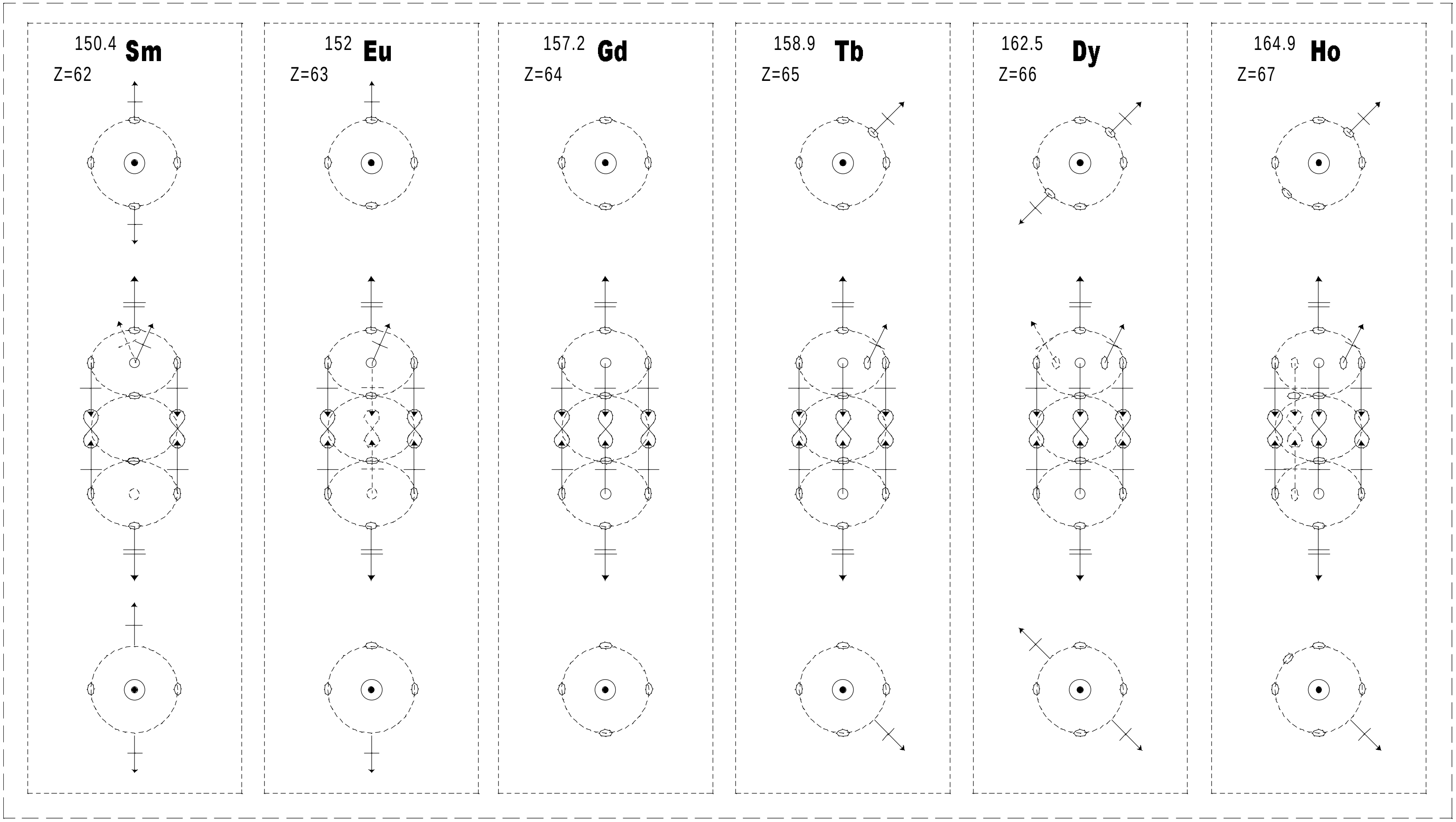

92.9 Nb
Z=41 N=52
(Ar)
(Ar)
95.9 Mo
Z=42 N=54
(Ar)
(Ar)
98.9 Tc
Z=43 N=55
(Ar)
(Ar)
101.1 Ru
Z=44 N=57
(Ar)
(Ar)
102.9 Rh
Z=45 N=58
(Ar)
(Ar)
106.4 Pd
Z=46 N=60
(Ar)
(Ar)

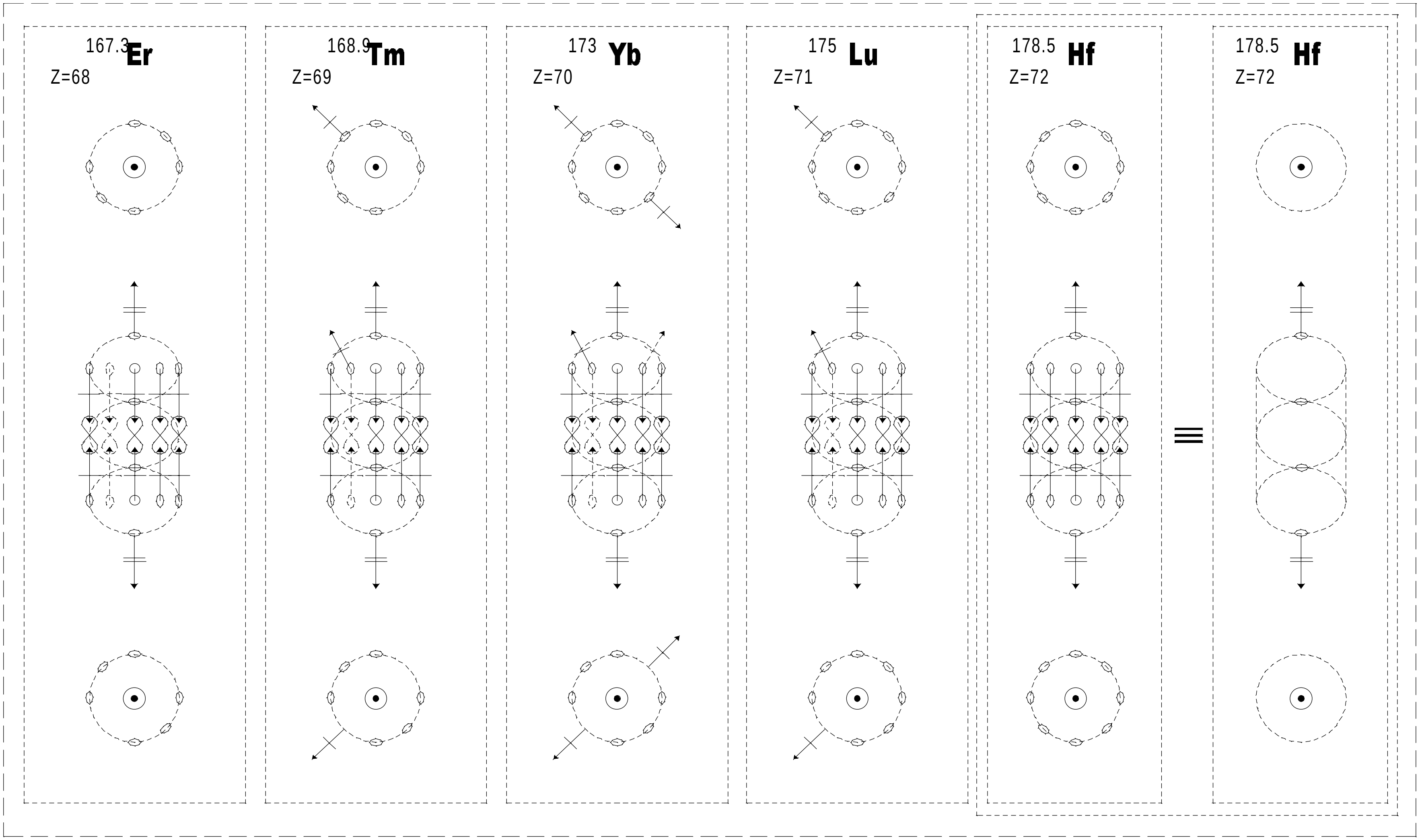

107.9 Ag
Z=47 N=61
(Ar)
(Ar)
112.4 Cd
Z=48 N=64
(Ar)
(Ar)
114.8 In
Z=49 N=66
(Ar)
(Ar)
118.7 Sn
Z=50 N=69
(Ar)
(Ar)
121.7 Sb
Z=51 N=71
(Ar)
(Ar)
127.6 Te
Z=52 N=76
(Ar)
(Ar)

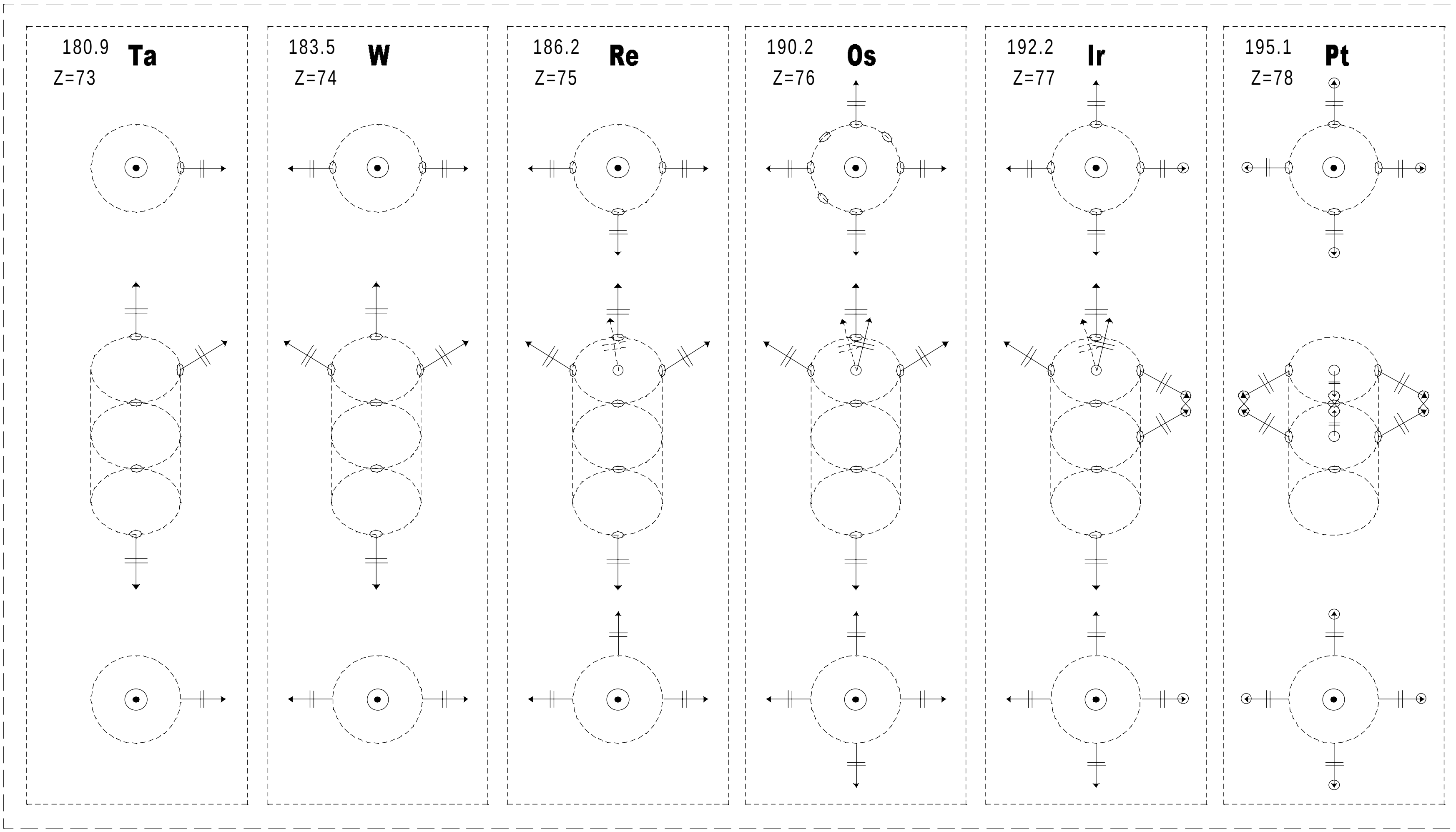

126.9 I
Z=53 N=74
(Ar)
(Ar)
131.3 Xe
Z=54 N=77
(Ar)
(Ar)
≡
131.3 Xe
Z=54 N=77
(Ar)
(Ar)
(Ar)
132.9 Cs
Z=55 N=78
(Ar)
(Ar)
(Ar)
137.3 Ba
Z=56 N=81
(Ar)
(Ar)
(Ar)

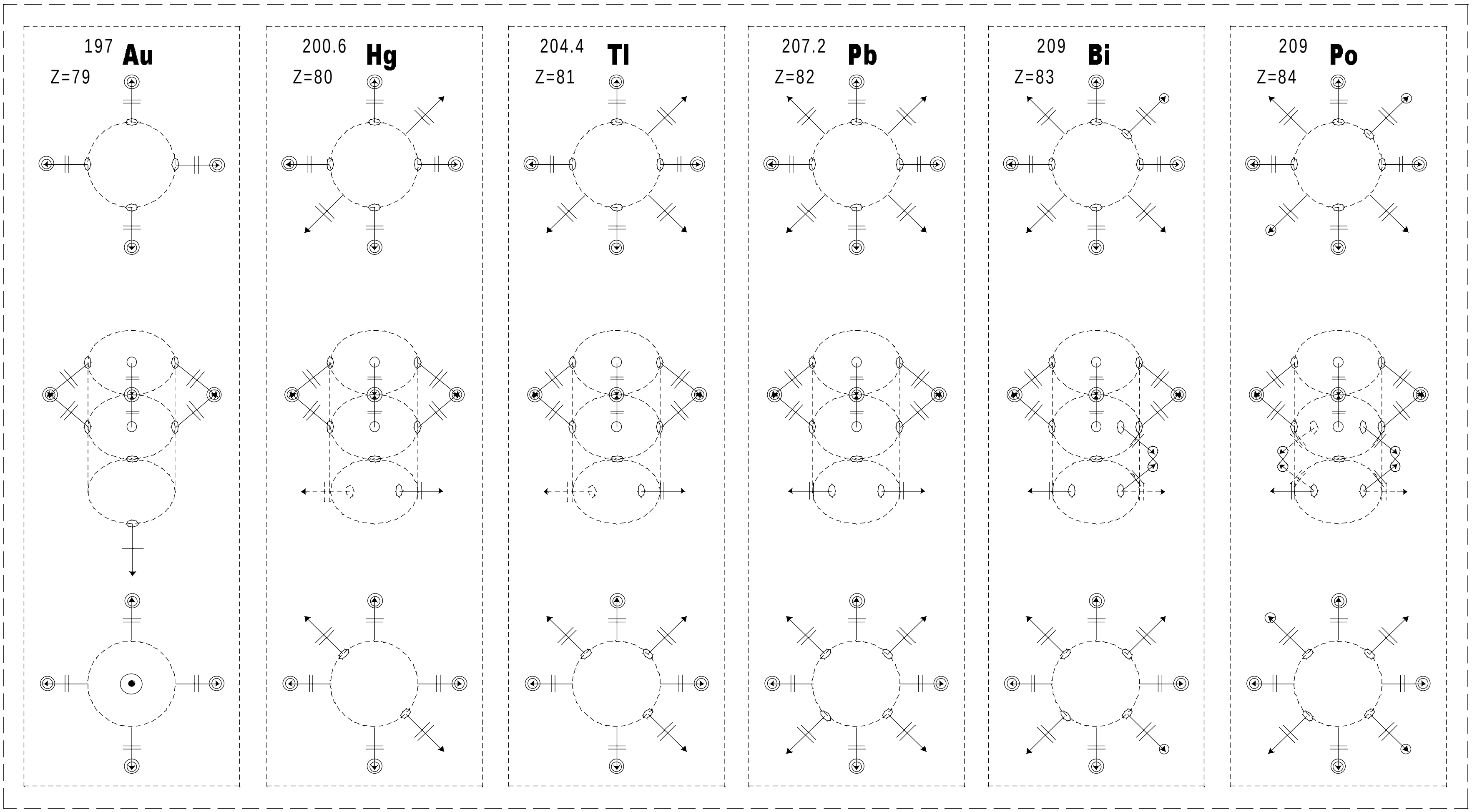


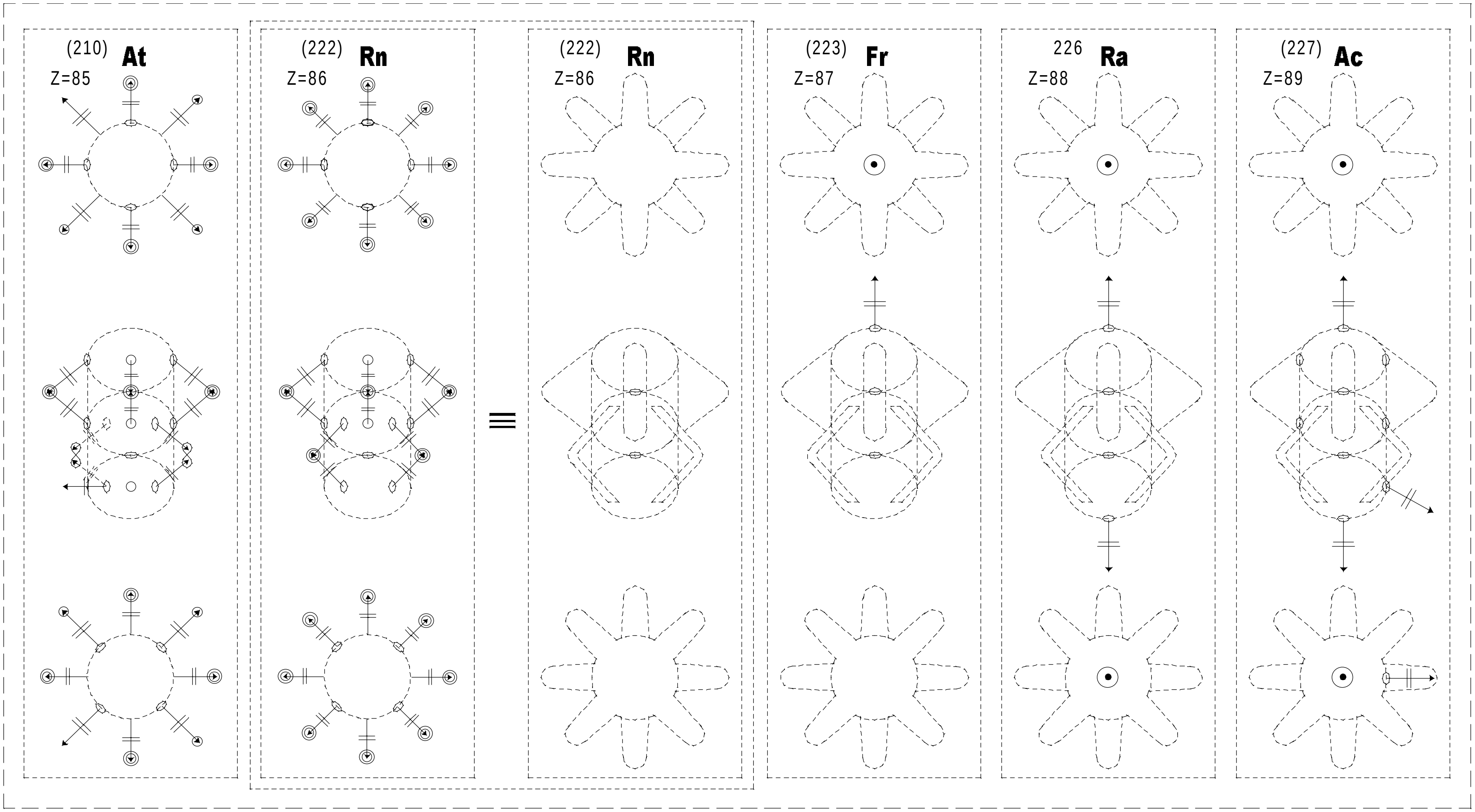
138.9 La
Z=57 N=82
(Ar)
(Ar)
(Ar)
140.1 Ce
Z=58 N=82
(Ar)
(Ar)
(Ar)
140.9 Pr
Z=59 N=82
(Ar)
(Ar)
(Ar)
144.2 Nd
Z=60 N=84
(Ar)
(Ar)
(Ar)
145 Pm
Z=61

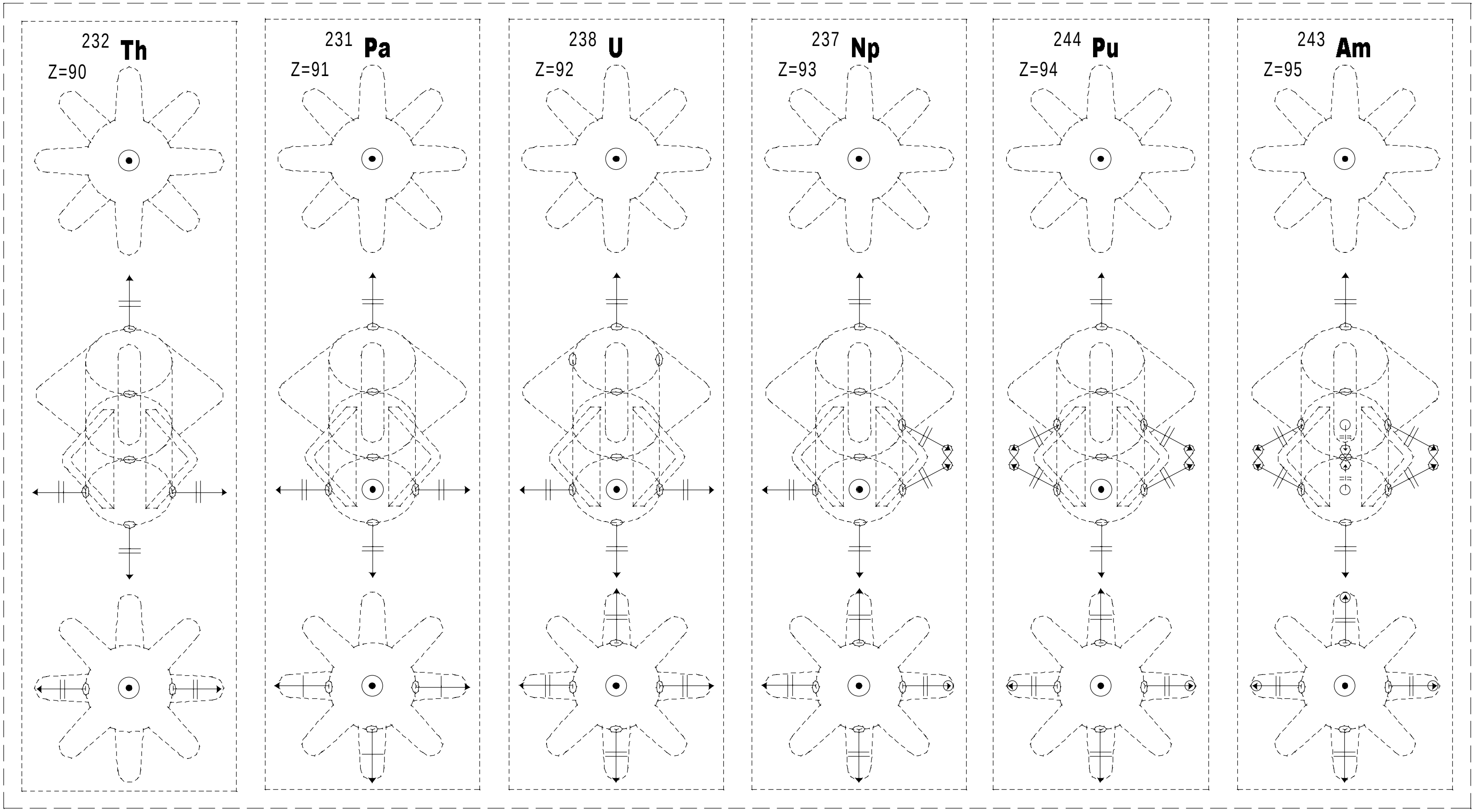

150.4 Sm
Z=62
152 Eu
Z=63
157.2 Gd
Z=64
158.9 Tb
Z=65
162.5 Dy
Z=66
164.9 Ho
Z=67

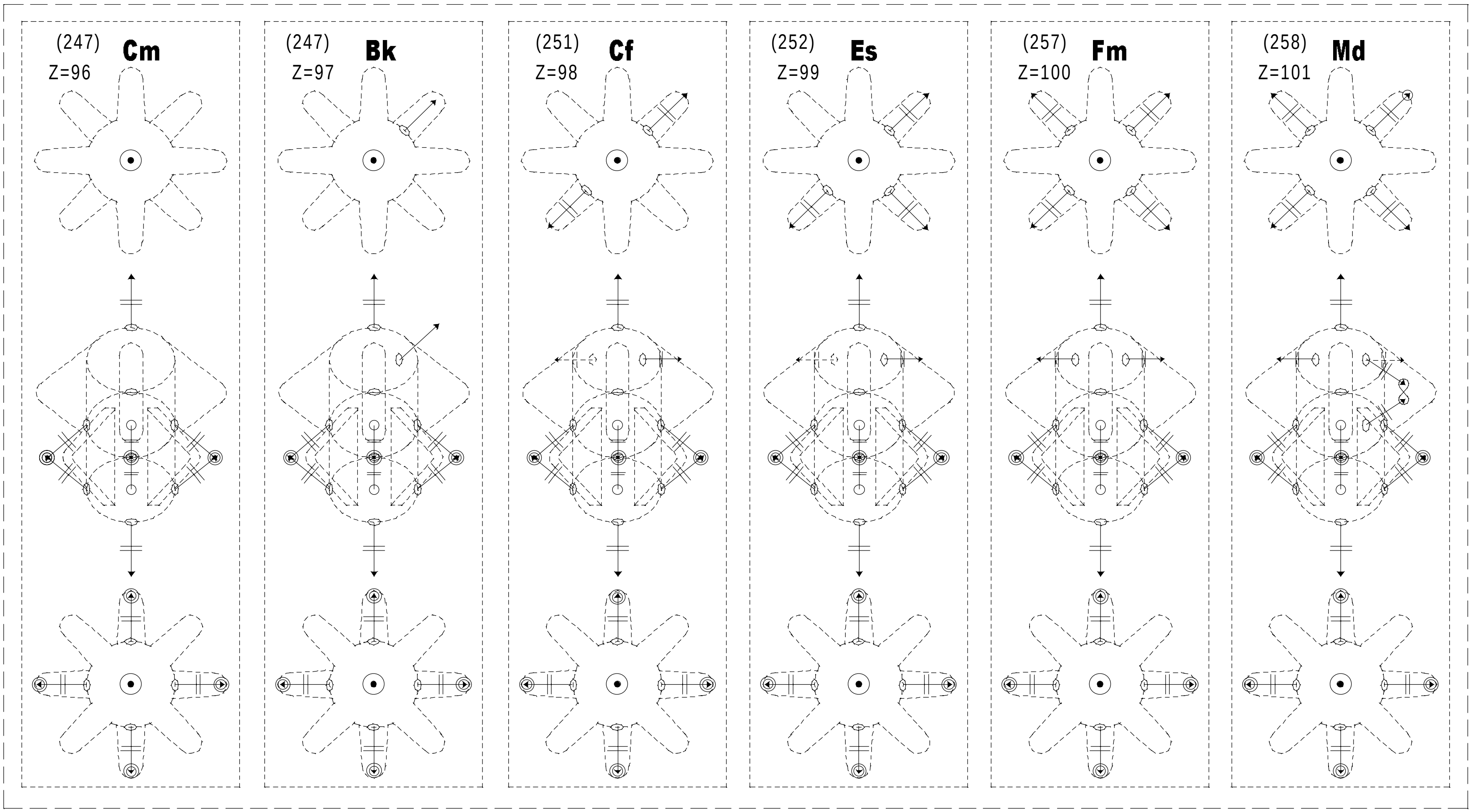

167.3 Er
Z=68
168.9 Tm
Z=69
173 Yb
Z=70
175 Lu
Z=71
178.5 Hf
Z=72
≡
178.5 Hf
Z=72

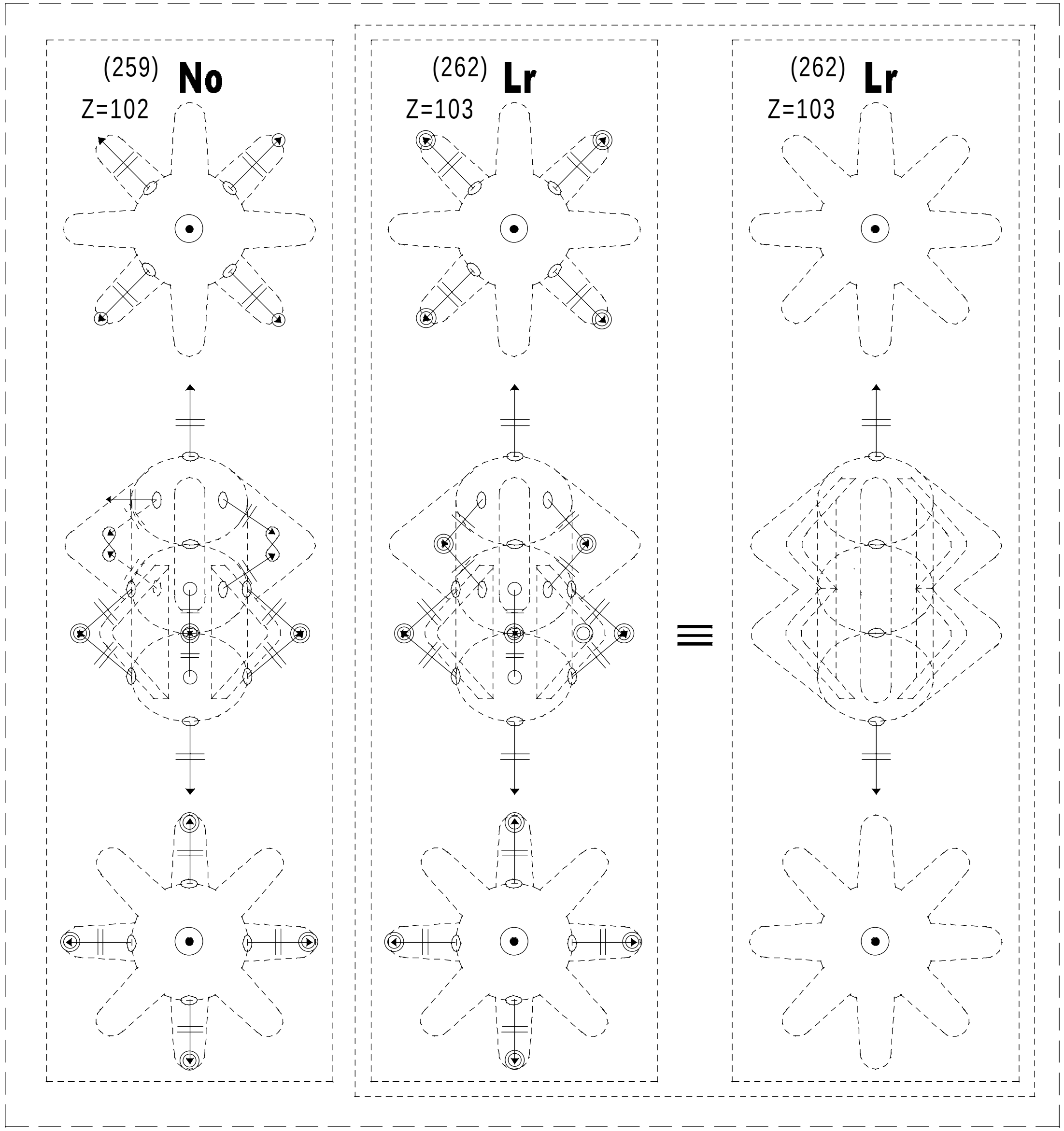

180.9 Ta
Z=73
183.5 W
Z=74
186.2 Re
Z=75
190.2 Os
Z=76
192.2 Ir
Z=77
195.1 Pt
Z=78


197
Au
Z=79
200.6
Hg
Z=80
204.4
Tl
Z=81
207.2
Pb
Z=82
209
Bi
Z=83
209
Po
Z=84

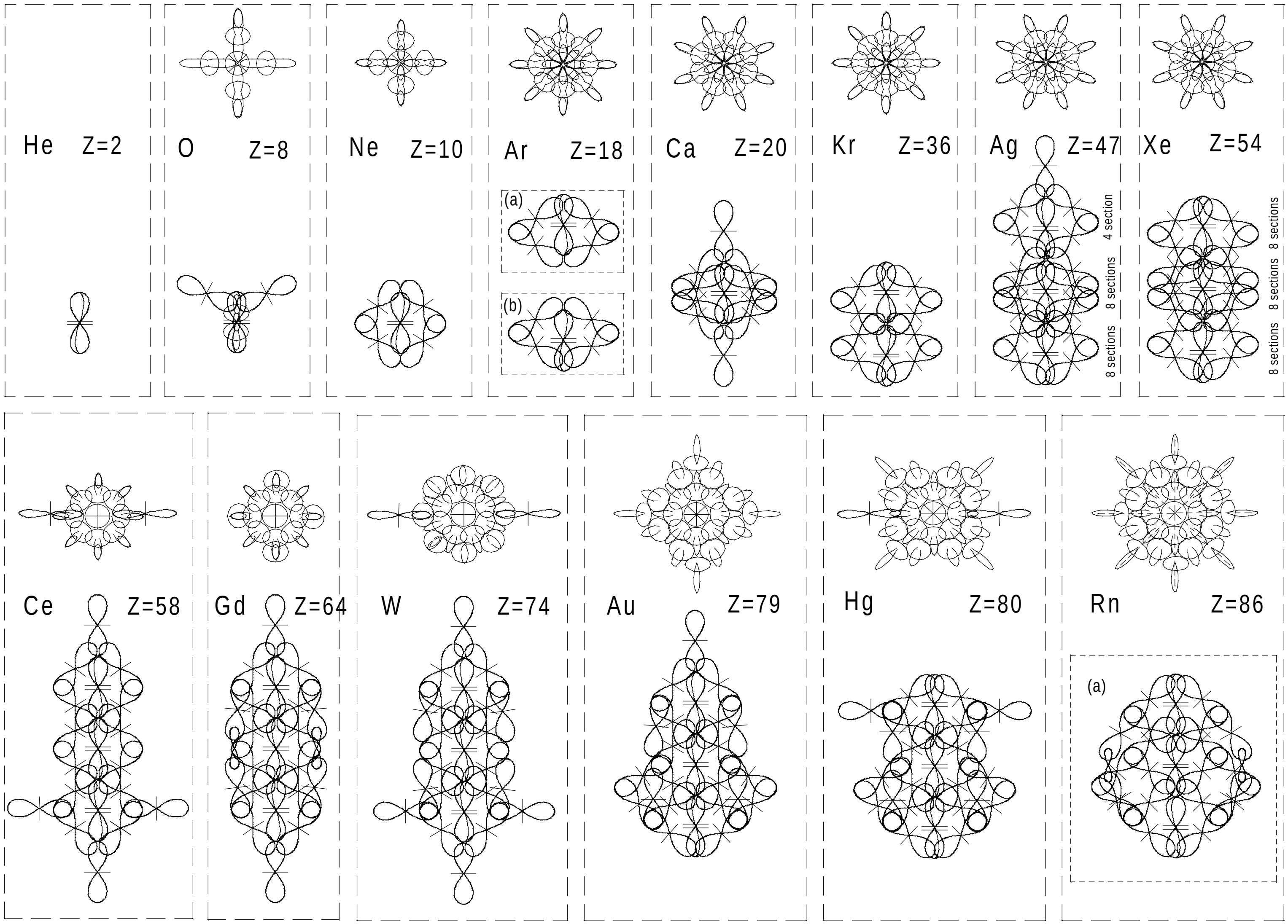

(210) At
Z=85
(222) Rn
Z=86
(222) Rn
Z=86
(223) Fr
Z=87
226 Ra
Z=88
(227) Ac
Z=89


232 Th
Z=90
231 Pa
Z=91
238 U
Z=92
237 Np
Z=93
244 Pu
Z=94
243 Am
Z=95


(247)
Cm
Z=96
(247)
Bk
Z=97
(251)
Cf
Z=98
(252)
Es
Z=99
(257)
Fm
Z=100
(258)
Md
Z=101


(259) No
Z=102
(262) Lr
Z=103
≡
(262) Lr
Z=103

BSM Atlas of Atomic Nuclear Structures Pojection views of selected elements



Note: (a) and (b) are polar sections of the nucleus with two selected planes. The angle between them is 22.5 deg

Periodic Table of atomic nuclear structures (according to BSM-SG)