Physics Journal: Theoretical and Experimental Studies

https://doi.org/10.64978/pjtes.2026.0626010

ISSN: 3142-8320

Research Article

Open Access Full Text Article

The Stability of the Hydrogen Atom in the STEP-19 Theory: Radiation, Spectral Lines, and Quantization

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Received: June 08, 2026; **Published:** June 26, 2026

How to cite this article:

M. Kolonutov, "The Stability of the Hydrogen Atom in the STEP-19 Theory: Radiation, Spectral Lines, and Quantization," *Phys. J. Theor. Exp. Stud.* 2(2), 1–14 (2026). https://doi.org/10.64978/pjtes.2026.0626010

Abstract

The topic of the article is the investigation of the planetary model of a hydrogen atom within the framework of the System Theory of the Electrical Phenomena STEP-19. The goal of the article is to derive mathematical models describing the motion of the electron and its electric field. The object of the study is the electron and its electric field within the hydrogen atom. The method of the study involves using the System Theory of the Electrical Phenomena as presented in a Russian-language article (ISBN: 978-613-9-45190-6) and its English-language version (ISBN: 978-613-9-93202-3). The basic results are as follows: 1) A necessary and sufficient condition under which an accelerating charge carrier does not radiate has been obtained. 2) The linear speed of the electron moving along a stationary orbit has been determined. 3) The equation of its motion in the case of random deviation from the stationary orbit has been derived. 4) The solutions of the equation for different values of the motion parameters have been studied. 5) The conditions under which the radiation entering the human organs of vision is processed into a particular color sensation have been described. 6) The causes of spectral line formation have been identified. 7) The mechanism of quantization of radiation has been shown.

Keywords: theory of electrical phenomena, stability of the hydrogen atom, radiation, polarization, spectral lines, quantization

Introduction

In the early 20th century, E. Rutherford proposed the planetary model of the atom. However, according to the understanding of the laws of the electromagnetic theory accepted at that time, and contrary to the actual existence of atoms, the model predicted their instability. Orbiting the nucleus, the electron would radiate energy and, after losing that energy, fall into the nucleus. For a long time, the problem of explaining atomic stability appeared insoluble.

There are many ways to solve knotty problems: firstly, to investigate and understand the way to resolve the issue, secondly to act like Alexander of Macedon did with the Gordian Knot, and thirdly, to turn a blind eye to the problem, ignoring its existence. N. Bohr and the entire physics community that followed him chose the third way, which manifested in the introduction of postulates that defied all the rules of electrodynamics. Nevertheless, the problem itself remained unresolved, since overcoming its difficulties required a revision of electrodynamics. And it was comparable to sacrilege, a refusal to worship the electromagnetic religion.

Thus, the problem of atomic stability has remained relevant to this day. Resolving this problem most directly concerns the need to explain the mechanism of "electromagnetic" radiation, identify the causes of spectral line formation, and understand the quantization of that radiation.

The first step toward resolving the problems was an analysis of the erroneous philosophical assumptions that form the basis of existing electromagnetic theory. A critical analysis of these assumptions is undertaken in the first section of the work».

The second section presents the summary of the System Theory of the Electrical Phenomena (STEP-19), to the extent necessary to understand the section containing the main results of the study.

In the third section it is established that the accelerated motion of a charged body is not accompanied by radiation in the case when the scalar product of the vectors of its velocity and acceleration is equal to zero. This condition singles out orbits having the form of circles from among all possible orbits of an electron's motion. Such orbits are stationary, motion along them is not accompanied by losses for radiation.

In the fourth section the equation of oscillations of the electron in the case of its random deviation from the stationary orbit has been derived. A program of numerical solution of the equation was presented. It was shown that radiation emerges as a consequence of the electron's oscillations relative to its stationary orbit.

The fifth section is devoted to the analysis of perception by the human visual system of radiation with different types of polarization. It was found that circularly and elliptically polarized radiation emitted by an atom cannot be perceived visually. Plane-polarized radiation can be perceived, but only if certain conditions are met. These conditions are that, for this type of polarization, the radiation perceived by a person represents the superposition of emissions generated by an oscillating electron when it is located at different, diametrically opposite parts of the orbit. This is equivalent to the existence of two radiation sources, each producing radiation whose wavelength equals the length of the semi-circumference of the electron's orbit. The fulfillment of this requirement is necessary for the human brain to transform the signal from the visual system into color perception, i.e. into the spectral line of a particular color (depending on the radiation frequency).

The equality of radiation wavelength to the length of the semi-circumference of the orbit not only makes the radiation perceivable by the visual system, but also causes it to be quantized. The radiation produced on one half of the orbit is interrupted while the electron is on the other half, and then resumes. Thus, a quantum will contain the number of complete oscillations that the electron makes during the half-period of its revolution around the atom's nucleus.

1. Philosophical error forming the basis of electromagnetism

Sailors observing flashes of light from a lighthouse are sure that light propagates in portions (quanta). But the lighthouse keeper knows that the lamp burns continuously and takes up arms against any sailors' theories about the quantum nature of light.

The situation with the electromagnetic theory of light is exactly the same. Failing to understand the mechanism of light generation and mistaken about its nature, scientists proposed two rival explanations: the particle theory (P. Gassendi, I. Newton) and the wave theory (Ch. Huygens A.-J. Fresnel). The third group of scientists (de Broglie) embraced a unifying idea, the idea of wave-particle duality.

Today it is impossible to join any of these trends due to the erroneous nature of the electromagnetic theory used as the basis for each of the three mentioned trends. For these words not to seem empty and meaningless, let us step back 200 years to the time of the clash of views between two members of the French Academy of Sciences: J.-B. Biot and A.-M. Ampère. The first of them strongly believed that the interaction of current-carrying conductors and magnets is achieved by means of "magnetic molecules," and is irreducible to the interaction of currents. A.-M. Ampère thought the very term mentioning the magnetic component of interaction to be outdated. He writes in:[1, p. 128] "*The name of electromagnetic phenomena which had been assigned to them until now was appropriate when it concerned only interactions between a magnet and electric current discovered by Monsieur Oersted, but this name may be misleading now that it had been proven by me that phenomena of the same type happen without any magnet, from pure interaction of two electric currents*."

The introduction by M. Faraday of the notion of the "field" into scientific thinking and the formal unification of magnetic and electric fields by J.C. Maxwell, made it possible to treat the electromagnetic field as a single material medium whose existence rests on mutual transformations and which serves as the carrier of electromagnetic waves. A.-M. Ampère's ideas that the magnetic properties of bodies result from currents within them received no further development. That was the first and the most important error of the emerging theory. It arose from the failure of the theory's authors to understand the philosophical categories of "essence" and "phenomenon." This was the reason why this philosophical non-sense occurred in the form of unification of the phenomenon (magnetic field) and the essence (electric field) as a single object of research. This very circumstance later opened the door to the infiltration of all sorts of mystical ideas into the theory of electricity, including the idea of wave-particle duality. A. Ioffe was one of the first to recognize the danger.[2, p. 74] Writing to A. Einstein, he urged him to influence the formation of a physical worldview, warning that "*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*."

To clarify the philosophical error involved in accepting the concept of the electromagnetic field, recall the dialectically related pair of philosophical categories: "essence" and "phenomenon," which characterize any object of cognition. The essence is the core meaning of a material substance (a thing). The essence reflects something that remains unchanged and distinguishes the thing from its accidental properties, states, and from other material substances.

The phenomenon is something that makes the existence of a certain essence manifest, sensibly perceptible, though it is hidden beneath a multiplicity of sensory impressions evoked in a human being by objects of the outside world. For illustration, consider these examples: a lion is an essence, while a lion's roar is a phenomenon; the Sun is an essence, while dawn is a phenomenon; the air is an essence, while the wind is a phenomenon. One can distinguish essence from phenomenon by this criterion: an essence may exist without manifesting itself in any particular phenomenon, but no phenomenon can appear without an underlying essence. The wind cannot exist in airless space, but air exists even when there is no wind at all.

Applying this test to the notions of "electric field" and "magnetic field" makes it at once clear that the electric field is the essence, while the magnetic field is the phenomenon. The presence of a magnetic field with induction **B** at a given point in space merely indicates that an electric field with strength **E** exists at this point and is in motion with velocity **v**, $\mathbf{B} = c^{-2}\,\mathbf{v} \times \mathbf{E}$. There are no other ways for a magnetic field to arise except through the motion of the electric field.

Unfortunately, when the theory of electricity was developed, and contrary to A.-M. Ampère's view, the magnetic field came to be treated as an essence rather than a phenomenon, given equal ontological status with the electric field. This resulted in numerous dead ends in the theory of electromagnetism; rather than correcting the theory, researchers sought an escape by proclaiming additional postulates to patch it. This is how N. Bohr's postulates emerged, as did Maxwell's equations, the Schrödinger equation and several lesser-known propositions that contradicted classical mechanics. The impotence of electromagnetic theory was obscured by a thesis that the new phenomena could not be explained in terms of classical physics and that cause-and-effect analysis was inappropriate.

The separation of electromagnetic theory from classical mechanics had a huge negative effect on the development of the theory. The reason for the separation was the discovery of the forces of interaction of the magnetic field with the moving charge carrier, which supposedly had a non-central character (the Lorentz force). The theory, resorting to the Lorentz force and treating the magnetic field as an essential entity began to develop on its own, following a unique course distinct from mechanics. This course has led, for example, to refusal to comply with the requirements of Newton's third law, to the belief that the electric field is incapable of motion, and to the acceptance of several other false propositions.

It follows from this philosophical-physical digression that the theory of electricity can succeed only when its object is essence, i.e., the electric field only. Acknowledgment of the magnetic field as a phenomenon rather than essence under study has a positive effect: it opens up an opportunity to unite the mechanics and the theory of electricity. Such theory of electricity was developed and published in books.[3,4] Some information from this theory is given below, to the extent it contributes to the understanding of the principal problem addressed by this article.

2. Basic information about STEP-19

2.1 Basic initial propositions

The main propositions forming the basis of the theory are as follows.

1. Any physical body, irrespective of its size, consists of a charge carrier and an electric field inseparably connected with it.
2. The electric field is a continuous material medium capable of transmitting the force exerted by one charged body on another, therefore, like any material substance, it is characterized by a set of properties that permit the application of the laws of theoretical mechanics;
3. The electric field serves as a carrier of energy, which is a type of mechanical energy: "*All energy is the same as mechanical energy, no matter whether it exists in the form of a usual motion or in the form of elasticity, or in any other form. The energy in electromagnetic phenomena is mechanical energy*."[5, p. 301] The energy of the electric field exists in the electrostatic, $W_{es}(Q, v)$, or electrokinetic, $W_{ek}(Q, v)$, form.

2.2 The system of physical quantities used by the theory

A set of physical quantities used in the electromagnetic theory historically emerged as a means of describing the conditions and results of a multitude of diverse experiments. In some cases, it led to the absence of any physical explication of notions that, in a narrower and more exact way, presents commonsense knowledge through physical quantities. The examples of such not-quite-defined notions are the vector potential, the strength of the electric field, and the Poynting vector. As was said of the latter:[6, p. 45] "*Nevertheless, by ascribing a physical significance to the vector* ***S*** (the Poynting vector. M. K.) *what we get is a surprising picture of a closed-loop energy flux. ...the idea of a closed energy flux seems not only meaningless, but downright incorrect*."

Therefore, the terminology of the theory of electromagnetism is not quite suitable for capturing the properties specific to the electric field as an object of investigation. The approach outlined below enables us to develop a systematically arranged set of physical quantities that are free from the aforementioned drawbacks but nevertheless capable of capturing all manifestations of the electric field.

The energy of the electrostatic and the electrokinetic fields of the charge carrier forms the basis for constructing the system of physical quantities for the theory. All other quantities characterizing the fields are expressed as derivatives of energy with respect to the corresponding arguments. Electrostatic quantities for the field of a spherical charge carrier are presented in Table 1, while electrokinetic and electrodynamic quantities are in Table 2.

Table 1. Electrostatic quantities

Name of quantity	Formal presentation	Physical content
Electrostatic energy	$W_{es} = \frac{Q^2}{8\pi\varepsilon_0 R}$	Energy localized in the field of a spherical charge carrier Q with radius R
Electrostatic potential	$\varphi_{es} = \frac{\partial W_{es}}{\partial Q}$	Energy of the field per unit of charge
Flux of pressure force vector	$F = -\frac{\partial W_{es}}{\partial R}$	Integral force effect of the field on the carrier's surface
Field strength at the carrier's surface	$E_{es} = -\frac{\partial^2 W_{es}}{\partial Q \partial R} = -\frac{\partial \varphi_{es}}{\partial R}$	Integral force effect of the field on the carrier's surface per unit of charge
Capacitance	$C = \frac{\partial^2 W_{es}}{\partial Q^2}$	Carrier's constructive characteristic (Quantity reciprocal to capacitance in the electromagnetic theory)

Table 2. Electrokinetic and electrodynamic quantities

Name of quantity	Formal presentation	Physical content
Electrokinetic energy	$W_{ek} = \frac{1}{2} W_{es} \frac{v^2}{c^2} = \frac{Q^2}{16\pi\varepsilon_0 R} \frac{v^2}{c^2}$	Kinetic energy of the field moving at speed *v*
Electrokinetic potential	$\varphi_{ek} = \frac{\partial W_{ek}}{\partial Q} = \frac{1}{2} \varphi_{es} \frac{v^2}{c^2}$	Kinetic energy of the field per unit of charge
Impulse	$\mathbf{p} = \frac{\partial W_{ek}}{\partial v} \mathbf{1}_v = \frac{W_{es}}{c^2} \mathbf{v} = m\mathbf{v}$	Electrokinetic energy per unit of speed
Vector potential	$\mathbf{A} = \frac{\partial^2 W_{ek}}{\partial Q \partial v} \mathbf{1}_v = \frac{Q\mathbf{v}}{4\pi\varepsilon_0 c^2 R}$	Impulse per unit of charge
Electrokinetic strength	$\mathbf{E}_{ek} = -\boldsymbol{grad}\varphi_{ek} =$ $= \frac{1}{2} E_{es.r} \frac{v^2}{c^2} \mathbf{1_r} - \frac{1}{2} E_{es.z} \frac{v^2}{c^2} \mathbf{1_z}$	Field strength depending on speed, (cylindrical coordinate system (r, θ, z))
Electrodynamic strength	$\mathbf{E}_{ed} = -\frac{d\mathbf{A}}{dt} = -\frac{\varphi_{es}\mathbf{a}}{c^2}$	Field strength depending on acceleration
Inductance	$L = \frac{\partial^4 W_{ek}}{\partial^2 Q \partial^2 v} = (4\pi\varepsilon_0 c^2 R)^{-1}$	Constructive characteristic of a carrier in motion

All the physical quantities (except capacitance) presented in the tables are not formally different from physical quantities used in electromagnetic theory. The only difference is that they have an essentially different content, and collectively they constitute a complete system formed in a specific way. The system proved sufficient for describing any properties and states of the electric field.

3. The electron in the planetary model of the hydrogen atom

3.1 Radiation due to the electron's revolution around the nucleus

One example of a false thesis that has been accepted as true in electromagnetic theory is the proposition that any charged body undergoing accelerated motion loses energy for radiation. For decades, this prejudice has captured the minds of all experts: from amateurs to the most distinguished scholars. Here is the opinion of Louis de Broglie: "*Otherwise, moving under the action of Coulomb's forces inside extremely small region of space, they* (electrons, M. K.) *would have had non-zero acceleration and would inevitably have to lose energy in the form of electromagnetic radiation, which contradicts the main proposition about atomic stability*."[7, p. 64]
It is quite easy to refute this proposition. To do this, one has to investigate a change in the electron's energy with time. Suppose there is an electron orbiting the atom's nucleus. Energy W of such an electron is the sum of the electrostatic $W_{es}(Q,R)$ and electrokinetic $W_{ek}(Q,v)$ energies, $W = W_{es} + W_{ek}$. Let us find the derivative of energy W with respect to time,

$$\frac{dW}{dt}=\frac{dW_{es}(Q,R)}{dt}+\frac{d}{dt}\left(\frac{1}{2}W_{es}\frac{(\mathbf{v},\mathbf{v})}{c^2}\right)=\frac{dW_{es}(Q,R)}{dt}+m(\mathbf{v},\mathbf{a}) \tag{3.1}$$

The presented expression for the derivative (3.1) shows that the value of the derivative will always be zero, if certain conditions are met.

1) $R = const$,

2) dot product $(\mathbf{v},\mathbf{a}) = 0$.

Both of these conditions are satisfied when the electron's orbital motion is uniform and its orbit is circular. No change in the electron's energy occurs while it is in circular motion $dW/dt = 0$. Because there are no radiative losses under these conditions, any circular orbit is stationary, and the atom therefore represents a stable structure. Hence, there are no reasons for introduction of any artificial, illogical postulates explaining the stability of an atom. N. Bohr's famous postulates led science into the realm of scholasticism, which is known to be quite far from the natural sciences.

3.2 Forces acting on an electron

Let us use the quantities of strengths given in Tables 1 and 2 to determine the peculiarities in the behavior of the moving electron's electric field. Let us introduce a coordinate system (r, z) attached to a provisionally immobile atomic nucleus, directing the coordinate axis r along the radius to a certain point of the electron's instantaneous position in its stationary orbit; the z axis is then collinear with the velocity vector of the electron's orbital motion at this point.

The strength of the field of the electron moving uniformly in a stationary orbit is determined by the strength of the superposition of the electrostatic, electrokinetic, and electrodynamic fields,

$$\mathbf{E}=\mathbf{E}_{es}+\mathbf{E}_{ek}+\mathbf{E}_{ed}=E_{es.r}\left(1+\frac{1}{2}\frac{v^2}{c^2}\right)\mathbf{1}_r+E_{es.z}\left(1-\frac{1}{2}\frac{v^2}{c^2}\right)\mathbf{1}_z-\frac{\varphi_{es}\mathbf{a}}{c^2} \tag{3.2}$$

At the location of atomic nucleus that is, at the center of the circle along which the electron moves the component of the strength $E_{es.z}$ equals zero, $E_{es.z} = 0$, thus relation (3.2) takes the following form:

$$\mathbf{E}=E_{es.r}\left(1+\frac{1}{2}\frac{v^2}{c^2}\right)\mathbf{1}_r-\frac{\varphi_{es}a}{c^2}\,\mathbf{1}_r. \tag{3.3}$$

Let us find the force F_p exerted on the atomic nucleus by the electron's field,

$$\mathbf{F}_p=\int_0^e\mathbf{E}de=\frac{e^2}{8\pi\varepsilon_oR^2}\left(1+\frac{1}{2}\frac{v^2}{c^2}\right)\mathbf{1}_r+\frac{e^2a}{8\pi\varepsilon_oRc^2}\mathbf{1}_r \tag{3.4}$$

After transformations, taking into account that the mass of the field $m=e^2/8\pi\varepsilon_oRc^2$, we obtain,

$$\mathbf{F}_p=\left(-ma+m\left(\frac{c^2}{R}+\frac{v^2}{2R}\right)\right)\mathbf{1}_r \tag{3.5}$$

According to Newton's third law, the force F_e acting on the electron from the proton's field will be

$$\mathbf{F}_e=-\mathbf{F}_p=\left(ma-m\left(\frac{c^2}{R}+\frac{v^2}{2R}\right)\right)\mathbf{1}_r \tag{3.6}$$

The resultant of the radial forces for motion in the stationary orbit must be zero. From this condition we obtain,

$$F_e=ma-m\left(\frac{c^2}{R}+\frac{v^2}{2R}\right)=0 \tag{3.7}$$

Because in circular motion the electron's centripetal acceleration is $a=v^2/R$, quite an important conclusion follows from relation (3.7): the orbital speed of an electron in a stationary orbit is always (irrespective of the orbital radius) $\sqrt{2}$ times the speed of light,

$$v=\sqrt{2}\,c \tag{3.8}$$

This result is consistent with A. Einstein's formula that expresses, in his opinion, the equivalence of mass and energy, $E = mc^2$. Indeed, at $v = \sqrt{2}\,c$ we have $E = mv^2/2 = mc^2$. On the other hand, expression (3.8) refutes his own postulate that bodies cannot travel with a speed exceeding the speed of light. Nevertheless, the fact that the electron's linear orbital speed exceeds the speed of light should not be regarded critically. Within the framework of the proposed theory there is no upper limit on the speeds of bodies and no need to use Lorentz transformations as it was when the Special Theory of Relativity was developed. The result (3.8) overturns A. Einstein's postulate forbidding superluminal motion thus disclaiming the legitimacy of incorporating the Lorentz transformations into physics. Unlike Galilean transformations, the Lorentz transformations mix spatial and temporal coordinates. This feature of the transformations historically formed the basis for the false concept of unified spacetime. By delegitimizing the use of the Lorentz transformations in physics we effectively dismantle the edifice of the Special Theory of Relativity, an outcome that will make physics healthier by purging it of the mysticism advanced by that theory.

Let us transform formula (3.7) which expresses the action of a set of forces on the electron. Expanding the brackets in the second summand and collecting like terms, we obtain,

$$F_e = \left(-m\frac{c^2}{R} + m\frac{v^2}{2R}\right) = 0 \tag{3.9}$$

Let us express the second summand in terms of the electron's angular momentum in a stationary orbit, $L_0 = m\sqrt{2}cR_0$.
This transformation will later allow us to use the law of conservation of angular momentum to determine the angular frequency of the electron's oscillations; moreover, it provides the condition for the electron to remain in a stationary orbit in the form,

$$F_e = \left(-m\frac{c^2}{R_0} + \frac{L_0^2}{2mR_0^3}\right) = 0 \tag{3.10}$$

It follows from the resulting expression that the first summand represents the dependence of the attractive force F_{att} of the electron towards the atomic nucleus (centripetal force) on the radius of the stationary orbit, whereas the second summand F_{rep} represents the dependence of the repulsive force on this radius (centrifugal force),

$$F_{att} = -m\frac{c^2}{R}, \tag{3.11}$$

$$F_{rep} = \frac{L_0^2}{2mR^3}. \tag{3.12}$$

Figure 1 demonstrates the function graphs of these relations: by a dash-dot line $F_{att}(R)$, by a dashed line F_{rep}(R) and their sum F = F_{att} + F_{rep} (a solid line), the angular momentum being $L_0 = 5.7 \times 10^{-29}$ Js. The radius labeled R_0 in the figure is the radius of the stationary orbit corresponding to the accepted value of angular momentum.

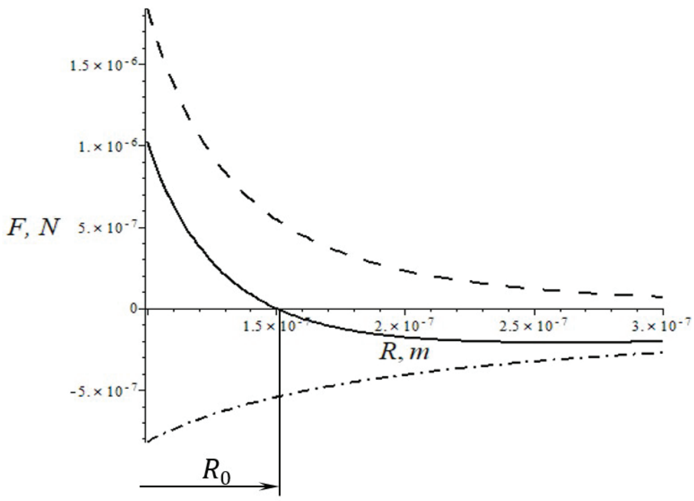

Figure 1

Figure 1 indicates that a random reduction of the electron's orbital radius to the value of $R = R_0 - r$ leads to the predominance of the repulsive force, and conversely, at $R = R_0 + r$ the attractive force becomes greater than the repulsive force. In both cases the forces restore the electron to its fstationary orbit. This ensures the stability of the electron's orbit and, hence, the stability of the atom.

The common claim of monographs and textbooks that, without observing N. Bohr's postulates, the atom will immediately cease to exist, has proved false. The only reason these postulates appeared and why they have persisted is that, in a long-running struggle between intuition (faith) and discursive reasoning, faith gained temporary advantage. Faith is tenacious because it carries no cost for overcoming doubts, performing a thorough cost-and-effect analysis, or ensuring logical coherence and consistency in reasoning and all other components of discursive cognition.

4. The electron's oscillations. Radiation

4.1 The equation of oscillations

Random deviations of an electron from its stationary orbit, together with the restoring forces, give rise to oscillations of the electron relative to the orbit. Oscillating motion cannot lead to a change in the electron's angular momentum from the value it had in the stationary orbit, $L_0 = m\sqrt{2}cR_0$, so the equality must hold

$$L = m\left(\sqrt{2}c + v(t)\right)\left(R_0 + r(t)\right) = L_0, \tag{4.1}$$

where $v(t)$ and $r(t)$ are random deviations of the electron's orbital speed and radial position from the values in the stationary orbit. Whence it follows that the electron's orbital speed is also subject to oscillations relative to the speed $\sqrt{2}c$ of undisturbed motion in the stationary orbit,

$$v(t) = \sqrt{2}c\left(\frac{R_0}{R_0 + r(t)} - 1\right) \tag{4.2}$$

Thus, the electron will simultaneously undergo three motions:

1. Uniform circular motion around the nucleus along a stationary orbit with orbital speed $\sqrt{2}c$ and a certain angular frequency of revolution ω_{cir};
2. Radial oscillations relative to the points of this stationary orbit with angular frequency ω_{osc};
3. Tangential oscillations of the orbital speed relative to the speed in the stationary orbit with the same angular frequency ω_{osc}.

Orbital motion of the electron is uniform circular motion with the speed $\sqrt{2}c$ and requires no additional study.

Now let us describe the electron's radial oscillating motion executed after a random, radially directed impulse action. Suppose that as a result of this action the electron ends up outside the stationary orbit at a certain distance $R = R_0 + r(t)$ from the atom's nucleus. Under these conditions, the electron's behavior will be described by a differential equation reflecting the action of Newton's second law,

$$m\frac{d^2 r(t)}{dt^2} = \frac{1}{2}\frac{L_0^2}{m\left(R_0 + r(t)\right)^3} - m\frac{c^2}{\left(R_0 + r(t)\right)} \tag{4.3}$$

The equation was solved numerically. In the Maple environment the program of solution is as follows:

```
restart;

R0 := 80*10^(-9);

m := 9.11*10^(-31);

c := 2.99792458*10^8;

L0 := sqrt(2)*c*m*R0;

dec := diff(r(t), `$`(t, 2))-L0^2/(2*m^2*(R0+r(t))^3)+c^2/(R0+r(t)) = 0;

ans := dsolve({dec, r(0) = .5*10^(-9), (D(r))(0) = 0}, r(t), numeric);

proc(x_rkf45)  ...  end;

with(plots):

odeplot(ans, [t, r(t)], 0 .. 1.5*10^(-15));
```

Figure 2 shows the solution graph $r(t)$ at given values, $R_0 = 80 \times 10^{-9}$ m and initial values $r(0) = 0.5 \times 10^{-9}$ m, $dr/dt = 0$ at $t = 0$.

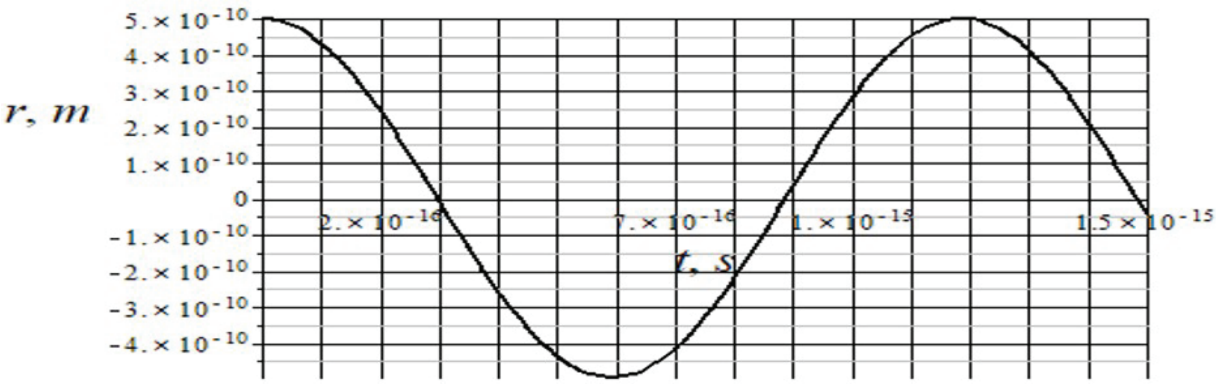

Figure 2

By visual inspection, the graph closely resembles the graph of a harmonic function. This is due to the relatively small initial value $r(0)$.

For simplicity, we restrict our analysis to radial oscillations that can be approximated, to varying degrees of accuracy, by a harmonic function, $r(t) = r_m \cos(\omega_{osc} t)$.

The electron's radial oscillations are inevitably accompanied by tangential oscillations of its orbital speed that changes in accordance with relation (4.2).

These oscillations give rise to radial and tangential electrodynamic components of the electron's electric field. The strength of these components is determined by the relation $\mathbf{E}_{ed} = -\varphi_{es}\mathbf{a}/c^2$ (see Table 2).

Substituting the respective accelerations of the oscillating electron, we obtain the strength for radial and tangential oscillations, respectively,

$$\mathbf{E}_{ed.r} = -- \varphi_{es}\mathbf{a}_{\boldsymbol{r}}/c^2, \qquad (4.4)$$

$$\mathbf{E}_{ed.\tau} = -- \varphi_{es}\mathbf{a}_{\boldsymbol{\tau}}/c^2 \qquad (4.5)$$

where $a_r = -r_m\omega_{osc}^2 \cos(\omega_{osc} t)$ is the acceleration in radial oscillations,
$a_\tau = dv(t)/dt = \sqrt{2}c\,(R_0 r_m \omega_{osc} \sin(\omega_{osc} t))/((R_0 + r_m \cos(\omega_{osc} t))^2)$ is the acceleration in tangential oscillations. Strengths (4.4) and (4.5) characterize the electrodynamic field at a distance r from the carrier at which the electrostatic potential is determined.

It is worth noting that there are no prohibitions against orbital or oscillating motion of the electron.

4.2 Radiation

The electron's oscillations cause disturbance in its electric field that manifests as a transverse wave of the electrodynamic field. In the theory of electromagnetism, this wave came to be called the "electromagnetic wave." However, such a name only distorts the physical nature of the phenomenon, because the magnetic field is entirely unrelated to the wave emergence. Naturally, a magnetic field does arise, but only as evidence a consequence of the motion of the electron's electric field. The wave of the electrodynamic field exists not because the energy of the electric field transforms into the energy of the magnetic field, but because the potential energy of the field's elastic deformation transforms into the kinetic energy of its oscillating motion. In this sense, the electric field is no different from any other elastic material substance in which a wave process occurs.

The wave is characterized by a change in the electrodynamic field strength in accordance with the relation obtained in.[8] This relation, using the notation adopted here, has the form:

$$E_{ed} = \frac{e r_m \omega_{osc}}{4\pi\varepsilon_0 c r_0^2\, J_2\left(\frac{\omega_{osc} r_0}{c}\right)} \left(J_1\left(\frac{\omega_{osc} z}{c}\right)\cos(\omega_{osc} t) + Y_1\left(\frac{\omega_{osc} z}{c}\right)\sin(\omega_{osc} t)\right) \qquad (4.6)$$

where e is the electron charge, $J_1(x)$ is the first kind first order Bessel function, $Y_1(x)$ is the second kind first order Bessel function, r_0 is the charge carrier's radius, z is the current radial coordinate of the propagating wave,

When the argument x of the Bessel function $J(x)$ satisfies the condition $x > 5$, approximating this function by a harmonic relation is permissible,

$$E_{ed} \approx \frac{er_m}{4\pi\varepsilon_0 r_0^2\, J_2\left(\frac{\omega r_0}{c}\right)} \sqrt{\frac{2\omega_{osc}}{\pi r c}} \cos\left(\frac{\omega_{osc} r}{c} - \omega_{osc} t - \frac{3}{4}\pi\right) \tag{4.7}$$

The material provided in this section allows us to assert that:

1. An electron's motion upon random deviation from its stationary orbit is described by the solution of equation (4.3);
2. An electron in a stationary orbit becomes a radiation source only when forced to oscillate relative to that orbit during its orbital motion.
3. Radiation propagates as a transverse wave of electrodynamic field strength (4.6)
4. There are no restrictions on the values of the electron's orbital radius or angular momentum connected with its ability to generate radiation of a given angular frequency.

What remains is to consider the properties of radiation. The main questions to be answered are as follows:

1) How does polarization arise during radiation?
2) How does the linear radiation spectrum form?
3) Why does quantization of radiation occur?

5 Subjective perceptions of the objective process of radiation

5.1 Peculiarities of functioning of the visual system

The human visual system can perceive and transform radiation within a specific frequency range (visible radiation), which has the character of a transverse wave. Frequency, being an objective characteristic of radiation, is transformed by the visual system into the subjective perception of a particular color.

Light rays refracted by the eye form an inverted and reduced image of the object in question on the retina. The obtained image is transferred to the brain, where it becomes part of our perception after further processing. The quality of the retinal image depends on multiple factors, including exposure time. Anyone can appreciate the influence of this factor by trying to read, while sitting in a compartment of a moving train, an inscription on the wall of an oncoming train. It is impossible because the exposure time of this inscription is very short.

The process of radiation generation in an atom takes place at a speed exceeding eye accommodation time by several orders of magnitude. Therefore, the visual system can only form a steady picture on the retina, when the radiation continues for some time with the same values of parameters, such as amplitude, frequency, position of the plane of polarization etc. Naturally, this stationarity interval of radiation must be greater than the exposure time needed by the visual system.

Let us point out one more peculiarity in the perception of radiation emitted by multiple sources. A human being can distinguish the sources of radiation, if they are spaced apart by a distance not less than permitted by the angular resolution limit of the eye (two to three arcminutes). In our case, it means that only the superposition of radiation emitted from different points along the trajectory of an oscillating electron can be observed. In other words, radiation generated by electron oscillations at different points of the orbit is perceived as originating from one certain point, for example, from the center of the orbit.

5.2 Radiation polarization

5.2.1 Circular polarization

Like any other wave process, the wave of electrodynamic strength of the electron's field is characterized by a wave vector showing the direction of wave propagation and by the vector of the electrodynamic strength $\mathbf{E}_{ed}$, which is always located in a plane perpendicular to the wave vector (in the plane of polarization) but may have different directions within that plane.

The change in the direction of this vector $\mathbf{E}_{ed}(t)$ or in its modulus $E_{ed}(t)$ over time gives a comprehensive and objective characteristic of the radiation, but these changes are not directly observable. The objectively existent always manifests through phenomena, which in turn highly depend on the observer's perspective determined by the observation conditions. This relation is expressed in a certain polarization of the radiation.

Supposing the organs of vision of the observer investigating the radiation are located on a straight line passing through the atomic nucleus perpendicular to the plane of the electron's orbital path (Figure 3).

In this case, radial oscillations of the electron occur with the direction of the electron's oscillations constantly changing in accordance with the angle $\theta = \omega_{cir} t = \frac{\sqrt{2}ct}{R_0}$.

For the observer located in this position, the radiation is characterized by a uniformly rotating vector of electrodynamic strength Eed, whose modulus remains unchanged. Radiation with such behavior of the strength vector represents circularly polarized radiation. In this case, the plane of polarization does not only turn through a given angle, but rotates continuously with angular frequency ωcir equal to the angular frequency of the electron's revolution around the atom's nucleus, $\omega_{cir} = \sqrt{2}c/R_0$. Due to limited capabilities of the organs of vision, direct observation of circularly polarized radiation originating from an atom is impossible.

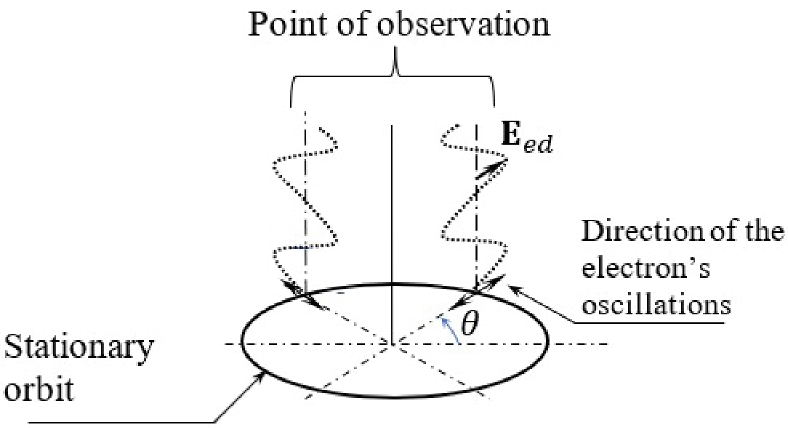

Figure 3

5.2.2 Elliptical polarization

Let us consider how the radiation is perceived from a different perspective of the observer. Suppose now that the angle between the normal to the electron orbital plane and the line of observation makes an arbitrary angle α < π/2, as shown in Figure 4. In this case, the electron's oscillations at different points of the orbit will not appear identical. Oscillations at points B and B′ will be transverse to the line of observation, but oscillations at points A and A′ will contain not only a transverse but also a longitudinal component that is not perceived by organs of vision.

The human visual system reacts only to transverse waves. For this reason, the perceived quantity in the radiation from the orbital region adjoining points A, and A′ of the orbit, will be the vector of strength $\mathbf{E}_{\perp} = \mathbf{E}_{ed}\cos\alpha$. In the case of wave generation from regions adjoining points B, B′ the strength will not undergo any distortions, i.e. $\mathbf{E}_{\perp} = \mathbf{E}_{ed}$. Radiation in which the vector of strength changes not only in direction, but also in modulus represents elliptically polarized radiation.

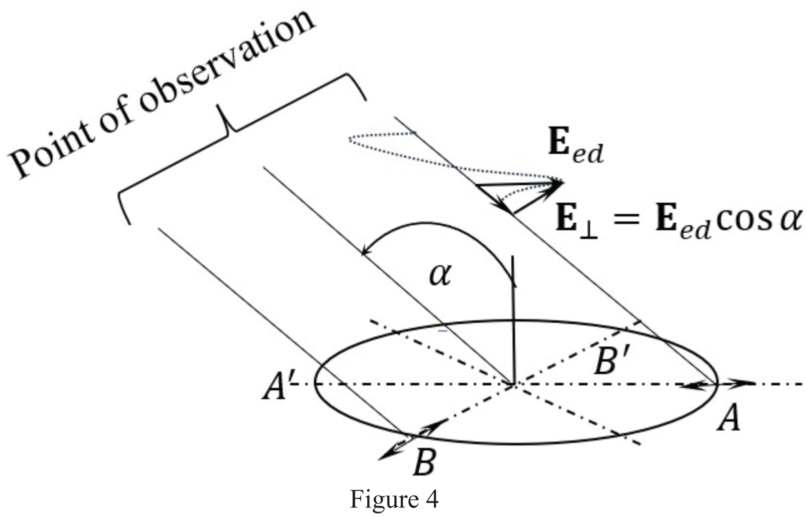

Figure 4

Due to a short exposure time, elliptically and circularly polarized radiation cannot create a region of stable excitation on the retina, which is a necessary condition for forming a specific color sensation.

5.2.3 Linear polarization

5.2.3.1 Spectral lines

Suppose the observation takes place from a point located in the plane of the electron's orbital path, i.e., with the observation angle α = π/2. In this case, oscillations appear to take place in one plane (the plane of the orbit). Such type of polarization is called linear, and a disturbance wave is said to be plane-polarized. With such perspective of the observer, radiation from regions adjoining points A, and A′ will become inaccessible, because in this case $\mathbf{E}_{\perp} = \mathbf{E}_{ed}\cos(\pi/2) = 0$. The perception will be limited to the radiation generated at points located on semi-circumferences (A − B′ − A′) and (A′ − B − A) of the orbit (for the sake of brevity, in the text to follow it will be referred to as radiation originating from points B and B′). Hence, it follows that one will be able to observe the superposition of radiation from two sources generating radiation with the same angular frequency. The modulus of the vector of strength of this superposition can take different values depending on the initial phases of radiations constituting it. As an example, let us consider the superposition of two harmonic oscillations:

$$\psi_1 = A\cos(\omega t + \varphi_1) \tag{5.1}$$

$$\psi_2 = A\cos(\omega t + \varphi_2) \tag{5.2}$$

At $\varphi_1 \neq \varphi_2$ their superposition $\psi = A\cos(\omega t + \varphi_1) + A\cos(\omega t + \varphi_2)$ takes the form

$$\psi = 2A\cos\varphi_m \cos(\omega t + \varphi) \tag{5.3}$$

where $\varphi_m = (\varphi_1 - \varphi_2)/2$, $\varphi = (\varphi_1 + \varphi_2)/2$. Consequently, the amplitude of the superposition depends on the half-difference of initial phases of the waves constituting it and will have its maximum value only in case of their equality, $\varphi_1 = \varphi_2$.

To satisfy the condition for the equality of the initial phases of the waves originating from points B and B′ of the orbit, it is required that the radiation wavelength λ fit into the orbit's circumference an even number of times, $2\pi R_0 = 2n\lambda$ or, at $n = 1$, $\pi R_0 = \lambda$. This condition is equivalent to the relation between the angular frequency ω_{osc} of the electron's oscillation and angular frequency ω_{cir} of its revolution around the atom's nucleus $\omega_{osc} = 2\omega_{cir}$.

If the waves of the electric field originating from the points B and B′ of the orbit have the same plane of polarization, equal angular frequency, constant amplitude, and wavelength meeting the condition $\lambda = \pi R_0$, then the visual system experiences stable excitation. If the exposure period needed by the eye is exceeded, then in this case the brain will process the excitation into the sensation of a color. It is the color specific to the frequency with wavelength $\lambda = \pi R_0$ and no other. This is the mechanism behind the occurrence of spectral lines.

The electron's oscillations and, consequently, radiation with any other frequency, in no way depend on whether someone is observing the atom or not. The atom radiates in all cases, but the visual system, due to its constitution, is selective. It does only what it can.

As an illustration, Table 3 presents the results of the numerical solution of equation (4.3) for several values of radius R_0 of the stationary orbit. The period T_{osc} of the radiation wave, specified in the second column of the table, was determined by measuring the respective time period according to the solution graph.

The last row of the table shows the calculation results for radiation, which, judging by the value of the radius R_0, probably takes place during recombination of a hydrogen atom. Interestingly, the wavelength of this radiation has turned out to be equal to the wavelength of the cosmic microwave background radiation. In this regard, serious doubts arise about the existence of the cosmic microwave background, the Big Bang and the truth of the whole related theory. There is nothing behind this radiation but the processes of ionization and recombination of hydrogen atoms, continuously unfolding throughout the Universe.

Table 3. Verification for satisfaction of requirement $\lambda = \pi R_0$

R_0, nm	T_{osc}, f_s	$\lambda = T_{osc}\sqrt{2}c/2$, nm	λ/R_0	Series assignment
38.83	0.5755	122.0	3.142	Lyman series
80.00	1.1800	249.3	3.116	no radiation is observed
126.37	1.8790	397.0	3.141	Balmer series
408.00	6.05	1282.5	3.143	Paschen series
1052.0	15.6	3307.0	3.143	Pfund series
595000	8850	1876000	3.15	"cosmic microwave background" radiation

The qualitative conclusion is that the radiation emitted by an oscillating electron objectively exists regardless of any specific parameters of its motion. But it becomes perceptible to the human visual system only in case of linear polarization, and only when the radiation parameters remain stationary for a time longer than the visual system's reaction time to induced stimulation.

The described spectral line formation does not require the existence of "allowed electron orbits," "energy levels," "quantum numbers," "spatial de Broglie standing waves," "orbitals," or similar obsolete concepts. All atomic models derived from quantum-mechanical concepts do not withstand cause-and-effect analysis and therefore may be used only as calculation models nothing more. They cannot serve as a basis for constructing a physical picture of micro-world phenomena, because they rest on mystical assumptions rather than on materialistic worldview.

5.2.3.2 Quantization of radiation

As shown above, radiation produced by oscillations of an electron bound in an atom becomes perceptible and analyzable by the human visual system only in the particular cases when the ratio of the radiation wavelength λ to the radius R_0 of the stationary orbit equals the number π. This circumstance predetermines one more peculiarity of visual perception, namely, the quantization of radiation. To understand the causes of this phenomenon, let us consider Figure 5.

When the condition $\lambda = \pi R_0$ is satisfied, a full oscillation of the electron completes while it travels along the semi-circumference of the orbit. This allows us to speak of two radiation sources, one of which is provisionally located at point B, the other at point B′. The sources alternately generate exactly one wave period each for every period of the electron's revolution about the atomic nucleus (see Figure 5). Thus, the plane-polarized radiation emitted by each source and perceptible to the human visual system becomes quantized. It is important to emphasize that not every kind of radiation is subject to quantization, but only the one that meets the stated requirements. A quantum should not be interpreted as a fragment of the electron's electric field; it just represents a field disturbance in the form of its electrodynamic component arising during the electron's radial oscillations. A quantum formed by the mechanism described above gives no grounds to regard it a fundamental elementary particle, as is customary in modern electromagnetic theory where a quantum of radiation is called a photon.

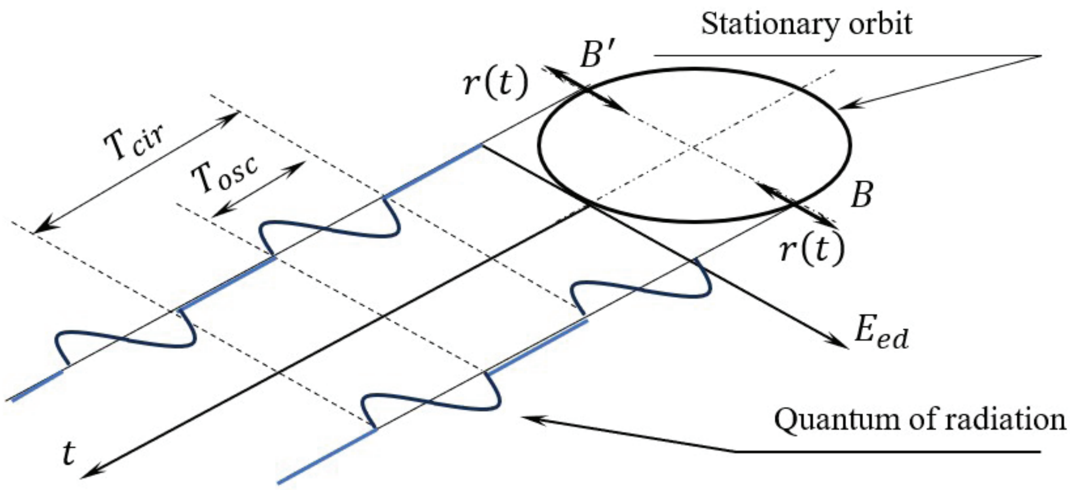

Figure 5

The described quantization in no way corresponds to the quantization on which the so-called old quantum theory was built. That theory was supposed to include a discrete set of system states that were regarded as allowed, such as orbits in N. Bohr's model. At the same time, it was postulated that the system could occupy no states other than those allowed. However, the theory did not specify who determined those allowed (or forbidden) states, or on what grounds. Implicitly, some form of "divine intervention" appears to have been assumed. Thus, human sensations in the quantum theory were treated as properties inherent in the observed object itself. This is a most striking example of a gnoseological error: a failure to understand the sense of such philosophical concepts as "essence" and "phenomenon."

An oscillating electron radiates continuously, but observers located at different angles relative to the orbital plane rely on their own perceptions. Some observe the wave aspect of the radiation, others the quantum aspect. Neither of them sees the essence behind the phenomenon; instead, the essence eludes us, and a noumenon (a concept born by the mind) takes the form of wave-particle duality. It resembles the situation described at the very beginning of the article the light of a lighthouse, which appears discrete to sailors but continuous to the lighthouse keeper.

Inspired by M. Planck's success in solving the black-body radiation problem by using the idea of energy quantization, physicists began applying this technique to whatever came to hand. They sought to quantize motion, time, space, electrostatic fields, force interactions, and so on. Moreover, none of the proponents of quantization took the trouble to analyze its causes or to describe its mechanism. Quantization became a fashionable practice that gradually evolved into the basis of contemporary scientific paradigm: fundamental physical theories must be quantum theories. Far from promoting understanding of natural phenomena, this trend has created still more room for researchers' wild mathematical fantasies.

Conclusion

At one time some opponent of the planetary model of the hydrogen atom raised an objection that cast doubts on this model. Their argument was that an electron undergoing acceleration should always emit radiation, and therefore, would inevitably fall onto the atom. Although this objection was ultimately false, and was not refuted by anyone at the time, it nevertheless contributed strongly to the shift to N. Bohr's model. That model required abandoning compliance with the laws of classical mechanics and adopting quantum description of phenomena. It was expressed in postulating a discrete set of energy levels at which an electron was allowed to reside. Shortly thereafter E. Schrödinger appeared, who presented energy levels as eigenvalues of a certain operator. As a result, quantum mechanics took shape. The physical content of processes was not addressed at either stage of its development. Instead, there was only a succession of postulates and their mathematical consequences. Essentially, instead of a theory, a mathematical model of the electron's behavior was constructed – one founded on heuristics (the fruits of scientists' imagination). A model, as they say, has fairly good prognostic qualities, but it is not characterized by general applicability; for example, the attempts to use it to describe the stability of even a two-electron atom (a helium atom) have failed.

The predictive power of this model alone is not enough to turn the model into a theory. Empirical confirmation must be complemented by a check for logical coherence and internal consistency, by an analysis of causal relationships, and by establishing agreement with other theories within the framework of a particular worldview.

N. Bohr's model fails to withstand these checks. A question formulated by E. Rutherford in his letter to N. Bohr is evidence of that: "*Your views on the mechanism of the production of the hydrogen spectrum are very ingenious and seem to be well worked out. However, the combination of Planck's ideas with the old mechanics makes it very difficult to form a physical picture of what underlies such a mechanism. It seems to me that there is a serious stumbling-block in your hypothesis, and I do not doubt that you are fully aware of it, namely: how does the electron decide at what frequency it must oscillate when it passes from one stationary state to another? It seems to me that you will be forced to assume that the electron knows beforehand where it is going to stop*..."

To this day, no one knows the answer to E. Rutherford's question. The reason for the inability to find an answer to the question lies in the falsity of the very concept of the Bohr model of the atom with its postulated discrete set of energy levels.

If the theory outlined in the main part of the article is subjected to a similar analysis, the resulting objective picture of radiation emergence will be as follows.

An electron bound in an atom is in constant motion; therefore, its interaction with the nucleus cannot be described in the language of the electrostatics. To this end, the formulas of electrodynamic strength obtained in[3,4] were used. Using these electrodynamic strength formulas, the centrifugal and centripetal forces acting on the electron were determined. The equality of these forces determines the electron's orbit as a circle. It is further shown that the uniform circular motion is not accompanied by radiation, so such orbit is stationary. If the electron accidentally deviates from this stationary orbit, the centrifugal and centripetal force become restoring forces, so the electron is set into oscillatory motion. This motion excites an electric field, giving rise to radiation in the form of the electrodynamic strength wave propagating through the electron's electric field. This concludes the description of the mechanism that produces radiation.

We turn to the subjective perception of this radiation by human visual system. If the frequency, initial phase, or other parameters of the wave that makes up the radiation change during the time the eye needs to form an image or register a color on the retina, the brain ignores such time-varying signals. Conversely, when the intervals during which the radiation parameters remain stationary are long enough, the brain generates the perception of a specific color. It was shown that such stationarity intervals arise only in case of plane-polarized radiation and only at a stationary-orbit radius that is π times smaller than the radiation wavelength. Meeting this condition ensures stable excitation of the visual system, which appears as the perception of a spectral line. All other types of radiation that do not satisfy these conditions prove inaccessible to analysis by the human visual system. Thus, spectral lines represent a human sensation rather than an intrinsic property of atomic structure.

The constraint imposed on the radius of the stationary orbit and the wavelength of plane-polarized radiation results in another distinctive feature of this radiation: it becomes discrete. The sampling time is set by the radiation period.

The merits of the proposed description of the hydrogen atom are:

- The use of classical ideas about the observance of logic and the laws of physics, as was characteristic of any other scientific research at the time when "madness" was not yet regarded, contrary to N. Bohr's view, as a mark of a theory's truth;

- An adequate reflection of the structure and causes of phenomena occurring in the hydrogen atom, with a complete absence of non-logical assumptions and of uncaused motions and states of the electron;
- Adherence to a materialistic worldview in forming the concept of the arrangement and functioning of atomic structures;
- The removal of misconceptions in the theory of electricity caused by neglecting A.-M. Ampère's view of the role of the magnetic field in interaction between bodies.

The main results obtained in this study are as follows:

1. It was shown that the condition under which the accelerated motion of a charged body is not accompanied by radiation is that the dot product of the velocity and acceleration vectors is zero;
2. The balance of forces was found under the action of which an electron moves in a stationary orbit;
3. The electron's linear orbital speed in a stationary orbit was determined;
4. A differential equation describing the electron's oscillations relative to its stationary orbit was obtained;
5. It was established that an electron in a stationary orbit becomes a radiation source only when external influences force it to oscillate relative to that orbit during its orbital motion;
6. It was found that there are no restrictions on the value of the electron's orbital radius or angular momentum regarding its ability to generate radiation of a given frequency;
7. It was shown that the radiation from an oscillating electron becomes perceptible to the human visual system only 1) in case of linear polarization and 2) in case of fulfillment of this condition: the time during which parameters of the electron's motion remain stationary exceeds the visual system's reaction time to induced stimulation. The second condition is equivalent to the condition that the radiation wavelength must be equal to half the length of the circumference of the stationary orbit, $\lambda = \pi R_0$;
8. It was found that plane-polarized radiation with the wavelength $\lambda = \pi R_0$ is quantized, and the quantum duration equals the electron's oscillation period. This quantization differs fundamentally from the quantization in the old quantum system. There is no supposition about the existence of a discrete set of atomic states in the above-described mechanism of quantization.

References

1. A.-M. Ampère, *Electrodynamics* (USSR Academy of Sciences Publ., Moscow, 1954).
2. A. F. Ioffe, *Meetings with Physicists*: My Memories of Foreign Physicists (Nauka Publ., Leningrad, 1983).
3. M. G. Kolonutov, *The Theory of Electricity: Overcoming the Crisis. Analysis and Proposals* (LAP LAMBERT Academic Publishing, Mauritius, 2019).
4. M. G. Kolonutov, *Physics of Electrical Phenomena: Electric Field Mechanics* (LAP LAMBERT Academic Publishing, Mauritius, 2018).
5. J. C. Maxwell, *Selected Works in the Theory of Electricity and Magnetism* (Technical and Theoretical Literature Publ., Moscow, 1952).
6. K. Simonyi, *Theoretical Electrical Engineering* (trans. from German, ed. M. K. Polivanov; Mir Publ., Moscow, 1964), 774 pp.
7. L. de Broglie, *Revolution in Physics* (trans. from French, ed. M. K. Polivanov; Atomizdat Publ., Moscow).
8. M. Kolonutov, "The Electric Field of a Moving Charge Carrier," *Phys. J. Theor. Exp. Stud*., (2026), https://doi.org/10.64978/pjtes.2026.0306004