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Electrons in Atoms

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Abstract: It has been shown that there is no orbital component of energy of movement of the electron in the atom in the mathematical model of the law of the formation of the spectra of the atoms and the ions. Due to this fact, the concept of the orbital movement of the electron in the atom becomes a myth. A new hypothesis describes a precession movement of the electrons of the atoms. Valence electrons precessing on the nuclei of the atoms joint them into molecules with the help of their unlike magnetic poles.
Keywords: photon, electron, proton, nucleus, atom, spectrum, molecule.

INTRODUCTION

Democritus, Lucretius, and other ancient Greeks (the 5th century and the 3rd century B.C.) thought that everything consists of small invisible and inseparable particles, which they called atoms [1]. In 1902, Thompson supposed that the atom consists of the electrons and a positive part. In 1911, Rutherford proved that the positive part of the atom is concentrated at its nucleus. In 1913, Niels Bohr suggested the planetary model of the atom, in which the electrons move in the orbits of the nucleus as the planets of the Sun [2].

The notion concerning the orbital movement of the electron in the atom remains the main and the only one till the present day. By the way, such a notion does not give an answer to the simplest question: how do the electrons connect the atoms in the molecules in this case? Schredinger's equation, which is considered to be the main equation of quantum mechanics, regards it as inconceivable, because it can predict the probable occurrence of the electron in this or that part of the atom only [3]. Such a strange situation remains in physics and chemistry. It is only natural, because Schredinger's equation remains true outside the main axiom of the natural sciences: space-matter-time unity. Behaviour of the electron in the atom is within the framework of this axiom [4]. That's why the notion concerning behaviour of the electrons in the atom should be derived from the analysis of mathematical equations, which describe the behaviour of the electron within the framework of the above-mentioned axiom [4], [5], [6].

THEORETICAL AND EXPERIMENTAL PART

Spectroscopy has the largest array of the experimental data (any hundreds of thousand spectral lines) concerning the behaviour of the electron in the atom [7], [8]. That is why its behaviour can be understood from this array. The exciting theories of the formation of spectra of atoms and ions are limited by the calculation of the spectra of the hydrogen and hydrogen-like atoms only. The spectra of atoms with many electrons are calculated with the help of the approximate methods, which exclude the possibility of the formation of any notion concerning the moving of the electron in the atom [9].

If it were possible to find an analytical mathematical model to calculate the spectra of the atoms and ions, it would be an ideal case. But nobody has managed to do it. That's why it is necessary to solve a simpler problem: to find an empirical law of the formation of atomic and ionic spectra. The implementation of such attempt is described in the sources [4], [5], [10], [11], [13].

Books on spectroscopy [7], [8] describe the ionization potentials for each electron in electron-volts or the energy of their ionization E_i. The detailed analysis of the spectra, which correspond to each electron, shows that there are values of binding energies E_1 of the electrons with the nuclei of the atoms, which correspond to their first energy levels.

The passage of an electron from one energy level to another is completed with the absorption or irradiation of the photon with energy E_{ph}. Taking this fact into consideration, the mathematical model, which describes the processes of the absorption and irradiation of photons, looks like [1], [4], [5], [6], [10], [13]:

$$E_{ph} = E_i - \frac{E_1}{n^2}, \qquad (1)$$

where n = 2, 3, 4 … - the main quantum number.

It has tuned out that a definite value of binding energy E_b with the nucleus of the atom corresponds to each energy level of the electron in the atom, which is calculated according to the formula [13]:

$$E_b = \frac{E_1}{n^2}. \qquad (2)$$

Let us give some examples of the calculation of the spectra of any atoms and ions with the help of a model (1) using the experimental data of spectroscopy [7], [8].

Taking into consideration that the binding energy of the electron with the nucleus E_1 , which corresponds to the first energy level equal to the ionization energy E_i of the hydrogen atom, $E_i = E_1 = 13.598 eV$, and using formulas (1) and (2), we will get the energies of the photons E_{ph} emitted or absorbed by the electron and the binding energies E_b of the electron with the atomic nucleus, which correspond to n-energy levels as shown in Table 1 below (for hydrogen).

Table 1

Values	n	2	3	4	5	6
E_{ph} (experimental)	eV	10.20	12.09	12.75	13.05	13.22
E_{ph} (theoretical)	eV	10.20	12.09	12.75	13.05	13.22
E_b (theoretical)	eV	3.40	1.51	0.85	0.54	0.38

It results from the spectroscopy law (1) that during the transition of the electron from energy level n to $n+1$, the energies of the absorbed and emitted photons are calculated according to the formula [5], [6], [13]

$$E_{ph} = E_1\left[\frac{1}{n^2} - \frac{1}{(n+1)^2}\right]. \qquad (3)$$

Let us list the results of the calculation of the energies of the photons E_{ph} (theoretical) radiated or absorbed by the electron of the hydrogen atom during its transition between the levels n and $n+1$ as compared to the experimental data shown in Table 2 (for hydrogen).

Table 2

Levels	n, n+1	2…3	3…4	4…5	5…6	6…7	7…8
E_{ph} (experimental)	eV	1.89	0.66	0.30	0.17	0.10	0.07
E_{ph} (theoretical)	eV	1.888	0.661	0.306	0.166	0.100	0.065

From experimental spectroscopy it is known that the bond energy of the second electron and all subsequent electrons with the nucleus is not equal to the energy of their ionization. This radical difference from the first electron creates insurmountable obstacles by the calculation spectra of atoms and ions of more complicated elements if it is made with the use of the old physical and chemical notions. We will not describe here the methods for the determination of the binding energy of the second and other electrons with the atomic nucleus which correspond to its first energy level. Those who wish to do so can read about this in publications [4], [10], [11], [13].

For the first electron of the helium atom we have E_i=24.587 eV and E_1=13.48 eV. Using spectroscopic law (1) and (2), we'll get the necessary data as shown in Table 3 below (for helium).

Table 3

Values	N	2	3	4	5	6
E_{ph} (experimental)	eV	21.22	23.09	23.74	24.04	24.21
E_{ph} (theoretical)	eV	21.22	23.09	23.74	24.05	24.21
E_b (theoretical)	eV	3.37	1.50	0.84	0.54	0.37

The ionization energy E_i =75.638 eV of the second electron of the lithium atom is not equal to energy E_1 of its bond with the nucleus when it is present on the first energy level. But nobody has expected that there would be a fictitious energy of the second electron, which corresponds to the first energy level (E_1=54.152 eV). When it was found, formula (1) gave an experimental row of energies that are shown in Table 4 (for lithium).

Table 4

Values	n	2	3	4	5	6
E_{ph} (experimental)	eV	62.10	69.65	72.26	73.48	-
E_{ph} (theoretical)	eV	62.10	69.62	72.25	73.47	74.13

The second electron of boron atom has an E_i=37.930 eV and E_1=125.12 eV. If we substitute these values into formula (1), we shall have the results specified in Table 5 (for boron).

Table 5

Values	n	3	4	5	6	7
E_{ph} (experimental)	eV	24.03	30.11	32.96	-	-
E_{ph} (theoretical)	eV	24.03	30.11	32.93	34.45	35.38

Let us give an experimental row of energies to the first electron of the boron atom and a theoretical row with the help of the formula (1) as shown in Table 6.

Table 6

Values	n	2	3	4	5	6	7
E_{ph} (experimental)	eV	4.96	6.82	7.46	7.75	7.92	8.02
E_{ph} (theoretical)	eV	4.96	6.81	7.46	7.76	7.93	8.02
Values	n	8	9	10	11	12	13
E_{ph} (experimental)	eV	8.09	8.13	8.16	8.18	8.20	8.22
E_{ph} (theoretical)	eV	8.09	8.13	8.16	8.18	8.20	8.22
Values	n	14	15	16	17	18	19
E_{ph} (experimental)	eV	8.23	8.24	8.25	8.25	8.26	…
E_{ph} (theoretical)	eV	8.23	8.24	8.25	8.25	8.26	…

The ionization energy of the first electron of oxygen atom is equal to E_i = 13.618 eV and its binding energy with the atomic nucleus that corresponds to the first energy level is equal to E_1=13.752 eV. The energy indices of this electron according to formula (1) yield the results shown in Table 7 (for oxygen).

Table 7

Values	n	2	3	4	5	6
E_{ph} (experimental)	eV	10.18	12.09	12.76	13.07	13.24
E_{ph} (theoretical)	eV	10.16	12.09	12.76	13.07	13.24

Ionization energy of the second electron of oxygen atom is equal to E_i =35.116 eV, and its binding energy with the nucleus corresponding to the first energy level is equal to E_1=83.98 eV. We'd like to draw the attention of the readers to significant differences in experimental data of spectroscopy concerning the second potential of excitation given in reference books [7] and [8]. We have regarded the new data given in the reference book with great confidence [7]. Taking it into account we'll have the following indices for the second electron of oxygen atom (Table 8).

Table 8

Values	n	2	3	4	5	6
E_{ph} (experimental)	eV	14.12	25.83	29.81	31.73	32.88
E_{ph} (theoretical)	eV	14.12	25.79	29.87	31.76	32.78
E_b (theoretical)	eV	21.00	9.33	5.25	3.36	2.33

The ionization potential of the first electron of the chlorine atom is E_i = 12.967 eV, and its binding energy with the atom corresponding to the first energy level is E_1= 15.548 eV (Table 9).

Table 9

Values	n	2	3	4	5	6
E_{ph} (experimental)	eV	9.08	11.25	12.02	12.34	12.53
E_{ph} (theoretical)	eV	9.08	11.24	11.99	12.34	12.54
E_b (theoretical)	eV	3.28	1.46	0.82	0.52	0.36

The ionization potential of the first electron of the sodium atom is E_i = 5.139 eV, and its binding energy with the atom corresponding to the first energy level is E_1= 13.086 eV (Table 10).

Table 10

Values	n	2	3	4	5	6
E_{ph} (experimental)	eV	-	3.68	4.31	4.62	4.78
E_{ph} (theoretical)	eV	-	3.68	4.32	4.62	4.77
E_b (theoretical)	eV	3.27	1.45	0.82	0.52	0.36

It is obvious that there is enough information in order to make sure that formula (1) is a mathematical expression of the law of formation of the spectra of the atoms and ions (1) which includes: energy of the photons $E_{ph} = h \cdot \nu_f$ emitted or absorbed by the electron during its energy transitions; energy $E_i = h \cdot \nu_i$ of ionization of the electron and the binding energy $E_1 = h \cdot \nu_1$ of the electron, which corresponds to its first energy level of the electron in the atom. Then

$$E_{ph} = E_i - \frac{E_1}{n^2} \Rightarrow \nu_f = \nu_i - \frac{\nu_1}{n^2}. \qquad (4)$$

We can now see that formulae (1) and (4) do not have the orbital component of electron energy. That is why electron has not orbital motion in atom.

The analysis of the electromagnetic models of the photon and the electron within the framework of the Unity axiom by means of the laws of conservation of angular momentum and the formation of the spectra of the atoms leads to an equality of wavelengths λ to the radii r of these particles [4], [5], [6], [10], [13];

$$\lambda = r \qquad . \qquad (5)$$

As Planck's constant h is available in (1), (2), (3) and (4), we should pay attention to the essence of its dimensionality [4], [6], [10], [13]:

$$h = m\lambda^2\nu = mr^2\nu\left(\frac{kg \cdot m^2}{s}\right) = const. \qquad . \qquad (6)$$

In SI system this dimensionality corresponds to the following equal notions of modern physics and mechanics: angular momentum, moment of momentum, kinetic momentum, and spin. It results from this that the law of conservation of angular momentum governs the constancy of Planck's constant. It runs as follows: if the sum of external forces influencing a rotating body are zero then the angular momentum $\bar{h}$ of this body remains constant.

A lack of the orbital component of energy of the electron is the main peculiarity of mathematical models (1) and (4) of the law of formation of the spectra of atoms and ions. It draws attention to the lack of the orbital movement of the electron in the atom. The law of formation of the spectra opens new possibilities for us in cognition of the principles of the 'microworld' [4], [5], [6], [10], [13].

Analysis of the mathematical models, which describe the behaviour of the electron, has shown that it forms a rotating electromagnetic torus [5], [6]. As we do not know the model of the proton, we can imagine it is like a dot with the direction of a magnetic moment vector. The hydrogen atom formation process can be described in such a way.

When the hydrogen atom is formed, unlike the electric fields of the electron and proton that draw them together and its like magnetic poles that restrict rapprochement (Fig. 1a). If a scale of is chosen with the size of the proton being equal to one millimetre, the size of the electron will be nearly one meter, and the distance between the proton and the electron in the hydrogen atom will be about 100 metres according to Coulomb's law (Fig. 1b).

The spin of the electron is equal to Planck's constant. It is clear that the electron does not rotate round the nucleus of the hydrogen atom, it precesses on the nucleus (Fig. 1) [5], [6].

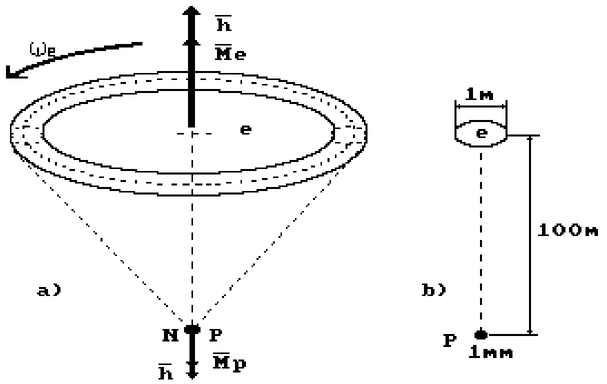

Fig. 1. Diagrams of model of the atom of hydrogen:
a) hydrogen atom, **b)** geometrical dimensions of the atom in the scale of the size of the proton (p) 1 mm.

$\overline{M}_e$ is magnetic moment of the electron

$\overline{M}_p$ is magnetic moment of the proton

$\overline{h}$ is electron and proton spin

We find out that the atomic nucleus, having the size by a factor of 10^3 less than the size of the electron, is arranged a certain distance R_i from the geometrical center of the electron, which can be calculated taking Coulomb's law. As the binding energy of the proton with the electron is equal to $E_1 = E_i = e^2 / R$ = 13.6 eV, we will have the following expression when n=1:

$$R_1 = \frac{e^2}{4\pi \cdot \varepsilon_o \cdot E_1} = \frac{(1.602 \cdot 10^{-19})^2}{4 \cdot 3.142 \cdot 8.854 \cdot 10^{-12} \cdot 13.598 \cdot 1.602 \cdot 10^{-19}} = 1.058 \cdot 10^{-10} m. \quad (7)$$

The calculation results for n=2,3,4… are given in Table 11.

Table 11

Values	n	2	3	4	5	6
E_{ph} (experimental)	eV	10.20	12.09	12.75	13.05	13.22
E_{ph} (theoretical)	eV	10.20	12.09	12.75	13.05	13.22
E_b (theoretical)	eV	3.40	1.51	0.85	0.54	0.38
R_i (theoretical)	x 10^{-10} m	4.23	9.54	16.94	26.67	37.89

The minimal distance, at which the electron comes to the proton, $R_i = 1.058 \cdot 10^{-10} m$ agrees with the size of the hydrogen atom that is currently accepted in modern physics. Thus, the hydrogen atom is a core with the proton at one end and the electron at the other one.

When electrons absorb photons, the binding energy of the electron with the nucleus is reduced (Table 10), and it goes to surface of the atom. When the electron emits the photons, its binding energy with the nucleus is then increased, and it penetrates deeper into the atom's "cell" towards the nucleus.

The nucleus of oxygen atom (for example) has such structure (Fig. 2) [12].

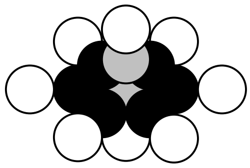

Fig. 2. The structure of nucleus of the oxygen atom with the protons being white and the neutrons black.

The oxygen atom consists of eight electrons (Fig. 3) [7], [8]. The greater the energy of binding, the nearer the electron is situated to the atomic nucleus [13].

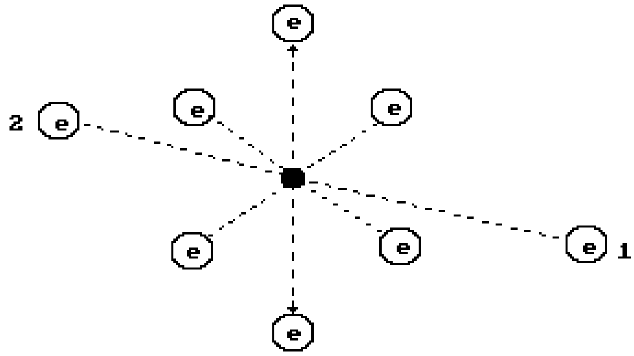

Fig. 3. Diagram of oxygen atom model.

We have shown that the electrons in the atom have no orbital movement, rather they interact with the nucleus like a rotating whipping top. Since the electrons and protons in atom have unlike electrical but like and unlike magnetic fields, there are forces which can bring them closer together and therefore limit their rapprochement. Due to this fact, the bond between the valence electrons in the molecule and between the electrons and the protons in the atom can be depicted with the help of simple lines as shown in Figures 3,4 [13].

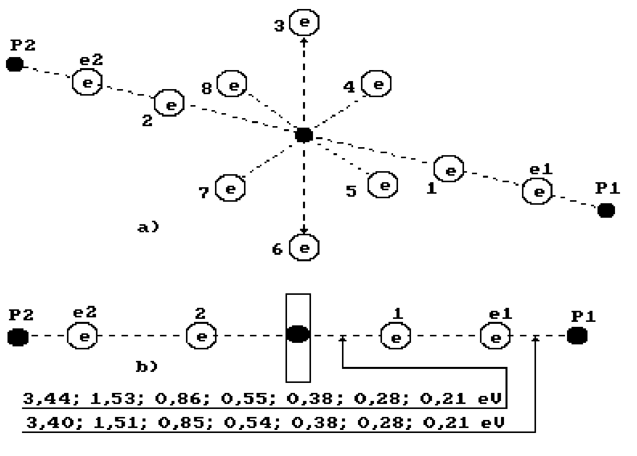

Fig. 4. Diagram of water molecule:
1, 2, 3, 4, 5, 6, 7, 8 are the electrons of oxygen atom
P_1, P_2 are the nuclei of hydrogen atoms (protons)
e_1 and e_2 are the numbers of hydrogen electrons

The bonds between the atoms in the molecule form the surface electrons, which we call valence electrons. The electrons of the atoms, which form a molecule, can get connected with each other or with the protons of the nuclei if the proton cell is free.

The structure of hydrogen atom (Fig. 1) demonstrates that if this atom unites with the first electron of oxygen atom by its only electron, the proton will be on the surface of the molecule and will form a zone of positive charge, which is generated by the proton of hydrogen atom (Fig. 4). The proton of the second hydrogen atom also forms the same zone. It is connected with the second electron of oxygen atom (Fig. 4).

The negatively charged zone is formed by the third through eighth electrons of oxygen and are arranged near the surface of the atom. The dipole water molecule is formed in such a way (Fig. 4) [6], [13]. Fig. 4 demonstrates a principle of water molecule formation and the series of binding energies of the first and second electrons of oxygen atom with its nucleus and the binding energies of the proton of the hydrogen atom with its electron.

CONCLUSION

The component of orbital energy of the electron is absent in the mathematical model of the formation of atomic spectra. That means that there is not orbital movement of the electrons in atoms. In this case the rotating electron will precesses on the proton of the nucleus. Such process of the interaction of the electron with the nucleus of the atom explains the principle formation of molecules by means of unlike magnetic poles of the valence electrons.

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