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ПРОБЛЕМНАЯ СТАТЬЯ

NOVEL VISUALIZATION OF THE PERIODIC SYSTEM OF ELEMENTS. THE ORTHOGONAL DIMENSION

НОВАЯ ВИЗУАЛИЗАЦИЯ ПЕРИОДИЧЕСКОЙ СИСТЕМЫ ЭЛЕМЕНТОВ. ОРТОГОНАЛЬНОЕ ПРЕДСТАВЛЕНИЕ

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КЛЮЧЕВЫЕ СЛОВА: Периодическая система элементов, новое графическое представление, ортогональная таблица, меандрирующая модель.

ABSTRACT: The Periodic system of elements is presented in a novel way such that rare earth and actinides, and the triads Fe/Co/Ni, Ru/Rh/Pd, Os/Ir/Pt, and Hs/Mt/Uun, are shown orthogonal within the table, and not separately as accompanying rows. The new graphic presentation facilitates the visual orientation, eliminates the now prevailing crunching of the elements in the middle of the table, and avoids the cognitive confusion of scattered positioning of the «a» and «b» element subgroups sometimes widely separated within the same row. A characteristic meandering pattern emerges whenever switch occurs between the horizontal and orthogonal dimension of the Periodic system; the inner meaning of these switches remains to be elucidated.

РЕЗЮМЕ: Периодическая система элементов представлена в новой форме, так, что лантаноиды и актиноиды, а также триады Fe/Co/Ni, Ru/Rh/Pd, Os/Ir/Pt и Hs/Mt/Ds помещаются ортогонально внутри таблицы, а не отдельно в дополнительных рядах. Новое графическое представление облегчает зрительную ориентировку, устраняет мозаичное размещение элементов в средней части таблицы и освобождает от трудностей восприятия, связанных с перемежающимся размещением элементов из основных и дополнительных подгрупп.

PERIODIC SYSTEM OF ELEMENTS

Since the time of D.I. Mendeleev the Periodic system of elements progressed from the genuine simplicity into a gigantic matrix-box mega-structure containing over 3000 important facts (Fluck, 2002). That amount of details surpasses the most complex esoteric mandala in its complexity; here the term mandala is used in the broad sense of an all-encompassing space of the highly structured visual symbols, like the chemical elements in the Periodic system (Argueles, Argueles, 1985; Holton et al., 1996). More important, the very notion of periodicity was doubted by some scientists because of the «rare earths» (Trifonov, 1984), the presence of «triads» like Fe/Co/Ni in the VIIIb period, the uncertainty of the proper placing of the hydrogen (Petryanov, Trifonov, 1984), and by problems on how to include the isotopes of the elements into the table (Flerov, Ilyinov, 1986), to enumerate the few most important objections.

IMPROVEMENT SUGGESTIONS

From time to time suggestions would come on how to re-arrange the Periodic system to provide for the meaningful inclusion of the plethora of available data. Pendulum, pyramid, and spiral graphic models of the Periodic system appeared (Mazuris, 1974); indeed, the pendulum model was embraced by the «occult chemistry» (Besand, Leadbeater, 2003).

Over a decade ago Magarshak and Malinsky (1992) suggested a three-dimensional (3D) Periodic table based on quantum mechanics and Hund's rule (1927). Namely, that the term of largest S and among these the term of largest L is lowest in energy[1]. In their case the number of chemical elements in periods is the

[1] Electron configuration. Since the number of the possible electrons in every electronic shell is limited (Paulie's Principle), the shells are arranged around the nucleus in the layers enumerated 1—7 or with capital letters K-Q. Only hydrogen H1 has 1s1 configuration; all the other elements have the first shell filled with two electrons ($1s^2$). For example: N^7 (nitrogen) electron configuration is $1s^2 2s^2 2p^3$ (Grlic, 1992).

following: 2, 2, 8, 8, 18, 18, 32, 32. Therefore, for instance, in period number 1 only hydrogen and helium are present, the second period consists of only Li and Be, the third has eight elements from B to Mg, the fourth again contains 8 elements from Al to Ca, and so on.

Strictly speaking, the 3-D model of Magarshak and Malinsky was not 3-D; in essence it was the upside-down turned Periodic system what was «lateralized» (laterally expanded) with respect to the Periods. Nevertheless, their approach accommodates for the Linus Pauling (1939) suggestion of introducing the index of the electro negativity of atoms to the Periodic table.

THE MEANDERING OF THE VERTICAL COMPONENT DIMENSION

The aim of this short paper is to overcome the traditional boundary of viewing the Periodic system as a one-dimensional row-by-row «typewriter» model and to allow us to capitalize on Periodic system vertical component dimension (like in «crosswords»). The result of this elaborate transformation is shown in Figure 1 entitled the World of the Periodic system of elements. Indeed, it may be nicknamed a «meandering» model of the Periodic system because of its visual resemblance to the meandering river or meandering motif of some ancient Greek vase. Instantly, there is no further need for the separate rows of the rare earth and actinide series, the triads (VIIIb subgroup) became easily identifiable, and the overall distinction between the «a» and «b» subgroups become visible at a glance. The whole periodic sequence of elements became quite orderly with each element in its own niche and without the voluntary displacing within the rows of the groups.

Now, some intriguing aspects of such a novel visualization of the Periodic system emerge. If we look at Figure 1, we see the «meandering» what appears to be not haphazard, but shows distinct rhythmicity, as if some imaginary polarity is switching on and off and what changes the direction of periodicity. Starting with the Group 4 we may observe the «to-the-right // down // to-the-left» repetitive pattern, and which is not identical with the Hund's rule series. Such a spatio-temporal pattern formation is certain to reflect some as yet unrecognized deep structural features of the elemental atom itself (Walgraef, 1997).

THE LIMITS TO GROWTH

It should be noted that up till now the last identified element has a number 115 and nobody knows what the last possible element may be. Spiranec (2005) in his book on Harmony developed an interesting

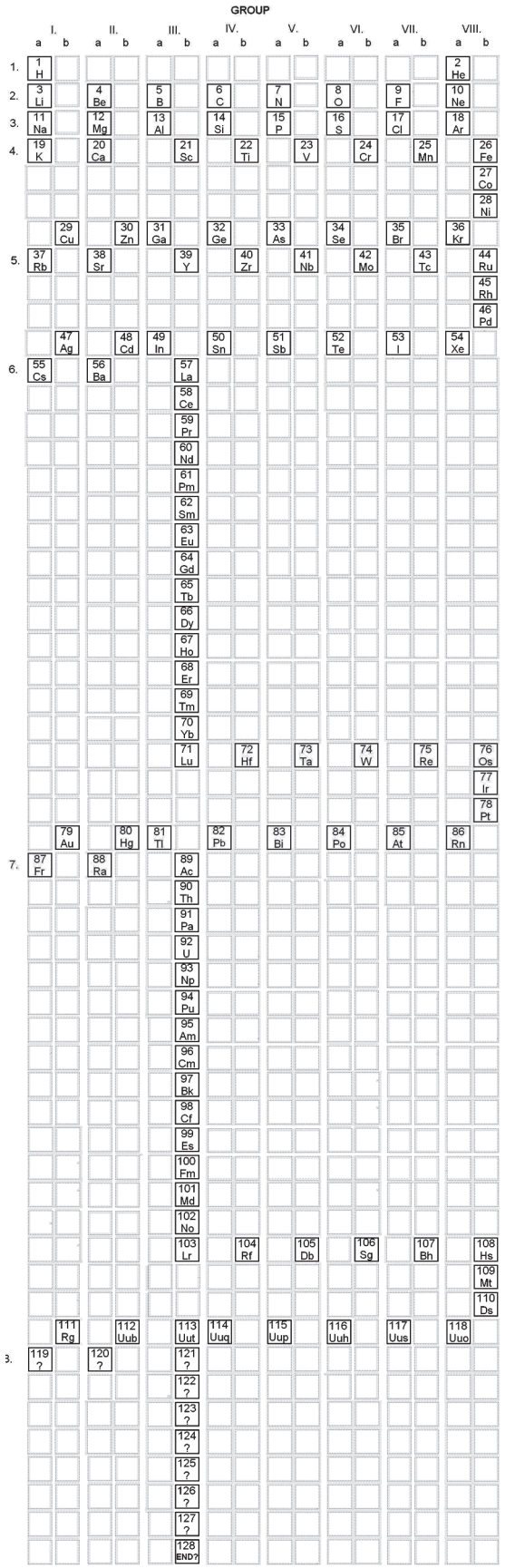

Fig. 1. *The World of the Periodic system of elements [elements 1—128]*

«new Pythagorean» geometrical model, by which he aimed to prove that the last possible element in the Periodic system would be element 128. Indeed, close enough to Flerov and Ilyinov (1986) conclusion that the element 126 (and perhaps 127) may be possible. It remains to be elucidated if the observed periodicity of the actinides along the groups (the second rare earth series) (Weast et al., 1965), is a reality or an artificial construct reflecting the projection of such a «meandering» Periodic system into the realm of the yet unknown. This «meandering» pattern (shifting regularly from horizontal to a vertical direction) reassembles the activation-inhibition (precipitation-diffusion) scheme process as may be seen in Zhabotinsky-Belousov reaction (Bell, 1999). Indeed, the observed «meandering» pattern looks like it falls under the Rule 110 proposed by Wolfram (2002) and what describes objects that move in time across the space and interacts with one another[2]. For all the practical purposes, the classical portion of the Periodic system (elements H^{1} to U^{92}) is shown in a new way in Figure 2.

ESSENTIAL ELEMENTS

Knowledge of the elemental structure and periodicity was crucial for the understanding of some aspects of interaction between the transition elements (Orgel, 1960), and for the development of the ligand-field theory (Hill, Matrone, 1970) in the biological (life) systems. This author shares the opinion of Holton (1996) and Aqscher (2002) that better visualization of complex systems, like the Periodic system of elements, can only help us to better understand and comprehend the nature's complexity. Considering the importance of trace elements in the human health and disease, and that not all the elements are essential in human nutrition (Skalny, 1999), a «shorthand» form of the «meandering» Periodic system model is shown in Figure 3 (The realm of the Essential elements to the Men); the iodine being the heaviest element known to be essential for the human health. Amazingly, only 28 elements (H^{1}, B^{5}, C^{6}, N^{7}, O^{8}, F^{9}, Na^{11}, Mg^{12}, Si^{14}, P^{15}, S^{16}, Cl^{17}, K^{19}, Ca^{20}, V^{23}, Cr^{24}, Mn^{25}, Fe^{26}, Cr^{27}, Ni^{28}, Cu^{29}, Zn^{30}, As^{33}, Se^{34}, Sr^{38}, Mo^{42}, Sn^{50} and I^{53}) comprise the essential metabolic network of the human life and well-being[3]. However, the possibility of the interactions among the essential and non-essential elements expands the number of the possible outcomes, and what may greatly affect the final response of any such a metabolic network.

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[2] Wolfram (2002) identified four kinds of behaviour for one-dimensional cell automata in a space-time diagram: (1) Alternate, (2) Nested, (3) Recursive, and (4) Random. Here presented «meandering» model of the Periodic system appeares as if (3) Recursive and generated by Rule 110. [NB. Wolfram is the inventor of the «Mathematica» software program. For critical review of Wolfram's work see Hayes B. 2002. The world according to Wolfram // Am. Sci. Vol.90. P. 308—312.]

[3] Today, it is thought that already 30 elements are essential for men and that titanium may be soon added to that list as the research on element essentiality is marching on (see Szolnin A., 2001. Biogenic elements. Cheliabinsk, Russia). I wish to thank the reviewer for drawing my attention to that important work of Szolnin since it should be noted that some of the valuable research done in the today Russia (and former USSR) is hard to get to read, to review, and to critically evaluate.

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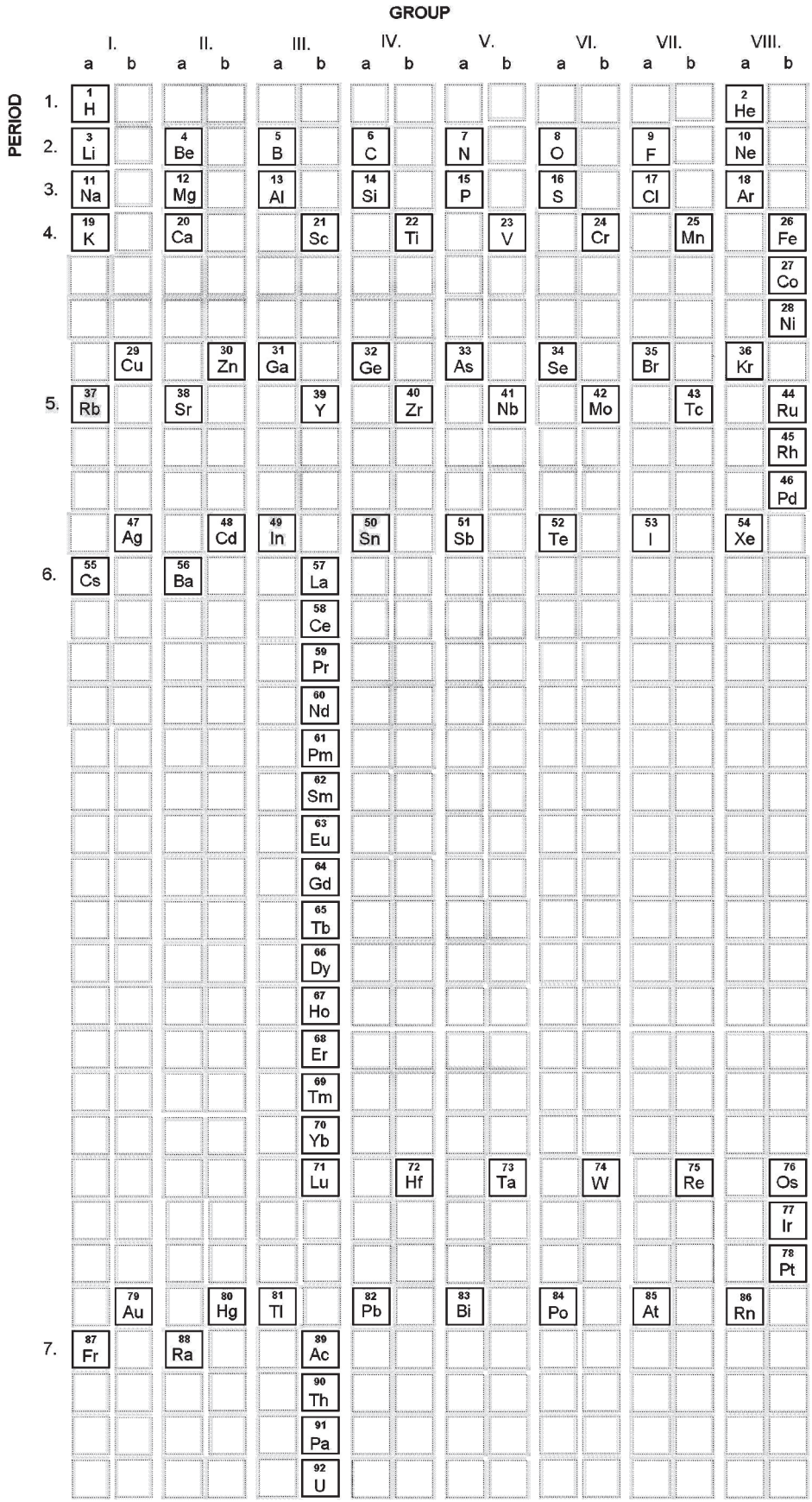

Fig. 2. *The naturally occuring elements of the Periodic system of elements [H^{1}—U^{92}]*

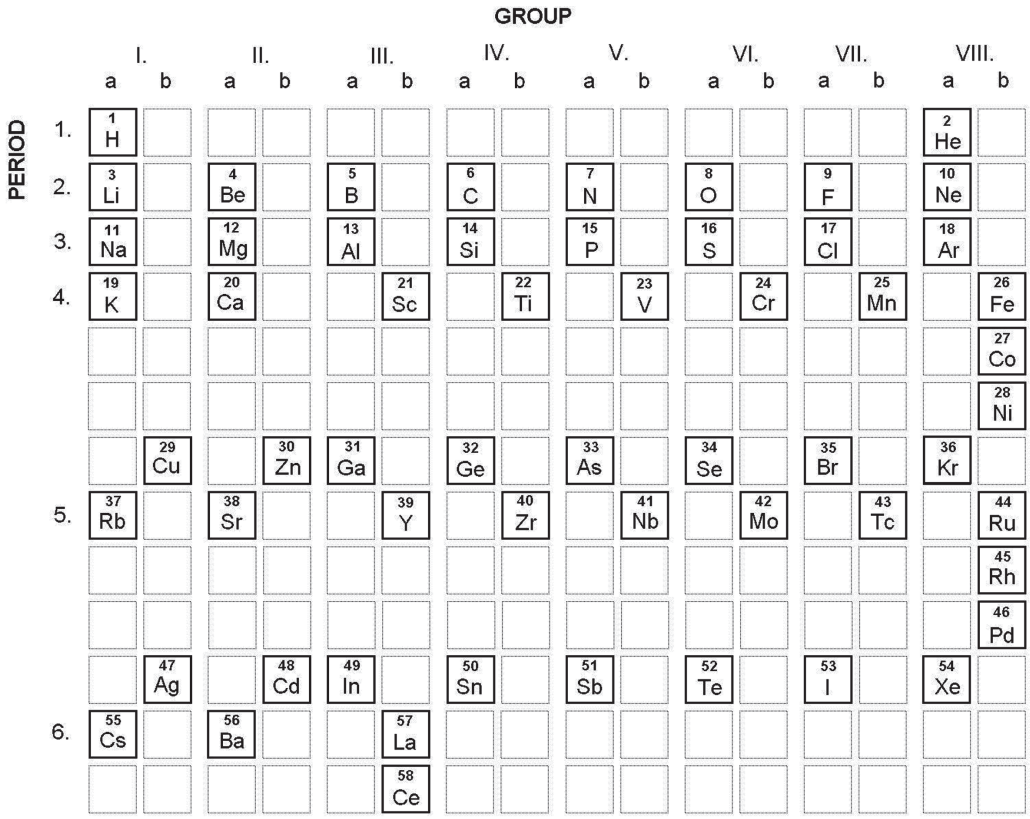

Fig. 3. *The realm of the Essential elemets to the Men*