New Theory of Atomic Structure

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Bohr and Zommerfild definitely proved Rezerford's planetary atomic model [1, 2]. However, as a result of difficulties appeared while explaining the fine atomic structure of hydrogen and complex atomic structure, their theory had been rejected. Now, atomic structure is described by the complex three-dimensional Shredinger's differential equation [3..5]. **Even for hydrogen atom, the solution of this equation cannot be expressed via elementary functions [6]. For atoms which have two or mode electons, Shredinger's equation cannot be solved even by numerical way [7].** It takes electronic computers to work for hundreds of hours [8] or several years [9] to compute a spectrum therm.

Our theory is a logical continuation of Bohr and Zommerfield's theory. An extensive material concerning the definition of values of the ionization potential and energy of therms of optical and x-rays had been used while formation. The referenced values of the ionization potential are given to high precision which reaches 8-10 decimal points. These data are reliable because they are gotten as a result of summarizing of the experimental material which is available to all mankind. The results of the theoretical research conducted by using techniques developed on a basis of our theory are adjusted with the experimental data above.

The velocity of interaction propagation is equal to the velocity of light. The finiteness of this velocity is determined by presence of the universal medium (ether). Newton's and Koulon's laws are precisely applied only to solids which are static for this medium. **For mobile solids, the effectiveness of interaction depends on the velocity of their motion relatively to the universal medium.** The equations of the motion effect are similar to the equations of Doppler effect in acoustics and optics. In case that both of interacting solids are mobile, the equation takes following form [10, 11]:

$$X' = X\sqrt{\frac{C^2 + V'^2 + 2CV'\cos\alpha_1'}{C^2 + U'^2 - 2CU'\cos\beta'_1}},$$

where X is the value depending on the motion velocity, C is the velocity of light, V and U are velocities of motion on interacting solids, α_1 and β_1 are the angles between directions of motion of the wave source and the receiver and the line joining the point the wave emanated from with the point it met with the receiver. Accented and unaccented letters are given for the values obtained correspondingly taking and not taking into account the motion effect. The motion of atomic nucleus can be neglected, then, the following equations are possible for values characterizing the electron orbital motion:

$$a' = \frac{a\sqrt{c^2 + V'^2}}{c} = \frac{ac}{\sqrt{c^2 - V^2}}, \qquad (1)$$

$$b' = \frac{bc}{\sqrt{c^2 + V'^2}} = \frac{b\sqrt{c^2 - V^2}}{c}, \qquad (2)$$

where a and b are the values which increase of decrease as a result of motion effect.

The integral of "electron - nucleus" system takes the following form [12]:

where m is the electron mass, V' is the velocity of electron, $\beta = l + m/M$, M is the nuclear mass, r' is the radius-vector, $\mu' = (z'e^2c^2 10^{-7})/m$, z' is a charge number, e is an elementary charge, l is the length of large axis of the orbit. Having obtained the orbital velocity and its radial and tangential components via the energy integral, it's possible to derive an equation describing the electron motion on the finite open curve [12]:

$$\frac{mV'^2\beta}{2} - \frac{\mu' m}{r'\beta} = \frac{\mu' m}{l'\beta},$$

where φ' is the turning angle of r radius-vector; n is a number that characterizes the degree of orbital oblongness; k is a number of steady state; V_a, V_n are velocities of electron in the apocenter and the pericenter; ra, rn are the apocentral and pericentral radiuses.

The results of the calculation with authors' formulas concur to a high precision to the experimental data. Table 1 shows the values of fundamental physical constants obtained experimentally and calculated by the formulas given below:

$$E'_н = \frac{e'^2 c^2 \cdot 10^{-7}}{2r'_н \beta_н}; \qquad V'_н = \sqrt{\frac{2E_н}{m\beta_н}}: \qquad \alpha'_\infty = \frac{V'_н \beta_н}{c}:$$

$$R'_\infty = \frac{V'_н \beta_н}{4\pi r'_н c}; \qquad h = 2\pi r'_н V'_н m\beta_н: \qquad \mathrm{T}_н = \frac{2\pi r'_н}{V'_н}.$$

Table 1. Physical Constants

Constant	Calculation	Experiment
Ionization Potential E'_H, eV	13.59829218	19.5985
Electron Velocity $V'H \cdot 10$-6, meters per second	2.186500601	-
Constant of Fine Structure $1/\alpha'_\infty$, m^{-1}		
Rydberg's Constant	1.097373153	1.097373153
Orbital Period for Electron	1.820657574	-
Plank's Constant	6.626075438	6.6260755

As a source data, the values of four constants have been taken [13]:

Velocity of Light $c = 2.99792458 \cdot 10^8$ mps;

Elementary Charge $e' = 1.60217733 \cdot 10^{-19}$ Cl;

electron mass $m = 9.10938968 \cdot 10^{-31}$ kg;

Bohr radius $r'n = 5.29177249 \cdot 10^{-11}$ m.

For hydrogen atom, $\beta_n = 1.000544617$.

Parameters of complex atoms can be expressed via parameters of Bohr orbit [12].

If the electron goes on round orbit then:

$$r' = \frac{r_н k^2}{z'}; \quad V' = \frac{V_н \beta_н z'}{k\beta}, \tag{3}$$

and if on elliptical then:

$$r'_n = \frac{r_н k^2 (1-\xi)}{z'}; \quad V'_n = \frac{V_н \beta_н z'(1+\xi)}{n\beta};$$

$$r'_a = \frac{r_н k^2 (1+\xi)}{z'}; \quad V'a = \frac{V_н \beta_н z'(1-\xi)}{n\beta},$$

where z' is an effective charge count, $\xi = \sqrt{1-\frac{n^2}{k^2}}$ is the eccentricity.

The full energy of the electron-atom system is:

$$E' = \frac{E_н \beta_н z'^2}{k^2 \beta}. \tag{4}$$

The orbital period for the electron and the kernel to go around center of mass:

$$T' = \frac{T_н k^3 \beta}{\beta_н z'^2}. \tag{5}$$

Formulas (1) and (2) have helped to determine:

$r_н = 0{,}529191323 \cdot 10^{-10}$ m;

$V_н = 2{,}186442460 \cdot 10^{6}$ m/a;

$E_н = 21{,}78571660 \cdot 10^{-19}$ Watt · Second;

$e = 1{,}602156024 \cdot 10^{-19}$ Kl;

$T_н = 1{,}520657574 \cdot 10^{-16}$ s.

Thus, having known the effective charge count it's possible to calculate all magnitudes that characterize the electron's orbital movement in the atom.

Atoms have planetary structure. When an electron turns from the one steady state to another, the waves are absorbed and emitted. **At the same time, in the multi-electron atoms, not only the electron that moved from the one orbit to another, but also the rest of electrons have their full energy changed.** The lengths of the optical and the roentgen waves emitted by the complex atoms are calculated according the formula [12]:

$$\frac{1}{\lambda''} = \frac{R_\infty}{\beta}\left(\frac{z'^2_1}{k_1^2} + \frac{z'^2_2}{k_2^2} + \ldots + \frac{z'^2_i}{k_i^2} - \frac{z'^2_{1b}}{k_{1b}^2} - \frac{z'^2_{2b}}{k_{2b}^2} - \ldots - \frac{z'^2_{ib}}{k_{ib}^2}\right), \tag{6}$$

where: $z'_1, z'_2, \ldots, z'_i, k_1, k_2, \ldots, k_i$ are the charge counts and the steady states of a nonexcited atom, $z'_{1b}, z'_{2b}, \ldots, z'_{ib}, k_{1b}, k_{2b}, \ldots, k_{ib}$ are the corresponding values of an exited atom. The electron numbering comes from the kernel to the periphery of the atom. Ridberg's constant $R_\infty = 1.097314784 \cdot 10^7$ m^{-1} is the same for all atoms.

Table 2. Energies of The Spectral Therms of The Hydrogen Atom

Therm of exited state	Therm energy, cm-1; Therm difference, cm-1	
	According to formulae (6)	Reference Data
$2p\left({}^2P^0_{1/2}\right)$ $2p\left({}^2P^0_{3/2}\right)$	82258,916 0,365 82259,281	82258,921 0,365 82259,286
$3p\left({}^2P^0_{1/2}\right)$ $3p\left({}^2P^0_{3/2}\right)$ $3d\left({}^2D_{5/2}\right)$	97491,617 0,108 97491,725 0,036 97491,761	97492,213 0,108 97492,321 0,036 97492,357

Table 2 shows the values of therms of a hydrogen atom taken from the reference and calculated by formulae (6). The difference between the calculated and the referenced value appears after the fifth or sixth decimal point. This is because last digits of the therm values are given not experimentally, but calculated by the established principles. The differences of the therms characterizing the fine structure of spectrums according to existent and new theory are equal.

The parameters of the orbits of an multi-electron atoms can be calculated via the values of the ionization potentials. Here is the sequence of calculations. First, the approximate values of an effective charge counts are calculated via the values of the ionization potentials. Then, the repetition factors of the orbital periods are calculated by the following formulas:

$$x_{i,1}=\frac{k_i^3\cdot z'^2_1}{k_1^3\cdot z'^2_i};\quad x_{i,2}=\frac{k_i^3\cdot z'^2_2}{k_2^3\cdot z'^2_i};\ldots x_{i,(i-1)}=\frac{k_i^3\cdot z'^2_{i-1}}{k_{i-1}^3\cdot z'^2_i}.$$

These formulas help to express the charge counts of all electrons via the chare count of the external electron. Then, having put new expressions into the formula (6), we would have an equation with the one unknown quantity:

$$E=\frac{R_\infty}{\beta}\left(\frac{x_{i,1}\cdot k_1\cdot z'^2_i}{k_i^3}+\frac{x_{i,2}\cdot k_2\cdot z'^2_i}{k_i^3}+\ldots+\frac{x_{i,(i-1)}\cdot k_{i-1}\cdot z'^2_i}{k_i^3}+\frac{z'^2_i}{k_i^2}-\frac{z'^2_{1b}}{k_{1b}^2}-\frac{z'^2_{2b}}{k_{2b}^2}-\ldots-\frac{z'^2_{(i-1)b}}{k_{(i-1)b}^2}\right). \tag{7}$$

Now it's possible to determine the exact values $z'_1, z'_2, \ldots, z'_i$ by sequential accomplishing the tasks for the ions of the given atom which have 2, 3, … , *I* electrons correspondingly. As it is shown above, having known the value *z′* for the electron, it is possible to determine all parameters of its orbit. In the published issues, the calculated values of the parameters of the electron's orbits are given for all possible ions of the first twelve elements in the Periodic Table. In this article, an example of calculation of the helium atom is given.

In a nonexited atom of the helium, both electrons are in the first steady state and move on the round orbits. The orbital period of the external electron is twice more that the orbital period of the internal electron. Energy consumption to remove an electron from a nonexited helium atom is *E* = 198310,76 Sn^{-1} = 39.3933902·10^{-19} Watt-Second. In this case, the equation (7) takes the following form:

$$E=\frac{R_\infty}{\beta}\left(2z'^2_2+z'^2_2-z'^2_{1b}\right).$$

Having calculated via this equation the values z^e_2 = 1.3914422, it is possible to find z'1 = 1.9677965 from $T_2 / T_1 = z_1'^2 / z_2'^2 = 2$ ratio. Now it is possible to calculate the parameters of the orbits of both electrons in the first steady state by the formulas (3), (4), and (5).

Table 3. Orbits of Electrons In Helium Atom

Steady state of second electron	Orbit type and number	Charge count		$x_{2,1} = \frac{T_2}{T_1}$
		z'_1	z'_2	
1	Round	1,9677965	1,3914422	2
2	1st round	1,9971808	1,2043454	22
	2nd round	1,9991896	1,0882210	27
	3rd round	2,0001251	1,0328602	30
	4th round	2,0001274	1,0328613	30
	5th round	1,9996570	0,9998285	32
3	1st round	1,9996874	1,1204559	86
	2nd round	1,9999251	1,0551392	97
	3rd round	1,9998483	1,0289134	102
	4th round	1,9998489	1,0289138	102
	5th round	1,9997306	1,0092539	106
	6th round	1,9997382	1,0092577	106
	7th round	2,0000089	1,0000045	108

Table 3 shows similarly calculated count charges of an electron in the helium atom for the cases when the external electron is in the one of three steady states.

Evidently from table 3, the external electron in the helium atom can have only one round orbit in the first steady state, 4 round and 1 elliptical in the second steady state, and 5 round and 2 elliptical orbits in the third steady state. The first orbit of the electron in the second steady state is very stable. Electron's transfer from this orbit to the orbit in the first steady state is possible only when the atoms collide [16]. Usually, the helium consists of two kinds of atoms. In some atoms, the external electron is moving on the orbit of the first steady state, and on the first orbit of the second steady state in the others. The first atoms are the ones of the parahelium, and the second atoms are the ones of the orthohelium.

For the atoms with the equal number of the electrons but different kernel charges, the following equity is valid:

$$E_{n+1} \cdot \beta_{n+1} = 2E_n \beta_n + \frac{2E_H \beta_H}{k^2} - E_{n-1} \beta_{n-1},$$

where: En is the ionization potential of the hydrogen atom, E_{n+1}, E_n, and E_{n-1} are the ionization potentials of the ions of three elements located next to one another, n is the number of the element, k is the number of the steady state of the external elements in the ions. **By this formula, the ionization potentials and the values for k have been calculated for 24 elements [12].** There is no principal difficulties for calculating the ionization potentials and the parameters of the electron's orbits for all elements in the Periodical Table.

Table 4. Atoms' Ionization Potentials

Number of The Electron	Fluorine		Neon		Natrium	
	Ionization Energy *E*, eV		Ionization Energy *E*, eV		Ionization Energy *E*, eV	
	Calculated	Referenced	Calculated	Referenced	Calculated	Referenced
1	1102,0	1101,8	1360,5	1360,2	1646,2	1646,4
2	953,43	953,5	1195,0	1195,4	1463,7	1464,7
3	185,14	185,14	239,0	239,1	299,86	299,7
4	157,06	157,11	207,05	207,2	263,83	264,2
5	114,21	114,21	157,91	157,91	208,41	208,44
6	87,141	87,23	126,15	126,4	172,36	172,38
7	62,710	62,646	97,118	97,16	138,33	138,6
8	34,971	34,98	63,456	63,5	98,916	98,88
9	17,423	17,418	40,964	41,07	71,639	71,8
10	-	-	21,565	21,559	47,287	47,29
11	-	-	-	-	5,1391	5,138

Table 4 shows the calculated and the referenced values of the ionization potentials of the fluorine, the neon, and the natruim atoms. Evidently, the calculated values of the ionization potentials conform well to the reference values.

Chemical and a set of physical properties of the elements are stipulated by the energy of binding external electrons with the atoms. The binding energy, and, therefore, the properties are periodically dependent on the number in the Periodical Table. While comparing the ionization potentials of all ions with the different kernel charges but with the equal number of the electrons, 12 periods shown in table 5 may be neatly discerned for known elements. Table also shows the 13th period for the elements that possibly exist in the Universe in conditions different from ones in the Solar System.

Table 5. Periodical Law

Period	Element Number In The Period													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
I	H	He												
II	Li	Be	B	C	N	O	F	Ne						
III	Na	Mg	Al	Si	P	S	Cl	Ar						
IV	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni				
V	Cu	Zn	Ga	Ge	As	Se	Br	Kr						
VI	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pb				
VII	Ag	Cd	Jn	Sn	Sb	Te	J	Xe						
VII	Cs	Ba	La	Ce	Pr	Nd	Pm	Sm	Eu	Gb	To	Dy	Ho	Er
IX	Tm	Yb	Lu	Hf	Ta	W	Re	Os	Jr	Pt				
X	Au	Hg	Tl	Pb	Bi	Po	At	Rn						
XI	Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm
XII	Md	No	Lr	Ku	Ns	106	107	108	109	110				
XII	111	112	113	114	115	113	117	118						

Table 6 shows how the electron layers are filled in the atoms of the elements of the 13th period. The period may give an idea how the electron layers are filled in the atoms of other elements.

The number of layers in the atom corresponds to the number of the period in which it is located. The maximum possible number of the electrons in the layer is equal to the number of elements in the period in which the layer is filled. In the first layer, both electrons are in the first steady state.

Eight electrons in the second layer are in the second steady state, the electrons of the third and the forth layer are in the third, and the electrons of all other layers are in the forth steady state.

Table 6. Allocation of Electrons In the Atoms of the 13th Period

Number of Element	Number of Layer												
	1	2	3	4	5	6	7	8	9	10	11	12	13
	k=1	k=2	k=3		k=4								
111	2	8	8	10	8	10	8	14	10	8	14	10	1
112	2	8	8	10	8	10	8	14	10	8	14	10	2
113	2	8	8	10	8	10	8	14	10	8	14	10	3
114	2	8	8	10	8	10	8	14	10	8	14	10	4
115	2	8	8	10	8	10	8	14	10	8	14	10	5
116	2	8	8	10	8	10	8	14	10	8	14	10	6
117	2	8	8	10	8	10	8	14	10	8	14	10	7
118	2	8	8	10	8	10	8	14	10	8	14	10	8

In specified periodical table of elements one period contains two elements, six periods contain 8 elements each, four periods contain 10 elements each, and two periods contain 14 elements each. In some periods, there is the same regularity in the change of the element's properties with the increase of the number of electrons in the atom's external layer. Thus, the second and the third periods beginning with alkaline elements; the fifth, the seventh, the tenth, and the thirteenth periods beginning with the elements of the copper group; the fourth; the sixth, the ninth, and the twelfth containing 10 elements each; the eighth and the eleventh containing 14 elements each are similar.

Bibliography:

1. Шпольский Э.В. Атомная физика. т.I – М.: Физмат, 1963.
2. Зоммерфельд А. Строение атомов и спектры. т. I – М.: Гостехиздат, 1956.
3. Вихман Э. Квантовая физика. т.4 – М.: Наука, 1986.
4. Борн М. Атомная физика. – М.: Мир, 1967.
5. Шпольский Э.В. Атомная физика т.2 – М.: Наука, 1984.
6. Спролул Р. Современная физика. – М.: Фмзматгиз, 1961.
7. Ландау Л.Д., Лифшиц Е.М. Квантовая механика. – М.: Физматгиз, 1961.
8. Кравцов В.А. Массы атомов и энергии связи ядер. – М.: Атомиздат, 1974.
9. Намбу Е. Кварки. – М.: Мир, 1984.
10. Сухоруков В.И., Сухоруков Г.И. Эффект Доплера при движении источника и приемника волн в произвольном направлении // Акустический журнал. – 1986, т.32, №1. – с. 134-136.

11. Сухоруков Г.И. Теоретические модели физического эксперимента. Диссертация на соискание ученой степени доктора физико-математических наук – Братск: 1998.
12. Сухоруков Г.И., Сухоруков В.И., Сухоруков Р.Г. Реальный физический мир без парадоксов. – Иркутск: Изд-во иркут. ун-та, 1993.
13. Власов А.Д., Мурин Б.П. Единицы физических величин в науке и технике: Справочние. – М.: Энергоатомиздат, 1990.
14. Радциг А.А., Смирнов В.М. Справочник по атомной и молекулярной физике. – М.: Атомиздат, 1980.
15. Таблицы физических величин. Справочник. Под ред. И.К. Кикоина. – М.: Атомиздат, 1976.
16. Гольдин Л.П., Новиков Г.И. Введение в атомную физику. – М.: Наука, 1969.

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