On discussion

NUCLEAR ISOTOPES AND MAGIC NUMBERS

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Dedicated to D.I.Mendeleev's 170-th anniversary, to the 135-th anniversary of Periodic Law discovery and to G.A.Gamov's 100-th anniversary

ABSTRACT. In addition to the formulas (1) and (2) from work of the author (Bezdenezhnyi, 1999, hereafter Paper I) alternative formulas (3)–(6) are derived for description of two sequences of magic numbers. Their properties are described. Dependences of some physical parameters as a function of the number of chemical element (Z), number of neutrons (N) and the mass number (A) are analysed. It is shown that magic numbers of protons (Z) and neutrons (N) are displayed in them. The concept of magic mass numbers (A) is proposed, and it is shown that they are also present in some dependences. The list of magic and twice magic (on Z and N) elements is extended, as well as the list of twice magic ones on A and Z or N. We propose to refer a nucleus that contains magic numbers of protons and neutrons to thrice magic nucleus if their sum is a magic number too. It is suggested that during the decay of "double -uranium" super-nucleus one of three twice magic elements (X(112,168), Y(126,184) and Z(168,258) or Z'(168,240)) predicted (in Paper I) will be formed fragment accompanying in areas of twice magic nuclei: Yb(70,112), Sn(50,70) and S(16,16) respectively.

Key words: nuclear astrophysics, r-, s-processes, Mendeleev's periodic system, isotopes, magic numbers

1. Introduction

As is generally known from nuclear physics (Mukhin, 1974), atomic nuclei containing certain numbers (2, 8, 20, 28, 50, 82, 126) of protons (P) or neutrons (N) show an enhanced stability that makes them distinguished among other nuclei neighbouring them. They are named as magic nuclei (isotopes of chemical elements), and the numbers of their protons and neutrons are called "magic numbers". Their explanation lies in the envelope nucleus model, in which the nucleons form the filled envelopes separately for P and N. According to the model of nucleus envelopes the nucleon energy levels with close values of energy are grouped into series far apart from each other which are called nucleon envelopes. According to the Pauli principle, a certain number of nucleons of a given kind can be placed on each envelope. Whenever an envelope is filled, it corresponds to the magic nucleus formation with the respective magic number. Nucleon envelopes of protons and neutrons are filled independently. The simultaneous filling up of proton and neutron envelopes is followed by a corresponding formation of particularly stable twice magic nucleus. At the same time the saturation of forces of nuclear interaction is attained - a high value of nuclear package (mass defect).

In previous author's work (Paper I), the Table (117.8) from "Quantum Mechanics" (Landau and Lifshits, 1963) has been analysed and two recurrentformulas have been found connecting all the set of magic numbers and corresponding to their two sequences - large and small ones:

$$M_i = M_{i-1} + \sum J(i-2) + J(i), \text{where i=1, 2,...} \quad (1)$$

$$m_{i-2} = M_i - J(i), \text{where i = 3, 4,...} \quad (2)$$

The numeral values, counted up on these formulas, are the following:

M_i: 2, 6, 14, 28, 50, 82, 126, 184, 258, 350, 462, ...

m_i: - - 8, 20, 40, 70, 112, 168, 240, 330, 440, ...

In that way, new magic numbers: 6, 14, 40, 70, 112, 168, 240, 258, 330, 350, 440, 462 were added to the before known ones. Numbers of neutrons 16, 96, 114, 152, appearing in the literature, are not magic ones: three from them are numbers of alpha-particle configurations, and 114 is a difference of magic numbers 184 and 70. The quantity of the nuclei referred to magic and twice magic ones was increased in connection with the increasing of the quantity of magic numbers. The author added (6,6), Si(14,14), Ni(28,28), Zr(40,50) Sn(50,70) to the previously known twice magic nuclei of isotopes: He (2,2), O(8,8), Ca(20,20), Pb(82,126). All of them have high peaks in abundance curve of isotopes (Figure 1 from author's quoted work according to Lang's (1978) data). Small double peaks in the well known curve of elemental abundances (Zyuss and Yuri) at magic numbers of neutrons 28, 40, 70, 112 have been added to double peaks of r-, s-processes of neutron capture at magic numbers 50, 82, 126. They convincingly confirm an existence of these two capture processes.

2. New results

Recently the author added the nuclei of isotopes Si (14,20), Ca (20,28), Ni (28,40), C (6,8), O (8,6), He(2,6) to twice magic ones. It is logically to name three last isotopes, and also Ca(20,20) and Si(14,14) as thrice magic nuclei, as they have simultaneously magic numbers of protons (Z) and neutrons (N) and their sum (mass number A=Z+N) is a magic number too. Magic mass numbers (for example =258) also are proved in the plots of dependences of some physical parameters.

Combining both sequences in one series, we have the first 20 magic numbers: 2, 6, 8, 14, 20, 28, 40, 50, 70, 82, 112, 126, 168, 184, 240, 258, 330, 350, 440, 462. Taking the differences between neighbouring values, we get series of 19 members: 4, 2, 6, 6, 8, 12, 10, 20, 12, 30, 14, 42, 16, 56, 18, 72, 20, 90. It is easily to notice that this series consists of two sequences of numbers - odd D_{2n-1} and even D_{2n}, the members of which are described by the following formulas:

$$D_{2n-1} = 2(n+1), \text{where n = 1, 2, ..., 10} \quad (3)$$

$$D_{2n} = n(n+1), \quad \text{where n = 1, 2, .., 9} \quad (4)$$

Thus, every subsequent member is expressed through previous one by formulas:

$$M_1 = 2, \quad (5)$$

$$M_{i+1} = M_i + D_i, \quad \text{where i = 1, 2, 3, ...} \quad (6)$$

are determined as $i = 2n$ or $i = 2n - 1$ for n in formulas (3) and (4). For example, at $n = 1$ $D_{2n-1} = D_1 = 2(1+1) = 4$ and $M_2 = M_1 + D_1$=2+4=6, D_{2n}=D_2=2 and M_3=M_2 + D_2=6+2=8 and etc.

In the model of nucleus with nucleon orbits, the Quantum Mechanics calculations for rectangular potential well give (Table 21, Enrico Fermi, 1951) the total numbers of filled states for closed shells: 2, 8, 20, 40, 70, 112, 168, ... Numbers 40, 70 and 112 coincide with those obtained by the author (Paper I), but the numbers 6, 14 and 28 are not present in this table. The numbers 2, 8, 20, 50, 82, 126 were referred to the magic ones, because nuclei with such number of protons or neutrons appeared especially steady and these numbers are confirmed by experiment. However, other numbers of nucleons in the closed shells become apparent in the experiment.

It will be shown in present work that magic numbers 6, 28, 40, 70, 112, 168, 184, 240, referred by author, also become apparent in experimental dependences between the physical parameters of isotopes. So, in Figure D2 taken from Luc Valentin's (1986), the effects of shells and magic numbers are superimposed upon the smooth dependence of binding energy as a function of the mass number (A) at N=28 and 50, Z=50, N=82 (marked there) and at twice magic nucleus Pb(82,126), but also distinct peaks are seen (Figure 1) at the twice magic O(8,8), thrice magic Si(14,14), twice magic (on A and N or Z): N=28 (A=50), Z=40 (N=50), Z=50 (N=70), Z=50 (N=82), Z=70 (N=82) and Z=112 (N=126). Noticeable declinations of the theoretical curve for binding energy from the experimental values for the lightest nuclei (Figure 4.3, Luc Valentine, 1986) are also explained by the effect of magic numbers: at A=4 (Z=N=2) and A=12 (Z=N=6).

The physicists discuss daring ideas of producing new nuclei by fission of super-heavy unstable nucleus of the "double- uranium" type R(184,292) obtained by bombardment of uranium target with ion U(92). The fission usually occurs in the fragments of unequal masses. Therefore, at this fission new transuranium elements can arise as well as new isotopes lighter than uranium.

Owing to this we had to extend the boundaries of Table 2 (Paper I). The following terms of both sequences of magic numbers: M_{10}=350, M_{11}=462 and m_8=330, m_9=440 were calculated by formulas (1) and (2). As a result of this, it is suggested that the super-nucleus may decay into one of four mentioned above twice magic isotopes X(112,168), Y(126,184) and Z(168,258) or Z'(168,240) plus fragment in areas of twice magic nuclei Yb(70,112), Sn(50,70) and S(16,16) respectively. It could serve as a test for presence of these unobserved twice magic isotopes by means of analysis of those fragments.

3. Properties of magic numbers

1) All magic numbers are even.
2) They fit to the recurrent formulas (1)-(2) or (3)-(6).
3) They are the sums of two or three other magic numbers: 8=2+6, 14=6+8, 20=6+14, 28=20+8, 50=40+8+2 (or 50=28+14+8); 70=50+20, 82=40+28+14, 112=70+28+14 (or 112=70+40+2), 126=112+14; 168=126+40+2 (or 168=126+28+14); 184=168+14+2 (or 184=126+50+8); 240=184+50+6 (or 240=168+70+2); 258=112+126+20, 330=184+126+20 (or 330=168+112+50), 350=330+20 (or 350=184+126+40), 440=350+82+8 (or 440=350+50+40), 462=350+112.
4) Multiplicities among magic numbers: eight from the first twenty magic numbers are multiple to the magic number 14: 28, 70, 112, 126, 168, 350, 462; eight magic numbers are multiple to the number ten: 20, 40, 50, 70, 240, 330, 350, 440. The numbers 70 and 350 can be met in both multiplicities; remaining six numbers are multiple too: 2 and 82=241, 6 and

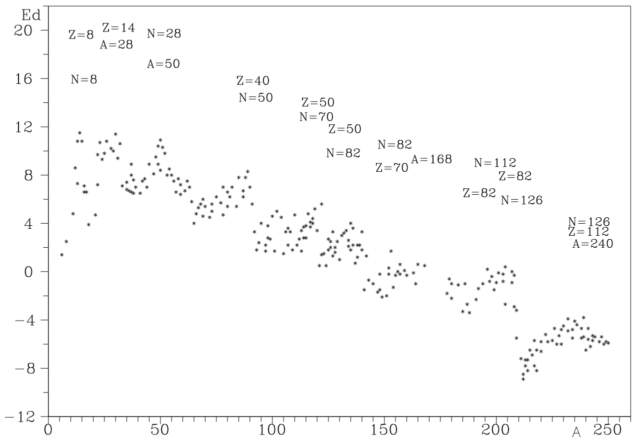

Figure 1: The effects of magic numbers in the dependence of binding energy as a function of the mass number A.

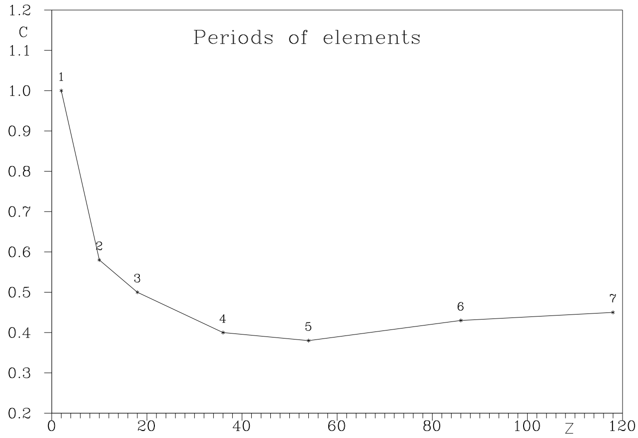

Figure 2: The dependence of C-ratio as a function of the maximal value of Z for every period of chemical elements.

258=643, 8 and 184=823. Besides, the numbers 23, 41 and 43 are the prime ones.

5) Numbers multiple to magic are also developed in dependences of physical parameters: 12, 16, 32, 56, 80, 164 et al.

6) In Figure 2 dependence of ratio (C) of the mean value of magic numbers on Z to similar ones on A for every period of chemical elements is shown as a function of the maximal value of Z for this period. Minimum C-values in the fifth period is seen.

4. Appearances of magic numbers in dependences of physical parameters

a). Behaviour of the packing factor.

Aston (1948) chose the oxygen atom 16 as the most appropriate standard. And percent deviation of masses of other atoms from an integer on this scale, shown in tenthousandth, was adopted by a packing factor. The graphical dependence of the packing factor (taken from Aston's (1948) data on isotopic weights) as a function of proton number shows a presence of magic numbers Z=2, 6, 8, 20, 28, 40, 50, 70 and 82. There is a minimum on the smoothed curve of the packing factor at Z=28 (Figure 3).

b). Dependence of neutron excess on atomic number.

Dependence of atom isotopic number (A-2Z) or neutron excess (N - Z) as a function of atomic number (Z) is shown in Figure 4. A connection of peak positions (local maxima and minima) with magic numbers can be seen. Local minima (N-Z) are seen at the magic numbers of protons: 2, 6, 8, 14, 20, 28, 40, 112, and also near the numbers of the alpha-particle configurations Z: 44, 60, 84 and 108. Local maxima are present at magic Z: 70 (weak) and 82, at the numbers of the alpha-particle configurations Z: 4, 12, 24, 36, 52, 56, 100 and at Z=114. Extrema of a small

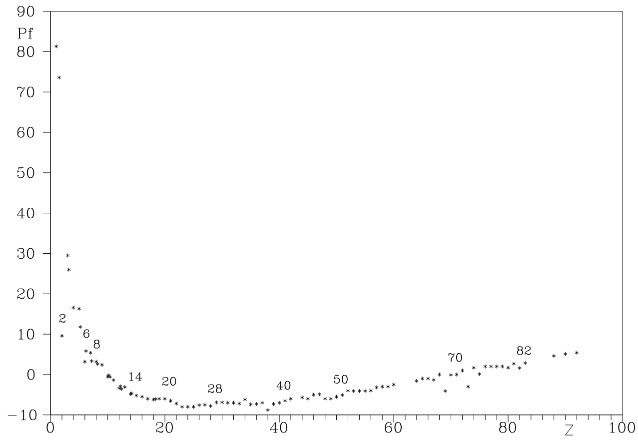

Figure 3: The dependence of the packing factor as a function of proton number Z.

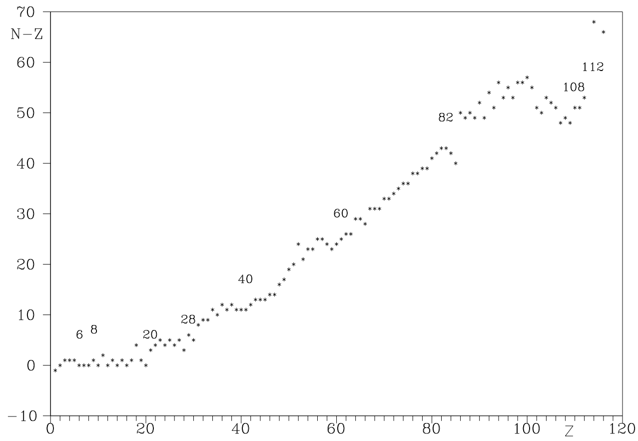

Figure 4: The dependence of neutron excess (N-Z) as a function of atomic number Z.

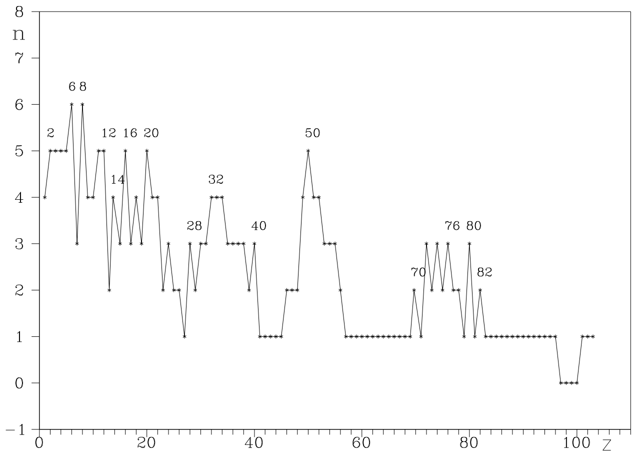

Figure 5: The dependence of total quantity of magic numbers for every chemical element as a function of Z.

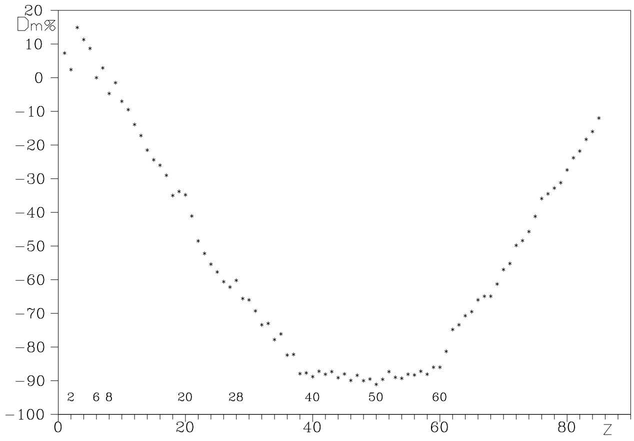

Figure 6: The dependence of the parameter $Dm_{\%}$ as a function of Z.

amplitude at the magic numbers of neutrons are seen in a similar dependence (N-Z) as a function of neutron number (N). A weak effect is also seen at magic mass numbers A: 6, 8, 14, 40, 50, 82, 126, 168 and 258.

c). Analysis of the dependences between isotopic mass excess and the mass number.

On the plots based on the data from Luc Valentine (1986), the four characteristic points can be considered: A_{min} and A_{max} are the left and the right borders of the range of isotopes as a function of the mass number for every element; the point of the mass number $A_{min(dm)}$ at minimum of the mass excess (dm) and corresponding minimal value of dm_{min}; the point $A_{\%}$ for isotope with maximal abundance ratio and the value $Dm_{\%}$ corresponding to it. About 17 % of A_{min} values coincide with magic numbers, for A_{max}, $A_{min(dm)}$ and $A_{\%}$ these coincidences are 19 %, 34 % and 30 % respectively. There are about 20 % of coincidences of numbers $A_{min(dm)}$ and $A_{\%}$. The plot of the dependence of total (on Z, N and A) quantity (n) of magic numbers for every chemical element as a function of its number Z is derived in Figure 5. There are peaks at the magic numbers Z = 2, 6, 8, 14, 20, 28, 40, 50, 70, 82, and also at the numbers of α-particle configurations: Z=12, 16, 24, 32, 72, 76, 80. In Figure 6 the dependence of $Dm_{\%}$ as a function of Z is shown: effects of the magic numbers Z = 2, 6, 8, 20, 28, 40, 50 and the numbers of α-particle configurations at Z=60=20+40 are seen. In Figure 7 the dependence of the parameter $Dm = dm_{max}$ - dm_{min}, giving the limits of the changes of dm for this isotope, as a function of Z is present. There are peaks at the magic numbers Z: 2, 6, 8, 14, 20, 28, 40, 50 and 82. There are also peaks at Z = 11, 37, 55, 87 for the elements of the first period (alkaline metals) and at the numbers of the α- particle configurations: Z = 24, 80, 84, 100 and at Z=90. Dividing Z for each element on its mass number $A_{\%}$, corresponding to the most

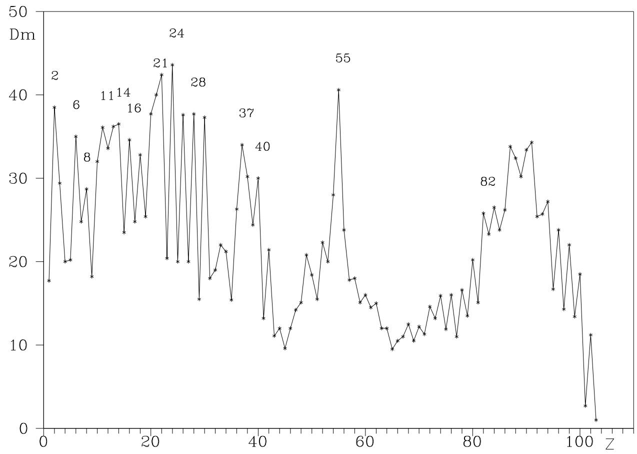

Figure 7: The dependence of the parameter Dm as a function of Z.

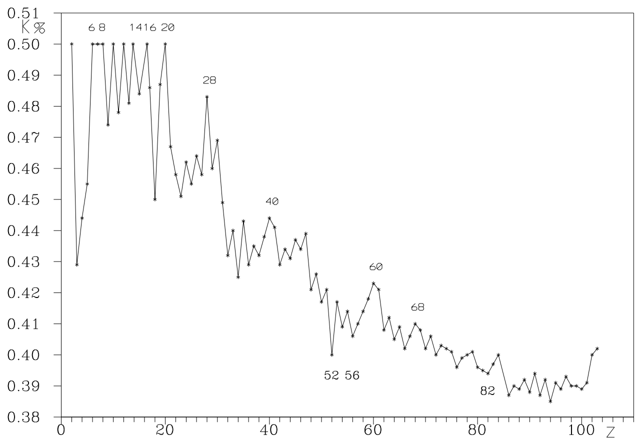

Figure 8: The dependence of the coefficient $k_{\%}$ as a function of Z.

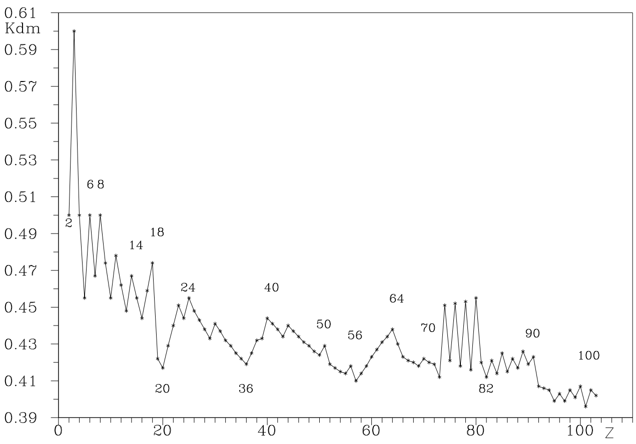

Figure 9: The dependence of the coefficient k_{dm} as a function of Z.

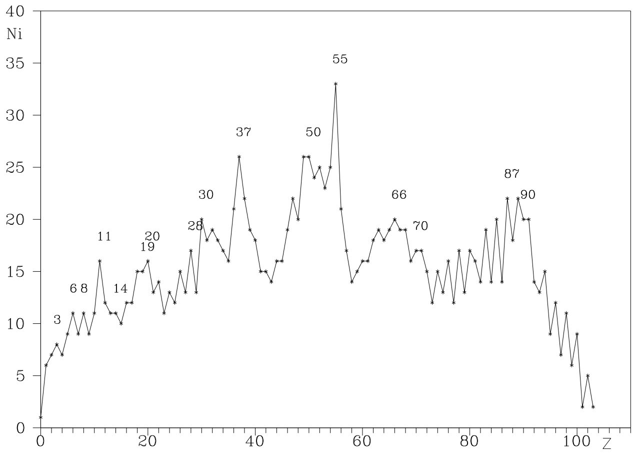

Figure 10: The dependence of quantity of isotopes (N_i) for each element as a function of its number Z.

abundant isotope, we get the coefficient $k_{\%}$. In Figure 8 the dependence of this coefficient ($k_{\%}$) as a function of Z is shown. In this Figure magic numbers Z: 6,8, 14, 20, 28, 40, 70, 82 are seen as well as the numbers of the α-particle configurations Z: 12, 16, 52, 56, 60, 68. In Figure 9 the dependence of a similar coefficient (k_{dm}) corresponding to the minimum of dm is shown. The magic numbers Z: 2, 6, 8, 14, 20, 28, 40, 50, 70. 82 and the numbers of the α-particle configurations Z: 36, 56, 64 and even numbers Z: 18, 90 are seen too.

In Figure 10 the dependence of quantity of isotopes (N_i) for each element as a function of its number Z is present. The magic numbers Z = 6, 8, 20, 40, 50, 70 and the sums of magic numbers: 30=28+2 and 90=40+50 are shown. Besides, peaks for all alkaline metals (at Z = 3, 11, 19, 37, 55, 87) are clearly expressed. They can be also seen on the dependence of A_{min} as a function of Z. For the elements of IA group (alkaline metals) the recurrent formulas for Z are the following:

Table 1: Calculations of Z_i for alkaline metals

i	1	2	3	4	5	6	7	8
n	1	2	2	3	3	4	4	5
D_i	2	8	8	18	18	32	32	50
Z_i	1	3	11	19	37	55	87	119

Table 2: Calculations of Z_i for noble gases

i	1	2	3	4	5	6	7
n	2	2	3	3	4	4	5
D_i	8	8	18	18	32	32	50
Z_i	2	10	18	36	54	86	118

$$Z_1 = 1,\ Z_{i+1} = Z_i + D_i,\ D_i = 2 \times n^2, \qquad (7)$$

where i = 2n-2 or i = 2n-1, i=1, 2, ..., 8, n=1, 2,..., 5.

Numerical results are given in Table 1. Similar results for the VIIIB elements (noble gases) are shown in Table 2. They are derived from the formulas (8).

$$Z_1 = 2,\ Z_{i+1} = Z_i + D_i,\ D_i = 2 \times n^2, \qquad (8)$$

where i = 2n-3 or i = 2n-2, i=1, 2, ..., 7, n=2, 3, 4, 5.

The model of atomic shells explains also the increased stability of the noble gases. Dependence of ionization potential (P_i) as a function of Z (Figure 11) gives the maxima of peaks at Z=2, 10, 18, 36, 54, 86 (for the noble gases) and minima at Z = 1, 3, 11, 19, 37, 55, 87 for alkaline metals.

d). Spin of the ground state of nucleus (I).

The behavior of the mean (on Z, N and A) spins of the basic state ($< I >$) of the nuclei is analysed. Spins (I) are taken from Luc Valentine's Table (1986). There are pulse groups of peaks within the areas of

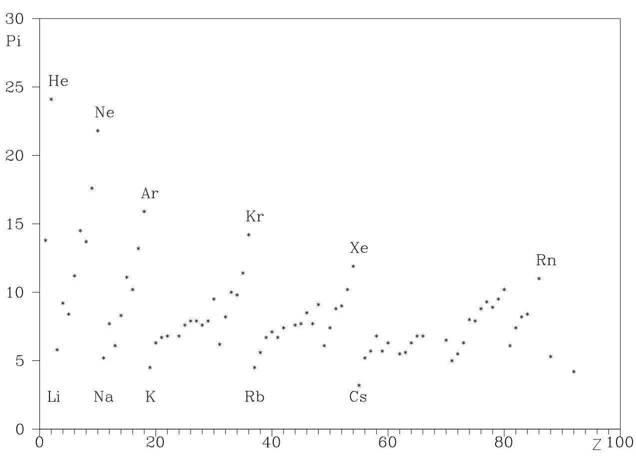

Figure 11: The dependence of ionization potential (P_i) as a function of Z.

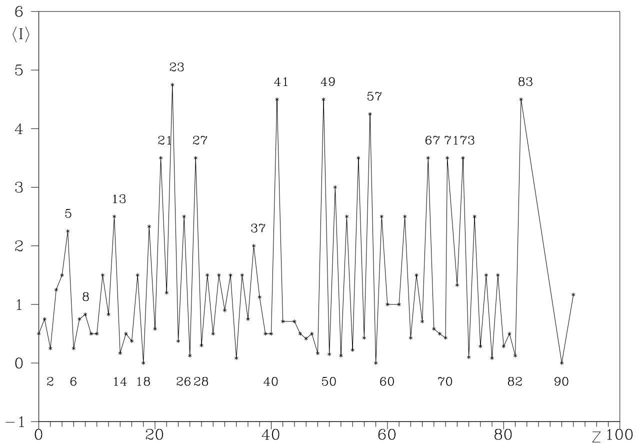

Figure 12: The dependence of the mean (on Z, N and A) spins of the basic state ($< I >$) of the nuclei as a function of Z.

magic numbers Z and N, and also A (less expressed). Apart from the rare cases, the spins of the ground state of nuclei (I) have small or zero values at even, α-particle configurations and magic Z, N and A. It testifies to the spherical, less deformed nuclear shells (see, e.g., Sobiczewski, 1996). But we do not agree that the numbers 108, 114 and 162 mentioned in that work should be considered as magic ones. Thus, the element Hs(108,162) is not only twice magic, but moreover it is not simple magic one. And the element Uuq(114,184) is not twice magic one but it is just simple magic one (the neutron number N=184)!

At the odd values of Z, N, and A (especially at the values differ by unit from magic and α-particle configurations ones) there are maximal peaks of $< I >$-values (Figure 12). There are minima at magic Z: 2, 6, 14, 20, 28, 40, 50, 70, 82 (local maximum is at Z=8) and at α-particle configurations Z: 52, 60, 64. There are also minima at magic N: 2, 6, 8, 14, 20, 28, 40, 50, 70, 82, 112, 126 and at α-particle configurations N: 12, 16, 24, 36, 44, 48, 56, 60, 68, 80, 84, 88, 96, 100, 108, 120, 144.

5. On the mass scale standard

The new atomic mass unit (carbon scale) was accepted in 1960 as 1/12 part of the carbon mass isotope with the mass number 12. It is equal to 1.66×10^{-24} g $= \frac{931481 keV}{c^2}$. This unit differs very small from the previous one (oxygen scale), but it is more appropriate for measuring of the masses by the mass-spectroscopy method, since carbon has much more different compounds than oxygen.

There was a time when Gamov made an attempt to introduce isotope of helium He (2, 4) as a standard for the mass scale identical both in physical and chemical respects. But helium is not a simple element, its isotope He (2, 3) has been discovered with the relative abundance 0.0001. Besides, the density of helium is difficult to measure, and in addition it is too close to the beginning of the scale for the aims of mass-spectroscopy.

For physical purposes it appears substantial for the unit of mass to be related with a certain simple atom. Such simple atoms could belong to elements not having more than one stable isotope, e.g. beryllium, sodium, aluminum or phosphorus. But deviations of their masses from integer numbers vary from 0.01 to 0.03; that is significantly larger than for hydrogen (0.0079) and helium (0.0026). From the author's point of view, fluorine F (9, 19) is more appropriated for these purposes. It has also one stable isotope, and mass deviation for it is only 0.0016, that only slightly exceeds that for oxygen isotope O (8, 8): 0.0006. A packing factor for fluorine is negligible and can be taken as zero. Moreover, fluorine is chemically identical to such elements as chlorine and bromine, which are not simple elements; however, these have been used as convenient auxiliary standards to determine atomic weight of silver, which is not simple element either. The fluorine ions can be easily obtained in mass- spectroscopy by using gaseous fluorinated boron. Molecules of hydrocarbons are very suitable to make measurements of the masses by the method of doublets, therefore the atoms of hydrogen, deuterium and carbon C (6, 12) adopted as additional standards as well.

As it known, the neutral atomic oxygen O (8, 8) with mass number 16 was used before as the basic standard for comparison of atomic masses by different physical and chemical methods (oxygen scale). This standard was adopted when oxygen was considered as a simple element. When the isotopes of oxygen O17 and O18 were discovered, it became evident that the adopted unit of mass differs from the classic chemical unit: 1/16 of the average atomic weight of oxygen. However, even after this, the chemical standard was kept as the previous one because the masses of many elements were rather close to integer numbers in its scale. And from the chemical point of view, the discovery of isotopes is not a very complicated matter to measure the atomic weight. Many chemists considered that advantages of a new scale could hardly compensate the inconveniences connected with the changes of atomic weights commonly adopted. But nevertheless, the new scale was accepted!

By the way, the isotope O16 is the twice magic nucleus, its proton and neutron numbers are equal to the magic number 8. It has the smallest deviation of the mass from the integer number due to this, hasn't it? And that isotope O16 is so abundant on the Earth, cradle of humanity. And it is so needed for the Life! The Earth's atmosphere contains 21% of oxygen and 78% of nitrogen (Seaborg and Valens, 1966). The Earth's crust consists of 46.6% of oxygen. And this despite of the fact that our Universe consists of 99% of hydrogen and helium, and all the rest elements (including oxygen) represent just 1%!

6. Mendeleev and Gamov

When engaged in the problem of abundance of chemical elements and their isotopes, magic and twice magic nuclei (Proceedings of the Memorial conference devoted to the 95-th G.A. Gamov's anniversary, Odessa, 1999 and present work), the author paid an attention the names of two great scientists - D. I. Mendeleev (1834 - 1907) and G.A. Gamov (1904 - 1968) and he was staggered by surprising parallels in the lives of these great people. As is seen from the given above dates of their lives, Gamov was born 70 years later than Mendeleev and died approximately 60 years after the death of the great chemist.

Both giants of thought lived and worked in Odessa for some time, the memorial plaques are witnesses of this fact: the one is on the wall of the National University building, another one is on the wall of the Richelieu lyceum, wherein Mendeleev used to teach. Further, the activity of both scientists was related to Petersburg, and what is more both genii manifested themselves in science very early. At the age of 35 Mendeleev discovered the Periodic Law. This enabled him to create the periodic system of chemical elements, and on its basis to predict the existence of some chemical elements, that were not known at that time. That was a fundamental work both in area of chemistry and physics, that apparently deserved the Nobel prize. However, it is rather strange, neither Mendeleev, nor Gamov (though because of different reasons) were not awarded with it.

At the age of 24 Gamov explained the origin of α-decay of isotopes - one of the most enigmatic problems of nuclear physics of that time. The velocities of nuclear reactions are calculated on the basis of this theory. Both of them have left an eternal trace in the investigation and discovery of the fundamental natural laws of matter, which the Universe consists of.

Both of them are versatile scientists, talented educational specialists, and popularizers of science. Mendeleev published over 500 works on chemistry, physics, metrology, aeronautics, agriculture, economics and enlightenment for the people, developed an industrial method of oil fractioning, and invented quite a new kind of smokeless powder. And Gamov was the most talented pedagogue as well, he himself was able not only to enjoy his favorite physics, but also to instill this feeling in his students, listeners of his numerous lectures, and also to the readers of his articles and popular books. For all that he was awarded with Calling prize of UNESCO. And the scope of his researches is striking: from purely theoretical works on cosmology, nuclear physics and astrophysics, genetics to the applied works at the most powerful explosion phenomenon (the thermonuclear explosion), and that is a real grandiosity as compared with gunpowder!

Both scientists are of a nobiliary origin. Mendeleev was born in the family of director of Tobol'sky Gymnasium which he graduated afterwards. Gamov's Father graduated from Odessa (Novorossiysky) University and then taught Russian and literature in one of Odessa private boy schools and in Odessa higher school. One of Gamov's uncles (maternal side) graduated from Odessa University, chemistry faculty. The discovery of poisonous (for fishes) layer of carbonic combination at the bottom of the Black Sea belongs to him," - wrote Gamov (1970) in his autobiography. In 1928 Gamov after studying a year at the physics-mathematics faculty of Odessa University began studying in Petersburg University which he graduated before the appointed time - in three years. In 1928 while being a post-graduate student of the second course he was recommended by the University as a probationer to the well-known Göttingen University. It was there that Gamov made his classic work on α-decay, and became a man of the world renown as a physicist-theorist.

In 1859 after obtaining his master's degree at the age of 25 Mendeleev went abroad for two years assignment. Mendeleev was not only a great scientist but also a progressive public person. Being Professor of St.-Petersburg University (1865 - 1890), he resigned protesting against the students' oppression. At the age of 42 being the luminary of world science Mendeleev was elected as a corresponding member of St.-Petersburg Academy of Sciences. In 1880 he was nominated as an Academician but failed to be voted. The public protested against that sharply.

Gamov was much luckier in this respect. At the age of 28 (in 1932) he was elected nearly unanimously (with the record count 42:1) as a corresponding member of Academy of Sciences of the USSR. He was the youngest member of the Academy. And in spite of such a great success he did not come back to his motherland in 1933. It was almost an escape! And he did not say good-bye! In1938 Academicians had to expel Gamov from the Academy under the government pressure. Indeed, extraordinary personalities cannot be attested according to the conventional public standard!

Under these conditions Gamov displayed a great flair and forethought! It was on the eve of political public purges, confessions and self-accusations, just before the shattering of science and culture! The horrible period of Solovki, Siberian camps and mass repressions! He realized that his nobiliary origin and friendship with "bourgeois" physicists would be remembered to him, and first of all his independence, intellectuality, his sparkling wit, a love for freedom and scientific creation.

If he had not made that step, we would not have a chance of speaking about Gamov as a creator of Hot Universe theory (or Big Bang theory), and about his prediction of microwave radiation, that was discovered in 1965 (15 years after his prediction) at Gamov's live, and about Gamov's pioneer work on finding the clue to solve the structure of universal genetic code (1953), when genetics itself as a science was considered as "a sale whore of imperialism" in his homeland. But the fate placed everything in the place. Already at the time of his life Gamov enjoyed recognition of his scientific achievements and predictions, tasted nectar of immortality!

Just the same words can be said about Mendeleev - they both are classics of science!

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