The nuclei of atoms in Periods 4, 5, 6 and 7

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In my previous paper on " The nucleus of an atom and the periodicity of the elements" I showed that the nucleus of an atom represented by neutron–proton units in the form of truncated tetrahedra could be assembled to show the periodicity of elements as suggested by Mendeleev.[1] The concept was simple for Periods 1, 2 and 3 (namely all the elements from hydrogen to argon). Periods 4 and 5 had the added complexity of the ten transition elements and Period 6 had even more complexity with not only ten transition elements but also fourteen rare-earth elements. The following notes on Periods 4, 5 and 6 show that the nuclei of these elements can be extensions of the octahedral structure of the nuclei of atoms. Period 7, of which we have only a few examples on Earth, actinium to americium, can follow the same building up of 48 neutron–proton units over the large radon nucleus to the next inert gas element with atomic number 134.

1. More meditations on Periods 4 and 5 of the elements

As I considered the imperfections of the 18-group Periodic Table, which is found in so many textbooks, and the complete lack of symmetry of any solid object with 18 faces, the models of the nuclei of atoms indicated to me that there is an alternative way of studying the elements from argon (atomic number 18) to xenon (atomic number 54) that includes the elements below:

K^{19}	Ca^{20}	Sc^{21}	Ti^{22}	V^{23}	Cr^{24}	Mn^{25}	Fe^{26}	Co^{27}	Ni^{28}	Cu^{29}	Zn^{30}	Ga^{31}	Ge^{32}	As^{33}	Se^{34}	Br^{35}	$\mathbf{Kr^{36}}$
Rb^{37}	Sr^{38}	Y^{39}	Zr^{40}	Nb^{41}	Mo^{42}	Tc^{43}	Ru^{44}	Rh^{45}	Pd^{46}	Ag^{47}	Cd^{48}	In^{49}	Sn^{50}	Sb^{51}	Te^{52}	I^{53}	$\mathbf{Xe^{54}}$

Period 4 contains 18 elements, 8 of the normal groups I to VIII and 10 shown above—vanadium to germanium—but we could change this to 4 standard elements: Group II calcium (Ca), Group IV titanium (Ti), Group VI selenium (Se), and Group VIII krypton (Kr); and 14 other elements. 14 is the number of faces of a tetrakaidecahedron, which is the cubic unit in many solids. It packs perfectly and makes a better structure than equilateral cubes.

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4 elements on a tetrahedron

9	Ca^{20}		Ti^{22}												Se^{34}		**Kr^{36}**

14 elements on a tetrakaidecahedron

K^{19}		Sc^{21}		V^{23}	Cr^{24}	Mn^{25}	Fe^{26}	Co^{27}	Ni^{28}	Cu^{29}	Zn^{30}	Ga^{31}	Ge^{32}	As^{33}		Br^{35}	

Period 5 also contains eighteen elements and *could be* a repeat of Period 4 as shown in textbooks, but the alternative is to combine Period 4 with Period 5 making a total of 36 elements (18 elements from Period 4 plus 18 elements from Period 5) and these elements could be distributed as 4 on a tetrahedron and 32 on an octahedron; that is, 4 elements on each face of the octahedron. The 4 elements on a tetrahedron that are missing from the table below are Group II calcium, Group IV titanium, Group VI tellurium and Group VIII xenon:

K^{19}		Sc^{21}		V^{23}	Cr^{24}	Mn^{25}	Fe^{26}	Co^{27}	Ni^{28}	Cu^{29}	Zn^{30}	Ga^{31}	Ge^{32}	As^{33}	Se^{34}	Br^{35}	**Kr^{36}**
Rb^{37}	Sr^{38}	Y^{39}	Zr^{40}	Nb^{41}	Mo^{42}	Tc^{43}	Ru^{44}	Rh^{45}	Pd^{46}	Ag^{47}	Cd^{48}	In^{49}	Sn^{50}	Sb^{51}		I^{53}	

This arrangement for the xenon nucleus would be very symmetrical as is shown by modeling with 4 + 32 = 36 neutron–proton (n–p) units on the octahedral argon nucleus. This then makes Period 6, with 32 known elements, more obvious, and why the 14 rare earth elements are so different from one another, and this leads us to another table:

Period	Neutron–proton units in outer layer	Inert gas	Extra neutrons in the outer layer	Atomic weight	Atomic number
1	2	Helium	0	4	2
2	8	Neon	0	20	10
3	8	Argon	4	40	18
4	14[a]	Krypton	12	84	36
4 and 5	32[a]	Xenon	19	131	54
6	32	Radon	27	222	86

[a] Plus 4 neutron–proton units that are not in the outer layer.

Figure 1 shows the 14 faces of the tetrakaidecahedron with n–p units and 4 extra n–p units in white set in a tetrahedral arrangement for the krypton nucleus. The 8 faces of an octahedral model of the xenon nucleus is with 32 n–p units as 8 faces of 4 truncated tetrahedra on each face and 4 extra n–p units in white set in a tetrahedral arrangement.[2]

[2] Although the models show the extra n–p units externally they would be a better representation if they were between the argon nucleus and the outer shell, but then they would not be visible on the photograph!

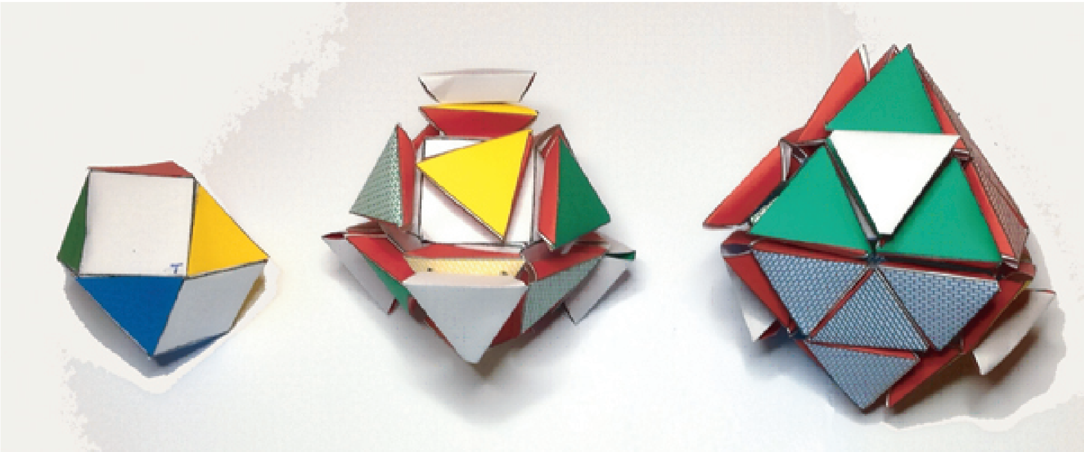

Figure 1. Periods 4 and 5 interpreted by a tetrakaidecahedron and an octahedron. **The left hand photograph** shows the tetrakaidecahedron, which is the most regular solid figure in the solid state of matter. All the edges are equal. The coloured triangular sides are those of an octahedron and the white square sides are those of a cube. **The central model** shows the tetrakaidecahedron with coloured n–p truncated tetrahedrons on all 14 sides and 4 white n–p truncated tetrahedrons on 4 sides of the octahedron set tetrahedrally. These white tetrahedrons should have been on the inside but then they would have been hidden from view. This is the model of a krypton nucleus. **The largest model** shows the octahedron of the xenon nucleus with 4 n–p coloured truncated tetrahedrons on the eight faces of an octahedron of the **argon** nucleus and 4 white n–p truncated tetrahedrons on the 4 sides of an octahedron set tetrahedrally. These white n–p units should be set on the inside but then they would be hidden from view. This is a model of the xenon nucleus.

2. The isotopes of plutonium

Isotope	Half-life /years	Particle emitted	Radiation emitted	Fission by slow neutrons
Pu-238	87	α		No
Pu-239	24 000	α	γ	Yes
Pu-240	6 500	α	γ	No
Pu-241	14	β	γ	Yes
Pu-242	376 000		γ	No

This table illustrates how the addition of just neutrons to the nucleus of an atom can radically change the properties of the nucleus without radically changing the chemical properties.[3] In this concept the nucleus is simpler and angular, whereas the electron cloud round the nucleus is more flexible. The nucleus has a much greater amount of energy stored within it than the electron cloud.

[3] The different properties of isotopes including their spectral emissions are described by F.W. Aston in *Mass Spectra and Isotopes*. London: Longmans, Green & Co. (1933).

The atom of an element is simpler than the molecule within which the atom is situated. The nucleus of the atom is simpler than the atom with its cloud of electrons. It contains neutrons and protons; the principal unit is a neutron with a proton in the form of a truncated tetrahedron and this will resonate with an electron in the surrounding cloud. Experimentally it would appear that the neutron and the proton are made up of mesons, ten of these to every neutron or proton. These mesons are simpler than either the proton or neutron.

Within the nucleus the neutron-plus-proton truncated tetrahedral units contain 20 mesons, but the extra neutrons that are not in these units are "worm-like" units filling in the gaps between the tetrahedral units. The "worm-like" neutrons will be made of 10 mesons. A free neutron not in a nucleus could be any shape. The idea that all subnuclear particles are spherical is misleading (even though they are usually shown as such in books and papers about nuclear physics).

The current high-energy physics assertion that there are many subnuclear particles is misleading. The concept of the present author is captured by the following progression:

Molecules contain many atoms of elements	→	Elements are restricted to about 100 types (hydrogen to actinides)	→	Isotopes of elements are restricted to less than 10 stable isotopes per element. The odd-weight isotopes appear to be important.	→	The nucleus of an atom contains three types of particle: neutrons and protons bound together in pairs, and extra neutrons of a different shape.	→	Neutrons and protons appear to be made up of 10 mesons each. Neutrons are charge neutral and protons have a single positive charge.

If one hits a brick with a hammer one obtains many pieces of brick, which one could classify individually but the effort would be nugatory. In high-energy nuclear physics equipment, nuclei are shattered and apparently many different fragments result, but in reality they are all built up of mesons. Suggesting myriads of diverse particles is, similarly, nugatory.

3. A table of the elements with only four groups

Mendeleev suggested a periodic table for the elements. There have been many suggestions for the representation[4] and one other classification is shown below:

Group 2 elements are all metals with, generally, a low valency.

Group 4 elements are rather flexible elements in their compounds.

Group 6 elements are generally associated with colour and smell; these elements usually have many valencies.

Group 8 elements are generally inert and frequently associated with the electrical and jewellery industries.

All the elements are individual, indeed all the isotopes are individual and the table below is only a general classification. It is more like the system of classification of plants and animals initiated by Linnaeus.

[4] For example, see Alper, R. The simplified periodic table: elements ordered by their subshells. *J. Biol. Phys. Chem.* **10** (2010) 74–80 and Scerri, E. Some comments on the recently proposed periodic table featuring elements ordered by their subshells. *J. Biol. Phys. Chem.* **12** (2012) 69–70.

Atomic number	Group 2 including Group 1	Group 4 including Group3	Group 6 including Groups 5 & 7	Group 8
1, **2**	H			He
3–**10**	Li, Be	B, C	N, O, F	Ne
11–**18**	Na, Mg	Al, Si	P, S, Cl	Ar
19–29	K, Ca	Sc, Ti, V	Cr, Mn, Fe	Co, Ni, Cu
30–**36**	Zn, Ga, Ge		As, Se, Br	Kr
37–47	Rb, Sr	Y, Zr, Nb	Mo, Tc, Ru	Rh, Pd, Ag
48–**54**	Cd, In, Sn		Sb, Te, I	Xe
55–56	Sr, Ba			
57–65	La, Ce, Pr	Nd, Pm, Sm	Eu, Gd, Tb	
66–71	Dy, Ho, Er	Tm, Yb, Lu		
72–79		Hf, Ta	W, Re, Os	Ir, Pt, Au
80–**86**	Hg, Tl, Pb		Bi, Po, At	Rn
87–88	Ac, Ra			
89–106	16 actinides	2 new		
107–**134**	14 new rare earth type	2 new	10 transition type	2 new