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Study on the Odd-Even Periodic Table of Chemical Elements

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Abstract: Odd-Even periodic table of chemical elements designed by the authors settles the position of Hydrogen and Helium. Additionally, it yields no exceptional arrangements for neither the Lanthanides, Actinide and super Actinides nor the six empty spots and the controversy on the positions of hydrogen and helium have been settled. It plays an important role in comparing the stability of nucleons and predicting the ordinal of the terminal element.

Key Words: Nuclear chemistry; Periodic table; Odd number; Even number.

1. Introduction

Currently, the most popular periodic table is the familiar rectangular one inserted in textbooks. It makes for good inserts or teaching charts with its lattice. However, its shortcomings include the following: first, it leaves inner transition elements like lanthanides and actinides outside of the table, thus losing its continuity, entirety and beauty as a whole; second, it does not clearly illustrate the physical limits of Periodic Law[1]. According to this arrangement, when g orbit or any other larger angular-momentum quantum orbits appears, the elements (super Actinides) must be arranged separately outside of the Table. This results in the infinite extension of the table; third, it has been developed from Mendeleev’s original table, which illustrates the groups and periods well, but lack illustration of the other rules found in Periodic Law, such as the diagonal rule, increasing atomic radius from top to bottom within groups, etc; fourth, it places hydrogen in group IA due to a similarity with other alkali metal elements: its outer valence electron number is one, and each can lose one electron to become a one-valence positive ion. However, unlike the positive ions of other alkali metal elements which can exist in crystal, hydrogen can only form a hydration positive ion. Moreover, hydrogen is a simple substance that is obviously non-metal. Therefore, it seems inappropriate to align it with the alkali metals. Some people arrange hydrogen in VIIA group, yet hydrogen's nonmetal property is clearly weaker than fluorine's, which violates the rule that the same group elements' nonmetal property weakens from top to bottom. Some think hydrogen should belong to group IVA. Clearly, hydrogen's placement within the table remains controversial and it warrants further study. Fifth, there are six empty spaces between the two main elements, hydrogen and helium according to current arrangement. There are two attitudes towards this placement: one is to let them be, the other is to look for a more reasonable arrangement that can remove the empty spaces without losing the benefits of the current table, thereby getting closer to objective laws.

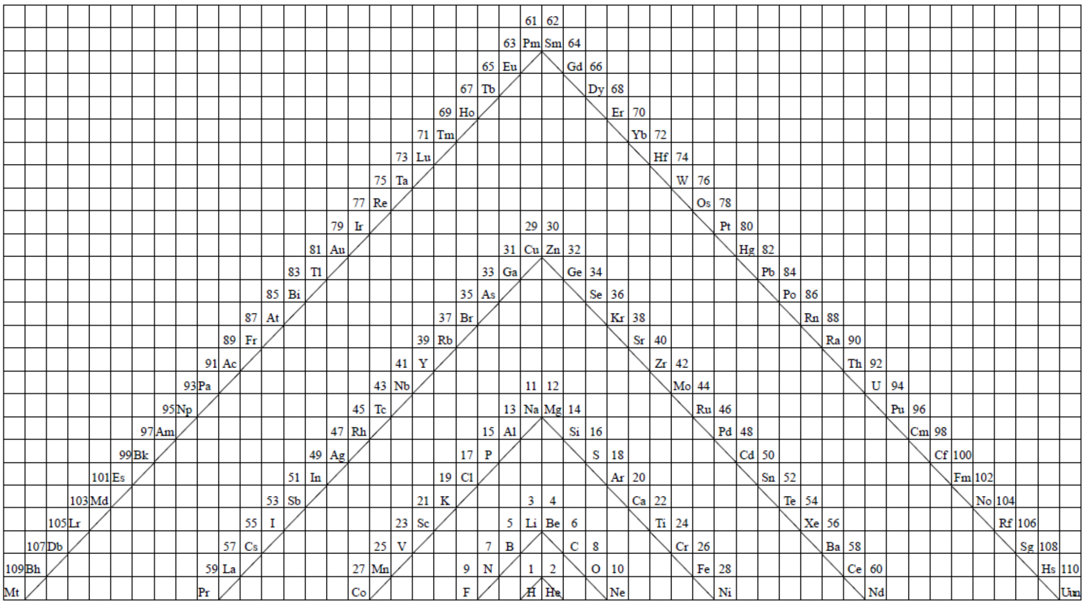
To seek more reasonable and more aesthetic arrangement of the elements, the authors of this paper have designed the Odd-Even Periodic Table of Elements inspired by Tomson-Born's tower form of the Periodic Table. The design of this table yields no exceptional arrangements of Lanthanides, Actinide and Super Actinides nor the six empty spots. It integrates atomic number with stability of elements and serves new purposes.

2. Odd-Even Periodic Table designed by author

2.1 Appearance

The odd-even periodic table designed by author is shown as follow.

This below table configuration has a pyramid-like shape, composed of five right-angle isosceles triangles arranged in concentric order, representing the elements that reside in the first five periods.



The way the atomic numbers are arranged is similar to the Hui Yang Triangle [2]. This configuration lends itself to an inherently strong order. Each element's position is "just right" —demonstrating a remarkable set of mathematical relationships. In the view of geometry and group theory, the whole figure is aesthetically symmetrical.

2.2 Arranging Principles and Structural Character

The basic right-angle isosceles triangle can be bisected into two right-angle isosceles triangles along the middle vertical line. The numbers of the nuclear charge (atomic number) in the left-facing triangle are all represented by odd numbers, while the right-facing triangle is represented by all evens. A Cartesian-like coordinate system can be established, with the first quadrant representing evens and the second quadrant representing odds.

2.3 Numbers of Elements

All known elements from No.1 to No.110 are arranged into fifty columns in the Odd-Even Table. The general filling direction is from left to right and from bottom to top, with odds to evens divided as described above. The number of elements in each period is $2n^2$, which correlates with the possible number of electrons found in the outer orbits around the nucleus. It follows that there are two elements in the 1st period, eight in the 2nd, eighteen in the 3rd, thirty-two in the 4th, fifty in the 5th, and subsequently there would be seventy-tow elements in the future period.

3. Applications and Significance of Odd-Even Periodic Table

3.1 Positions of Hydrogen and Helium have been settled

For a long time scientists have been debating about the positions of hydrogen and helium as they pertain to both each other as well as the other elements in the Periodic Table. We can easily resolve this problem by taking into consideration the origin of the elements. In the moments following the Big Bang, hydrogen and helium atoms were created. As the most basic atomic structure, hydrogen is the origin of all elements. Then hydrogen and helium began to bind and form star clusters and out of the furious fusion of these elements, the other atoms were created. In today's universe hydrogen remains its most abundant element, comprising about 88.6 percent of all known atoms. Helium's abundance is about one eighth of hydrogen's. Together, hydrogen and helium make up over 99.9 percent of all atoms in the universe. For that reason, it is reasonable to place hydrogen and helium alone together in the first period or the bottom of the "pyramid". The arrangement of the Odd-Even Table follows the creating order of elements. Furthermore, the hydrogen and helium produced firstly when the Big Bang about 15 billion years ago, then other elements formed.

3.2 Comparison of the stability of atomic nuclei of the elements

Counting all natural stable nuclides shows the number of stable isotopes of elements with even atomic numbers is much bigger than that of elements with odd atomic numbers. For example, ^{50}Sn has ten stable isotopes, but its neighbors Indium and Bismuth have only two. Elements with odd atomic numbers never have more than two stable isotopes, while elements of even atomic numbers have many more.

In the natural nuclides, the ones with even number of protons and even number of neutrons are common. Nuclides with this even-even composition are more than the total of all three other kinds of nuclides with even-odd, odd-even, and odd-odd compositions. Stable nuclides of odd-odd composition are very rare.

The following form gives a rough number of every type of natural nuclides[5]:

Tab.1 Percentage of elements with even atomic numbers is much bigger than the elements with odd atomic numbers.

Proton	Neutron	Total number	Percentage	Example
Even	Even	167	58	^{12}C
Even	Odd	58	20	^{9}Be
Odd	Even	54	19	^{7}Li
Odd	Odd	9	3	^{14}N

The fact that most elements' proton and neutron numbers are even is proof that nucleons inside nuclei prefer to exist in pairs. Like electrons outside of nuclei tend to be found in pairs, so are protons and neutrons inside the nuclei.

It has long-since been known that atoms with even atomic numbers are more stable than the ones with odd atomic numbers, and nuclei with an even-even composition of protons and neutrons are more stable than those with odd-even compositions. Generally speaking, in the Odd-Even Periodic Table, the elements in the rightmost triangle have more stable isotopes than those in the leftmost triangle; it follows that the atoms of the elements found in the rightmost triangle are more stable.

3.3 Theory of stable line elements

According to Magic Numbers, or scientists' statistical studies of all natural isotopes and their experimental data on atomic nuclei's binding energy, tarpaulin moment, neutron capture cross section, etc. [6], nuclei with protons of 2, 8, 20, 28, 50, 82, (114), (164) or neutrons of 2, 8, 20, 28, 50, 82, 126, (184), (196), (228) and (318) (the numbers in the blanks are predicted in theory) are usually more stable than their neighbors in the periodic table. The elements in Odd-Even Periodic Table with atomic numbers of 2, 8,20,44,82 form a straight line, which compute as the "island of stability" [10]. In fact, it is true. Element Ruthenium with atomic number of forty-four was found in 1844 when Russian chemist K.K Klaus analyzed an Os-Ir mine. Its neighbor to the left technetium is the only radioactive element before No.84 element polonium. The gap was not filled until in 1937 Italian scientists Perrier and Serge E. bombarded $^{98}_{42}Mo$ with neutrons and deuterons in the Laurence cyclotron to separate and examine some of the isotopes of technetium, finding it much less stable than Ruthenium. The element Rhodium with atomic number of 45 has an odd number of protons. It has only one stable isotope in nature ^{103}Rh, and twenty radioactive isotopes. Ruthenium has seven stable isotopes in nature, and fifteen radioactive isotopes [11]. Its chemical property is quite stable as well; it will not even dissolve in aqua. It follows that Rhodium belongs with elements with stable nuclei, a point that has neither been mentioned in textbooks nor previously considered.

3.4 Directing the Synthesis of Superheavy elements

Synthesizing atoms with an even number of nucleons is far easier than attempting the process with atoms with an odd number of nucleons. At present, elements of No.112, 114, 116, 118 have been synthesized, while elements of No. 113, 115, 117 remain undiscovered, twelve which is more proof that atoms of even number are more stable than atoms of odd number, further lending credence to any arrangement that creates a natural separation between the two.

3.5 Predicting the Ordinal Terminal Elements

Two approaches to predicting the terminal element in the Periodic Table have been presented. The first is to complete the current periodic table, considering its last element to be No.118 completing the seventh period, with No.168 to completing the eighth period, or No.218 completing the ninth period. Many people desire to see a Periodic Table with perfect rectangular symmetry. They consider Nos.118, 168 or 218 the terminal elements that can be synthesized, given the fact that atomic nuclei's stability decreases with increasing atomic numbers and relative stability of inert gases. For example, Zelei Xiu believes the Periodic Table consists of 168 elements that are convergent[7]. The other approach predicts, according to the theory of "Island of Stability"[8], elements No.126, 184, 228 with nucleons whose number count are considered "doubly magic" may be synthesized.

In the theory of the authors, based on electronic structure, the terminal element in the sixth period is No.182, with the terminal element in seventh period being No.280 as predicted by the Odd-Even Periodic Table. The elemental number of each period follows the natural $2n^2$. This theory includes the stable nucleons predicted according to the theory of the “Island of stability.” It also appeals to a natural sense of the aesthetic—demonstrating symmetry along more than one axis. The original rectangular Periodic Table is does not follow this aesthetic: it is not a perfect rectangle. Rather, it is a polygon composed of many rectangles. While the Odd-Even Periodic Table we designed is a perfect right-angle isosceles triangle, which is doubtless simpler, more symmetrical, and more attractive, it more importantly creates a model that comes closer to the objective law.

4. Conclusion

In light of the evidence regarding the periodic behavior of atoms as the increase in atomic number, the Odd-Even Triangle Periodic Table does a superior job of comparing stability of nucleons. Unlike the theory’s forerunners, not only did the designer of this table transform the Periodic Table’s geometric figure, but also the authors infused it with more meaning—illustrating additional natural relationships between the elements. The authors of this paper believe that this table will serve more purposes than those introduced above, somewhat like the Dirac Equation or Einstein’s Mass energy Relationship. Moreover, in designing the Odd-Even Table, we followed the combinatorial law of beautiful form (i.e. order, balance, symmetry, coordination, variation and unification[10] that fully reflects the natural world’s inherent symmetry and harmony.

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