Structure and properties of atomic nuclei in the theory of compressible oscillating ether

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Abstract. In the work, based on the equations of the compressible oscillating ether, derived from the laws of classical mechanics, ether mathematical models of the nuclei of atoms of chemical elements are constructed. It is shown that the nucleus of any atom is a superposition of perturbation waves of ether density in several protons and several neutrons, having a common center and propagating around a common axis in one direction or in opposite directions, that is, having unidirectional or oppositely directed spins. Formulas for the values of internal energies, masses, magnetic moments, and binding energies of atomic nuclei are derived, with an accuracy of fractions of a percent coinciding with their experimental values. Formulas for calculating the radii of atomic nuclei are obtained. Answers are given to many topical questions about the structure of atomic nuclei that modern atomic physics is not capable of answering, for example: why there are no nuclei consisting only of protons or only of neutrons; what is the nature of the nuclear forces holding together protons and neutrons in the nucleus; why the sizes of atomic nuclei practically do not depend on the atomic number of the chemical element; why the Coulomb barrier of the nucleus selectively works; why the fragments of the decomposition of heavy elements into two nuclides are asymmetric; what is the reason for the different percentage in nature of different isotopes of the same chemical element?

1. Introduction

The main structural elements of matter in the theory of compressible oscillating ether [1-2] proposed by the author are protons and electrons, which have equal in magnitude (q) but opposite in sign charges. These particles, together with their antiparticles (antiproton and positron), are spherical wave solutions of the system of equations of ether, generated by half-waves of folded photons and have Compton radii \( r_{e,p} \) such that \( 2\pi r_{e,p} \) are equal to the Compton wavelengths \( \frac{2\pi \hbar}{m_{e,p} c} \) of the particles, and the waves of the particles have constant angular velocities of distribution inside their balls. Hence the proton ball radius is approximately 1836 times less than the electron ball radius, moreover, the ether inside the proton is slightly compressed, and it is slightly sparsed inside the electron compared to the unperturbed ether of constant density \( \rho_0 \). The waves of ether density perturbations in proton and electron can interact in two ways: having unidirectional or oppositely directed spins. Neutron is an interaction (imposition) of the electron and proton waves with unidirectional spins and their combination with oppositely directed spins is the hydrogen atom (see [1]). Thus, neutron consists of compressed electron and proton, the charge of which is equal to the sum of their charges and,
therefore, is zero. The values of energies, magnetic moments, charges and masses of electron, proton and neutron calculated by the ether formulas have coincided with an inaccuracy of less than 0.2%, with the experimental so-called “anomalous” their values (see [1]). Between the radii of the neutron and proton there is a relationship \[ p_{nn} = \frac{8\pi}{9} \mu_N = 2.792526 \mu_N, \quad p_{pp} = \beta_p \mu_N = 1.7993895(r_P/r_p)\mu_N = -1.9154 \mu_N, \] (1.1)
where \( \mu_N = qr_P/2 \) is the nuclear magneton in the CGS system; and their internal energies are inversely proportional to their radii
\[ \varepsilon_p = \hbar \omega_p = \hbar c/r_p, \quad \varepsilon_n = 1.0659824 \hbar \omega_n = 1.0659824 \hbar c/r_n. \] (1.2)
And the most important thing is that the ether inside the neutron is also slightly sparsed as inside the electron, so the purpose of neutrons in the nucleus of chemical element is to remove the excess compression of the ether caused by the protons. So, a limited number of neutrons should be present in the nucleus of the atom, and their number should increase with the number of protons.

In the present work, ether mathematical models of the nuclei of atoms of chemical elements are constructed. It is shown that the nucleus of any atom is a superposition of perturbation waves of ether density in several protons and several neutrons, having a common center and propagating around a common axis in one direction or in opposite directions, that is, having unidirectional or oppositely directed spins. Answers are given to many topical questions about the structure of atomic nuclei that modern atomic physics is not capable of answering, for example: why there are no nuclei consisting only of protons or only of neutrons; what is the nature of the nuclear forces holding together protons and neutrons in the nucleus; why the sizes of atomic nuclei practically do not depend on the atomic number of the chemical element; why the Coulomb barrier of the nucleus selectively works; why the fragments of the decomposition of heavy elements into two nuclides are asymmetric; why there is no stable nucleus \(^{8}\text{Be}\); what is the reason for the different percentage in nature of different isotopes of the same chemical element; what determines the half-life of unstable elements; is the synthesis of new chemical elements possible?

2. Ether theory of the atomic nucleus
The nucleus of any atom is a superposition (imposition) of perturbation waves of ether density in several protons and several neutrons having a common center and propagating around the common axis in the same direction or in opposite directions, i.e. having unidirectional or oppositely directed spins. This explains the approximate equality of the sizes of all atomic nuclei. In this case, the radii of protons and neutrons entering into atomic nuclei can vary slightly, providing resonance relations between their frequencies. Thus, any atom whose nucleus consists of M protons and N neutrons actually consists of N + M protons and N + M electrons, some of which (N) have unidirectional spins forming nuclear neutrons, and the other part (M) have oppositely directed spins, forming the so-called electron shell of the atom. This leads to the important conclusion that each electron of the electron shell is associated mainly with its own proton of nucleus.

2.1. Internal energies and magnetic moments of nuclei
Let the protons and neutrons have radii \( r_P \) and \( r_n \) in the nucleus. Let us denote \( \lambda_p = r_P/r_p, \lambda_n = r_n/r_p \), where \( r_p \) is the Compton radius of a free proton, for which \( \lambda_p = 1 \). In accordance with the formulas given above, the internal energy of a nucleon (proton or neutron) in the nucleus of an atom is proportional to its frequency, and the magnetic moment is proportional to its radius. Thus, for all the protons and neutrons of the nucleus, we have
\[ \varepsilon_p = \frac{\lambda_p}{\lambda_p}, \quad \varepsilon_p = \pm \lambda_p \beta_p = \pm \lambda_p \frac{8\pi}{9}, \quad \varepsilon_n = \frac{s}{\lambda_n} \varepsilon_p, \quad \varepsilon_n = \mp 1.7993895 \lambda_n, \] (2.1)
where \( s = (l + 1)/m = 727/682 = 1.0659824 \) [1]. Then, if the nucleus of an atom (any nuclide) consists of M protons and N neutrons, then its internal energy in MeV is
\[ \varepsilon = \sum_{i=1}^{M} \varepsilon_{p,i} + \sum_{j=1}^{N} \varepsilon_{n,j} = \sum_{i=1}^{M} \frac{\varepsilon_{p,i}}{\lambda_{p,i}} + \sum_{j=1}^{N} \frac{s\varepsilon_{n,j}}{\lambda_{n,j}} = (\sum_{i=1}^{M} \frac{1}{\lambda_{p,i}} + \sum_{j=1}^{N} \frac{s}{\lambda_{n,j}})\varepsilon_{p} = (\sum_{i=1}^{M} \frac{1}{\lambda_{p,i}} + \sum_{j=1}^{N} \frac{s}{\lambda_{n,j}})938.342, \]

and its magnetic moment in nuclear magnetons is

\[ \beta = \sum_{i=1}^{M} \beta_{p,i} + \sum_{j=1}^{N} \beta_{n,j} = \sum_{i=1}^{M} (\pm \lambda_{p,i} \frac{8\pi}{9}) + \sum_{j=1}^{N} (\mp 1.7993895 \lambda_{n,j}), \]

where signs of the terms depend on the directions of proton and neutron spins, and \( \varepsilon_{p} = 938.342 = 938.272 \) with accuracy less than 0.01%. The task of the ethereal description of all nuclides of the periodic Mendeleev’s table consists in finding the quantities \( \lambda_{p,i} \) and \( \lambda_{n,j} \) such that the values of the energies of the nuclides and the binding energies of the nucleons in the nuclei would exactly coincide with their experimental values, and the errors in calculating the magnetic moments of nuclei would be fractions of a percent. The experimental data used in the work are taken from [4–8].

2.2. Ethereal models of the simplest nuclei.

The simplest nuclei of the Mendeleev’s periodic table of chemical elements, consisting of protons and neutrons, are deuteron, triton, helion and an \( \alpha \)-particle (except for the ether element Newtonium [3]).

The free deuteron (d) consists of a proton and a neutron having unidirectional spins (the directions of rotation of the waves of perturbations of the ether density). Therefore, for the internal energy and magnetic moment of a free deuteron, the following expressions are valid:

\[ \varepsilon_{d} = \bar{\varepsilon}_{p} + \bar{\varepsilon}_{n} = \left( \frac{1}{\lambda_{p}} + \frac{s}{\lambda_{n}} \right)938.342, \quad \beta_{d} = \bar{\beta}_{p} + \bar{\beta}_{n} = \lambda_{p} \frac{8\pi}{9} - 1.7993895 \lambda_{n}. \]

Therefore, the structure of a free deuteron is determined uniquely from formulas (2.4). Equating the value of the energy of the deuteron, calculated by the formula (2.4), to its experimentally found value \( \varepsilon_{d} = 1875.6128 \) (\( \varepsilon_{d} = \varepsilon_{\text{theor}} - \varepsilon_{\text{bindin}} = 1877.83738 - 2.22457 \)) and assuming that \( \lambda_{n} = 29/27\lambda_{p} \), we get \( \lambda_{p} = 0.996802, \beta_{d} = 0.8571 \), that is different from the experimentally found value \( \beta_{d} = 0.8574 \) by 0.03%.

Triton (t) consists of two neutrons and one proton, i.e. it is formed by adding a neutron to a deuteron, and neutrons have oppositely directed spins. In this case, the deuteron is compressed, and the added neutron expands. Therefore, the following expressions are valid for the internal energy and magnetic moment of a triton:

\[ \varepsilon_{t} = \varepsilon_{p} + \varepsilon_{n} + \varepsilon_{\alpha} = \left( \frac{1}{\lambda_{p}} + \frac{s}{\lambda_{n}} + \frac{s}{\lambda_{\alpha}} \right)938.342, \quad \beta_{t} = \beta_{p} + \beta_{n} - \beta_{\alpha} = \lambda_{p} \frac{8\pi}{9} - 1.7993895 (\lambda_{n} - \bar{\lambda}_{n}). \]

Equating the value of the energy of the triton, calculated by the formula (2.5), to its experimentally found value \( \varepsilon_{t} = 2808.9205 \) and assuming that \( \lambda_{n} = 45/44\lambda_{p}, \lambda_{\alpha} = 25/22\lambda_{p} \), we get \( \lambda_{p} = 0.9956121, \beta_{t} = 2.98385 \), that is different from the experimentally found value \( \beta_{t} = 2.9788 \) by 0.17%.

Helion (h) consists of two protons and one neutron, i.e. it is formed by adding a proton to the deuteron, and the protons have oppositely directed spins. At the same time, the added proton expands and, therefore, the deuteron shrinks. Therefore, the following expressions are valid for the internal energy and magnetic moment of helion:

\[ \varepsilon_{h} = \varepsilon_{p} + \varepsilon_{n} + \varepsilon_{\alpha} = \left( \frac{1}{\lambda_{p}} + \frac{s}{\lambda_{n}} + \frac{1}{\lambda_{\alpha}} \right)938.342, \quad \beta_{h} = \beta_{p} - \beta_{n} = (\lambda_{p} - \bar{\lambda}_{n}) \frac{8\pi}{9} - 1.7993895 \lambda_{n}. \]
Equating the value of the energy of the helion, calculated by the formula (2.6), to its experimentally found value $\varepsilon_a = 2808.3912$ and assuming that $\lambda_p = 32/28 \lambda_p$, $\lambda_n = 27/28 \lambda_p$, we get $\lambda_n = \lambda_p = 0.9958348$, $\beta_a = -2.1252$, that is different from the experimentally found value $\beta_a = -2.1276$ by 0.17%.

It is much more difficult to determine the structure of a free $\alpha$-particle (the nucleus of the helium-4 atom). It consists of two equal deuterons having oppositely directed spins. Therefore, the following expressions are valid for the internal energy and magnetic moment of the alpha particle:

$$
\varepsilon_a = 2\varepsilon_p + 2\varepsilon_n = \left(\frac{2}{\lambda_p} + \frac{2b}{\lambda_n} \right)938.342 = 2 \left(1 + \frac{bs}{\lambda_a}\right)938.342, \quad \beta_a = 0, \quad (2.7)
$$

where $b = \lambda_p/\lambda_n$, $\lambda_n = \lambda_p$. First equation of (2.7) is an equation with two unknowns and, therefore, has infinitely many solutions. We will proceed from the fact that adding a proton to a neutron leads to a sparseness of the ether of a free neutron, that is, to an increasing in its radius, and also leads to the compression of the ether in a proton, that is, to a decreasing in its radius (as is the case in the deuteron). But since the ether in the deuteron is still compressed (less than in the free proton), the addition of the deuteron to the deuteron should lead to an increasing in the radius of the proton and its return to a state close to the state of the free proton, i.e. to $\lambda_a = 1$. Equating the value of the energy of the $\alpha$-particle, calculated by the formula (2.7), to its experimentally found value $\varepsilon_a = 3727.378$ and assuming that $b = \lambda_p/\lambda_n = 46/49$, taking into account the possibility of answering all the above questions, we get $2(1 + bs) = 4.0014362$, $\lambda_p = 1.00733428$, $\beta_a = 0$. Note that the ratio of the radius of a free proton to the radius of a free neutron is $\lambda_p/\lambda_n = 31/33 > 46/49$. Thus, we assume that for a free $\alpha$-particle $\lambda_p = \lambda_p = 1.00733428$. Naturally, the internal energy (mass) and the binding energy of free deuteron, triton, helium and $\alpha$-particle coincide exactly with their experimental values.

2.3. Structure of complex nuclei

All nuclei of atoms of chemical elements are divided into four groups: even-even nuclei consisting of even number of protons and even number of neutrons, odd-odd nuclei consisting of odd number of protons and odd number of neutrons, even-odd nuclei consisting of even number of protons and odd number of neutrons; and odd-odd nucleus consisting of odd number of protons and even number of neutrons. We formulate the following hypothesis, the best confirmation of which is the coincidence of the obtained results and conclusions with experimental data:

- any even-even nucleus consists either of only $\alpha$-particles, or of $\alpha$-particles and several pairs of neutrons with opposite spins, or of $\alpha$-particles and several pairs of protons with opposite spins;
- any odd-odd nucleus consists of an even-even nucleus, and a deformed deuteron;
- any odd-even nucleus consists of an even-even nucleus and a deformed triton;
- any even-odd nucleus consists of an even-even nucleus and a deformed helion.

In this paper, only even-even nuclei of atoms of all chemical elements are considered. Such nuclei have zero magnetic moments, which is experimentally established and immediately follows from formulas (2.3), if we assume that each pair of protons or neutrons in an even-even nucleus have equal radii and oppositely directed spins, which makes the magnetic moment of such a pair equal to zero. We will proceed from the assumption that in addition to such pairs of protons and neutrons, any even-even nuclide contains a certain number of $\alpha$-particles, and the radii of the protons and neutrons of all the $\alpha$-particles are the same for a particular nucleus, but may differ in different nuclei, which is determined by different ether stress for different nuclides with different charges and different atomic weights. In other words, the values of $\lambda$ and $b$ in $\alpha$-particles of the nuclei of atoms of chemical elements may slightly differ from the values of $\lambda_a = 1.00733428$ and $b_a = 46/49$ for free $\alpha$-particle, the radii of additional protons must coincide with the radii of protons in $\alpha$-particles, and the ratio $c$ of
the radius of protons of $\alpha$-particles to radius of additional neutrons may also differ slightly from their ratio $b$ in free $\alpha$-particle. The point of consideration of initially even-even nuclei is that, firstly, their structure is much simpler than the structure of other nuclei, and, secondly, they are the core of the entire table of chemical elements, and therefore determine all the basic properties of the table. That is, knowing the structure of such nuclei and the principles of their organization, one can understand how the whole table is arranged, and what answers may be to the questions posed in the introduction. It is obvious that the remaining nuclei (odd-odd, even-odd, and odd-even) are intermediate among even-even nuclei.

It follows from (2.2), (2.7) that in the case of the presence of additional neutrons in the nuclide, the value $\lambda$ can be found from experimental data using the formula

$$\lambda = (2(1+bs)m + 2csk)938.342/\varepsilon,$$

(2.8)

where $m$ is the number of $\alpha$-particles in the nucleus, $k$ is the number of pairs of additional neutrons, $\varepsilon = \varepsilon_T - \varepsilon_{\text{b,exp}}$ is the nuclear energy in MeV, $\varepsilon_T$ is the theoretically calculated value of the nuclear energy, based on the experimental values of the energies of free protons (938.272) and neutrons (939.5654) that are part of the nucleus, and $\varepsilon_{\text{b,exp}}$ is the experimental value of the binding energy of protons and neutrons in the nucleus. In the case of the presence of additional protons in the nuclide, the value $\lambda$ is found from the experimental data using the formula

$$\lambda = (2(1+bs)m + 2k)938.342/\varepsilon,$$

(2.9)

where $m$ is the number of $\alpha$-particles in the nucleus, $k$ is the number of pairs of additional protons.

3. Ethereal structure and properties of even-even nuclei

Below the values of $\lambda$ are presented, calculated by formulas (2.8) - (2.9) for the main even-even nuclei of stable and unstable isotopes of the chemical elements of the Mendeleev’s periodic table. The index of the value of $\lambda$ means the atomic number of the isotope of the considered element. The values $\lambda$ for unstable isotopes are given in italics. The values $\lambda$ for the nuclei of isotopes with the highest percentage in nature among the stable isotopes of a given element, or for the isotopes that have the longest half-life for unstable elements, are highlighted in bold.

3.1. Nuclei of elements with stable isotopes.

$^4\text{Be}$ (b = 46/49, c = 30/32): $\lambda_8 = 1.004657$, $\lambda_{10} = 1.007322$, $\lambda_{12} = 1.005317$. Beryllium has no stable even isotopes. The only stable isotope of beryllium is $^9\text{Be}$. The value $\lambda$ for the nuclide $^9\text{Be}$ almost coincides with the value for the free $\alpha$-particle, which means the impossibility of the stable state of the given nuclide and its instantaneous decay into two $\alpha$-particles.

$^6\text{C}$ (b = 46/49, c = 30/32): $\lambda_8 = 1.007221$, $\lambda_{10} = 1.006726$, $\lambda_{12} = 1.007999$, $\lambda_{14} = 1.007573$, $\lambda_{16} = 1.006743$. The value $\lambda$ for the nucleus $^6\text{C}$ is much larger than the value for a free $\alpha$-particle, which ensures the stability of the structure of a nuclide consisting of three $\alpha$-particles. At the same time, the value $\lambda$ for the nucleus $^6\text{C}$ is close to the value $\lambda$ for the free proton, which explains the yield of two protons in the decay of this nucleus. Isotope $^6\text{C}$ has the maximum percentage in nature of 98.93%.

$^8\text{O}$ (b = 46/49, c = 30/32): $\lambda_{12} = 1.005079$, $\lambda_{14} = 1.006852$, $\lambda_{16} = 1.008311$, $\lambda_{18} = 1.007895$, $\lambda_{20} = 1.007528$. The value $\lambda$ for the nucleus of the nuclide $^8\text{O}$ slightly exceeds the threshold of stability with respect to $\alpha$-decay, that is approximately $\lambda = 1.00789$, what follows from an analysis of
the structure of unstable elements, starting with thorium $\alpha$Th (see sec.3.2). Therefore, oxygen has two stable isotopes $^{16}O$ and $^{18}O$ with a percentage in nature of 99.757% and 0.205%.

$^{10}$Ne (b = 46/49, c = 30/32): $\lambda_{18} = 1.006348$, $\lambda_{19} = 1.007661$, $\lambda_{20} = 1.008371$, $\lambda_{22} = 1.008268$, $\lambda_{24} = 1.008044$. Isotope $^{20}$Ne has the maximum percentage in nature of 90.48%.

$^{12}$Mg (b = 46/49, c = 30/32): $\lambda_{12} = 1.008801$, $\lambda_{24} = 1.008619$, $\lambda_{26} = 1.008567$, $\lambda_{28} = 1.008387$. Isotope $^{24}$Mg has the maximum percentage in nature of 78.99%.

$^{14}$Si (b = 46/49, c = 30/32): $\lambda_{18} = 1.008281$, $\lambda_{28} = 1.008822$, $\lambda_{30} = 1.008787$, $\lambda_{32} = 1.008645$. Isotope $^{28}$Si has the maximum percentage in nature of 92.2297%.

$^{16}$S (b = 46/49, c = 30/32): $\lambda_{30} = 1.008492$, $\lambda_{32} = 1.008871$, $\lambda_{44} = 1.008868$, $\lambda_{56} = 1.008770$, $\lambda_{58} = 1.008553$. Isotope $^{32}$S has the maximum percentage in nature of 94.93%.

$^{18}$Ar (b = 61/65, c = 31/33): $\lambda_{18} = 1.008412$, $\lambda_{36} = 1.008731$, $\lambda_{38} = 1.008860$, $\lambda_{46} = 1.008862$, $\lambda_{42} = 1.008841$. Isotope $^{40}$Ar has the maximum percentage in nature of 99.6003%, and the percentage in nature of the stable isotope $^{36}$Ar is 0.337%.

$^{20}$Ca (b = 46/49, c = 30/32): $\lambda_{38} = 1.008614$, $\lambda_{46} = 1.008934$, $\lambda_{42} = 1.008923$, $\lambda_{44} = 1.008894$, $\lambda_{46} = 1.008838$, $\lambda_{48} = 1.008774$. Isotope $^{40}$Ca has the maximum percentage in nature of 96.941%.

$^{22}$Ti (b = 46/49, c = 30/32): $\lambda_{44} = 1.008915$, $\lambda_{46} = 1.008974$, $\lambda_{48} = 1.008978$, $\lambda_{50} = 1.008951$, $\lambda_{52} = 1.008823$. Isotope $^{44}$Ti has the maximum percentage in nature of 73.72%.

$^{24}$Cr (b = 46/49, c = 30/32): $\lambda_{48} = 1.008957$, $\lambda_{50} = 1.009028$, $\lambda_{52} = 1.009046$, $\lambda_{54} = 1.008990$, $\lambda_{56} = 1.008876$. Isotope $^{52}$Cr has the maximum percentage in nature of 83.789%.

$^{26}$Fe (b = 46/49, c = 30/32): $\lambda_{52} = 1.008997$, $\lambda_{54} = 1.00907104$, $\lambda_{56} = 1.00907107$, $\lambda_{58} = 1.009018$, $\lambda_{60} = 1.008928$. Isotope $^{56}$Fe has the maximum percentage in nature of 91.754%.

$^{28}$Ni (b = 46/49, c = 30/32): $\lambda_{56} = 1.009033$, $\lambda_{58} = 1.00907111$, $\lambda_{60} = 1.009069$, $\lambda_{62} = 1.009033$, $\lambda_{64} = 1.008966$. Isotope $^{58}$Ni has the maximum percentage in nature of 68.0769%, and percentage in nature of the stable isotope $^{56}$Ni is 0.9256%.

The results obtained allow us to draw the following important conclusions. First, the greater the value $\lambda$ and the further it is separated from the threshold of stability relatively to the $\alpha$-decay ($\lambda = 1.00789$), the stronger the external pressure of the ether on the nucleus and, therefore, it is more stable. Therefore, the values $\lambda$ of stable isotopes of any chemical element lie in the vicinity of the maximum by $n$ of the curve $\lambda = \lambda(p,n)$ for a given element, with the maximum value corresponding to the isotope with the highest percentage in nature, and any unstable isotope has the value $\lambda$ less than any stable isotope (with the rare exception of isotopes with a percentage in nature, less than 1%, which can be explained by the errors in calculations and in experimental data on the measurement of the percentage of isotopes in nature). In addition, due to the pressure of the ether, isotopes with a large value $\lambda$ have a large specific binding energy, which is maximum for nickel isotopes. Secondly, all even-even nuclei from helium to nickel (with the exception of argon) have the same parameter values $(b,c)$, which explains the location of the curve of stable nuclides of these elements in a plane $(n,p)$ along a straight line. A decrease in the value of $b$ starting with zinc and with the transition to $b = 30/32$, and an increase in the value of $c$ cause a gradual departure of the stable nuclides curve in the plane $(n,p)$ from the straight line. This also explains the asymmetry of the fission fragments of heavy nuclei $\alpha$Th $\rightarrow \alpha$Cf (see sec. 3.2).
| Isotope | Percentage in nature of stable isotope | Isotope | Percentage in nature of stable isotope |
|---------|---------------------------------------|---------|---------------------------------------|
| $^{30}\text{Zn}$ | $\lambda_{62} = 1.008702$, $\lambda_{64} = 1.008735$ | $^{32}\text{Ge}$ | $\lambda_{72} = 1.008629$, $\lambda_{76} = 1.008671$, $\lambda_{74} = 1.0087$, $\lambda_{76} = 1.008694$, $\lambda_{78} = 1.008666$. Isotope $^{34}\text{Se}$ has the maximum percentage in nature of 36.28%. |
| $^{34}\text{Se}$ | $\lambda_{72} = 1.008384$, $\lambda_{74} = 1.008446$, $\lambda_{76} = 1.008487$, $\lambda_{78} = 1.008508$, $\lambda_{80} = 1.008513$, $\lambda_{82} = 1.008507$, $\lambda_{84} = 1.008482$. Isotope $^{80}\text{Se}$ has the maximum percentage in nature of 49.61% and percentage in nature of the stable isotope $^{74}\text{Se}$ is 0.89%. |
| $^{36}\text{Kr}$ | $\lambda_{58} = 1.008313$, $\lambda_{78} = 1.008368$, $\lambda_{80} = 1.008403$, $\lambda_{82} = 1.008422$, $\lambda_{84} = 1.008430$, $\lambda_{86} = 1.008424$, $\lambda_{88} = 1.008365$. Isotope $^{84}\text{Kr}$ has the maximum percentage in nature of 57.00%. |
| $^{38}\text{Sr}$ | $\lambda_{42} = 1.008335$, $\lambda_{56} = 1.008386$, $\lambda_{68} = 1.00842$, $\lambda_{88} = 1.008446$, $\lambda_{80} = 1.008406$. Isotope $^{86}\text{Sr}$ has the maximum percentage in nature of 82.58%, and percentage in nature of the stable isotope $^{84}\text{Sr}$ is 0.56%. |
| $^{40}\text{Zr}$ | $\lambda_{38} = 1.00840$, $\lambda_{90} = 1.008459$, $\lambda_{92} = 1.008447$, $\lambda_{94} = 1.008425$, $\lambda_{96} = 1.00840$, $\lambda_{98} = 1.008345$. Isotope $^{90}\text{Zr}$ has the maximum percentage in nature of 51.45%. |
| $^{42}\text{Mo}$ | $\lambda_{90} = 1.008391$, $\lambda_{92} = 1.008486$, $\lambda_{94} = 1.008518$, $\lambda_{96} = 1.008535$, $\lambda_{98} = 1.00854$, $\lambda_{100} = 1.008531$. Isotope $^{92}\text{Mo}$ has the maximum percentage in nature of 24.13%. |
| $^{44}\text{Ru}$ | $\lambda_{98} = 1.008377$, $\lambda_{96} = 1.008404$, $\lambda_{100} = 1.008417$, $\lambda_{82} = 1.008418$, $\lambda_{104} = 1.008409$. Isotope $^{102}\text{Ru}$ has the maximum percentage in nature of 31.55%. |
| $^{46}\text{Pd}$ | $\lambda_{102} = 1.008358$, $\lambda_{104} = 1.008376$, $\lambda_{106} = 1.008384$, $\lambda_{108} = 1.008382$, $\lambda_{106} = 1.008373$, $\lambda_{112} = 1.008356$. Isotope $^{106}\text{Pd}$ has the maximum percentage in nature of 27.33%. |
| $^{48}\text{Cd}$ | $\lambda_{96} = 1.008309$, $\lambda_{108} = 1.008349$, $\lambda_{110} = 1.008349$, $\lambda_{112} = 1.00835$, $\lambda_{114} = 1.00835$, $\lambda_{116} = 1.008342$, $\lambda_{118} = 1.008327$. Stable cadmium isotopes $^{112}\text{Cd}$ and $^{116}\text{Cd}$ with an approximately equal maximum percentage in nature of 24.13% and 28.73% have approximately equal maximum values $\lambda$. Percentage in nature of the stable isotope $^{116}\text{Cd}$ is 1.25%. |
| $^{50}\text{Sn}$ | $\lambda_{112} = 1.008316$, $\lambda_{114} = 1.008341$, $\lambda_{116} = 1.008357$, $\lambda_{118} = 1.008365$, $\lambda_{120} = 1.008366$, $\lambda_{122} = 1.008362$, $\lambda_{124} = 1.008353$, $\lambda_{126} = 1.008349$. Isotope $^{120}\text{Sn}$ has the maximum percentage in nature of 32.58%, and percentage in nature of the stable isotope $^{124}\text{Sn}$ is 0.97%. |
| $^{52}\text{Te}$ | $\lambda_{120} = 1.008368$, $\lambda_{122} = 1.008390$, $\lambda_{124} = 1.00841$, $\lambda_{126} = 1.008415$, $\lambda_{128} = 1.00842$, $\lambda_{130} = 1.00842$. Stable tellurium isotopes $^{128}\text{Te}$ and $^{130}\text{Te}$ with an approximately equal maximum percentage in nature of 31.74% and 34.08% have approximately equal maximum values $\lambda$. Percentage in nature of the stable isotopes $^{128}\text{Te}$ and $^{130}\text{Te}$ are 0.99% and 2.55%. |
| Isotope | Percentage | Nature of Isotope |
|---------|------------|------------------|
| Xe (b = 30/32, c = 31/33) | 1.008255 | Has the maximum percentage in nature of 26.89% |
| Ba (b = 30/32, c = 31/33) | 1.008247 | Has the maximum percentage in nature of 71.698% |
| Ce (b = 30/32, c = 78/83) | 1.008283 | Has the maximum percentage in nature of 88.45% |
| Nd (b = 30/32, c = 157/167 > 155/165 = 31/33) | 1.008273 | Has the maximum percentage in nature of 27.2% |
| Sm (b = 30/32, c = 157/167) | 1.008228 | Has the maximum percentage in nature of 3.07% |
| Gd (b = 30/32, c = 78/83) | 1.008125 | Has the maximum percentage in nature of 24.84% |
| Dy (b = 30/32, c = 47/50) | 1.008115 | Has the maximum percentage in nature of 31.83% |
| Er (b = 30/32, c = 78/83) | 1.008054 | Has the maximum percentage in nature of 35.08% |
| Yb (b = 30/32, c = 47/50) | 1.008050 | Has the maximum percentage in nature of 30.64% |
| Hf (b = 30/32, c = 157/167) | 1.007950 | Has the maximum percentage in nature of 40.78% |
| W (b = 30/32, c = 47/50) | 1.007974 | Has the maximum percentage in nature of 32.967% |
| Os (b = 30/32, c = 157/167) | 1.007950 | Has the maximum percentage in nature of 30.64% |
| Pt (b = 136/145 > 135/144 = 30/32, c = 78/83) | 1.008034 | Has the maximum percentage in nature of 29.86% |
| Hg (b = 136/145, c = 47/50) | 1.008052 | Has the maximum percentage in nature of 0.15% |
decay. Then we have for radon:

\[ \lambda_{220} = 1.0074248, \quad \lambda_{222} = 1.0074258, \quad \lambda_{210} = 1.0074256. \]

Among radium isotopes, the isotope \(^{226}\)Ra has the longest half-life of 1585 years which is longer than the half-life of the Californium isotope \(^{250}\)Cf, but less than the half-life of the curium isotope \(^{248}\)Cm (3.49 \times 10^5 years). Then we have for radium:

\[ \lambda_{220} = 1.0076127. \]

Among thorium isotopes, the isotope \(^{232}\)Th has the highest half-life of 1.4 \times 10^9 years. The value \(\lambda\) for this isotope should be close to the value \(\lambda = 1.00789\) of the threshold of the \(\alpha\)–decay. Then we have:

\[ \lambda_{230} = 1.0078875, \quad \lambda_{232} = 1.0078899, \quad \lambda_{234} = 1.0078896. \]

Among uranium isotopes, the isotope \(^{235}\)U has the highest half-life of 4.47 \times 10^6 years. The value \(\lambda\) for this isotope should also be close to the value corresponding to the threshold of the \(\alpha\)–decay, but less than for the isotope \(^{232}\)Th. Then we have for uranium:

\[ \lambda_{238} = 1.007846, \quad \lambda_{236} = 1.007843. \]

Among plutonium isotopes, the isotope \(^{244}\)Pu has the highest half-life of 7.9 \times 10^7 years. The value \(\lambda\) for this isotope should also be close to the value corresponding to the threshold of the \(\alpha\)–decay, but less than for the isotope \(^{238}\)Pu. Then we have for plutonium:

\[ \lambda_{240} = 1.0078073, \quad \lambda_{244} = 1.0078081, \quad \lambda_{246} = 1.0078066. \]

Among the even isotopes of curium, the isotope \(^{246}\)Cm has the highest half-life of 3.49 \times 10^5 years. The value for this isotope should be less than for the isotope \(^{244}\)Pu. Then we have for curium:

\[ \lambda_{248} = 1.0077668, \quad \lambda_{250} = 1.0077657. \]
Among the even isotopes of californium, the isotope $^{256}_{98}\text{Cf}$ has the highest half-life of 13 years. The value $\lambda$ for this isotope should be substantially less than for the isotope $^{248}_{96}\text{Cm}$, but a little more than for the isotope $^{268}_{100}\text{Po}$. Then we have for californium:

$\lambda_{256} = 1.0075824$, $\lambda_{258} = 1.0075849$, $\lambda_{258} = 1.0075834$.

Among the even isotopes of fermium, the isotope $^{252}_{100}\text{Fm}$ has the longest half-life of 1 day. The value $\lambda$ for this isotope should be substantially less than for the isotope $^{250}_{98}\text{Cf}$, and about the same as for the isotope $^{252}_{100}\text{Fm}$. Then we have for fermium:

$\lambda_{252} = 1.007432$, $\lambda_{252} = 1.007431$.

Among the even nobelium isotopes, the isotopes $^{254}_{102}\text{No}$ and $^{256}_{102}\text{No}$ have the highest approximately equal half-lives of 51 seconds and 1 minute although a maximum (2.78 hours) falls on the even-odd isotope $^{261}_{102}\text{No}$. The values $\lambda$ for these isotopes should be approximately equal and substantially less than for the isotope $^{252}_{100}\text{Fm}$. Then we have for nobelium:

$\lambda_{254} = 1.0073797$, $\lambda_{256} = 1.0073833$, $\lambda_{256} = 1.0073841$, $\lambda_{256} = 1.0073839$, $\lambda_{258} = 1.0073989$. Then we have for hassium:

$\lambda_{258} = 1.0074045$. For isotopes of hassium with large atomic numbers, experimental data are not available.

Among isotopes of rutherfordium, the isotope $^{266}_{105}\text{Rf}$ has the longest half-life of 10 hours. The value $\lambda$ for this isotope should be a little less than for the isotope $^{253}_{105}\text{Fm}$. Then we have:

$\lambda_{264} = 1.0074206$, $\lambda_{266} = 1.0074237$, $\lambda_{268} = 1.0074212$.

Among the even isotopes of seaborgium, the isotope $^{272}_{106}\text{Sg}$ has the longest half-life of 1.1 hours. The value $\lambda$ for this isotope should be less than for isotopes $^{252}_{105}\text{Fm}$ or $^{266}_{105}\text{Rf}$. Then we have:

$\lambda_{272} = 1.0074052$. For isotopes of seaborgium with large atomic numbers, experimental data are not available.

Among isotopes of darmstadtium, the isotope $^{286}_{110}\text{Ds}$ has the longest half-life of 11 seconds. The value $\lambda$ for this isotope should be substantially less than for the isotope $^{276}_{108}\text{Hs}$. Then we have:

$\lambda_{276} = 1.0073989$, $\lambda_{276} = 1.0074045$. For isotopes of darmstadtium with large atomic numbers, experimental data are not available.

Among the even isotopes of copernicium, the isotope $^{296}_{112}\text{Cn}$ has the highest half-life of 30 seconds. The value $\lambda$ for this isotope should be slightly less than for the isotope $^{286}_{108}\text{No}$ and greater than for the isotope $^{286}_{110}\text{Ds}$. Then we have for copernicium:

$\lambda_{294} = 1.0073721$. For isotopes of copernicium with large atomic numbers, experimental data are not available.

Among the even isotopes of flerovium, the isotope $^{306}_{114}\text{Fl}$ has the longest half-life of 2.8 seconds. Then we have:

$\lambda_{306} = 1.0073365$, $\lambda_{308} = 1.0073521$. For isotopes of flerovium with large atomic numbers, experimental data are not available.

Among isotopes of livermorium, the isotope $^{320}_{116}\text{Lv}$ has the longest half-life of 18 milliseconds. The value $\lambda$ for this isotope should be close to the value $\lambda = 1.0073343$ for a free $\alpha$–particle. Then we have:
\[ L^\nu \left( b = \frac{76}{81} > 75/80 = \frac{30}{32}, c = \frac{125}{133} \right) \quad \lambda_{290} = 1.0073305, \quad \lambda_{292} = 1.0073396. \] For isotopes of livermorium with large atomic numbers, experimental data are not available.

The only synthesized even isotope of oganesson \( \frac{280}{116} \text{Os} \) has a half-life of about 1 millisecond, but experimental data on the binding energy of nucleons in the nucleus of the isotope are missing. One can only assume that the value \( \lambda \) for this isotope lies in a narrow neighborhood of the value \( \lambda = 1.0073343 \) for a free \( \alpha \)-particle.

It follows from the obtained results that the isotopes of chemical elements \( \text{Zr} \rightarrow \text{Se} \) and also \( \text{Th} \rightarrow \text{Ds} \) have the same value \( b = 30/32 \). In addition, the elements \( \text{Th} \rightarrow \text{Cm} \) have the same value \( c = 32/34 \), the element \( \text{Cf} \) has the value \( c = 95/101 \) and the elements \( \text{Ru} \rightarrow \text{Cd} \) have the same value \( c = 139/148 \). Consequently, in the case of independent fission of heavy elements \( \text{Th} \rightarrow \text{Cf} \), the appearance of a light fragment with \( Z \leq 28 \) is almost impossible, and the probability of its appearance with \( 29 \leq Z \leq 33 \) is very small, since these elements have a value \( b \) different from its value in the fissionable heavy nucleus. The probability of the appearance of heavy fragments with \( Z > 56 \) during decay of \( \text{Th} \) and with \( Z > 64 \) during decay of \( \text{Cf} \) is also very small. In turn, the probability of decay into two fragments with \( 34 \leq Z \leq 64 \) will depend on the probability of the transition of additional neutrons of heavy elements from the state with \( c = 32/34 \) or \( c = 95/101 \) to the state of a free neutron with \( c = 31/33 \) and then to the state that the elements with \( 34 \leq Z \leq 64 \) have. The probability of such a transition is equal to one for \( \text{Sn} \rightarrow \text{Xe} \rightarrow \text{Ba} \), high for \( \text{Kr} \rightarrow \text{Sr} \rightarrow \text{Zr} \rightarrow \text{Te} \), less high for \( \text{Se} \rightarrow \text{Mo} \rightarrow \text{Ce} \rightarrow \text{Cd} \), small for \( \text{Nd} \rightarrow \text{Sm} \) and very insignificant for \( \text{Ru} \rightarrow \text{Pd} \rightarrow \text{Cd} \). Consequently, the most probable decay will occur into fragments with \( 36 \leq Z \leq 40 \) and \( 50 \leq Z \leq 56 \) and the probability of fission of heavy nuclei \( \text{Th} \rightarrow \text{Cf} \) into two symmetric fragments with \( 45 \leq Z \leq 49 \) is very small. However, the nuclei of the fermium isotopes \( \text{Fm} \) can obviously be divided into two symmetric fragments.

4. Conclusion and consequences

In the work, based on the equations of compressible oscillating ether, derived from the laws of classical mechanics, ether mathematical models of even-even nuclei of atoms of chemical elements are constructed. Formulas for the internal energies, masses, magnetic moments, and binding energies of atomic nuclei are derived. Formulas for calculating the radii of atomic nuclei are obtained.

It is proven that the ether inside the proton is slightly compressed, and inside the neutron it is slightly rarefied, from where the intended purpose of nature of neutrons in the atomic nucleus follows - to remove the excess compression of the ether caused by protons. Therefore, nuclei consisting of only protons or of only neutrons cannot exist, and a limited number of neutrons must be present in the nucleus of an atom, and their number should increase with increasing number of protons. An excess of neutrons in any particular isotope causes excessive compression of the ether, which is removed by \( \beta^- \)-decay or electron capture, converting one of the protons into a neutron. On the other hand, an excess of neutrons in any particular isotope causes excessive rarefaction of the ether, which is removed by \( \beta^- \)-decay, converting one of the neutrons into a proton. This explains the picture of the location of stable and unstable nuclides in the plane \((p, n)\), fully confirmed by the above calculations using the ether formulas.

Any nuclide is arranged as a head of cabbage, being a superposition of proton and neutron wave balls having a common centre and a common axis of rotation of the waves of perturbations of ether density. Therefore, the sizes of atomic nuclei practically do not depend on the atomic number, but, as shown above, they slightly change under the influence of tensions in the ether, first increasing slightly, and then decreasing with increasing number of neutrons for a fixed number of protons, as well as with increasing number of protons for a fixed number of neutrons. At the same time, the approaching of the
proton radius of the nucleus to the radius of the free proton leads to proton decay, the approaching of the radii of the protons of the nuclear $\alpha$–particles to the radius of the free $\alpha$–particle leads to $\alpha$–decay, and the approaching of the radii of the neutrons of the nucleus to the free neutron radius causes neutron decay. In this regard, it can be argued that the discovery of new chemical elements is unlikely, since the radii of the protons of the $\alpha$–particles of livermorium and oganesson are already close to the radius of the free $\alpha$–particle, and the nuclei of such particles cannot exist (see the example of the $^{11}_{4}Be$ nucleus). Although there is a hypothetical probability of a jump-like transition through the barrier $\lambda = \lambda_{\alpha} = 1.0073343$ to the existence of islands of stability of chemical elements with substantially large atomic numbers and radii of protons of $\alpha$–particles lying in the interval $1 < \lambda \ll \lambda_{\alpha}$.

It follows also from the obtained results, that the nuclei of the most stable isotopes of any element have a maximum value $\lambda_{\text{max}}$ in the vicinity of which the values $\lambda$ of other stable isotopes are located. The stability of a nuclide means an approximate equality at a given $\lambda$ stresses of the ether inside the protons and outside the neutrons of the nuclide, that is, where the ether is slightly compressed. Outside the protons, but inside the neutrons of the nuclide, the ether is slightly sparse, and, therefore, the compression of the ether outside the nuclide puts pressure on the nuclide from the outside. These are the very nuclear forces that keep protons and neutrons together in the nucleus of an atom, that is, the nuclear forces are the forces of compressed ether. Therefore, nuclear forces are solely products of the ether and do not exist without it. In addition, it also follows from the obtained results that non-Coulomb, namely, nuclear forces are an obstacle to the absorption of a free proton or a free $\alpha$–particle, and the closer the value $\lambda$ in nuclide is to the values $\lambda_{\alpha}$ or $\lambda_{p}$, the easier it will be for the absorption of an $\alpha$–particle or proton, that is experimentally confirmed by the absorption of $\alpha$–particles by the nucleus $^{9}_{4}Be$. It is likely that the Coulomb forces are not an obstacle in nuclear interactions at all, and the Coulomb barrier simply does not exist.

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