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Planetary Model of a Helium Atom

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ABSTRACT

The relevance of the problem under study is driven by the need to identify physical causes that ensure the stability of atoms without resorting to arbitrarily accepted postulates, e.g. in the form of N. Bohr's postulates, or the formalism of quantum mechanics.

The goal of the paper is to construct and investigate a planetary model of a helium atom, which would demonstrate the stability of the atom and show the mechanism of formation of its radiation spectrum.

The Systematic Theory of the Electrical Phenomena (STEP) developed by the author on the basis of the propositions of theoretical mechanics served as theoretical grounds for the study.

The main results of the study are as follows:

1. a physically meaningful model of a helium atom has been constructed, demonstrating the stability of the atom against perturbations of the electron orbit;
2. the explanation has been given to the mechanism of formation of the line spectrum of atomic radiation;
3. foundations have been laid for the method of modelling of electrical phenomena based on the understanding of the electric field as a continuous material medium.

The presented materials demonstrate a new method of modelling of force interaction in systems whose elements are charged bodies, and can be used when constructing models of any multi-electron systems.

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Introduction

Science is to supply any given person with an adequate reflection of reality enabling him/her to successfully cope with emerging life challenges. Such a reflection can be achieved firstly, by realizing the chains of cause-effect relations existing between the objects of the world around us, or, secondly, by formally comparing information about the functioning of objects, i.e. by constructing a formal model devoid of physical content. The first way makes use of physics, which objectifies its results by means of mathematics. The second way involves the primacy of mathematics with the hope that a mathematical result can somehow be compared to physical processes in the real world, thus giving it practical relevance.

Both ways can be distinctly traced in the development of the theory of electrical phenomena. All essential results constituting the basis for the theory were obtained 100-200 years ago by following the first of the above-mentioned ways. The development of science at this stage resulted in a multitude of empirical laws, such as for instance, the Biot-Savart law, Ampere's law, Faraday's law etc., which formed the nucleus of the contemporary theory of electricity. However, instead of explicating cause-effect relationships, revealing and analysing physical facts underlying experimentally observed phenomena, science embarked on a course of inventing formal constructions and formulating own laws.

One example of such a formal construction is quantum mechanics, which, despite some successes, immediately raised doubts among a number of physicists as regards the validity and logic of its basic propositions. To overcome these doubts, the creators of quantum mechanics had to propose the idea of wave-particle duality and the concept of complementarity, which in their opinion, linked the new science with the results of experimental physics and gave meaning to the concepts used in it. Actually, there was a need for some interpretation of the theory that was a pure product of reflection. The interpretation, if endorsed by certain stakeholders, came to be recognized as a valid scientific knowledge. The criterion of the scientific nature of knowledge has moved away from the sphere of practical human activity to the sphere of agreement. For example, such was the "Copenhagen interpretation" of quantum mechanics. This, in turn, opened the way to indeterminism in science, which denies the objective nature of causal relationship and the cognitive significance of causal explanation in science. The situation was so disturbing that A. Ioffe had to address to A. Einstein with these words: "*One cannot fail to see the fog of mysticism that enveils the distinct outlines of physics; frustration and rejection of the reality of nature itself is being poured into science*" [1].

The danger of physics sliding towards formal constructions based on mystical assumptions still remains. This is noted, for example, by the author of the paper [2]: "*At the century's end, the physical science stopped being a source for the rational and materialistic worldview component. ... At the same time, it demonstrates the signs of crisis with respect to both its method and its philosophy*".

Unfortunately, the problems outlined, despite their importance for the development of theory, fail to result at present in a due public discussion. A certain background is created by the works of Ju. Petrov, Petrov YI, S. Arteha, K. Kann and Kann KB, Je. Meerovich [3-8]. As a rule, their authors try to correct the drawbacks of electromagnetism without attacking its foundations or propose constructions on even more mystical grounds. This is what makes the position of these authors false. The relevance of the proposed article lies in the fact that it advocates a materialistic outlook both in the theory of electricity as a whole and in such an incidental point as the question of understanding the behaviour of elementary particles constituting an atom.

The specific purpose of the undertaken study is to prove that a helium atom represented by the planetary model has stability not because the electron follows N. Bohr's postulates, but because it experiences a force effect on the part of superposition of the electric fields of other elements of the atomic structure.

For more than a century the traditional electromagnetic theory has failed to adequately explain even one-electron atom structure, so the use of this theory was recognized as futile for the purpose at hand. The study was so complex that it necessitated the use of previously developed Systematic Theory of the Electrical Phenomena (STEP), which [9]

1. does not use any extralogical judgments or postulates;
2. only the electric field, which is a continuous material medium is recognized as an essence;
3. the magnetic field is treated as a phenomenon that only represents the expression of mechanical motion of the electric field;
4. there are no contradictions with the fundamental laws of mechanics, which allows using mechanics to describe the behaviour of the electric field.

The first section of this paper contains the description of some misconceptions of electromagnetic theory which made it unsuitable for an adequate reflection of natural phenomena.

The second section is devoted to the summary of the main results of the STEP theory, to the extent necessary to understand what is presented in the third (main) section of the paper.

The third section contains a proof of the helium atom stability and a description of the peculiarities of formation of its radiation spectrum.

Misconceptions and Errors of Electromagnetic Theory

Radiation at Accelerated Motion of a Charged Body

Virtually all textbooks expounding electromagnetic theory contain disguised false propositions characterized by their tenacity. Thus, it is postulated in theory that any accelerated motion of charge carriers is accompanied by radiation of electromagnetic waves. For nonrelativistic speeds, J. Larmor established (1897) the proportionality of the radiation power to the square of acceleration. Without any particular analysis, this result was generalized to all kinds of accelerated motion of charged bodies and became a stumbling block for explaining the stability of the planetary model of an atom by means of the classical theory. The difficulty was as follows: when an electron moves round the nucleus there is a centripetal acceleration around the nucleus as a result of which the electron, having supposedly radiated all the energy available to it, must inevitably fall onto the nucleus.

The problem of stability of an atom was solved by N. Bohr in a very peculiar way. Consistent with reality, but contrary to the theory and logic, he postulated that in some states (in some orbits) the electron did not emit electromagnetic waves. Science embarked on a course prescribed by Bohr, but another problem emerged – the problem of adequacy of the electromagnetic theory, which is still unable to answer the question why there is no radiation in these states (in these orbits).

It is paradoxical that the standpoint based on a false interpretation of J. Larmor's results gave rise to a new science, as the author puts it [10]: *"A total discrepancy between the conclusions based on the classical interpretation of the nuclear model and experimental facts raised doubts as to whether the laws of classical physics should be applied to electrons in atoms and resulted in the development of the modern quantum mechanics".*

Let us show that there are such kinds of motion at which a charged body moving with acceleration does not radiate. The best way to identify the conditions under which a moving charge carrier becomes a source of radiation is to analyse how the energy of its electric field varies with time. In order to do that, let us consider the motion of the electric field along with the charge carrier q. The field energy is made up of electrostatic W_{es} and electrokinetic W_{ek}energy:

$$W_{es} = q^2/8\pi\varepsilon_0 R \,, \qquad (1.1)$$

$$W_{ek} = \frac{1}{2}mv^2, \qquad (1.2)$$

where $m=W_{es}/c^2$ is the mass of the moving electric field.

Electrostatic energy does not depend on the speed or acceleration of motion; therefore, we will only study the change in time of electrokinetic energy W_{ek},

$$W_{ek} = \frac{1}{2}W_{es}\frac{v^2}{c^2} \,. \qquad (1.3)$$

Let us keep in mind that $v^2=(v,v)$, so the derivative of kinetic energy with respect to time will be represented as follows:

$$\frac{dW_{ek}}{dt} = \frac{1}{2}m\frac{d(\mathbf{v},\mathbf{v})}{dt} = m(\mathbf{a},\mathbf{v}) \,, \qquad (1.4)$$

Formula (1.4) directly points to the fact that a charge carrier moving with acceleration can radiate or absorb energy only when the dot product $(\mathbf{a},\mathbf{v})\neq 0$. But in case of circular motion the dot product $(\mathbf{a},\mathbf{v})$ will always be zero. In this case, there is no radiation, and the atom retains its electrokinetic energy for any length of time. It means that all circles centred on the nucleus of the atom will be fixed orbits.

Electromagnetic Field

In canonical physics, the electric field and the magnetic field are considered to be immobile material essences indicating the existence of a single electromagnetic field. The proof of the existence of a single electromagnetic field lies in the fact that a magnetic field, even if it does not exist in some frame of reference, will by all means emerge at a transition to another frame of reference that is moving relative to the first one.

The basic misconception here is an implicit postulate that the electric field is always immobile. The materiality of the electric field is not refuted, but it (the field) appears to be devoid of the basic property of all material bodies, deprived of the ability to move. It is to avoid using the notion of "moving field" that the theory is forced to introduce the notion of a "moving frame of reference." Overcoming this misconception allows us to consider the magnetic field not as an essence, but as evidence of the motion of the electric field.

The theory of the electrical phenomena will then appear as a special case of theoretical mechanics, and firstly, it will simplify the description of electrical phenomena, secondly, it will reveal new possibilities for their formal analysis, and thirdly, it will protect from conceptual errors.

Identification of the Electric Field

Traditionally, the field is said to exist if the test charge experiences a force, and does not exist otherwise. Such method of identification of the electric field has been in operation probably since M. Faraday's time, but it is by no means adequate in all cases.

At the modern level of understanding, even amateur physicists know that using a "test charge" one can only establish the presence (absence) of a potential gradient in a given point of the field, but one cannot assert anything about the existence of an electric field as a material essence in it. Nevertheless, textbooks presenting the theory constantly demonstrate the identification of the mathematical concept "potential gradient" and the material object "electric field." Substitution of concepts is another misconception of electromagnetic theory.

There is a similar misconception in the issue of the presence of the field in the vicinity of any material body, even if it is uncharged. In this case, the electric fields of its electrons and nuclei act upon a "test charge" placed in the vicinity of the body, with equal but oppositely directed forces. Naturally, the resultant force in this case is equal to zero, and the "test charge" does not react in any way to the presence of fields, creating an illusion of their absence.

There is a large number of studies exploring ways to overcome errors and contradictions generated by the above-described misconceptions, as well as by many others, but all of them were performed within the framework of the concept of electromagnetism. The analysis of these studies has shown that the very paradigm of electromagnetism is unsound. To break through the impasse is to apply the theory of electrical phenomena, the subject of which is the electric field considered as material continuum. Some propositions of this theory are given in the next section, to the extent necessary to understand the main part of the paper.

Theoretical Foundations of Modelling

The electric field of any charged body has electrostatic energy that is equal to the work done when creating that field. Formally, energy is represented by the function of distance R and charge Q, W_{es} (Q,R). All possible derivatives of this function with respect to charge and distance form a complete set of physical quantities necessary and sufficient to reflect all properties of the field in a static state. For example, the potential of an electrostatic field φ_{es} is determined by the derivative ($\varphi_{es} \overset{\text{def}}{=} dW_{es}/dQ$), the intensity E_{es} – by the mixed derivative E_{es} ($\overset{\text{def}}{=} d^2 W_{es}/dQdR$). The definitions of all other quantities are introduced in the theory in a similar way.

These definitions do not always coincide with the definitions accepted in the traditional theory, but they help avoid its mistakes.

When moving along with the charge carrier, the field obtains electrokinetic energy. If mass m of the field is defined according to A. Einstein, $m=W_{es}/c^2$, then the electrokinetic energy W_{ek} will be expressed by the formula

$$W_{ek} = mv^2/2 = \frac{1}{2} W_{es} \frac{v^2}{c^2}. \qquad (2.1)$$

Similar to the static case, all possible derivatives of energy W_{ek} with respect to all arguments form a complete set of physical quantities necessary and sufficient to reflect electrokinetic properties of the field. For example, the electrokinetic potential φ_{ek} is expressed by the derivative

$$\varphi_{ek} \overset{\text{def}}{=} dW_{ek}/dQ = \frac{1}{2} \varphi_{es} \frac{v^2}{c^2}, \qquad (2.2)$$

the vector potential – by the mixed second-order derivative,

$$\mathbf{A} \overset{\text{def}}{=} \frac{d^2 W_{ek}}{dQdv} \mathbf{1}_v, \qquad (2.3)$$

where $1_v=\mathbf{v}/v$ is the unit vector of the velocity vector.

The electrokinetic intensity E_{ek} of the field of a charge carrier moving along the z axis of a cylindrical coordinate system (r,θ,z), depends on both the spatial characteristic of the field and the character of its motion, so this quantity is determined by the sum, taken with the opposite sign, of the electrokinetic potential gradient and the derivative of the vector potential with respect to time,

$$\mathbf{E}_{ek} \overset{\text{def}}{=} -\left(\mathbf{grad}\varphi_{ek} + \frac{d\mathbf{A}}{dt}\right) =$$

$$= \frac{1}{2} E_{es.r} \frac{v^2}{c^2} \mathbf{1}_r - \frac{1}{2} E_{es.z} \frac{v^2}{c^2} \mathbf{1}_z - \frac{\varphi_{es}\mathbf{a}}{c^2}, \qquad (2.4)$$

where $E_{es.r}$, $E_{es.z}$ are the projections of the vector of the electrostatic field intensity on the respective axes of the cylindrical coordinate system; 1_r, 1_z are unit vectors of coordinate axes; a is the acceleration of motion.

The analysis of the helium atom stability undertaken in the third section will require knowledge of the intensity of the resultant field, i.e. the field that is a superposition of the electrostatic and electrokinetic fields. The intensity E of this superposition is the sum of

$$\mathbf{E} = \mathbf{E}_{es} + \mathbf{E}_{ek} =$$

$$= E_{es.r}\left(1 + \frac{1}{2}\frac{v^2}{c^2}\right)\mathbf{1}_r + E_{es.z}\left(1 - \frac{1}{2}\frac{v^2}{c^2}\right)\mathbf{1}_z - \frac{\varphi_{es}\mathbf{a}}{c^2}. \qquad (2.5)$$

The obtained expression allows us to state that in motion the field intensity depends on both the velocity and acceleration of motion. The field intensity increases (as compared to the electrostatic intensity) in a radial direction (transverse relative to the velocity vector), and decreases in a longitudinal direction. The intensity component due to acceleration is always opposite in direction to the acceleration vector.

Planetary Model of a Helium Atom
The Stability of an Atom
Forces in Orbital Motion

A helium atom has a nucleus consisting of two neutrons and two protons around which two electrons are orbiting. In subsection 1.1 it was shown that an electron moving with centripetal acceleration radiates only under condition that the dot product of its velocity and acceleration vectors is not equal to zero. In case of uniform circular motion, this dot product is always zero, hence only circles can be fixed orbits of electrons in an atom. When a charged body rotates, its electric field receives meridian intensity [9, p. 144], whose action forces both electrons to move along orbits located in one and the same plane. Notably, the electrons are in exactly the same conditions and therefore their fixed orbits coincide. Mutual repulsive forces cause the electrons to be in diametrically opposite points of the orbit, which is reflected in Figure 1, which shows some instantaneous location of the elements of the atom in the coordinate system associated with the nucleus.

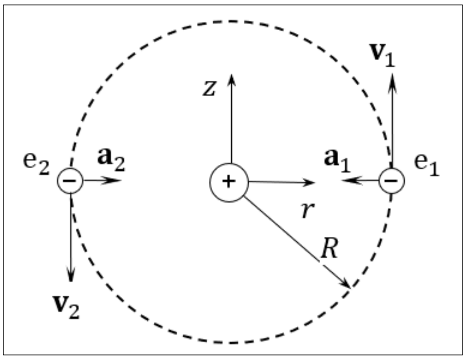

Figure 1

In order to determine the forces acting, for example, on the electron e_1 during its revolution around the nucleus, let us find the electric field intensity at a point where this electron is located. The field is created by two moving sources: the nucleus of the atom and the electron e_2, so to determine its intensity let us use the relation (2.5) obtained exactly for the case of moving charge carriers. Correct application of this relation requires that the motion of the field sources be represented by motion in a coordinate system associated with the electron e_1, so let us consider the location point of this electron as the instantaneous velocity centre and locate in it the origin of the coordinate system (z,r) (Figure 2).

In this coordinate system, the speeds and accelerations of the second electron e_2 and the atomic nucleus will be determined by the following expressions: $v_{e2}=2_{v1}$; $v_n=v_1$; $a_{e2}=(2v_1^2)/(R$; $a_n=(v_1^2)/R)$.

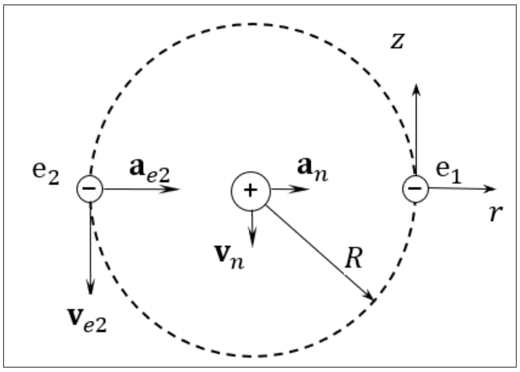

Figure 2

The instantaneous arrangement of charge carriers is such that at the point of location of a provisionally immobile electron e_1 (at the origin of coordinates) the component E_z of the vector of the electrostatic field intensity of the nucleus will always be equal to zero, so the formula (2.5) for calculation of the electric field intensity of the moving nucleus will be recast in the form,

$$\mathbf{E}_n = \mathbf{E}_{n.r} = \left(\mathrm{E}_{n.es}\left(1+\frac{1}{2}\frac{v_1^2}{c^2}\right) - \varphi_{n.es}\frac{v_1^2}{c^2 R}\right)\mathbf{1}_r\ , \qquad (3.1)$$

where 1_r is the unit vector of the r axis, $\mathrm{E}_{n.es}$, $\varphi_{n.es}$ are respective intensity and potential of the electrostatic field of the atomic nucleus at the location point of the electron e_1.

In the same way, let us find the electric field intensity of the second electron at the same point (at the origin),

$$\mathbf{E}_{e2} = \mathbf{E}_{e2.r} = \left(E_{e2.es}\left(1+\frac{1}{2}\frac{(2v_1)^2}{c^2}\right) - \varphi_{e2.es}\frac{(2v_1)^2}{2c^2 R}\right)\mathbf{1}_r\ , \qquad (3.2)$$

where $E_{e2.es}$, $\varphi_{e2.es}$ are respective intensity and potential of the electrostatic field of the electron e_2 at the location point of the electron e_1.

The last two formulas include the quantities of intensity and potential of the electrostatic field of the nucleus, and of the electron field at a point corresponding to the origin. These quantities are known from the electrostatics course:

$$E_{n.es} = \frac{q_n}{4\pi\varepsilon_0 R^2}\ ; \qquad \varphi_{n.es} = \frac{q_n}{4\pi\varepsilon_0 R}\ ; \qquad (3.3)$$

$$E_{e2.es} = \frac{q_{e2}}{4\pi\varepsilon_0 (2R)^2} = \frac{q_{e2}}{16\pi\varepsilon_0 R^2}\ ; \qquad \varphi_{e2.es} = \frac{q_{e2}}{8\pi\varepsilon_0 R}\ . \qquad (3.4)$$

Thus, the electron located at the origin will be in the resultant electric field with the intensity

$$\mathbf{E} = \mathbf{E}_n + \mathbf{E}_{e2} =$$

$$= \left(\frac{q_n}{4\pi\varepsilon_0 R^2}\left(1-\frac{1}{2}\frac{v_1^2}{c^2}\right) + \frac{q_{e2}}{16\pi\varepsilon_0 R^2}\left(1-2\frac{v_1^2}{c^2}\right)\right)\mathbf{1}_r\ . \qquad (3.5)$$

The nucleus of an atom has a positive charge equal to the modulus of the doubled charge of the electron, so let us introduce a quantity $e=-q_{e2}>0$, then $q_n=2e$ and the last formula will be recast in the form

$$\mathbf{E} = \frac{\mathrm{e}}{8\pi\varepsilon_0 R c^2}\left(\frac{7c^2}{2R} - \frac{v_1^2}{R}\right)\mathbf{1}_r\ , \qquad (3.6)$$

Hence it follows that the electron e_1 will experience a force $F_{orb}=-e\mathbf{E}$, due to orbital motion,

$$\mathbf{F}_{orb} = \frac{\mathrm{e}^2}{8\pi\varepsilon_0 R c^2}\left(\frac{v_1^2}{R} - \frac{7c^2}{2R}\right)\mathbf{1}_r = m\left(\frac{v_1^2}{R} - \frac{7c^2}{2R}\right)\mathbf{1}_r, \qquad (3.7)$$

where m is the mass of the electric field of the electron involved in the motion,

$$m = \frac{\mathrm{e}^2}{8\pi\varepsilon_0 R c^2}\ , \qquad (3.8)$$

In a fixed orbit with a radius $R=R_0$ at the speed of the electron v_0 the force F_{orb}, acting on it will be

$$\mathbf{F}_{orb} == m\left(\frac{v_0^2}{R_0}-\frac{7c^2}{2R_0}\right)\mathbf{1}_r. \qquad (3.9)$$

Both force and acceleration at uniform revolution of an electron have a radial character, so vector designation of the quantities will be abandoned hereunder.

Forces due to Intrinsic Rotation

The part of the force acting on the electron that arises due to the intrinsic rotation of the nucleus of the atom and the second electron will be calculated in the same way as it was demonstrated for the case of orbital motion. To reduce the length of the paper, let us consider calculation of the force only for the rotating nucleus of an atom.

Let us distinguish a spherical region in the electric field of the nucleus, the center of which coincides with the location point of the nucleus, and the radius is equal to the radius R of some orbit of the electron revolution.

Let us find the law of change in the moment of inertia $J_b(r)$ of the selected sphere when the current radius changes r from $r=0$ to $r=R$,

$$J_b(r)=\frac{e^2r^5}{60\pi\varepsilon_0R^4c^2}\,. \qquad (3.10)$$

Let us determine the relation between electrokinetic energy $W_{ek}(r)$ and distance r in the classical way,

$$W_{ek.rot}(r)=\frac{1}{2}\omega^2 J_b(r)=\frac{7}{240}\frac{e^2r^5}{\pi\varepsilon_0R^6}\,. \qquad (3.11)$$

The intensity $E_{ek.rot}$, created by the field rotation will be found by taking the mixed derivative,

$$E_{n.rot}=-\frac{d^2W_{ek}(r)}{dqdr}=-\frac{7}{24}\frac{e\,r^4}{\pi\varepsilon_0R^6}\,. \qquad (3.12)$$

Knowing the intensity $E_{ek.rot}$, it will not cause any problem to determine the force acting on the electron located at distance $r=R$ from the nucleus,

$$F_{n.rot}=(-e)E_{ek.rot}=\frac{7}{24}\frac{e^2}{\pi\varepsilon_0R^2}=\frac{7}{3}m\frac{c^2}{R}\,. \qquad (3.13)$$

Having performed similar operations, let us determine the force $F_{e.rot}$ with which the electron is acted upon by the rotating electric field of the second electron. It will amount to

$$F_{e.rot}=-\frac{5}{6}m\frac{c^2}{R}\,. \qquad (3.14)$$

Thus, the motion of the electron is due to the sum of three forces: 1) the force due to orbital motion (3.7), 2) the force generated by the intrinsic rotation of the nucleus (3.13), and 3) the force due to the rotation of the second electron (3.14). Taking this into account, we obtain the equation of motion of the electron.

The Equation of Motion of the Electron

Let us represent the motion of the electron as the sum of motion along the fixed orbit with a radius R_0 and the motion caused by the external impulse action, which makes the electron deflect from the fixed orbit to the distance r. Let us denote the distance between the electron and the nucleus as $R=R_0+r$ and represent the equation of motion of the electron in the form

$$m\frac{d^2r}{dt^2}=F_{orb}+F_{n.rot}+F_{e.rot}=m\left(\frac{v_1^2}{R}-2\frac{c^2}{R}\right). \qquad (3.15)$$

This equation, at r=0=const (revolution along a fixed orbit) gives the condition for determining the speed of the electron v_0 in this orbit, $v_1=v_0$, $R=R_0$,

$$v_0=\sqrt{2}c=1{,}41\,c\,. \qquad (3.16)$$

The result obtained shows that the speed of the electron moving along a fixed orbit does not depend on its radius, and the value of the speed is a constant greater than the speed of light.

This result contradicts the electromagnetic theory, in which, because of the use of the Lorentz transformations, such a speed is considered impossible. However, the requirement to follow the Lorentz transformations is purely formal there, not physically determined, so the result (3.16) should not be taken critically or rejected as anti-scientific.

In case the orbit of the electron randomly deflects from the fixed orbit, the electron will retain the value of momentum $L_0=mv_0R_0$, that it had in the fixed orbit. This will allow to write the equation of motion (3.15) in the form

$$m\frac{d^2r}{dt^2}=\frac{L_0^2}{m(R_0+r)^3}-2\frac{mc^2}{(R_0+r)}\,. \qquad (3.17)$$

The first summand of the right-hand side expresses the force $F_1>0$, which repels the electron from the nucleus,

$$F_1=\frac{L_0^2}{m(R_0+r)^3}\,. \qquad (3.18)$$

The second summand is negative, $F_2<0$, and therefore it is the force of attraction of the electron to the nucleus of the atom,

$$F_2=-2\frac{mc^2}{(R_0+r)}\,. \qquad (3.19)$$

Figure 3 shows the graphs of the obtained relations: $F_1(R)$ (green), $F_2(R)$ (blue) and the graph of their sum $F(R)=F_1(R)+F_2(R)$ (black) at some given value $R_0=18{,}4\cdot10^{-8}$ m.

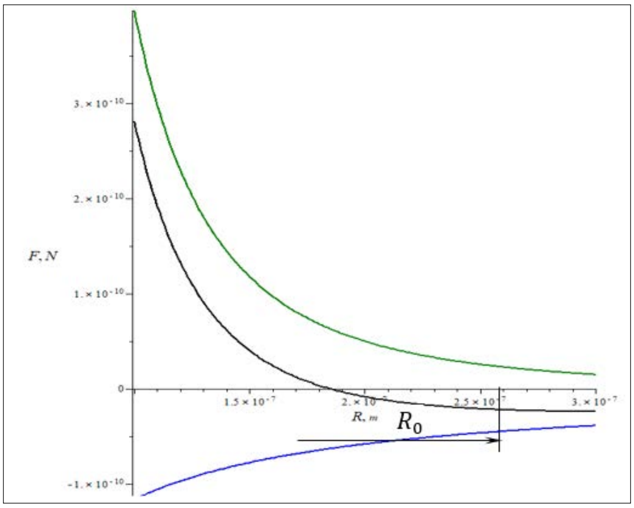

Figure 3

As can be seen from Figure 3, a random reduction of the orbital radius to $R<R_0$, leads to the predominance of the repulsive force F1 and, conversely, at $R>R_0$ the attractive force F_2 becomes greater than the repulsive force. The restoring force always has a direction that favours decreasing the modulus of the distance r from the fixed orbit. The stability of such an orbit is undoubted, and it was possible to determine it without resorting to N. Bohr's postulates or to any other heuristic assumptions of non-physical character.

Conditions for Radiation Occurrence

To determine the motion of an electron that has deflected from the fixed orbit to the distance r, one should solve the equation (3.17). However, finding a solution to the equation in an analytical form has come against certain difficulties. An alternative solution could be numerical, but in this case one must know the radius R_0 of the orbit, for the calculation of which there is no relevant a priori data.

In order to overcome this problem, let us confine ourselves to finding the solution of the equation (3.17) at so small $|r|$, at which the approximation of its right-hand side

$$F(r) = \frac{L_0^2}{m(R_0+r)^3} - 2\frac{mc^2}{(R_0+r)} \tag{3.20}$$

in the neighbourhood of the point $r=0$ is expressed by the following linear function $F(r)=-kr$ and it does not lead to unacceptable errors. In these conditions, it is natural to express the slope k by the value of the modulus of the derivative $r=|dF(r)/dr|$ at $r=0$,

$$k = \left|\frac{dF(r)}{dr}\right|_{r=0} = 4\frac{mc^2}{R_0^2} \tag{3.21}$$

Under the assumptions made, the behaviour of the electron will correspond to the behaviour of a simple harmonic oscillator making free oscillations:

$$r(t) = A\cos(\omega t + \varphi)\ . \tag{3.22}$$

As an initial condition for the deflection $r(t)$ let us assume its amplitude value, $r(0)=r_{max}$, which predetermines the value of the phase φ=0. As it is commonly known, the natural angular frequency of a harmonic oscillator ω, is determined by the relation *k/m*,

$$\omega = \sqrt{k/m} = 2\frac{c}{R_0}\ . \tag{3.23}$$

Thus, the electron will simultaneously make two types of motion:
1. revolution around the nucleus of the atom at a speed $v_0=\sqrt{2}\ c$,
2. harmonic oscillations relative to the fixed orbit with deflection from it $r(t)$,

$$r(t) = r_{max}\cos\left(2\frac{c}{R_0}t\right). \tag{3.24}$$

Of these two types of motion, only the second one serves as the cause of radiation. In case of this (second) type of motion, the dot product of velocity and acceleration vectors is never zero, and this is a necessary and sufficient condition for the existence of radiation.

The Peculiarities of an Observer's Perception of the Radiation of an Atom

Both electrons included in the atomic structure are the sources of radiation. Let us assume these two electrons are making harmonic oscillations differing from each other by initial phases:

$$\psi_1 = A\cos(\omega t + \varphi_1)\ , \tag{3.25}$$

$$\psi_2 = A\cos(\omega t + \varphi_2)\ . \tag{3.26}$$

It is shown in the theory of oscillations [11] that the superposition of two initial oscillations represents a modulated oscillation occurring with the same frequency, but importantly, with an amplitude that depends on the half-difference of the initial phases of initial oscillations,

$$\psi = 2A\cos(\varphi_m)\left(\cos(\omega t + \varphi)\right), \tag{3.27}$$

where $\varphi_m = (1/2)(\varphi_1 - \varphi_2)$.

Hence, it follows that the oscillations of electrons cannot be antiphase, because in case of antiphase oscillations, the amplitude of the modulated oscillation would be equal to zero, and it would be impossible to see radiation. On the contrary, at in-phase oscillations of electrons, the amplitude of the radiation wave acquires the greatest value, which greatly facilitates its detection.

Let us emphasize that radiation always exists, but its detection depends essentially on the angle (point of view) under which the observation is made. This idea is demonstrated in Figure 4.

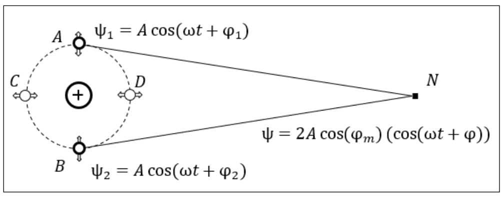

Figure 4

If the observation is made from the point *N*, located in the orbital plane, then the radiation emanating from electrons that are oscillating in-phase in the neighbourhood of points *A* и *B* represents a transverse wave for the observer. Such radiation is easily detected by the visual organs. But the oscillations of electrons in the neighbourhood of points *C* and *D* cannot excite a transverse wave for the observer located at the same point *N*. For him/her, the oscillations of the electric field of the electron will have a longitudinal character. However, it does not exclude that another observer located at some point on a straight line perpendicular to the segment *C D* will at the same time identify the distortion of the electric field caused by the oscillations of electrons as a transverse wave. This means that the waves perceived by observers may represent short-time wave pulses following each other at a rate determined by the orbital motion of electrons.

In physics, these pulses came to be called "photons." But their existence is simply postulated there, and their origin is not discussed. Moreover, modern science, with no reasonable basis whatsoever, considers the photon as a fundamental elementary particle, which is a carrier of electromagnetic interaction, but has neither dimensions nor any internal structure. This understanding is an example of the helplessness of the electromagnetic theory, which has proved to be unable to explain neither the stability of atoms nor the origin of photons, but endowed them with mystical properties, while referring to the wonders of the wave–particle duality.

There is another peculiarity of perception of radiation in the form of a photon sequence. It consists in the fact that oscillations of the electric field must keep their parameters unchanged, at least for the time of accommodation of the organs of vision. First of all, it concerns the coincidence of the phase of oscillations in photons sequentially entering the organs of vision, as well as the maintained direction of polarization of oscillations.

Preliminarily, let us pay attention to the fact that the source of radiation (oscillating electron), apart from the oscillating speed, has an orbital speed, $v_0=\sqrt{2}\,c$, while radiation is perceived by a fixed observer. This causes the wavelength of the electron trajectory λ to be greater than the wavelength of the observed radiation λ_{see} by a factor of √2, $\lambda=\sqrt{2}\ \lambda_{see}$. The corresponding relation is also established with respect to angular frequencies $\omega_{see}=\omega/\sqrt{2}$.

Let us now proceed to the determination of the radius R_0 of the fixed orbit in which the electron radiation forms a yellow spectral line. This can be done in two independent ways.

Firstly, the radiation is effected by two electrons, so the requirement for coincidence of the phase of oscillations dictates that the following condition be fulfilled: the wavelength λ must be equal to half the length of the circumference of the electron's fixed orbit,

$$\lambda = \pi R_0\,. \qquad (3.28)$$

Hence,

$$R_0 = \lambda/\pi = \sqrt{2}\,\lambda_{see}/\pi\,. \qquad (3.29)$$

The second way is associated with using the formula (3.23), and solving it with respect to, R_0, we obtain

$$R_0 = 2\frac{c}{\omega} = \frac{\lambda}{\pi} = \frac{\sqrt{2}\lambda_{see}}{\pi}\,. \qquad (3.30)$$

The results of determining the radius of the fixed orbit by means of the above-mentioned methods coincided. It indicates that there is no contradiction in the above calculations.

After substituting into the formula experimentally known parameters, angular frequency or, for example, the wavelength of the yellow radiation, $\lambda_{see}=580\cdot10^{-9}$ m, it is not difficult to calculate the radius of the fixed orbit,

$$R_0 = \sqrt{2}\ 580\cdot10^{-9}/\pi = 261{,}1\cdot10^{-9}\ \text{m}.$$

At any other frequencies, radiation certainly exists, for example, as radiation of higher harmonics, inevitably appearing due to the nonlinearity of the dependence of restoring force *F*(*r*) on distance *r*. However, this radiation will not be detected visually because of the violation of the requirement that its wavelength λ_n must correspond to the orbital radius R_0. The requirement $\lambda_n=\pi R_0$ is violated. This peculiarity of perception determines the linear character of spectrum: not all, but only those frequencies are observed for which the dependence between the orbital radius and the radiation frequency is defined by the formula (3.29).

This requirement disappears when the behaviour of the electron is observed from a point outside the plane of the electron orbit. In this case, all waves of the electric field emerging from the oscillations of the electrons will be transverse and, seemingly, their observation is not limited in any way. The obstacle here is circular polarization of waves that occurs with the angular frequency $\omega=v_0/R_0=\sqrt{2}\ c/R_0$ of the revolution of electrons around the nucleus. At such a rate of change of the object of observation, physiological capabilities of a human being do not allow to comprehend it as radiation of a certain wavelength.

It follows from the above that linear character of spectrum is determined not by the nature of the processes the electron is involved in, but only by the possibility of detecting its radiation. Quantization of orbits is a seeming phenomenon, not a feature determined by its quantum mechanical properties bestowed on it by the physics of the 20th century.

Conclusion

Science should not demand believing in miracles that contradict trivial knowledge based on the logic of common sense and mathematical education, such as it is. Unfortunately, the explanation of the stable existence of atomic structures did not do without such miracles, the role of which was once played by N. Bohr's postulates. The desire to remove the postulates unsupported by physical content out of the theory, served as the motivation for writing this paper.

The main results of the performed study are as follows:

1. the necessary and sufficient conditions have been revealed for radiation occurrence at accelerated motion of a charge carrier;
2. the equation of oscillations of the electron with respect to the stationary orbit of its revolution has been compiled and solved;
3. the cause of quantization of radiation and the nature of the emergence of photons has been found;
4. the reason due to which atomic radiation spectrum acquires linear character has been described.

   The totality of the results refutes the formally mystical view of an atom, in which the behaviour of a particle is determined by prescriptions invented by people, not by physical reasons.

This allows to consider the article as a contribution to the struggle between materialistic and mystical worldviews, constantly demonstrated in works concerning the explanation of natural phenomena and the behaviour of objects.

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