

The Archetypes of Mendeleev's Periodic Law of Elements

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Premise



The work is an illustrative continuation of Wolfgang Pauli's idea about archetypes in modern science, about the symbols that have a dual function: pre-scientific (religious, mythical, ornamental, etc.) and scientific in the modern sense of the word. Pauli in his arguments relied on the work of Plato, Johann Kepler, Carl Gustav Jung.

1. Archetypes

One of the creators of quantum mechanics Wolfgang Ernst Pauli wrote: "The process of understanding nature as well as the happiness that man feels in understanding – that is, in the conscious realization or new knowledge – seems thus to be based on a correspondence, a "matching" of inner images pre-existent in the human psyche with external objects and their behavior. This interpretation of scientific knowledge, of course, goes back to Plato and is, as we shall see, advocated very clearly by Kepler... These primary images, which the soul can perceive with the aid of an innate "instinct," are called by Kepler archetypal. Their agreement with the "primordial images" or archetypes introduced into modern psychology by C. G. Jung and functioning as "instincts of imagination" is very extensive... A true spiritual descendant of the Pythagoreans, ... he attached the utmost importance to geometric claiming that its theorems "have been in the spirit of God since eternity". His basic principle was "Geometria est archetypus pulchritudinis mundi" (Geometry is the archetype of the beauty of the world)." [2]

2. Priori of knowledge

Pauli notes that one must guard against

transferring this *priori* of knowledge into the conscious mind and relating it to definite ideas capable of rational formulation.

My work is a humble attempt to transfer “this *a priori* of knowledge into the conscious mind”. Geometric forms proposed for consideration are those that “had simultaneously a religious and a scientific function” in the past and could serve as “spontaneous images” to visualize the periodic law of elements.

2.1 Pythagoreans and Figurate numbers

The mathematical study of figurate numbers is said to have originated with Pythagoras, possibly based on Babylonian or Egyptian precursors. The fourth triangular number of ten objects, called tetractys in Greek, was a central part of the Pythagorean religion. Figurate numbers were a concern of Pythagorean geometry. To generate any class of figurate numbers, Pythagorean used gnomons. The connotation of the term *gnomon* is that originally given by Hero of Alexandria, namely, 'A Gnomon is that form that, when added to some form, results in a new form similar to the original.

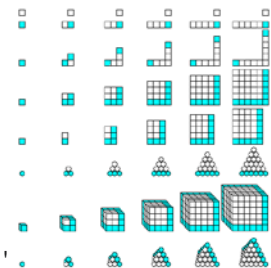


Fig.2 Some figures and their gnomons.

2.3 Plato and mathematics

While not a mathematician, Plato was considered an accomplished teacher of mathematics. Like the Pythagoreans he believed the mystery of the world to be contained in number.

There is the dualism or opposition between the ideal and the actual – the soul is prior to the body, the intelligible and unseen to the visible and corporeal.

In the dialogue *Timaeus* Plato associated each of the four classical elements (earth, air, water, and fire) with a regular solid (cube, octahedron, icosahedron, and tetrahedron respectively) due to their shape, the so-called Platonic solids. The fifth regular solid, the dodecahedron, was supposed to be the element which made up the heavens.



Fig.1 Platonic solids.

All of these shapes are made of triangular grid. Therefore triangle can be regarded as an atomic element in Democritean sense.

2.4 Kepler

“For the purpose of illustrating the relationship between archetypal ideas and scientific theories of nature, Johannes Kepler (1571-1630) seemed to me (W. Pauli) especially suitable, since his ideas represent a remarkable intermediary stage between the earlier, magical-symbolical and the modern, quantitative-mathematical descriptions of nature.” [2]



Fig.3 Kepler's Platonic solid model of the Solar System (1596).

3 Variety of Periodic Law Archetypes

The key archetype, in our opinion, is the concept of the square and its gnomon. This is due to the well-known fact that the electron filled shell contains $2n^2$ electrons, and the number of electrons on the subshell is twice the odd number — the gnomon of the square.

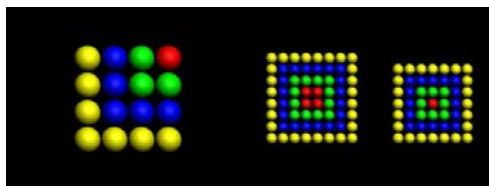


Fig.4 Squares (two-dimensional objects) and gnomons of square (one-dimensional objects).

3.1 Line

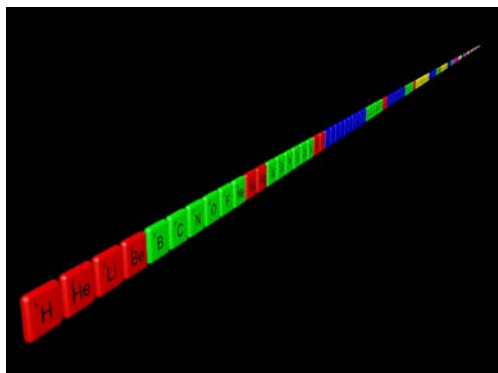


Fig.5 Line - beads, rosary, chain – 1D object.

3.2 Grille



H	He																	B	C	N	O	F	Ne																						
Li	Be											Al	Si	P	S	Cl	Ar																												
Na	Mg											K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Pb	Tl	Po											
Cs	Ba	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No
Fr	Ra	U	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og																												

Fig.6 The common modern table. The established tradition is to divide the table into lines and columns.

3.3 Spiral

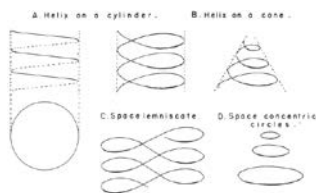


Fig.7 From Edward G. Mazurs Collection of Periodic Systems Images.

3.3.1 The Phyllotactic Periodic Table of elements

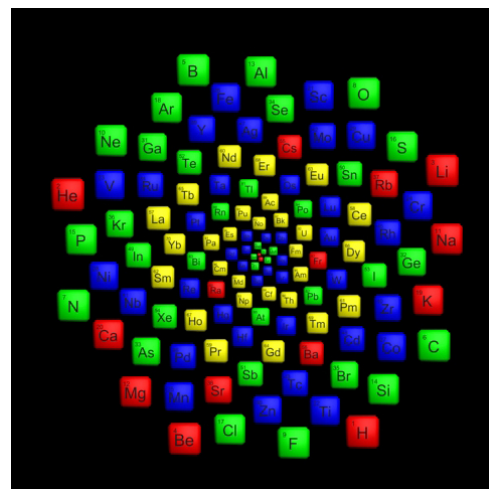


Fig.8 The distribution of elements on a sunflower head pattern. The charge of atom nucleus corresponds to the age of the seed in the collective fruit. (author's model).

3.4 Shells



Fig.9 Any multiple shell object.

3.5 Pyramid

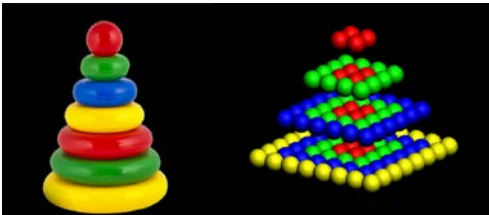


Fig.10 Every next layer of the pyramid is its gnomon. An addition maintains self-similarity.

3.6 Platonic solids

3.6.1 Octahedron

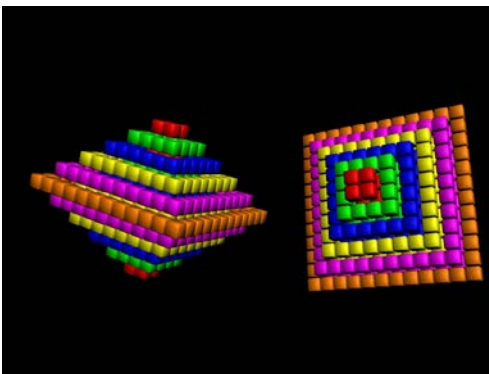


Fig.11 Octahedron (author's model).

3.6.2 Gnomons of Tetrahedron

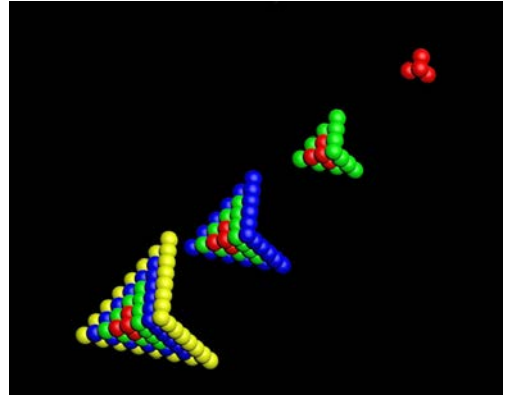


Fig.12 Bended squares as gnomons of Tetrahedron.

3.6.3 Tetrahedron

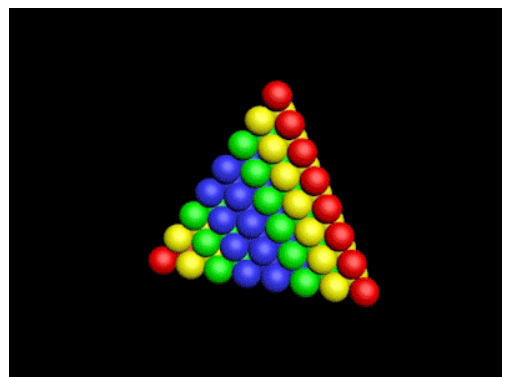
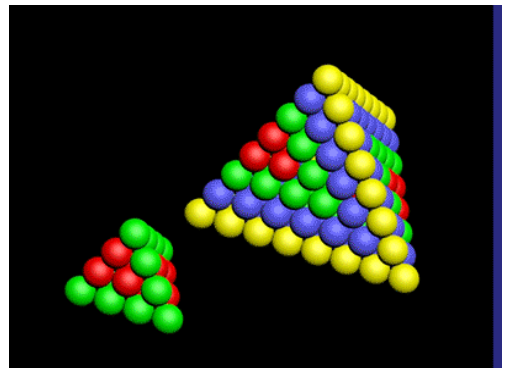


Fig.13-14 Tetrahedron (author's models).

These models were made even before I became acquainted with the works of Pierre Demers. Apparently, the priority of creating a tetrahedral table and pyramidal shapes on a quadrangular base (Fig.10 on the right) - one large pyramid 120 and four pyramids 30 - belongs to this amazing Canadian scientist. Pierre Demers left this world in 2017 at the age of 102. I'm sorry I didn't get in touch with him.

I see the novelty of my work today in the idea of a *gnomonal* construction of a table in the context of the Pythagorean figurate numbers approach.

3.7 Triangle

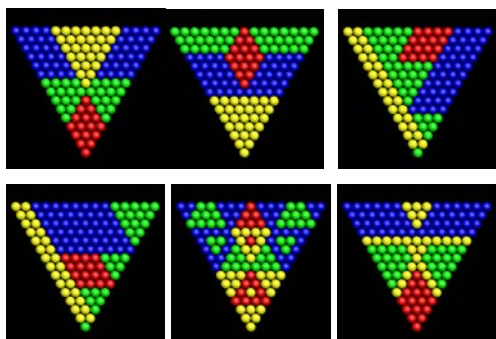


Fig. 15 By happy coincidence, 120 is a tetrahedral and a triangular number at the same time.

3.8 The tables built on the motifs of ornaments

The tables of the periodic law built on the motifs of ancient folk and modern ornaments take a special place. They include not only geometric archetypes, but also magic-symbolic, cultural and religious archetypes of the collective unconscious. Note that the periodic law table, built on the basis of the Native American ornament, surpasses the modern Mendeleev table in the

parameter reflecting quantum numbers in its structure.

3.8.1 Ancient folk ornament Octagonal star



Fig. 16 A pillow with Octagonal star.

Octagonal star as ornament motif appeared before the birth of Christianity. This symbol (Alatyr, Svarog's Cross, Vasmirog) remained in ethnic religion and ancient patterns predominantly of Slavic, Finno-Ugrian, and Turkic peoples.

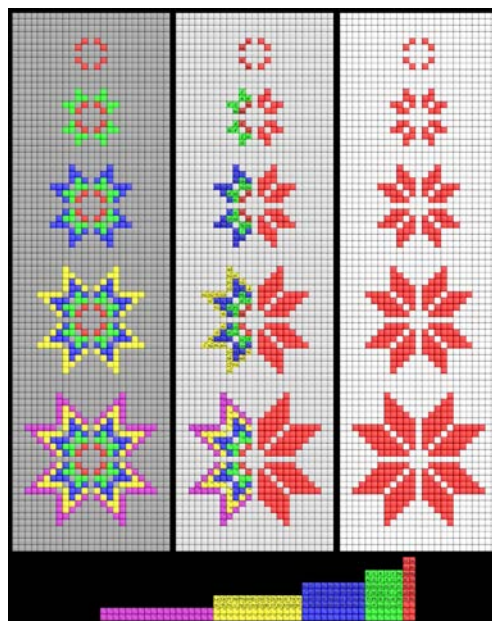


Fig.17 The table of the Periodic law built on the motif of Octagonal star.

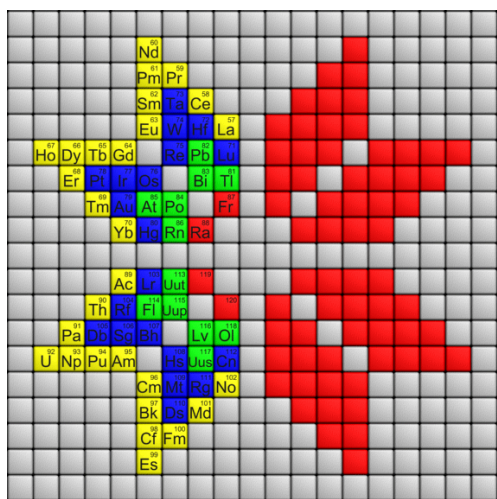


Fig.18 The detail of the above figure: 7-8 periods.

3.8.2 Native American Indian ornamental Periodic Table



Fig.19 Ancient Native American Indian ornament.

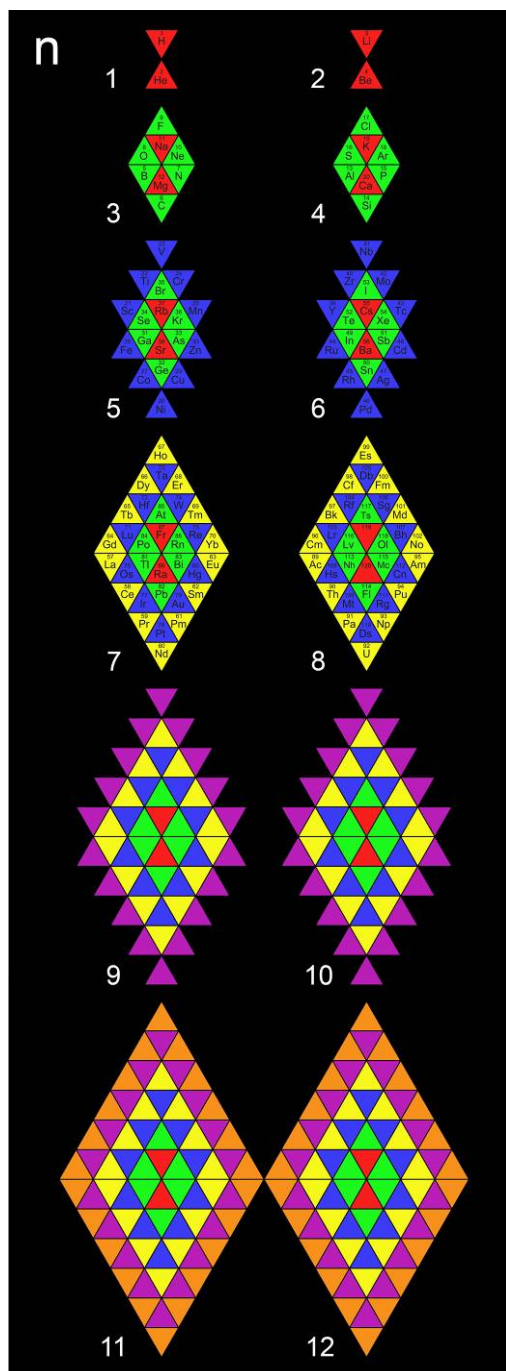


Fig.20 The principal quantum number n designates the principal electron shell.

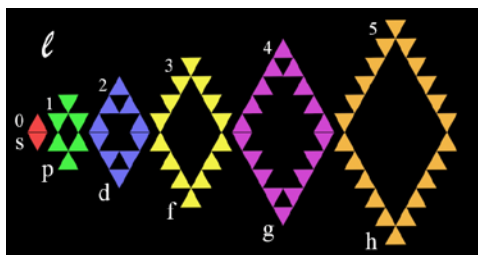


Fig.21 The orbital angular momentum quantum number l determines the shape of an orbital.

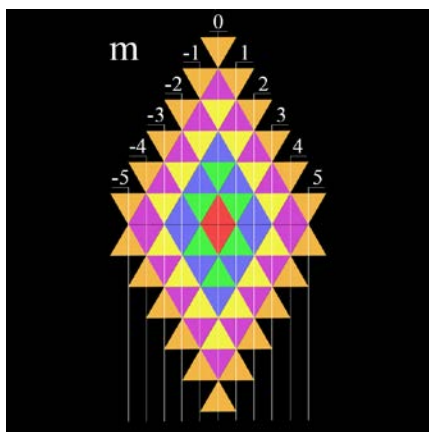


Fig.22 The magnetic quantum number m_l determines the number of orbitals and their orientation within a subshell.

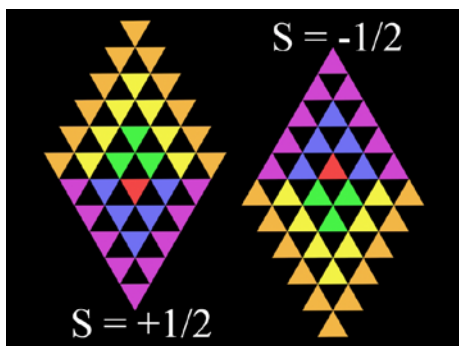


Fig.23 The electron spin quantum number m_s designates the direction of the electron spin.

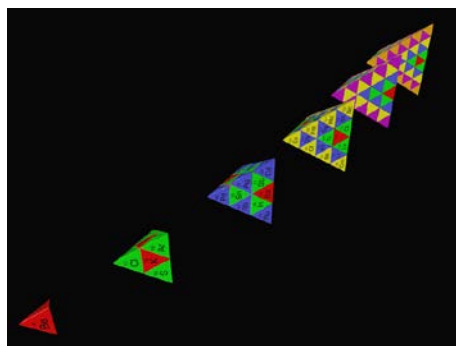


Fig.24 The Tetrahedral Periodic Table based on Native American Ornament

3.8.4 Ancient and Modern Patchwork Patterns



Fig.27 The Projection of Periodic Law on the patchwork ornament.

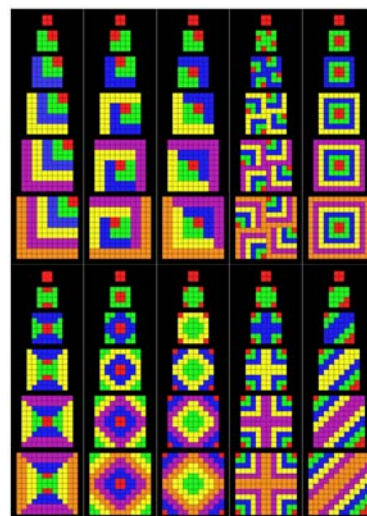


Fig.28 Ancient and Modern Patchwork Patterns

3.9 The tiles on the pavement

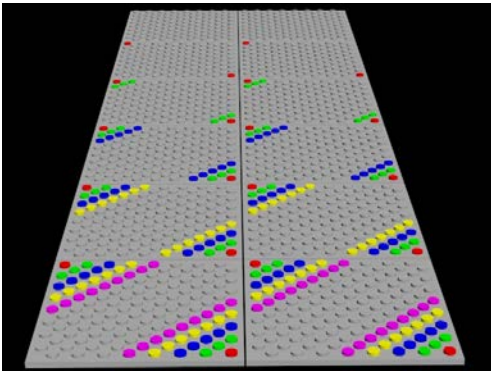


Fig.29 The projection of Periodic Table on the pavement tiles.

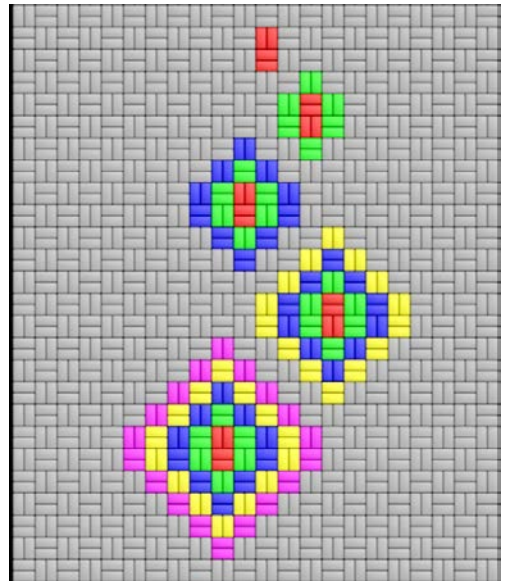


Fig.30 The projection of Periodic Table on the pavement tiles.

3.10 An architectural example from nuclear physics

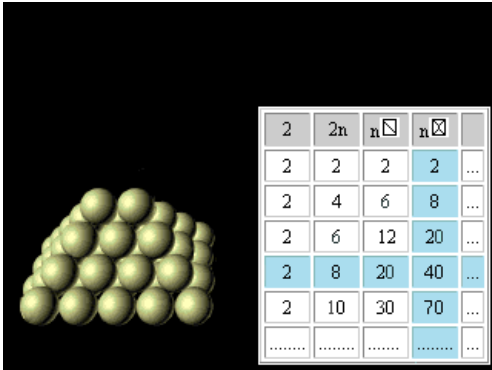


Fig.25 Oblong pyramidal numbers for atom nucleus and its gnomons



Fig.26 Oblong pyramid in ancient architecture.

3.11 Periodic Law archetype in painting

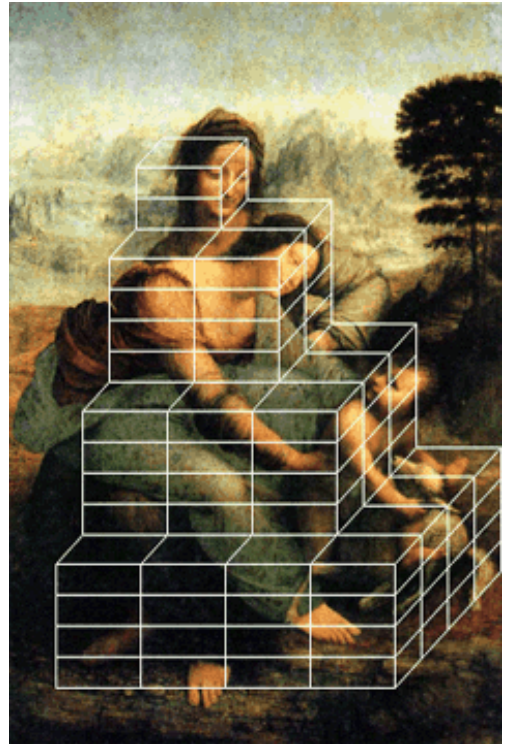


Fig.31 Leonardo da Vinci. *Madonna and Child with St Anne*. c. 1510. Oil on wood, 168 x 130 cm. Musée du Louvre, Paris

"An example of using a pyramidal composition in combination with a technique *Mise en abîme* .

In Western art history, *Mise en abîme* is a formal technique of placing a copy of an image within itself, often in a way that suggests an infinitely recurring sequence. In film theory and literary theory, it refers to the technique of inserting a story within a story.

3.12 Periodic Law archetype in literature

Shells	Subshells	This is the house that Jack built
K	s	This is the house that Jack built.
L	p	This is the malt that lay in
	s	the house that Jack built.
M	d	This is the rat that ate
	p	the malt that lay in
	s	the house that Jack built.
N	f	This is the cat that killed
	d	the rat that ate
	p	the malt that lay in
	s	the house that Jack built.
O	g	This is the dog that worried
	f	the cat that killed
	d	the rat that ate
	p	the malt that lay in
	s	the house that Jack built.

Fig.32 Conformity of filling of electron shells to some children's literary works by the example of a poem "This Is The House That Jack Built". The structural principle is repetition with addition.

4 Periodic system for kids

Our view on the symbolic representation of the Dmitri Ivanovich Mendeleev's Periodic Law of elements suggests a new approach to teaching chemistry and physics as academic courses.

The teaching is divided into two stages. At the first stage, which, according to Jung, can be called *subconscious*, the child at the sensual level is introduced to the geometric archetypes of Periodic Law. Educational games with cubes, balls, pyramids, mosaics, coloring, constructors, beadwork, kirigami, modeling et cetera in an entertaining and safe form will not only strengthen the intellect, but also prepare the child for the second, conscious stage of obtaining

academic knowledge. This *conscious stage* for the vast majority of students is very painful and difficult to pass now. Thus, the age threshold for the beginning of chemistry and quantum physics studying will be reduced from 14 to 1.5 – 3 years old

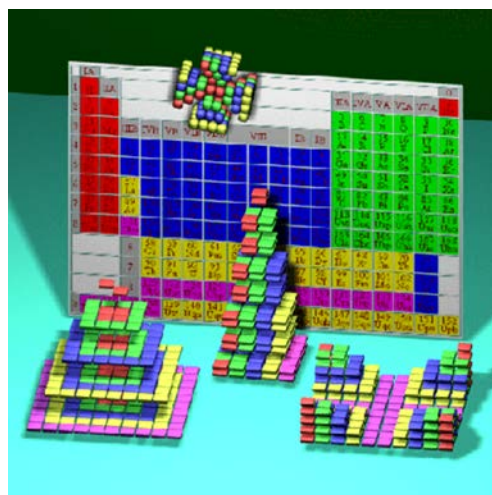


Fig.33 Periodic system for kids.

References

- [1] Plato, "Timaeus" <http://classics.mit.edu/Plato/timaeus.html>
- [2] Pauli, W.E. (1948) "The Influence of Archetypal Ideas on the Scientific Theories of Kepler" <https://ru.scribd.com/document/45712272/The-Influence-of-Archetypal-Ideas-on-the-Scientific-Theories-of-Kepler>.