The atomic structure of chemical elements in the theory of compressible oscillating ether

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Abstract. Previously, the basic laws and equations of electrodynamics, atomic nuclei, elementary particles theory and gravitation theory were derived from the equations of compressible oscillating ether. In this work, the theory of atomic structure for all chemical elements is constructed. A formula for the values of the energy levels of the electrons of an atom, which are the values of the energies of binding of electrons with the nucleus of an atom in the ground unexcited state, is derived from the equations of the ether. Based on experimental data on the ionization energies of atoms and ions, it is shown that the sequence of values of the energy levels of electrons has jumps, exactly corresponding to the periods of the table of chemical elements. It is concluded that it is precisely these jumps, and not quantum-mechanical rules, prohibitions and postulates that determine the periodicity of the properties of chemical elements. Ethereal correction of the table of chemical elements is presented which returns it to the form proposed by D.I. Mendeleev.

1. Introduction
According to the modern quantum-mechanical model of the structure of the atom, an electron in an atom, which has a point size, can move around the nucleus of an atom only in a random way, being inside an electron cloud (orbital), which has a certain shape and size and corresponds to certain energy of the electron. Geometrically, the orbital is set by solving the Schrödinger equation for a given atom and is characterized by principal \( n \), orbital \( l (l = 0,1, ..., n - 1) \) and magnetic \( m_l \) \( (m_l = -l, ... ,0, ... ,l) \) quantum numbers. The set of electrons of an atom with a given value of the principal quantum number \( n \) forms an electron layer or energy level. Electronic energy levels are designated by numbers 1, 2, 3,..., \( n \). The set of electrons with given values of \( n \) and \( l \) forms an electronic sublevel. The total number of orbitals of the type \( l \) sublevel is \( 2l + 1 \). It is postulated in accordance with Pauli’s principle that there can be no more than two electrons in each orbital. Thus, under the assumptions made, at each energy level \( n \) there can be \( 2n^2 \) electrons. That is, on the first energy level there can be 2 electrons, on the second - 8, on the third - 18, on the fourth - 32 electrons. And since the number of electrons in an atom is equal to the charge of the atomic nucleus, this design is formally, but quite well suited to describe the periodicity of the properties of all 118 chemical elements currently known. Indeed, the first period of Mendeleev’s table of chemical elements contains two elements, the second and third periods contain 8 elements each, the fourth and fifth periods contain 18 elements each, and the sixth and seventh periods contain 32 elements each.
However, such a quantum-mechanical explanation of the structure of atoms of chemical elements is, in principle, incorrect, primarily because the electron is not a point object, but has dimensions three orders of magnitude larger than the dimensions of the atomic nucleus. As a result, the electron cannot revolve around the nucleus of the atom and, therefore, in the atom, in principle, neither electron orbits nor orbitals can exist. In addition, the characteristics of a deterministic electron in an atom cannot depend on quantum numbers, which are a consequence of the solution of the physically meaningless Schrödinger equation, and the energy levels of electron cannot be characteristics of the electron themselves, since they take on sufficiently small and, moreover, negative values compared to the electron energy. The futility of applying the methods of quantum mechanics to describe chemical processes arising from the properties and structure of the electron shells of atoms has been recognized in recent decades by many prominent scientists. For example, in [1], numerous inconsistencies were noted that occur when explaining chemical phenomena in the framework of quantum chemistry. In addition, it is stated that "ideal coincidences of quantum-chemical calculations with experimental data indicate not the correctness of the theory, but about the unlimited adjustable computational possibilities of quantum chemistry."

The aim of the work is to propose another, more reasonable approach to describing the structure of the atom and explaining the periodicity of the properties of chemical elements, based on the theory of compressible oscillating ether [2-6] and known experimental data on spectra of atoms of chemical elements beginning from the hydrogen atom.

2. Structure and spectra of the hydrogen atom

Modern theoretical physics describes the hydrogen atom by the Schrödinger equation, the basic equation of nonrelativistic quantum mechanics. The argument in favor of the applicability of the physically meaningless Schrödinger equation for describing the hydrogen atom and other hydrogen-like atoms is the experimentally confirmed fact that the difference between the energy levels of an electron obtained by solving the stationary Schrödinger equation coincides with the energy of the emitted photon when transition of a hydrogen atom from state \( n \) to state \( m \) with lower (negative) energy

\[
\hbar \nu = E_n - E_m = \frac{\alpha^2 E_e}{2} \left( \frac{1}{m^2} - \frac{1}{n^2} \right) = R \left( \frac{1}{m^2} - \frac{1}{n^2} \right), \quad n > m, \tag{2.1}
\]

where \( \alpha = q^2/\hbar c \approx 1/137 \) is the fine structure constant, \( E_e = \hbar \omega_e \) is the internal energy of an electron, \( R = \alpha^2 E_e/2 \) is the Rydberg's constant. At the same time, the Schrödinger equation explains neither the structure of the hydrogen atom, nor the essence of the processes of absorption and emission of photons by the atom, nor the reasons for the appearance of squares in the denominators of energy levels, nor the physical essence of the energy levels themselves. The equation itself does not follow from any more general physical laws and postulates a physically meaningless finding of an electron simultaneously in different areas of space. Electron is considered point like, which is incorrect, and energy levels are negative, which is also meaningless. In addition, as will be shown below, the Schrödinger equation does not fully describe the structure of even the simplest hydrogen atom, namely, its non-emitting hydrino states.

2.1. Etherial structure of hydrogen atom

Unlike a neutron, a hydrogen atom is a superposition of waves of perturbations of the ether density inside a proton and an electron with oppositely directed spins. That is, the centers of the electron and the proton in the hydrogen atom coincide, and the azimuthal waves of compression-rarefaction of the ether density move in them in opposite directions. This leads to the spinning of the electron in the atom with a decrease in its energy and an increase in its radius. The dimensions of an atom and its energy levels are determined by the energy levels of the binding of a proton with an electron. Therefore, the main thing in understanding the structure of the hydrogen atom and all other atoms is to correctly describe the bond of an electron with a proton in an atom, taking into account that not only
an electron is a point object, but has dimensions approximately 1836 times larger than the dimensions of a proton, which excludes the presence in the atom electronic orbits and orbitals.

The meaning of the bond between a proton and an electron in a hydrogen atom is that their electric fields become bound for all \( r > r_b \), where \( r_b \) is the bond radius. In this case, the total energy of the proton-electron system decreases by the value of the binding energy \( E_b \). There is no bond and the particles are free if the bond radius tends to infinity \( (r_b \to \infty) \). When an electron is bound with a proton, the electron spins up to the bond radius \( r_b (r_b \gg r_e) \) and the frequency \( \omega_b (\omega_b \ll \omega_e) \). It was shown in [2] that the energy \( E \) of an electron excited by a bond with arbitrary \( \omega \) and \( r \), including \( \omega_b \) and \( r_b \), can be written in the form

\[
E = \frac{\rho^2 \omega^2 \pi^2 V e r}{4} = \left( \frac{\hbar}{c} \right) \omega^2 r. \tag{2.2}
\]

For a free and excited electron \( r_e \omega_e = c = r_b \omega_b \) and, therefore, the energy of a free electron is equal to \( E_e = \hbar \omega_e \) and the energy of an excited electron is equal to \( E_b = \hbar \omega_b \). The radius of the ball \( r_b \) of an excited electron is the radius \( r_e \) of the hydrogen atom. Part of the energy of the wave of an excited electron in the form of the energy of a half-wave of a folded photon of a doubled period goes to the binding of a proton with an electron in the binding region \( r > r_b \), the other part is emitted into space by a photon with a binding energy \( E_b = \hbar \omega_{ph} \). Thus, a hydrogen atom in any bound state has the structure of two nested balls: a proton and an electron excited by a bond with a proton, the radius of which \( r_b \) is the radius of the atom.

In [2], an important formula was derived for the binding energy of an electron with a proton in a hydrogen atom in any of its states

\[
E_b = \hbar \omega_{ph} = \frac{q^2}{2r_b}. \tag{2.3}
\]

The lower the binding energy, the larger the size of the atom. The specific values of the quantities \( E_b, r_b, E_e, \omega_b \) and \( \omega_{ph} \) depend on the state in which the hydrogen atom is located.

2.2 **Ground state of the hydrogen atom.**

Let us denote the binding energy, the energy of the electron excited by the bond, the bond radius (the radius of the atom) and the bond frequency in the ground stable state of the hydrogen atom through \( E_1, E_e, r_1 \) and \( \omega_1 \). Let the energy of an excited electron in the ground state of a hydrogen atom decreased by a factor of \( \alpha \) in comparison with the energy of a free electron, where \( \alpha \ll 1 \) - is a constant to be determined. As in the ground stable state \( \omega_1 r_1 = c \), that is, an excited electron in the ground state retains the angular velocity \( \omega_1 \) of the azimuthal wave up to \( r \leq r_1 \), and the linear velocity of the azimuthal wave is equal to \( c \sin \theta \) for \( r > r_1 \), then we find from (2.2) that

\[
E_1^e = \hbar \omega_1 = a\hbar \omega_e = \left( \frac{\hbar}{c} \right) (a\omega_e)^2 \frac{r_e}{\alpha}, \tag{2.4}
\]

whence it follows that \( \omega_1 = a\omega_e, \quad r_1 = r_e / \alpha \).

We will assume that in the ground state of the hydrogen atom, along with the law of conservation of energy, the law of conservation of momentum must also be fulfilled. Then the momentum \( p_b \) lost by the proton-electron system and transferred by the electron to the emitted photon should be equal to the momentum \( p_e \) acquired by the proton-electron system and transferred to the excited electron by the proton-electron binding region at \( r > r_1 \), that is, the momentum of the packet of light waves of the excited electron in the binding region. The energy transferred by the electron to the emitted photon is equal to the binding energy \( E_1, p_b = \sqrt{2m_e E_1} \) and the momentum of the packet of light waves of the excited electron at \( r_1 < r < \infty \) is \( p_e = E_1^e/c = \hbar \omega_1/c \). Equating \( p_e = p_b \) we get
$$p_e = \frac{\hbar \omega_1}{c} = \frac{\hbar \alpha \omega_e}{c} = p_b = \sqrt{2m_e E_1} = \sqrt{2m_e \frac{q^2}{2r_1}} = \sqrt{\frac{\hbar \omega_e \alpha q^2}{c^2 r_e}} = \frac{\hbar \omega_e}{\sqrt{c}} \frac{\alpha q^2}{\sqrt{\hbar c}}. \quad (2.5)$$

From (2.5) we find that the coefficient $\alpha$ is a fine structure constant $\alpha = q^2/\hbar c$. Thus, the physical meaning of the fine structure constant $\alpha$ consists in the ratio of the energy of an electron excited by a bond with a proton, which forms a hydrogen atom in its stable state, to the energy of a free electron.

Substituting the found value of the bond radius $r_1 = r_e/\alpha$ into (2.3), we obtain the value of the binding energy $E_1$ of the hydrogen atom in the ground stable state, that is its ionization energy

$$E_1 = \frac{\alpha q^2}{2r_e} = \frac{\hbar^2 \omega_e}{2} = \frac{\alpha^2 E_e}{2} \approx 13.6 \text{ eV}, \quad r_1 = r_a = \frac{r_e}{\alpha} \approx 52.8 \cdot 10^{-10} \text{ cm}. \quad (2.6)$$

2.3. Excited and hydrino states of the hydrogen atom.

Let us rewrite the bond equation (2.3) for the binding energy $E_1$ in the form

$$E_1 = \hbar \omega^1_{ph} = \frac{\hbar^2 \omega_e}{2} = \frac{1}{2} \left( \frac{\hbar}{c} \right) \omega^2_{e} \frac{r_e}{2r_1}. \quad (2.7)$$

The binding energy is the half-wave energy of a doubled period folded photon. Consequently, the folded photon of the doubled period born in the ground state has the energy $2E_1 = \hbar \alpha^2 \omega_e$. Excited states of the hydrogen atom with a lower binding energy $E_n$ correspond to the states of an excited electron, in which the angular velocities of the waves of compression-rarefaction of the density of the ether in the angle come into resonance with the angular velocity of the wave in the ground state, i.e.

$$\omega_n = \frac{\omega_1}{n} = \left( \frac{\alpha}{n} \right) \omega_e.$$

In this case, as follows from (2.7), a double-period folded photon is born with the energy

$$2E_n = \left( \frac{\hbar}{c} \right) \omega^n_{e} \frac{r_e}{2} = \left( \frac{\hbar}{c} \right) \left( \frac{\alpha}{n} \right) \omega_e \frac{r_e}{2 r_n}. \quad (2.8)$$

From (2.8) we find the binding energy $E_n$ and the bond radius $r_n$, equal to the radius of the electron and the radius of the hydrogen atom $r_a$ in the $n$-th excited state

$$E_n = \frac{\alpha^2 E_e}{2n^2} = \frac{E_e}{2n^2} = \frac{\alpha^2 \omega_e}{2n^2} = \hbar \omega^n_{ph}, \quad r_n = r_a = \frac{r_e}{\alpha} n^2 = r_1 n^2. \quad (2.9)$$

Consequently, when a hydrogen atom moves to a higher excitation level with a lower binding energy and a larger atomic radius, additional energy is required, and when a hydrogen atom moves to a lower excitation level with a higher binding energy and a smaller atom radius, a certain amount of energy is released. This process of absorption-emission of photons by a hydrogen atom is obviously described by the formulas

$$\hbar \omega = E_m - E_n = \frac{\alpha^2 E_e}{2} \left( \frac{1}{m^2} - \frac{1}{n^2} \right) = R \left( \frac{1}{m^2} - \frac{1}{n^2} \right), \quad n > m, \quad (2.10)$$
with positive values of the binding energies $E_n > 0$ and with the replacement in (2.1) of $E_n - E_m$ by $E_m - E_n$.

Obviously, the angular velocities of the compression-extension waves of the ether density in excited electrons can enter into resonance with the angular velocity of the electron wave in the ground state not only when $\omega_n = \omega_1/n$, but also when $\omega_n = \omega_1 = n\alpha\omega_e$. Such states of the hydrogen atom are called hydrino states. The binding energies $E_n$ and the bond radii $r_n$ (atomic radii) in hydrino states are found by substituting $\omega_n = n\alpha\omega_e$ into equation (2.8)

$$2E_n = \left(\frac{\hbar}{c}\right)\omega_n^2 r_e = \left(\frac{\hbar}{c}\right)(n\alpha\omega_e)^2 r_e = \frac{q^2}{r_n^2}. \quad (2.11)$$

From (2.11) we find

$$E_n = \frac{n^2\alpha^2E_e}{2} = n^2E_1 = \frac{\hbar}{2}\left(\omega_b\right)^2 r_e = \frac{\hbar}{2}\left(\frac{\hbar}{\alpha}\right)\left(\frac{\alpha\omega_e}{n}\right)^2 r_e, \quad (2.12)$$

The transition of the hydrogen atom to the hydrino state with a smaller radius of the excited electron and a higher binding energy should be accompanied by a decrease in the energy of the hydrogen atom and, consequently, the release of energy into the external environment. Consequently, for a hydrogen atom in an unstable hydrino state, the process of absorption of a photon and a transition to a stable ground state should be natural. Thus, even if there is a possibility of a transition of a hydrogen atom to a hydrino state (for example, with the participation of catalysts, as suggested in [7]), the mechanism of this transition remains unclear. It is likely that the presence of dark matter in the Universe can be explained by its presence in the form of hydrogen atoms in a hydrino non-radiating (absorbing) state. Especially since, the hydrogen atom, along with the neutron, is the simplest structure of matter, formed by the superposition of waves of elementary structures of matter: a proton and an electron.

### 3. Spectra of many-electron atoms

Let now the atom contains $Z$ electrons and $l - 1$ electrons are removed from it, $l \leq Z$. Let us show first that the approach developed above to describe the hydrogen atom is also valid in the case of hydrogen-like atoms, when $l = Z$, where $Z$ is the charge of the atomic nucleus.

#### 3.1. Spectra of hydrogen-like atoms.

Indeed, if an atom (or ion) has one electron, and the nucleus of an atom has $Z$ protons, then this electron is bound to all $Z$ protons, and the energy levels of binding of an electron with a nucleus are expressed by the formula

$$E_{b,n} = \frac{Zq \cdot q}{2r_{b,n}} = \frac{1}{2}\left(\frac{\hbar}{c}\right)\left(\omega_{b,n}\right)^2 r_e = \frac{1}{2}\left(\frac{\hbar}{c}\right)\left(\frac{\alpha\omega_e}{n}\right)^2 r_e, \quad (3.1)$$

whence it follows that

$$r_{b,n} = \frac{q^2\alpha^2}{\hbar^2 Z\omega_e^2 r_e} = \frac{r_en^2}{\alpha^2 Z}; \quad E_{b,n} = \frac{Z^2\alpha^2\hbar}{2r_e n^2} = \frac{Z^2\alpha^2}{2r_e n^2} = \frac{Z^2E_H}{n^2}, \quad (3.1)$$

where $E_H = \alpha^2E_e/2 \approx 13.598 \text{eV}$ is the ionization energy of a hydrogen atom, that is, the binding energy of an electron with a proton (nucleus) in the ground unexcited state of the atom $r_H = r_e/\alpha \approx 52.8 \cdot 10^{-10} \text{cm}$ is the radius of the hydrogen atom. It was established experimentally long ago that formulas (3.1) for $n = 1$ describe the values of the ionization energies $E_1$ and the radii of all hydrogen-like atoms almost exactly. This directly follows from Table 1 below of the experimental values of the
ionization energies of atoms and ions taken from the NIST database [8]. The values lying on the main diagonal of Table 1, corresponding to the last electrons of each atom, almost exactly satisfy formula (3.1) for $n = 1$ and $Z = 1, \ldots, 10$: 13.5984; 54.418; 122.454; 217.719; 340.226; 489.662; 667.046; 871.410; 1103.118; 1362.2. However, it can be seen from Table 1 that with an increase in the values of the nucleus charge $Z$, a slight compression of an electron occurs with an increase in its frequency $\omega_e$ to a value of $\omega_{ez}$ and a decrease in its radius $r_e$ to a value of $r_{ez}$, so that the value of the electron energy $E_e = \hbar \omega_e$ in formula (3.1) should be replaced by a close value $E_{ez} = \hbar \omega_{ez}$ and formula (3.1) itself takes the form

$$ r_{b,n} = \frac{r_{ez} n^2}{a Z}; \quad E_{b,n} = \frac{Z^2 \alpha^2 \hbar c}{2 r_{ez} n^2} = \frac{Z^2 E_{ez}}{n^2}, \quad (3.2) $$

where $E_{ez} = \alpha^2 E_{ez}/2$, $E_1 = E_H$, $r_{ez} = r_e (E_H/E_{ez})$.

**Table 1.** Ionization energies $E_i$ of atoms and ions from H to Ne

| Element | Ionization Energy (eV) |
|---------|------------------------|
| H       | 13.598                 |
| He      | 24.587                 |
| Li      | 5.392 75.640 122.454  |
| Be      | 9.323 18.211 153.897 217.719 |
| B       | 8.298 25.155 37.931 259.375 340.226 |
| C       | 11.260 24.383 47.888 64.494 392.087 489.993 |
| N       | 14.534 29.601 47.449 77.474 97.890 552.072 667.046 |
| O       | 13.618 35.121 54.936 77.414 113.899 138.120 739.290 871.410 |
| F       | 17.423 34.971 62.708 87.140 114.243 157.165 185.186 953.911 1103.118 |
| Ne      | 21.565 40.963 63.45 97.12 126.21 157.93 207.276 239.099 1195.829 1362.2 |

The experimental values of $E_{ez}$ for $1 \leq Z \leq 108$ can be found by formula (3.2), using the values of the ionization energies $E_i$ of the last electrons of atoms of chemical elements with numbers $Z \leq 108$ given in the NIST database: $E_{ez} = E_{ij}/Z^2$. For example, for $Z = 18$ (argon) $E_{18} = 4426.22/18^2 = 13.66$, for $Z = 36$ (krypton) $E_{36} = 17936/36^2 = 13.84$, for $Z = 54$ (xenon) $E_{54} = 41299.71/54^2 = 14.16$. For $Z = 86$ (radon) $E_{86} = 112843.7/86^2 = 15.26$, for $Z = 108$ (hassium) $E_{108} = 194917/108^2 = 16.71$. Thus, formula (3.2) accurately describes the values of the ionization energies $E_i$ and the radii of all hydrogen-like atoms for all $1 \leq Z \leq 108$. For chemical elements with numbers $109 \leq Z \leq 118$ there is no data in the NIST database.

Let us now show that formula (3.2) also describes the spectra of all hydrogen-like atoms. This follows from tables 2,3. The experimental values of the excitation energies $E_{ex,n}$, which are necessary for the transition of an electron from the ground state to the $n$-th excited level, were taken from [8,9]. The $E_{ex,n}$ values presented in [9] with two decimal places are supplemented with a third digit from the NIST database. The obtained experimental values of $E_{ex,n}$ are presented in Table 2.
Table 2. Excitation energies \( E_{ex,n} \) of hydrogen-like atoms for \( l = Z \)

|          | Consecutive values of excitation energies \( E_{ex,n} \), eV |
|----------|----------------------------------------------------------|
| H        | 10.199 12.087 12.748 13.054 13.221 13.321 13.386 13.431 |
| He II    | 40.813 48.371 51.017 52.241 52.906 53.307 53.567 53.746 |
| Li III   | 91.84 108.848 114.80 117.556 119.053 119.955 120.541 120.943 |
| Be IV    | 163.285 193.527 204.111 209.011 211.671 213.276 214.317 215.031 |
| B V      | 255.161 302.422 318.963 326.618 330.776 333.284 334.911 336.026 |
| C VI     | 367.474 435.547 459.37 470.395 476.384 479.995 482.339 483.945 |
| N VII    | 500.247 592.927 625.359 640.369 648.521 653.436 656.627 658.814 |
| O VIII   | 653.503 774.582 816.952 836.561 847.211 853.632 857.799 860.656 |
| F IX     | 827.251 980.541 1034.182 1059.005 1072.486 1080.615 1085.89 1089.506 |
| Ne X     | 1021.518 1210.833 1277.076 1307.729 1324.377 1334.414 1340.928 1345.393 |

Table 3. Spectra of \( l \)-th electrons at \( l = Z \)

| n  | 1          | 2          | 3          | 4          | 5          | 6          | 7          | 8          | 9          |
|----|-------------|------------|------------|------------|------------|------------|------------|------------|------------|
| HI | 13.5984 3.9994 1.5114 0.8504 0.5444 0.3774 0.2774 0.2124 0.1674 |
|    | 13.5984 3.9996 1.5109 0.8499 0.5439 0.3777 0.2775 0.2125 0.1679 |
| He II | 54.4178 13.6048 6.0468 3.4008 2.1768 1.5118 1.1108 0.8508 0.6718 |
|    | 54.4178 13.6045 6.0464 3.4011 2.1767 1.5116 1.1105 0.8502 0.6718 |
| Li III | 122.4543 30.6136 13.6062 7.6543 4.8983 3.4013 2.4993 1.9133 1.5113 |
|    | 122.4543 30.6136 13.6060 7.6534 4.8982 3.4015 2.4991 1.9133 1.5118 |
| Be IV | 217.7186 54.4336 24.1916 13.6076 8.7076 6.0476 4.4426 3.4016 2.6876 |
|    | 217.7186 54.4296 24.1910 13.6074 8.7087 6.0477 4.4432 3.4019 2.6879 |
| B V  | 340.2258 85.0648 37.8038 21.2628 13.6078 9.4498 6.9418 5.3148 4.1998 |
|    | 340.2258 85.0565 37.8029 21.2641 13.6090 9.4507 6.9434 5.3160 4.2003 |
| C VI | 489.9933 122.5193 54.4463 30.6233 19.5983 13.6100 9.9983 7.6543 6.0483 |
|    | 489.9933 122.4983 54.4437 30.6246 19.5997 13.6109 9.9998 7.6561 6.0493 |
| NVII | 667.0460 166.7990 74.1190 41.6870 26.6770 18.5250 13.6100 10.4190 8.2320 |
|    | 667.0460 166.7615 74.1162 41.6904 26.6818 18.5291 13.6132 10.4226 8.2351 |
| O VIII | 871.4101 217.9071 96.8281 54.4581 34.8491 24.1991 17.7781 13.6111 10.7541 |
|    | 871.4101 217.8525 96.8233 54.4631 34.8564 24.2058 17.7839 13.6158 10.7581 |
| F IX  | 1103.1176 275.8666 122.5766 68.9356 44.1126 30.6311 22.5026 17.2276 13.6116 |
|    | 1103.1176 275.7794 122.5686 68.9449 44.1247 30.6422 22.5126 17.2362 13.6187 |
| Ne X  | 1362.1995 340.6815 151.3665 85.1235 54.4705 37.8225 27.7855 21.2715 16.8065 |
|    | 1362.1995 340.5499 151.3555 85.1375 54.4879 37.8388 27.7999 21.2844 16.8173 |
To calculate the values of the binding energies of these electrons with the nucleus and their spectra, we will use the method proposed by F. Kanarev [10]. The experimental values $E_{b,n}^{\text{exp}}$ of the binding energies of electrons with a nucleus at the $n$-th energy level, we calculate as the difference between the values of the ionization energy and the excitation energy

$$E_{b,n}^{\text{exp}} = E_i - E_{\text{ex},n}.$$

(3.3)

The results obtained are presented in the first rows of Table 3. The theoretical values of the binding energies $E_{b,n}$ calculated by formula (3.2) are presented in the second rows of Table 3. Analysis of the data in Table 3 allows us to conclude that the last electron of any atom interacts with all protons of the atom (with all nucleus), its binding energy with the nucleus in the ground unexcited state ($n = 1$) coincides with its ionization energy $E_i$, and the energy spectrum of excited states is almost exactly describing by formula (3.2). This fact confirms once again that the ionization energy and energy levels of electrons of hydrogen-like atoms are the energy levels of binding of electrons with the nucleus in the ground and excited states, and not the energy levels of the states of the electron itself, as is commonly believed in quantum mechanics. Only etheric representations of the structure of atoms made it possible to derive formula (3.2) and explain its physical meaning.

3.2. Spectra of other many-electron atoms

Let us now consider the values of the ionization energies $E_i$ of the penultimate electrons of the atoms ($l = Z - 1$), which are in Table 1 under the main diagonal. Let us write out from the tables [8,9,11,12] the experimental values of the excitation energies $E_{\text{ex},n}$ of penultimate electrons of the atoms (Table 4). In this case, the excitation energies of 23.01 eV and 20.96 eV for the first electron of the helium atom He I are excluded from the table. They are absent in some reference books, and in other reference books they are given without indicating the line brightness, that is, as very weak or unobservable lines. For the same reasons, the excitation energies 198.56 eV and 202.95 eV for the fourth electron of the boron atom B IV and the energy 560.97 eV for the seventh electron of the oxygen atom O VII are excluded from the table. In some cases, one value was chosen from the close values of the excitation energies.

| Table 4. Excitation energies $E_{\text{ex},n}$ of $l$-th electrons at $l = Z - 1$. |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                 | Consecutive values of excitation energies $E_{\text{ex},n}$ eV |
| **He I**        | 21.22           | 23.09           | 23.74           | 24.04           | 24.21           | 24.31           | 24.37           |
| **Li II**       | 62.21           | 69.64           | 72.26           | 73.47           | 74.12           | 74.51           | 74.79           |
| **Be III**      | 123.67          | 140.39          | 146.28          | 149.01          | 150.50          | 151.40          | -              |
| **B IV**        | 205.54          | 235.35          | 245.83          | 250.69          | 253.34          | 254.94          | 255.98          |
| **C V**         | 307.87          | 354.49          | 370.90          | 378.51          | 382.65          | 385.17          | 386.66          |
| **N VI**        | 430.68          | 497.96          | 521.56          | 532.63          | 538.49          | 542.11          | 544.61          |
| **O VII**       | 573.93          | 665.60          | 697.78          | 712.70          | 720.82          | 725.63          | 728.75          |
| **F VIII**      | 737.67          | 857.53          | 899.59          | 918.92          | 929.67          | 935.56          | 940.68          |
| **Ne IX**       | 922.00          | 1074.00         | 1127.00         | 1151.70         | 1164.60         | 1173.50         | 1179.30         |
The experimental values of the binding energies $E_{b,n}^{\exp}$ of the penultimate electrons of the atoms with the nucleus at all their energy levels can be found from formula (3.3) as the difference between the values of the ionization energies and the excitation energies required for the transition to these energy levels. The values of $E_{b,n}^{\exp}$ presented in the first rows of Table 5, are compared with the calculated theoretical data obtained by a formula similar to (3.2)

$$r_{b,n} = \frac{r_{\infty} n^2 E_Z}{a l} = \frac{n^2 E_H}{l E_x r_H}; \quad E_{b,n} = \frac{l q \cdot q}{2 r_{b,n}} = \frac{l^2 E_z}{n^2}, \quad (3.4)$$

where $E_{b,1} = l^2 E_z$ are the binding energies of the $l$-th electron with the atomic nucleus containing $Z$ protons, in the ground stationary state at the first fictitious energy level. The theoretical results obtained by formula (3.4) are presented in the second rows of Table 5 for different electrons of different atoms, where $E_z = 13.56$ eV for all $Z = 2, \ldots, 10$.

### Table 5. Spectra of $l$-th electrons at $l = Z - 1$

| n | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    |
|---|------|------|------|------|------|------|------|------|
| 0 | He I | 3.37 | 1.50 | 0.85 | 0.55 | 0.38 | 0.28 | 0.22 |
|   |      | 13.56| 3.39 | 1.51 | 0.85 | 0.54 | 0.38 | 0.28 | 0.21 |
| 1 | Li II| 13.43| 6.00 | 3.38 | 2.17 | 1.52 | 1.13 | 0.85 |
|   |      | 54.24| 13.56| 6.03 | 3.39 | 2.17 | 1.51 | 1.11 | 0.85 |
| 2 | Be III| 30.27| 13.51| 7.62 | 4.89 | 3.39 | 2.49 | ---  |
|   |      | 122.04| 30.51| 13.56| 7.63 | 4.88 | 3.39 | 2.49 | 1.91 |
| 3 | B IV | 53.83| 24.02| 13.54| 8.68 | 6.03 | 4.43 | 3.39 |
|   |      | 216.96| 54.24| 24.11| 13.56| 8.68 | 6.03 | 4.43 | 3.39 |
| 4 | C V | 84.22| 37.60| 21.19| 13.57| 9.43 | 6.92 | 5.43 |
|   |      | 339.00| 84.75| 37.67| 21.19| 13.56| 9.42 | 6.92 | 5.30 |
| 5 | NVI | 121.39| 54.11| 30.51| 19.44| 13.58| 9.96 | 7.46 |
|   |      | 488.16| 122.04| 54.24| 30.51| 19.53| 13.56| 9.96 | 7.63 |
| 6 | OVII| 165.39| 73.72| 41.55| 26.63| 18.51| 13.69| 10.54|
|   |      | 664.44| 166.11| 73.83| 41.53| 26.57| 18.47| 13.56| 10.38|
| 7 | F VIII| 216.23| 96.37| 54.31| 34.98| 24.23| 18.34| 13.22|
|   |      | 867.84| 216.96| 96.43| 54.24| 34.72| 24.11| 17.71| 13.56|
| 8 | Ne IX| 273.80| 121.80| 68.80| 44.10| 31.20| 22.30| 16.53|
|   |      | 1098.40| 274.59| 122.04| 68.65| 43.93| 30.51| 20.10| 17.16|

It follows from Table 5 that the theoretical values of the binding energies of excited electrons with the nucleus at different energy levels (except for the first fictitious level) almost exactly coincide with their experimental values. A similar analysis can be carried out for the values of the ionization energies of electrons standing on the third, fourth, fifth, sixth, seventh, eighth, ninth and tenth
diagonals of Table 1 from \( l = Z - 2 \) up to \( l = Z - 9 \). The results of such an analysis, presented in detail in the monograph [6], allow us to draw the following conclusions about the atomic structure of chemical elements:

1) each electron in a neutral atom is associated with all protons of the nucleus, but regardless of the nuclear charge, the spectrum of an electron, starting from the second energy level, is determined exclusively by the number of free protons, that is, an ion with \( l - 1 \) free protons has, starting from the second energy level, the same spectrum as a hydrogen-like atom with a charge \( Z = l \); for example, the fourth electron of carbon has the same spectrum as the hydrogen-like beryllium atom, and the spectrum of the first electron of any atom practically coincides with the spectrum of the hydrogen atom, starting from the second energy level;

2) the energy levels to which the excited electrons are transferred are not electronic orbits or orbitals, but are discrete levels of the values of the binding energies of excited electrons with protons of the nucleus, described by formula (3.2) starting from the second energy level;

3) the internal basis of the electron shell of any atom is the presence of the last two paired electrons corresponding to the protons of one \( \alpha \)-particle of the nucleus and located at the first ground, close to the nucleus, energy level \( (E_Z \gtrsim 13.6 \text{ eV}) \); all other electrons of any atom must be at the first ground more lower energy levels, that is, have large radii and smaller values of the binding energy with the nucleus;

4) it is not surprising that the values of the ionization energies of each atom exceed the real values of the binding energies of the first electrons at the first ground energy levels, since the energy required to ionize the first electron is also spent on breaking its bonds not only with its own, but also with other protons of the nucleus; for example, as follows from Table 1, the ionization energy of the helium atom is 24.578 eV, while in fact the helium atom has two paired electrons at the first energy level \( E_Z = \frac{54.4178}{4} = 13.6045 \text{ eV} \);

5) since the second energy level of the hydrogen atom is about 3.4 eV, and according to the NIST database, the cesium atom has the lowest ionization energy of 3.8939 eV, which is close enough to the second level of the hydrogen atom, at which the dependence of the electron on neighboring protons disappears, then from this it follows that the first electron of a cesium atom should be located at an energy level with a binding energy slightly less than 3.8939 eV, and all electrons of any atom with a nuclear charge \( Z \) should be located at the first ground energy levels with energies in the range \( (3.89 \text{ eV}, E_Z) \).

The formulated conclusions lead to the obvious consequence that formula (3.2) should describe not only excited, but also the ground states of electrons in an atom, the energy levels of which should lie in the interval \( (3.89 \text{ eV}, E_Z) \). That is, for each \( 1 \leq Z \leq 118 \), all electrons of an atom with a charge \( Z \) in the ground unexcited state must occupy energy levels with values of the binding energy with the atomic nucleus \( Z^2 E_Z / m^2 \) such that

\[
3.89 < \frac{Z^2 E_Z}{m^2} \leq E_Z .
\]  

Since \( 13.5984 \leq E_Z \leq 16.8 \text{ eV} \), then from (3.5) one can roughly estimate that \( m = Z, Z + 1, \ldots, m_Z \), where \( m_Z < 2Z \). That is, for each atom with a charge \( Z \), the number of energy levels at which electrons in an atom can be located is not more than the number of electrons. In this case, at each level, except for the level with the minimum energy at odd \( Z \), there should be two electrons with oppositely directed spins, corresponding to the protons of one \( \alpha \)-particle of the nucleus. Therefore, about half of the electron levels should be unoccupied.
4. Periodic system of chemical elements

To understand what electronic levels each specific atom has and where the conditions for the ionization energies $E_i$ of some atoms and ions from Ne to Lr.

| Element | $E_1$ | $E_2$ | $E_3$ | $E_4$ | $E_5$ | $E_6$ | $E_7$ | $E_8$ | $E_9$ | $E_{10}$ | $E_{11}$ | $E_{12}$ | $E_{13}$ | $E_{14}$ | $E_{15}$ | $E_{16}$ |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Ne      | 21.57 | 40.96 | 63.45 | 97.12 | 126.21 | 157.93 | 207.28 | 239.1  | 1195.83 | 1362.2 |
| Ca      | 6.113 | 11.87 | 50.91 | 67.27 | 84.50  | 108.78 | 127.2  | 147.24 | 188.54  | 211.28 |
| Zr      | 6.634 | 13.13 | 22.99 | 34.34 | 80.35  | 96.38  | 112.0  | 133.7  | 153.0   | 172.02 |
| Ce      | 5.539 | 10.85 | 20.198| 36.758| 65.55  | 77.6   | 91     | 106    | 125     | 140    |
| Th      | 6.307 | 12.1  | 18.32 | 28.65 | 58.0   | 69.1   | 82     | 95     | 118     | 133    |
| Lr      | 4.96  | 14.54 | 21.8  | 43.6  | 56.0   | 80.0   | 96.0   | 121    | 143     | 165    |

Table 6. Ionization energies $E_i$ of some atoms and ions from Ne to Lr.
periodicity of the properties of chemical elements come from, we write out from the NIST database and put in Table 6 the ionization energies of atoms and ions for several chemical elements with characteristic charges of atomic nuclei: $^{10}\text{Ne}$, $^{20}\text{Ca}$, $^{40}\text{Zr}$, $^{58}\text{Ce}$, $^{90}\text{Th}$, $^{103}\text{Lr}$. On these elements, the sequence of jumps in the values of ionization energies is clearly traced, which indicates that the energy levels, which are not occupied by electrons, located in the same sequence. Choosing other elements does not change the observed picture. Bold type in Table 6 shows pairs of adjacent electrons with an abrupt change in the values of ionization energies. It can be seen that if we move from the last two internal electrons with the smallest radius and the largest binding energy with the nucleus, then such jumps occur after the second, tenth, eighteenth, twenty-eighth, thirty-sixth, forty-sixth, fifty-fourth, sixty-eighth, seventy-eighth, eighty-sixth, hundredth, and probably one hundred and tenth electrons, for which there is no ionization data. In this case, the jumps after the fifty-fourth and after the eighty-sixth electrons that appear on the $^{55}\text{Ce}$ and $^{87}\text{Fr}$ elements disappear after a few elements.

Thus, all electrons of any atom are broken up into layers by jumps of their ionization energies. The first layer contains two internal electrons, the second layer contains the next eight electrons (from the third to the tenth) with a lower binding energy with the nucleus, the third layer also contains eight electrons (from the eleventh to the eighteenth), the fourth layer contains eighteen electrons (from the nineteenth to the thirty-sixth) and consists of two fragments containing ten (to twenty-eighth) and eight electrons. The fifth layer is similarly arranged, also containing eighteen electrons in its two fragments (from thirty-seventh to forty-sixth and from forty-seventh to fifty-fourth). The sixth layer contains thirty-two electrons (fifty-fifth to eighty-sixth) and consists of three fragments containing fourteen (to sixty-eighth), ten (to seventy-eighth) and eight electrons. The seventh layer is similarly arranged, also containing thirty-two electrons (from sixty-seventh to one hundred and eighteenth) and consisting of three fragments containing fourteen (to one hundredth), ten (to one hundred and tenth) and eight electrons. Thus, the division of electrons into layers fully corresponds to the division of all chemical elements by periods of the Mendeleev periodic table.

Let us now find, using formula (3.5), what specific values of the binding energy with the nucleus have the electrons of the electron shells of the atoms of all chemical elements. Obviously, with an increase in the index $m$ in (3.5), there is a decrease in the values of the binding energy of electrons and, consequently, a decrease in the values of their ionization energy. Therefore, the absence of jumps in the ionization energies corresponds to successive values of the index $m$ in formula (3.5), and the presence of a jump corresponds to the omission of one or several indices. Below the electronic configurations of atoms of several chemical elements are presented. Electronic configurations of atoms of all chemical elements ($1 \leq Z \leq 118$) are presented in [6].

\textbf{\(\text{He}\).} The helium atom has two paired electrons with opposite spins, located at the energy level $E_2 = 13.6045 \text{ eV}$. The atom does not enter into chemical reactions, does not form molecules and chemical bonds. The ionization energy of the atom is $24.5874 \text{ eV}$. This ends the first electron layer (period).

\textbf{\(\text{Li}\).} The lithium atom has two paired electrons with opposite spins at the energy level $E_3 = 122.454/3^2 = 13.606 \text{ eV}$, belonging to the first electron layer, and one electron at $4.898 \text{ eV}$, belonging to the second electron layer. The $7.653 \text{ eV}$ level (see Table 3) is not occupied by electrons of the lithium atom. The electronic configuration of the lithium atom: $(13.606)\left(\frac{4.898}{3}\right); 5.392$. The number between the numbers in brackets denotes the number of unoccupied energy levels between the electron layers (in this case 1). The last number is the value of the ionization energy of the atom. The electronic (valence) level is underlined, on this level the electron is rather weakly bound to the atomic nucleus and can enter into chemical bonds. The valence of lithium is 1 and it falls into the first group of elements.

\textbf{\(\text{C}\).} A carbon atom has two paired electrons with opposite spins at the energy level $E_6 = 489.993/6^2 = 13.611 \text{ eV}$ belonging to the first electron layer, as well as two electrons at a level of
7.656 eV and two electrons at a level of 6.049 eV, belonging to the second electron layer. The 9.999 eV level (see Table 3) is not occupied by the electrons of the carbon atom. Electronic configuration of the carbon atom: (13.611)1(7.656, 6.049); 11.26. The valency of carbon is 4 and it falls into the fourth group of elements.

\[ {\text{11Na}} \]. The third period begins with a sodium atom, which has two electrons belonging to the first electron layer and occupying the energy level \( E_{11} = 1648.702/11^2 = 13.626 \text{ eV} \), eight electrons occupying in pairs the energy levels of the second electron layer, and one electron occupying the third electron layer. Electronic configuration of sodium atom: (13.626) 1 (9.756, 8.412, 7.328, 6.440) 2 (4.567); 5.139. The valence of sodium is 1 and it falls into the first group of elements.

\[ {\text{20Ca}} \]. The calcium atom has two electrons belonging to the first electron layer and occupying the energy level \( E_{20} = 5469.862/20^2 = 13.675 \text{ eV} \), eight electrons belonging to the second electron layer, eight electrons belonging to the third electron layer, eight electrons belonging to the fourth electron layer and four electrons belonging to the first fragment of the fifth electron layer. Electronic configuration of the calcium atom: (13.675) 1 (12.606, 12.026, 11.486, 10.981) 2 (9.651, 9.261, 8.895, 8.549) 3 (7.351, 7.091, 6.844, 6.61, 6.388) 4 (5.429, 5.263, 5.105, 4.954) 2 (4.538, 4.411); 6.634. The valence of calcium is 2 and it falls into the second group of elements.

\[ {\text{40Zr}} \]. The zirconium atom has two electrons belonging to the first electron layer and occupying the energy level \( E_{40} = 22236.67/40^2 = 13.898 \text{ eV} \), eight electrons belonging to the second electron layer, eight electrons belonging to the third electron layer, ten and eight electrons belonging to the fourth electron layer and four electrons belonging to the first fragment of the fifth electron layer. Electronic configuration of the zirconium atom: (13.898) 1 (12.606, 12.026, 11.486, 10.981) 2 (9.651, 9.261, 8.895, 8.549) 3 (7.351, 7.091, 6.844, 6.61, 6.388) 4 (5.429, 5.263, 5.105, 4.954) 2 (4.538, 4.411); 6.634. The valence of zirconium is 4 and it falls into the fourth group of elements.

\[ {\text{58Ce}} \]. The cerium atom has two electrons belonging to the first electron layer and occupying the energy level \( E_{58} = 47965.72/58^2 = 14.259 \text{ eV} \), eight electrons belonging to the second electron layer, eight electrons belonging to the third electron layer, ten and eight electrons belonging to the fourth electron layer, ten and eight electrons belonging to the fifth electron layer, ten and eight electrons belonging to the sixth electron layer. Electronic configuration of the cerium atom: (14.259) 1 (13.324, 12.891, 12.478, 12.085) 2 (11.011, 10.685, 10.373, 10.075) 3 (9.001, 8.759, 8.527, 8.304, 8.09) 4 (7.134, 6.963, 6.798, 6.639) 5 (5.792, 5.667, 5.546, 5.428, 5.315) 3 (4.994, 4.797, 4.702, 4.61) 2 (4.351, 4.269); 5.539. The valence of zirconium is 4 and it falls into the fourth group of elements.

\[ {\text{73Ta}} \]. The tantalum atom has two electrons belonging to the first electron layer and occupying the energy level \( E_{73} = 78394.7/73^2 = 14.711 \text{ eV} \), eight electrons belonging to the second electron layer, ten and eight electrons belonging to the third electron layer, ten and eight electrons belonging to the fourth electron layer, ten and eight electrons belonging to the fifth electron layer, fourteen electrons belonging to the first fragment, and five electrons belonging to the second fragment of the sixth electron layer. Electronic configuration of the tantalum atom: (14.711) 1 (13.937, 13.572, 13.222, 12.885) 2 (11.949, 11.659, 11.38, 11.11) 3 (10.123, 9.897, 9.678, 9.467, 9.262) 4 (8.332, 8.163, 7.999, 7.839) 5 (6.977, 6.847, 6.721, 6.598, 6.479) 10 (5.354, 5.267, 5.182, 5.099) 5 (5.017, 4.938, 4.86, 4.785, 4.711, 4.639, 4.568) 2 (4.366, 4.301, 4.238); 7.55. The valence of tantalum is 5 and it falls into the fifth group of elements.

\[ {\text{85At}} \]. The astatine atom has two electrons belonging to the first electron layer and occupying the energy level \( E_{85} = 109886.0/85^2 = 15.209 \text{ eV} \), eight electrons belonging to the second electron layer, eight electrons belonging to the third electron layer, ten and eight electrons belonging to the fourth electron layer, ten and eight electrons belonging to the fifth electron layer, fourteen, ten and seven electrons belonging to the sixth electron layer. Electronic configuration of the astatine atom: (15.209) 1 (14.517, 14.19, 13.873, 13.566) 2 (12.705, 12.436, 12.176, 11.923) 3 (10.989, 10.772, 10.562, 10.358, 10.16) 4 (9.249, 9.081, 8.919, 8.76) 5 (7.892, 7.76, 7.631, 7.505, 7.382) 10 (6.212, 6.12, 6.029, 5.941) 5 (5.855, 5.77, 5.687, 5.606, 5.527, 5.45, 5.374) 6 (4.884, 4.819, 4.756, 4.694, 4.633)
4 (4.347, 4.292, 4.239, 4.187); 9.3. The valence of astatine is 7 and it falls into the seventh group of elements.

$^{92}$U. The uranium atom has two electrons belonging to the first electron layer and occupying the energy level $E_{92} = 131.821/92^2 = 15.574\text{eV}$, eight electrons belonging to the second electron layer, eight electrons belonging to the third electron layer, ten and eight electrons belonging to the fourth electronic layer, ten and eight electrons belonging to the fifth electronic layer, fourteen, ten and eight electrons belonging to the sixth electron layer, and six electrons belonging to the first fragment of the seventh electron layer. Electronic configuration of the uranium atom: (15.574) 1 (14.919, 14.606, 14.303, 14.01) 2 (13.182, 12.922, 12.67, 12.425) 3 (11.514, 11.302, 11.095, 10.894, 10.699) 4 (9.796, 9.63, 9.467, 9.309) 5 (8.437, 8.303, 8.173, 8.046, 7.921) 10 (6.726, 6.631, 6.537, 6.446) (6.357, 6.27, 6.184, 6.1, 6.018, 5.938, 5.859) 7 (5.280, 5.214, 5.149, 5.085, 5.023) 9 (4.456, 4.404, 4.354, 4.304) 1 (4.208, 4.16, 4.114); 6.194. The valence of uranium is 6 and it falls into the sixth group of elements.

$^{103}$Lr. The livermorium atom has two electrons belonging to the first electron layer and occupying the energy level $E_{103} = 172.930/103^2 = 16.30\text{eV}$, eight electrons belonging to the second electron layer, eight electrons belonging to the third electron layer, ten and eight electrons belonging to the fourth electronic layer, ten and eight electrons belonging to the fifth electronic layer, fourteen, ten and eight electrons belonging to the sixth electron layer, fourteen electrons belonging to the first fragment of the seventh electron layer and three electrons belonging to the second fragment. Electronic configuration of the livermorium atom: (16.30) 1 (15.685, 15.391, 15.104, 14.826) 2 (14.035, 13.786, 13.543, 13.306) 3 (12.42, 12.212, 12.009, 11.811, 11.619) 4 (10.722, 10.555, 10.392, 10.233) 5 (9.35, 9.214, 9.081, 8.823) 10 (7.584, 7.485, 7.387, 7.292) (7.198, 7.106, 7.016, 6.927, 6.84, 6.755, 6.671) 9 (5.914, 5.845, 5.778, 5.712, 5.647) 15 (4.74, 4.691, 4.643, 4.595) (4.548, 4.502, 4.456, 4.411, 4.367, 4.323, 4.28) 3 (4.115, 4.075); 4.96. The valence of livermorium is 3 and it falls into the third group of elements.

Thus, the system of chemical elements, based on the law of arrangement of electronic energy levels following from the ether theory, has seven periods. The first period contains two elements, the second and third periods contain one row of eight elements, the fourth and fifth periods contain two rows of ten and eight elements, the sixth and seventh periods contain three rows of fourteen, ten and eight elements. In total, the system contains thirteen rows of chemical elements corresponding to thirteen fragments of seven electronic layers. Each row is naturally divided into eight groups in accordance with the valence values of the chemical elements of the row, which are set, as a rule, by the number of electrons in the layer with the lowest values of their energy levels (the levels of bonding of electrons with the nucleus). Small differences in the penultimate fragments of the electronic configurations of atoms determine the division of each group into two subgroups: main (A) and secondary (B).

In addition, considering the first and second rows of the sixth and seventh periods, each containing fourteen and ten elements, it can be seen that the electronic configurations of the atoms of the first two elements of the first rows ($^{55}$Cs, $^{56}$Ba and $^{87}$Fr, $^{88}$Ra) are similar to the electronic configurations of atoms of elements of the main subgroups of the first two groups considered above. The electronic configurations of the atoms of the third elements of the first rows ($^{57}$La and $^{89}$Ac) are similar to the electronic configurations of the atoms of the elements of the secondary subgroup of the third group. Subsequently, with an increase in the charge of the atomic nucleus, a gradual fusion of the seventh-eighth and tenth-eleventh electron fragments occurs, which is the reason for the appearance of two sets of fourteen elements each with approximately equal values of the binding energy levels and similar electronic configurations that differ from the configurations of the elements of the two subgroups considered above (A and B). These two sets of elements, including $^{57}$La and $^{89}$Ac and called lanthanides and actinides, are usually isolated from the table of chemical elements and depicted in separate rows. It is believed that all of them should be in the third group along with $^{57}$La and $^{89}$Ac. However, it is well known that $^{58}$Ce and $^{90}$Th have a valence of 4 and should be in the fourth group,
93Pr should have, and 91Pa has a valence of 5, and both of them should be in the fifth group. 90Nd must have, and 92U has a valence of 6, and both must be in the sixth group. 93Np has a valence of 7, therefore, 61Pm, which has the similar electronic configuration, should be assigned, together with the 93Np to the seventh group; 69Tm and 101Md should be assigned to the first group, since they each have one electron starting a new row of elements. For the same reason, the second group should include ytterbium 70Yb and nobelium 102No. But the subgroups of all these elements should differ from the two subgroups A and B. In this regard, it seems expedient, instead of considering the groups of lanthanides-actinides (62Sm, 93Np), (63Eu, 95Am), (64Gd, 96Sm), (65Tb, 97Bk), (66Dy, 98Ce), (67Ho, 99Er), (68Er, 100Fm) are expediently placed in the third subgroup (C) of the eighth group. The remaining pairs of elements of the second rows of the sixth and seventh periods (71Fr, 87Ac) are expediently placed in the third subgroup (C) of the eighth group. The remaining pairs of elements of the second rows of the sixth and seventh periods (72Hf, 106Re), (73Ta, 108Db), (74W, 109Os), (75Re, 107Pd) should be placed in the second subgroups (B) of the fourth - seventh groups, respectively. Mendeleev's periodic system of chemical elements will take the following form (table 7).

| Period Row | Groups of Elements |
|------------|--------------------|
| 1 1 | 1H | 2He |
| 2 2 | 3Li | 4Be | 5B | 6C | 7N | 8O | 9F | 10Ne |
| 3 III | 11Na | 12Mg | 13Al | 14Si | 15P | 16S | 17Cl | 18Ar |
| IV 4 | 19K | 20Ca | 21Sc | 22Ti | 23V | 24Cr | 25Mn | 26Fe | 27Co | 28Ni |
| V | 29Cu | 30Zn | 31Ga | 32Ge | 33As | 34Se | 35Br | 36Kr |
| VI 5 | 37Rb | 38Sr | 39Y | 40Zr | 41Nb | 42Mo | 43Tc | 44Ru | 45Rh | 46Pd |
| VII | 47Ag | 48Cd | 49In | 50Sn | 51Sb | 52Te | 53I | 54Xe |
| VIII 6 | 55Cs | 56Ba | 57La | 58Ce | 59Pr | 60Nd | 61Pm | 62Sm | 63Eu, 64Gd, 65Tb, 66Dy, 67Ho, 68Er |
| IX | 69Tm | 70Yb | 71Lu | 72Hf | 73Ta | 74W | 75Re | 76Os, 77Ir, 78Pt |
| X | 79Au | 80Hg | 81Tl | 82Pb | 83Bi | 84Po | 85At | 86Rn |
| XI | 87Fr | 88Ra | 89Ac | 90Th | 91Pa | 92U | 93Np | 94Pu, 95Am, 96Cm, 97Bk, 98Cf, 99Es, 100Fm |
| XII 7 | 103Md | 102No | 103La | 104Rf | 105Db | 106Sg | 107Bh | 108Hs, 109Mt, 110Ds |
| XIII 111Rg | 112Cn | 113Nh | 114Fl | 115Mc | 116Lv | 117Ts | 118Og |
The view of Table 7, based on the real structure of the energy levels of the binding energies of electrons with atomic nuclei, differs both from the form of the short and long forms of Mendeleev’s table of chemical elements used by modern science, and from the table proposed by D.I. Mendeleev himself in his work entitled “Attempt chemical understanding of the world ether” [13]. The essence of the periodic law, which consists in the periodic dependence of the properties of simple substances and compounds of elements on the charges of the nuclei of atoms of elements, which is equivalent to the dependence on the number of electrons in the electron shell of atoms, does not change in all cases. However, the modern forms of the periodic table (short and long) are based not on knowledge of the nature and size of the electron and the electronic structure of the atom, but on the formal hypothesis of the sequential filling by electrons of the electron levels of atoms, which, in principle, cannot be. Moreover, the numbers of electrons occupying certain levels are adjusted in such a way that they can be formally obtained from the quantum numbers of the Schrödinger equation. At the same time, one had to “close my eyes” to the fact that the number of elements in the periods is repeated (the second and third periods have eight elements each, the fourth and fifth - eighteen elements each, the sixth and seventh - thirty-two elements each). It was also necessary to introduce the inexplicable Pauli prohibition, Hund's rule, Klechkovsky's rule and other rules, postulates and prohibitions.

The most convenient and close to the description of the essence of the periodic processes occurring in atoms, described in this paper, is the modern short form of the periodic table, containing seven periods and eight groups. The idea of representing a system of periodic elements in the form of such a table goes back to D.I. Mendeleev himself. This form of the table is immortalized by a mosaic in St. Petersburg on the building of the All-Russian Research Institute of Metrology [13]. However, for the sake of quantum-mechanical concepts from the table were taken out and placed in separate lines of the family of lanthanides and actinides, each containing fourteen elements of the third group of the sixth and seventh periods. The long form of the table consists of eighteen groups and does not contain subgroups and rows at all, which clearly contradicts the sequence of energy levels of the binding energies of electrons with atomic nuclei found in this work. The long form of the table was designed solely in an attempt to more fully adjust the properties of chemical elements to the quantum-mechanical structure of the atom, which contradicts its natural structure. In addition, the lanthanide and actinide families are also highlighted on separate lines. The differences between our table and the table of D.I. Mendeleev himself are as follows: in the table given in [13], noble gases are in the zero group, and the table itself begins with the ether element, “which is much lighter than hydrogen” and conventionally called Newtonium. The ether element Newtonium (Nt) undoubtedly exists, which logically follows from the results of this work, but it is not a chemical element and cannot enter into chemical bonds. Therefore, it is hardly advisable to place it “in the zero group of the zero row”, as it was done by D.I. Mendeleev, but it must be present in some form in the table. We have it placed in the header of the table. As for the noble gases, which at the time of D.I. Mendeleev were considered inert, they must complete periods and, therefore, be in the eighth, and not in the zero group, since their electron shells complete the corresponding electronic layers. In addition, each group of elements contains not two, but three subgroups.

5. Conclusion

Let us draw a short conclusion from the results obtained in this work and in works [2-6] exclusively from the theory of compressible oscillating ether and confirmed by experimental data on the structure of atoms of all chemical elements. It is shown that an atom of any chemical element consists of a nucleus and an electron shell. The nucleus of any atom is a superposition (imposition) of waves of perturbation of the ether density in several protons and several neutrons, having a common center and propagating around a common axis in one or opposite directions, i.e. having unidirectional or oppositely directed spins. Neutrons are made up of protons and electrons with unidirectional spins, and
the electron shell is made up of electrons with oppositely directed spins to their protons in the nucleus. Thus, protons and electrons are the initial structural units of matter, which are waves of small radial oscillations of the ether density, propagating with a constant angular velocity around the axes of their balls, which have Compton radii. Therefore, the radius of the electron is three orders of magnitude larger than the radius of the proton and, therefore, electrons, in principle, cannot rotate around the nucleus of an atom either in orbits or in orbitals.

Each electron of the electron shell of an atom is associated mainly with its own proton of the nucleus, and in an excited state, starting from the second energy level, only with its own proton. The energy levels of electrons are the values of the energy levels of the binding of electrons to the nucleus in the ground and excited states, the formulas for the calculation of which are derived in this work. When an atom is excited by a photon, the electron goes over to a level with a lower binding energy with the nucleus, and its radius increases. On the basis of experimental data on the ionization energies of atoms and ions, it is shown that the sequence of values of the energy levels of electrons has jumps, exactly corresponding to the periods of the table of chemical elements. It is concluded that it is these jumps, and not the quantum-mechanical rules, prohibitions and postulates, that determine the periodicity of the properties of chemical elements. For each atom, the values of the electronic (valence) levels are determined. The electrons which occupy these levels are rather weakly bound to the nucleus of the atom and can enter into chemical bonds. An ether correction of the modern table of chemical elements is presented, returning it to the form proposed by D.I. Mendeleev.

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References
[1] Gankin V Y, Gankin Y V 1998 How chemical bonds form and chemical reactions proceed (Boston: Inst. of theoretical chemistry) 323
[2] Magnitskii N A 2019 Theory of compressible oscillating ether J. Results in Physics 12 1436-1445
[3] Magnitskii N A 2018 Fundamentals of the theory of compressible oscillating ether IOP Conf. Series: Journal of Physics: Conf. Series 1141 012052
[4] Magnitskii N A 2019 Structure and properties of atomic nuclei in the theory of compressible oscillating ether IOP Conf. Series: Journal of Physics: Conf. Series 1391 012084
[5] Magnitskii NA 2021 Gravitation in the theory of compressible oscillating ether IOP Conf. Series: Journal of Physics: Conf. Series 1730 012012.
[6] Magnitskii N A 2021 Theory of compressible oscillating ether (M.: URSS) 216 (in Russian).
[7] Mills L 2010 The grand unified theory of classical physics (Blacklight Power Inc.) v.1-3.
[8] NIST: Atomic Spectra Database Lines Form - phys.nist.gov/PhysRefData/ASD/lines_form.html
[9] Striganov A R, Odintsova G A 1982 Tables of Spectral Lines of Atoms and Ions (Moscow: Énergoizdat) 312
[10] Kanarev F M The beginnings of the physical chemistry of the microworld https://www.micro-world.su/index.php/2010-12-22-11-45-21
[11] Striganov A R, Sventitskii N S 1968 Tables of spectral lines of neutral and ionized atoms (N.Y.: Springer) 900
[12] Zaidel A N, Prokofev V K, Raiskii S M 1970 Tables of spectral lines (N.Y.: Springer) 782
[13] https://salik.biz/articles/45521-zasekrechennye-razdely-tablicy-mendeleeva.html