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Arrangement of chemical elements in the three-dimensional matrix

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ABSTRACT: It is emphasized in the article that thanks to the discovery of D.I. Mendeleev and the Periodic Table of chemical elements existing for more than 150 years, as well as the international table IUPAC, chemistry has been actively developing and keeps developing. A new model for arranging chemical elements in the form of a three-dimensional matrix has been proposed. This makes it possible to predict new elements with the designation of nuclear masses and the electronic structure of shells. There have been developed new patterns according to the cyclicity (block structure) of horizontal rows and the structure of vertical groups and their physical conception have been specified.

KEYWORDS: cyclicity and block structure, three-dimensional matrix of chemical elements, nuclear masses, proton-neutron structure of nuclei, electronic levels, electronic characteristics of levels and sublevels (orbitals), prediction of new elements.

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INTRODUCTION

The periodic law and its presentation in the form of tables of chemical elements by D.I. Mendeleev and the international IUPAC is an outstanding discovery of mankind. At the end of 2019, the entire world scientific community under the auspices of the UN celebrated the 150th anniversary of this event. Currently, the tables contain 118 elements, but not all of them are found in natural form, since some are obtained artificially. The authors have written a new work on the Three-dimensional matrix of chemical elements [3].

There have been considered the concepts of the Universe and a **physical model of the Big Bang and the expanding Universe** is adopted to describe the emergence of chemical elements, the task is set to describe them in the form of a three-dimensional expanding matrix of chemical elements. At the top of the matrix are hydrogen (**H**) and helium (**He**), being the basis for the creation of all subsequent elements, and further other elements are arranged along the expanding spiral and group principles of valences serve as the boundaries for such structure.

The second most important consideration is the origin and evolution of the Universe, **all living and non-living in it in a spiral** [10, 11]. Being obvious for the living nature, for non-living nature it is assumed that chemical elements might serve as the building blocks for this spiral, which will form molecules in the future when interacting with each other. The entire material inorganic world is formed from molecules. And then natural processes take place i.e. the creation of living matter: plants, animals and people. Thus, the entire development of the mineral and living world proceeds in spirals.

Presented generalisations show that when **structuring a system of chemical elements**, in addition to the periodicity of the formation of valence groups of outer orbitals, the **concept of cyclicity and block structuring of elements horizontally is preferable**.

MAIN PART

1. Cyclicity and block structure of chemical elements

The modern periodic system is based on the nuclear charge (Z), which determines the place of an element in

the system [1, 13, 14]. Nuclear periodicity is expressed in a periodic change in the properties of atomic nuclei. The main parameter that determines this periodicity is the number of protons (P) and neutrons (N) in the nucleus. Figure 1 shows the dependence of the mass of nuclei of elements (protons and neutrons) and the mass of neutrons for the discovered 118 chemical elements.

The authors have calculated the neutron-proton ratio in the nuclei of chemical elements. In the short-period table 1, a, the averaged indicators of these ratios for the blocks are presented. It should be noted that these averaged values for blocks are equal both in the short-period table and in the IUPAC table (Table 1, b). Therefore, the **block structure**, in our opinion, corresponds to the concept of **cyclicity** i.e. the completeness of the system of periodicity of two periods, including the families of lanthanides and actinides.

The study of the three-dimensional periodic matrix of chemical elements based on a multiparameter coordinate system clearly demonstrates the stable formation of **block patterns in the cyclic periodicity** in the properties of chemical elements in periods and blocks with an increase in their ordinal numbers and unites all the previously described periodicity options [4, 7]. It should be noted that the concepts of "period" of the two types of tables are identical (there are 7 of them each), but an important circumstance that requires special attention is the obvious discrepancy between the «rows» and the group valence principle of periodicity in a long-period table.

In [3, 4], it was concluded that the 3D-spirally diverging system of the matrix of chemical elements has 4 periodicity blocks and 7 periods. Analysis of the structure of period formation confirms that periods can be divided into simple ones, in which one element is formed in each group (2 elements with an external signal orbital and 6 elements with an external valence orbital, 8 in total) and more complex ones containing grouped "families" elements within one group (**III** or **VIII**). Thus, in blocks, everything can be represented as follows (Table 1).

– The first block **A** corresponds to short single-element periods (and rows **0-1**) of the matrix, where the first elements are hydrogen and helium (**H**^{1}-hydrogen and **He**^{2}-helium). For the first block, the ratio of neutrons (N) to protons (P) can be taken equal to 1.

– The second block **B** structurally positions the completeness of the cyclic eight-element periodicity, which corresponds to simple periods (and rows) **2** (includes 8 elements from **Li**^{3} to **Ne**^{10}) and **3** matrices (includes 8 elements from **Na**^{11} to **Ar**^{18}). For the second block, N:P is less than 1.1.

– The third block C structurally represents the completeness of the cyclic 10- and 8-element periodicity in the block, two additional "families" have appeared: iron

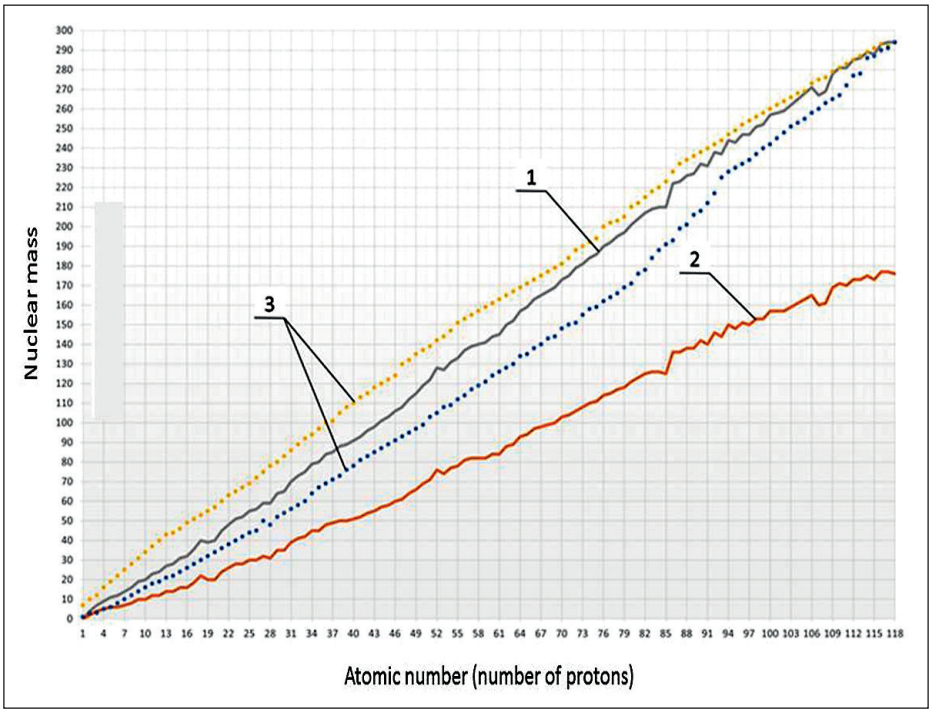

Fig. 1. **Dependences of nuclear masses (protons and neutrons) and mass neutrons (neutrons) for 118 chemical elements:** 1 – the number of protons and neutrons; 2 – the number of neutrons; 3 – isotopes

Table 1

The ratio of neutrons and protons in the nuclei of atoms of chemical elements

a) Mendeleev Table

Ratio of neutrons (n) to / protons (p)	Blocks, periods / rows	I	II	III	IV	V	VI	VII	VIII		
	A 1	H 1 1,008 1							He 2 4 1,0		
Less than 1,1	B 2	Li 3 4 7 1,33	Be 4 5 9 1,25	B 5 6 11 1,20	C 6 6 12 1,0	N 7 7 14 1,0	O 8 8 16 1,0	F 9 10 19 1,11	Ne 10 10 20 1,0		
	B 3	Na 11 12 23 1,09	Mg 12 12 24 1,0	Al 13 14 27 1,08	Si 14 14 28 1,0	P 15 16 31 1,07	S 16 16 32 1,0	Cl 17 18 35 1,09	Ar 18 22 40 1,22		
Less than 1,3	C 4/4-5	K 19 20 39 1,05	Ca 20 20 40 1,0	Sc 21 24 45 1,14	Ti 22 26 48 1,18	V 23 28 51 1,22	Cr 24 28 52 1,17	Mn 25 30 55 1,20	Fe 26 30 56 1,15	Co 27 32 59 1,19	Ni 28 31 59 1,11
		Cu 29 35 63 1,21	Zn 30 35 65 1,17	Ga 31 39 70 1,26	Ge 32 41 73 1,28	As 33 42 75 1,27	Se 34 45 79 1,32	Br 35 45 80 1,29	Kr 36 48 84 1,33		
	C 5/6-7	Rb 37 49 85 1,32	Sr 38 50 88 1,32	Y 39 50 89 1,28	Zr 40 51 91 1,28	Nb 41 52 93 1,27	Mo 42 54 96 1,29	Tc 43 55 96 1,28	Ru 44 57 101 1,30	Rh 45 58 103 1,29	Pd 46 60 106 1,30
		Ag 47 61 108 1,30	Cd 48 64 112 1,33	In 49 66 115 1,35	Sn 50 69 119 1,38	Sb 51 71 122 1,39	Te 52 76 128 1,46	I 53 74 127 1,40	Xe 54 77 131 1,43		
Less than 1,55	D 6/8-9	Cs 55 78 133 1,42	Ba 56 81 137 1,45	La 57 82 139 1,44	Hf 72 106 179 1,49	Ta 73 108 181 1,48	W 74 110 184 1,49	Re 75 111 186 1,48	Os 76 114 190 1,50	Ir 77 115 192 1,49	Pt 78 117 195 1,50
		Au 79 118 197 1,49	Hg 80 121 201 1,50	Tl 81 123 204 1,52	Pb 82 125 207 1,52	Bi 83 126 209 1,52	Po 84 126 210 1,50	At 85 125 210 1,47	Rn 86 136 222 158		
	D 7/9-11	Fr 87 136 223 1,56	Ra 88 138 226 1,57	Ac 89 138 227 1,55	Rf 104 161 265 1, 55	Db 105 163 268 1,55	Sg 106 165 271 1,56	Bh 107 160 267 1,50	Xs 108 161 269 1,49	Mt 109 169 278 1,55	Ds 110 171 281 1,55
		Rg 111 170 281 1,53	Cn 112 173 285 1,54	Nh 113 173 286 1,53	Fl 114 175 289 1,54	Mc 115 173 288 1,50	Lv 116 177 293 1,53	Ts 117 177 294 1,51	Og 118 176 294 1,49		

Ce 58 82 140 1,41	Pr 59 82 141 1, 39	Nd 60 84 144 1,40	Pm 61 84 145 1,38	Sm 62 88 150 1,42	Eu 63 89 152 1,41	Gd 64 93 157 1,45	Tb 65 94 159 1,45	Dy 66 97 163 1,47	Ho 67 98 165 1,46	Er 68 99 167 1,46	Tm 69 100 169 1,45	Yb 70 103 173 1,47	Lu 71 104 175 1,46
Th 90 142 232 1,58	Pa 91 140 231 1,53	U 92 146 238 1,59	Np 93 144 237 1,55	Pu 94 150 244 1,60	Am 95 148 243 1,56	Cm 96 151 247 1,57	Bk 97 150 247 1,55	Cf 98 153 251 1,56	Es 99 153 252 1,55	Fm 100 157 257 1,57	Md 101 157 258 1,55	No 102 157 259 1,54	Lr 103 159 262 1,54

b) IUPAC Table

n/p ratio	Block, period	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII
1,0	A 1	H 1 1,008 1																	He 2 2 4 1,0
Less than 1,1	B 2	Li 3 4 7 1,33	Be 4 5 9 1,25											B 5 6 11 1,20	C 6 6 12 1,0	N 7 7 14 1,0	O 8 8 16 1,0	F 9 10 19 1,11	Ne 10 10 20 1,0
	B 3	Na 11 12 23 1,09	Mg 12 12 24 1,0											Al 13 14 27 1,08	Si 14 14 28 1,0	P 15 16 31 1,07	S 16 16 32 1,0	Cl 17 18 35 1,09	Ar 18 22 40 1,22
Less than 1,3	C 4	K 19 20 39 1,05	Ca 20 20 40 1,0	Sc 21 24 45 1,14	Ti 22 26 48 1,18	V 23 28 51 1,22	Cr 24 28 52 1,17	Mn 25 30 55 1,20	Fe 26 30 56 1,15	Co 27 32 59 1,19	Ni 28 31 59 1,11	Cu 29 35 64 1,21	Zn 30 35 65 1,17	Ga 31 39 70 1,26	Ge 32 41 73 1,28	As 33 42 75 1,27	Se 34 45 79 1,32	Br 35 45 80 1,29	Kr 36 48 84 1,33
	C 5	Rb 37 49 85 1,32	Sr 38 50 88 1,32	Y 39 50 89 1,28	Zr 40 51 91 1,28	Nb 41 52 93 1,27	Mo 42 54 96 1,29	Tc 43 55 98 1,23	Ru 44 57 101 1,30	Rh 45 58 103 1,29	Pd 46 60 106 1,30	Ag 47 61 108 1,30	Cd 48 64 112 1,33	In 49 66 115 1,35	Sn 50 69 119 1,38	Sb 51 71 122 1,39	Te 52 76 128 1,46	I 53 74 127 1,40	Xe 54 77 131 1,43
Less than 1,55	D 6	Cs 55 78 133 1,42	Ba 56 81 137 1,45	La 57 82 139 1,44	Hf 72 106 179 1,49	Ta 73 108 181 1,48	W 74 110 184 1,49	Re 75 111 186 1,48	Os 76 114 190 1,50	Ir 77 115 192 1,49	Pt 78 117 195 1,50	Au 79 118 197 1,49	Hg 80 121 201 1,50	Tl 81 123 204 1,52	Pb 82 125 207 1,52	Bi 83 126 209 1,52	Po 84 126 210 1,50	At 85 125 210 1,47	Rn 86 136 222 158
	D 7	Fr 87 136 223 1,56	Ra 88 138 226 1,57	Ac 89 138 227 1,55	Rf 104 161 265 1,51	Db 105 163 268 1,55	Sg 106 165 271 1,56	Bh 107 160 267 1,50	Xs 108 161 269 1,49	Mt 109 169 278 1,55	Ds 110 171 281 1,55	Rg 111 170 281 1,53	Cn 112 173 285 1,54	Nh 113 173 286 1,53	Fl 114 175 289 1,54	Mc 115 173 288 1,50	Lv 116 177 293 1,53	Ts 117 177 294 1,51	Og 118 176 294 1,49

(Fe) and platinum (Pt) – from ruthenium (Ru) to palladium (Pd).

The third block **C** presents the first short pair of rows **4** (includes 10 elements from **K**[19] to **Ni**[28]) and **5** of the short-period table (includes 8 elements from **Cu**[29] to **Kr**[36]) and the second short pair of rows **6** (includes 10 elements from **Rb**[37] to **Pd**[46]) and **7** short-period tables (includes 8 elements from **Ag**[47] to **Xe**[54]). In the long-period table, a pair of rows **4** and **5** corresponds to period **4**, and a pair of rows **6** and **7** corresponds to period **5**. For the third block, the N:P ratio is less than 1:1.3.

– The fourth block **D** structurally represents the completeness of the cyclic 24 and 8-element periodicity as a block of chemical elements **D**, which additionally included the "families" of lanthanides (**La**) and actinides (**Ac**), as well as two "families": osmium (**Os**), iridium (**Ir**), platinum (**Pt**) and chassium (**Hs**), maitnerium (**Mt**), darmstadtium (**Ds**).

The fourth block corresponds to the first pair of the long row of lanthanides **8** (includes 24 elements from **Cs**[55] to **Pt**[78]) and the short row of the short-period table (includes 8 elements from **Au**[79] to **Rn**[86]) and the second pair of the long row of actinides 10 (includes 24 elements from **Fr**[87] to **Ds**[110]) and the short row 11 of the short-period table (includes 8 elements from **Rg**[111] to **Og**[118]). In the long-period table, a pair of rows **8** and **9** corresponds to period **6**, and a pair of rows **10** and **11** corresponds to period **7**. "Families" of lanthanides, actinides and some grouped metals require special study and attention of researchers. For block **D**, the N: P ratio is less than 1.55.

Thus, the block structure of the three-dimensional matrix of chemical elements using a three-dimensional coordinate system can provide a significant increase in information content (multidimensionality) compared to short-period and long-period tables of chemical elements.

2. Three-dimensional periodic matrix of chemical elements

Various literary sources draw attention to the contribution to the development of the periodic system of chemical elements by *D.I. Mendeleev, Yu.-L. Mayer, A. Chancourtois, J. Newlands, W. Odling and G. Hiprix* [6].

There may be highlighted the main prerequisites for the creation of the three-dimensional periodic matrix of chemical elements:

– based on the laws of the development of the Universe, the authors propose to consider the structure of the arrangement of chemical elements in the form of an expanding conical spiral. The main initial elements hydrogen and helium are at the beginning of the spiral.
– the spatial spiral provides, in comparison with the tabular form, a sequential continuous arrangement of elements with the possibility of including lanthanides and actinides and all discovered (discovered) and predicted families. All known structures should find their reflection on the spiral on the basis of a deep study of the short-period and long-period tables, taken as a basis in different countries.

Thus, the three-dimensional matrix showcases:

– arrangement of all known elements along the coordinate axes which forms a planetary model of their structure. Atomic numbers ***n*** with the dimension of a continuous series of natural numbers from 1 to 118 (and more) are evenly arranged along a spiral from top to bottom.
– the ordinal number of the element coincides with the magnitude of the nuclear charge (Z) and the same total number of energetically balancing electrons in the orbitals of the shells. The approach is universal for both short-period tables and long-period tables.
– an exponential increase in the number of elements in periods from the first to the eleventh (and further) is shown, which forms a 3D-spiral spatial system of the framework of the matrix of chemical elements (Fig. 2) [4].

The proposed representation of the three-dimensional periodic matrix of chemical elements in the form of an expanding conical spiral is a universal tool that makes it possible to study a large variety of physical and chemical properties of already known and not yet discovered elements and their compounds [5]. The versatility of the three-dimensional matrix also lies in the fact that, in addition to the mandatory serial number and strict coordinate binding of chemical elements to groups, there appears a tremendous potential to structurally analyse physical and chemical properties of elements and the laws of their interaction.

3. Electron characteristics of elements and analysis of their cyclicity in the structure of the volumetric matrix of chemical elements

The spatial form of the Three-dimensional Periodic Matrix made it possible to structure the anomalous families of the **III** (lanthanides and actinides) and **VIII** (metalloids) groups of the third **C** and fourth **D** levels of block periodicity, and the level formulas of electron shells facilitate the study of systemic regularities of periodicity, including the mechanisms of saturation and transition electrons at different energy levels (orbital) of electron shells [2]. The consistency of the periodicity is relevant in the study of fine mechanisms of interlevel transitions and stable failures of the synthesis of electron orbitals (Table 2).

Distribution of electrons over energy levels (states) of shells ***K, L, M, N, O, P, Q, X*** (EL), consisting of sublevels (orbitals) ***s-, p-, d-, f-, g-, h*** - at each level, satisfies the principle of minimum potential energy. The maximum number of electrons at the energy level is calculated by the

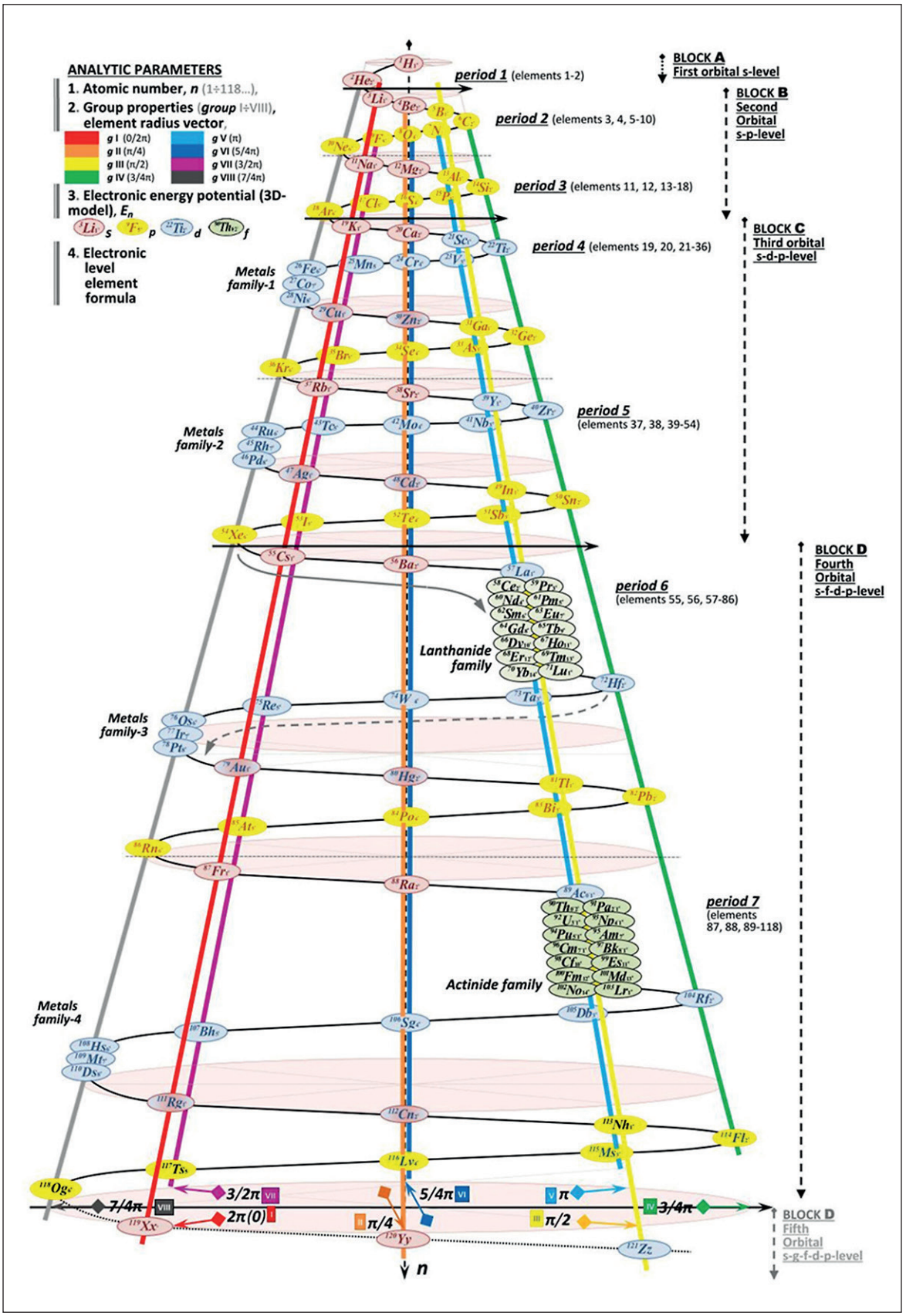

Fig. 2. **Three-dimensional matrix of chemical elements with analytical parameters**

formula $R = 2n^2$, where n is the level number or the principal quantum number (1, 2, 3, etc.). Each filled level corresponds to a certain set of sublevels (orbitals) (Table 3).

The sequence of filling the orbitals with electrons is limited by the Madelung rule [12, 13]. Periodicity, as a cycle of valence transformation in a system of chemical elements, manifests itself in the formation of two successive orbitals – the initial *s*-orbital and the valence *p*-orbital – with the number of valence electrons continuously increasing within the periods [8].

Initial are two groups of elements. Group ∫ of chemical elements with one electron at the s^1 sublevel is **Li**[3] –

Table 2
The structure of energy levels and sublevels (orbitals) for blocks

Block A – **1** energy level (*valence orbital* $K^s \equiv 1s^2$)
ends with Helium **He**

Block B – **3** energy levels
$K^sL^{s\text{-}p}M^{s\text{-}p\text{-}}$ (*valence orbital* $M^{2\text{-}6\text{-}} \equiv 3s^2 3p^6$)
ends with Argon **Ar**

Block C – **5** energy levels
$K^sL^{s\text{-}p}M^{s\text{-}p\text{-}d}N^{s\text{-}p\text{-}d\text{-}}O^{s\text{-}p\text{-}}$ (*valence orbital* $O^{2\text{-}6\text{-}} \equiv 5s^2 5p^6$)
ends with Xenon Ксеноном **Xe**

Block D – **7** energy levels
$K^sL^{s\text{-}p}M^{s\text{-}p\text{-}d}N^{s\text{-}p\text{-}d\text{-}f}O^{s\text{-}p\text{-}d\text{-}f\text{-}}P^{s\text{-}p\text{-}d\text{-}}Q^{s\text{-}p\text{-}}$
(*valence orbital* $Q^{2\text{-}6\text{-}} \equiv 7s^2 7p^6$)
ends with Oganesson **Og**

Predicted energy levels
and electronic structure of the orbitals
(sublevels) of Block E
Block E – **9** energy levels are predicted. from №119 to №218
$K^sL^{s\text{-}p}M^{s\text{-}p\text{-}d}N^{s\text{-}p\text{-}d\text{-}f}O^{s\text{-}p\text{-}d\text{-}f\text{-}g}P^{s\text{-}p\text{-}d\text{-}f\text{-}g\text{-}}Q^{s\text{-}p\text{-}d\text{-}f\text{-}}R^{s\text{-}p\text{-}d\text{-}}X^{s\text{-}p\text{-}}$
(*valence orbital* $X^{2\text{-}6\text{-}} \equiv 9s^2 9p^6$)
ends with element № **218**

Table 3
Principal quantum number, types and number of orbitals, maximum number of electrons at sublevels and levels

Energy level (n)	Number of sublevels (n)	Orbital type	Number of orbitals		Maximum number of electrons	
			In sublevel	In level, equals to n^2	In sublevel	In level, equals to $2n^2$
K (n = 1)	1	1s	1	1	2	2
L (n = 2)	2	2s 2p	1 3	4	2 6	8
M (n = 3)	3	3s 3p 3d	1 3 5	9	2 6 10	18
N (n = 4)	4	4s 4p 4d 4f	1 3 5 7	16	2 6 10 14	32

Fr[87], etc. The filling of the s^1 sublevel with the first electron indicates (signals) the completion of the filling of the valence shell of the previous period. The second group of chemical elements with two electrons at the s^2 – sublevel are **Be**[4] – **Ra**[88], etc. The filling of the s^2-sublevel with two electrons shows its saturation and the forthcoming formation of the ***p***-valence shell sublevel, starting with the first electron of the p^1 – sublevel and the subsequent set of sublevels of the valence period. For clarity and convenience of analysis, electronic formulas of chemical elements were used.

Thus, the unification of elements in new periods begins with a systemically bound pair of chemical elements of groups **I** and **II**, showing the completion of the filling of the valence electron shells of the atoms of the elements of the previous period and the readiness for the formation of the valence electron shell of the new period. In this case, in the chemical elements of group **I**, an act of formation of a new two-electron initial orbital of the ns sublevel of the corresponding energy level (from ***K, L, M, N, P, O, Q, X***) occurs by filling the formed energy shell with the first electron (ns^1, electronic formula designation ***K, L1, M1***, etc.), and in the subsequent chemical element of group II, the same atomic orbital is filled with a second saturating electron (ns^2, electronic formula designation ***K2, L2, M2***, etc.), forming a stable pair electrons of the outer atomic orbital. This initial pair completes the filling of the Is^2 sublevel, after which the next layers of the corresponding energy level of the periodic sequence of chemical elements of the Three-dimensional matrix are filled.

On the other hand, the filling of the outer atomic orbital with a stable pair of electrons always precedes the onset of the formation of a new layer of the valence shell of the atom. The initial elements of all periods of the matrix form new periods, on a new valence orbital (***np1***), by filling the corresponding energy level with the first electron and reflect the periodic laws of the formation of the elements of the material world. The mechanism of block periodicity of filling atomic orbitals is present at all levels of the Three-dimensional periodic matrix of chemical elements.

According to the regularities of the periodicity of the formation of chemical elements, a special role is seen for the initial atomic orbitals of two successive elements. The first element of the pair states the completion of the stable state formation in the structure of the electronic layers of the previous, fully completed period with the limiting filling of the shells of all energy levels with electrons. All first elements are odd. Best practices confirm that the electronic layers of elements shells of a fully completed period have a high degree of resistance to external energy influences and a clear gravitation to stationary interaction with the energy field of the atomic nucleus [9, 12]. This regularity implies the indifference of the electronic layers of extremely filled atomic shells to the manifestation of valence (chemical interaction).

The second element is a harbinger of the formation of new electronic layers of elements in the subsequent period, consisting of electrons of energy levels new shells. All second elements are even. The electronic layers of the shells of the elements of the forming period do not have a high degree of resistance to external energy influences and have a lesser tendency to interact with the energy field of the atomic nucleus. This regularity implies the ability of the outer electronic layers of the unfilled shells of atoms to manifest polyvalence when combined into molecules.

The first elements of the valence ***p***-orbitals of the new period in each energy level form elements with a p^1-orbital with one valence electron (**B**[5] – **Nh**[113], etc.). All such elements are odd and belong to group **III** of chemical elements. The second element – with two valence electrons of the p2-orbital in each energy level (**C**[6] – **Fl**[114], etc.). All elements are even and belong to group **IV** of chemical elements. The subsequent elements with three valence electrons of the p^3 orbital and a different number of electrons of the valence orbital in each energy level are structured similarly, belonging to groups **V, VI, VII** and **VIII** of chemical elements, respectively.

The regularities of the formation of models of electronic shells of atoms using electronic-level formulas allow, on the basis of the block approach and structural analysis, to predict chemical elements beyond the 118th element, to form the structure of new periods, starting with the chemical elements of the 11th period of D.I. Mendeleev Table or the 8th period of the IUPAC table [15]. The electron-orbital formulas assume, based on the block approach, an extremely abbreviated description of the structure of chemical elements.

4. Prediction of new chemical elements

Of the known chemical elements in the short-period system, only 83 are found on Earth, the lightest of which is hydrogen (its atomic number is Z = 1), and the heaviest is uranium (Z = 92). Obviously, only those elements survived in the solar system and on the planet Earth, the lifetime of which is longer than the age of the Earth (4.5 billion years). Others broke up and did not survive to this day. Uranus, which has a half-life of about 4.5 billion years, is still decaying. It is a radioactive element [16]. In nature, stable formations (nuclei of elements, consisting of different numbers of protons and neutrons) exist only up to lead and bismuth, followed by a small area that includes thorium and uranium found on Earth. But as soon as the serial number of an element exceeds the number of uranium, its lifetime decreases sharply. For example, the nucleus of element 100 is 20 times less stable than the nucleus of uranium, and this instability only intensifies further due to the spontaneous nuclear

fission. With further attempts to obtain new elements, scientists around the world face the increasing difficulty of synthesis [18–20]. And only a small part of nuclear research ends with the successful synthesis of a new element. No laboratory can be compared with a neutron star, which can create other forms of matter. During the life of stars there take place nuclear reactions that are beyond the human's power. Scientists are trying to find new types of elements, but experiments in search of "natural" superheavy elements still continue [17]. There arises a question: What is the practical use of such an expensive event to create new unstable elements? Despite this, the development of experimental methods for the transformation of elements led to the expansion of the periodic tables at the expense of transuranic elements, the problem of the table boundary remains one of the most fundamental in modern theoretical chemistry.

The orbital structure representation formulated by the authors makes it possible to predict the block pattern for the emergence of new elements, with the formation of families of lactanoids, actinides and other with ***d-, f-, g-, h***-orbitals in the reverse order between ***s***- and ***p***-orbitals in the third group. There is a special prospect to predict chemical elements of the families of group **III** outside block **D.** The reason is that if the cyclic families of lanthanides and actinides of group **III** in the paired block **D** consist of **14** ***f***-elements in each period, then the families of elements in the paired block E will consist of **32** ***g-f***-elements in each period, and the families of elements in the paired block **F** will consist of **54** ***h-g-f***-elements in each period, etc. [15]

The issues that determine the possibility of the predicted elements existence in special physical conditions have not been considered yet. However, taking into account the "theory of stability areas", supported by the discoverer of the element ***Og***[118], Academician of the Russian Academy of Sciences Yu.Ts. Oganesyan, such existence of potential chemical elements is possible [16, 17], and the question of predicting new elements arises again. The structural analysis allows to predict the structure of so far unknown elements of the periodic system within 119–168 elements of the **8**th period and within 169–218 elements of the **9**th period of the block structure **E**, as well as within 219–290 elements of the **10**th period and

Table 4

Block structural analysis for D.I. Mendeleev Table with blocks E and F

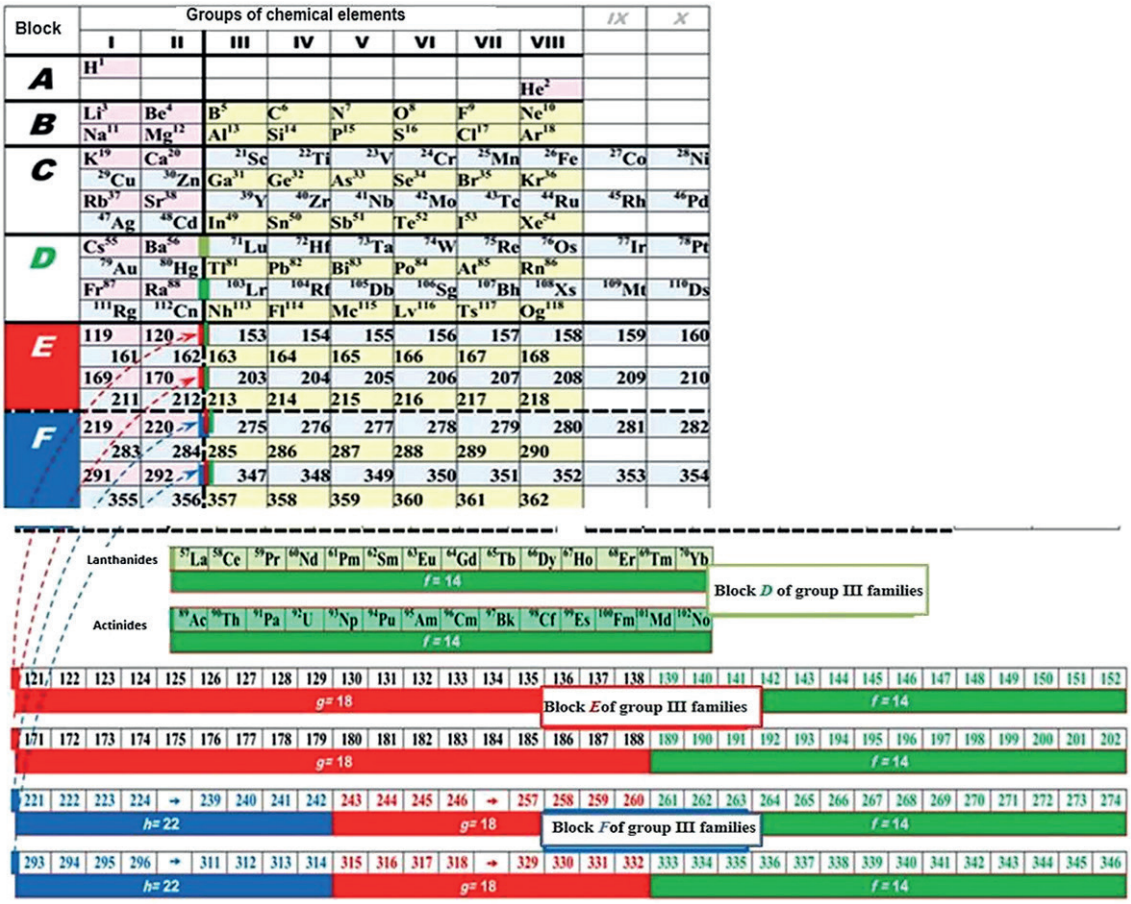

Table 5
Comparison of Mendeleev's Tables, IUPAC and VMCE

Mendeleev Table	IUPAC Table	VMCE/ GYS	Novelty
no cell continuity		complete continuity (no empty cells)	3D-Matrix model – continuously expanding eight-sector spiral
I – II – III ÷ VIII	**I ÷ XVIII**	**I – II – III – IV ÷ VIII**	is based on 8 valence groups of elements
lanthanides and actinides are taken out of the tables		families of group **III** are part of matrices and are presented in table 2	all families of chemical elements are included in group **III**
{**La**}, {**Ac**}	{**La**},{**Ac**}		
K-L-M-N-	***K-L-M-N-***	***K-L-M-N-*** and new levels (***O-P-Q-***)	energy levels of chemical elements
He^{2}, Ne^{10}, Zn^{30}, Yb^{70}	**He^{2}, Ne^{10}, Zn^{30}, Yb^{70}**	**He^{2}, Ne^{10}, Zn^{30}, Yb^{70}, (Yn^{138})**	boundary elements with complete electronic structure
no forecast of new elements		structural ordinal analysis is not limited	Forecasting of new chemical elements

within 291–362 elements of the **11**th period of the block structure **F** and subsequent blocks.

For the first time, a preliminary structural analysis of a short-period table is presented based on the forecast of four new periods of predicted chemical elements (Table 4). Thus, the idea of block structure made it possible to substantiate electronic-level formulas, including the alleged new chemical elements of the **5th** block **E** with numbers 119 to 218 and further.

Further the use of digital models for research in chemistry will be considered, which can significantly increase the effectiveness of computer modelling methods. Taking into account the crucial role of materials science, it is appropriate to conclude: "*whoever masters the digital system first can become a leader in many spheres of human life*."

CONCLUSION (MAIN CONCLUSIONS)

1. The periodic law and its representation in the form of tables of chemical elements is **the greatest discovery in chemistry**. DI Mendeleev's two-dimensional tables of chemical elements and IUPAC table played a huge role in the development of chemistry. However, the fact that there are currently more than **500 options** for their modernization, including the statements of N.N. Semyonov, indicate the **need to continue wor**k in this direction at a **new level** of comprehension.

2. First of all, it is the **formation of a physical model** for the probable **origin of chemical elements**. The concept of the Universe as an expanding system presented in the work of Stephen Hawking and Martin Rees is a compelling evidence for it. In our opinion, the physical interpretation (model) of the origin and development of the Universe makes it possible to formulate a more general concept of the structuring process of chemical elements and its representation in the form of an expanding conical spiral as well as to draw a number of new conclusions.

3. Like the Universe, the proposed three-dimensional Periodic Matrix is an expanding system (spiral) and a continuous sequence in the arrangement of elements from hydrogen (1) and helium (2) to Oganesson (118) with the inclusion of lanthanides and actinides in it and possible inclusion of other information with the preservation of the periodicity for the groups of elements and the valence framework of the matrix, proposed by D.I. Mendeleev. **Hydrogen and helium are obviously structural elements** and all other elements were formed on their basis.

4. The authors formulated the concept of cyclicity in the arrangement of the horizontal levels of chemical elements in the blocks of the Three-dimensional matrix of chemical elements. Each of the blocks provides an approximate equality of the neutrons – protons mass ratio in the nuclei of chemical elements. **There has been formulated the pattern of 4 levels of block cyclic structure in the existing system of chemical elements**. The blocks additionally include all cluster formations, as well as the families of lanthanides and actinides. New regularities of periodicity in the block matrix structure of chemical elements from block **A** to block **D** were obtained, combining the periods presented in the tables of chemical elements by D.I. Mendeleev and IUPAC.

5. On the basis of **cyclicity**, the **structures of the electron shells** for the known 118 elements in four blocks **A, B, C, D** are presented, which also makes it possible to obtain electron-orbital formulas, including for new elements (119–218) of block **E** of the periodic system and

the subsequent block **F**. In block **E**, for **100** new elements their **atomic numbers** and **nuclear masses** are presented. Elements 119 and 218 could be named after N.N. Semenov Sm[1] and Sm[2].

6. It should be noted that a **progressive amount of new elements** is in group III of the three-dimensional matrix and special attention should be paid to the formation of chemical elements in this group for blocks **C, D** and subsequent ones, the number of which is progressively increasing for new blocks **E** and **F**. This circumstance *100 years ago made it necessary* to move the groups of lanthanides and actinides outside the tables of D.I. Mendeleev and IUPAC.

7. Thus, the three-dimensional matrix of chemical elements is a **more general structure to further generalize main features of chemical elements** (their valence, polyvalence and valence abodes in the tables of D.I. Mendeleev and IUPAC). Its volume and the concept of cyclicity made it possible to make such a generalization, and the **tabular forms of D.I. Mendeleev and IUPAC** are presented in its composition (Table 5).

8. The use of the three-dimensional matrix of chemical elements allows to apply mathematical methods and **create digital models** for the interaction of chemical elements with each other, which will make it possible to obtain new types of molecules for new materials.

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