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ELECTRICAL INTERACTION OF ELECTRON-PROTON TANDEM

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Abstract: Based on the adapted Coulomb's law for the case of moving masses, taking into account the finite velocity of electric field propagation, differential equations of the electromechanical state of the electron-proton tandem are obtained. The real states are simulated, as well as a number of unreal transition states of electron capture by a proton into its own orbit. Contrary to the prohibitions of quantum physics in the field of microworld, the mathematical concept of an electromechanical black hole with a radius $r_{em} = 5,6358 \cdot 10^{-15}$ m similar to that taking place in celestial mechanics has been introduced.

The transients indicating the collapse of the laws of electricity and mechanics at distances $r(t) < r_{em}$ are simulated. A discussion has been started on this issue.

Key words: Coulomb's law of moving masses, electron-proton pair, differential equations of electromechanical state, collapse of laws of electricity and mechanics.

1. Introduction

This article is a logical continuation of the series of works [1, 2], published in previous issues of this journal. These are the methods of the latest achievements of neoclassical electricity and mechanics we have applied to the analysis of the electromechanical state of interaction of electrically charged bodies. Now it is a question of how to adapt theoretical results [2] to the inseparable “electron-proton” pair. It is on its force interaction that the whole microworld with its atomic-molecular structure is based [3].

Unfortunately, the methods of classical physics have been pushed out of the microworld. But this is primarily the fault of the methods themselves, which in space-time form were completely inapplicable to the analysis of real problems. And it is first of all about the following:

1. The inability of the methods of classical physics to work with elliptical orbits.
2. Inability to work with broken orbits, and thus to describe the chaotic motion.
3. The impossibility of constructing a theory of multimass systems.
4. Failure to explain the precession of non-circular orbits, etc.

We deliberately do not mention the effects associated with the interaction with external fields which are derived from the above.

And yet, for the foundations of quantum physics, the analysis of the relationship between classical and quantum physical representations cannot be unimportant. Therefore, to unconditionally drive the wedge between the natural-mathematical unity of the world, on the one hand, the mega- and macroworld, and on the other hand, the microworld may be premature. After all, the creators of quantum physics themselves understand this.

Quantum physics does not allow the methods of classical physics beyond the limit at which the numerical value of a variable with dimension (J·s) of the elementary quantum of action is commensurate with the Planck constant h = 6.626.10^{-34}. And in our examples, the momentum of the electron emv in the proton orbit falls into this zone. But we use the hospitality of the author [8], who writes: “The smallness of variable action does not always indicate the complete unsuitability of classical theory. In many cases, it can give some qualitative idea of the behavior of the system, which can be clarified by quantum mechanical approach”.

Purpose of work. To show that the electromechanical state of the atomic structure “electron-proton”, despite the scanty spatial dimentions of the microworld, can be successfully described on the basis of modern laws of neoclassical electricity for better understanding the unity of the physical process of mega-, macro- and microworld.

2. Differential equations of electro-mechanical state

Successful mathematical modeling of intraatomic transient electromechanical processes is possible only on the basis of equations involving the adapted Coulomb’s law in the case of moving charged bodies [1, 2]. This takes into account the finite rate of propagation of the electric field and the law of conservation of charge.

The force law of electrical interaction in the modern interpretation of the electron-proton pair looks like this

$$\mathbf{F} = \frac{kqQ}{r^2}\left(1 + \frac{v^2}{c^2} + 2\frac{v}{c}\mathbf{r}_0 \cdot \mathbf{v}_0\right)\mathbf{r}_0, \qquad (1)$$

where $\mathbf{F}$ is the force vector; $\mathbf{v}$ is the velocity vector; Q is the charge of a stationary proton; q is the charge of a moving electron; r is the distance between the electrical centers of the interacting bodies; v is the mutual speed of movement; c is the speed of light in vacuum; $\mathbf{r}_0, \mathbf{v}_0$ are the unit vectors of distance and trajectory of motion; k is the world constant:

$$k = 8.987742 \cdot 10^9 \text{ Nm}^2\text{C}^{-2}.$$

The second term in parentheses (1) is responsible for the Lorentz force [1], and the third one for the new component [2], which plays a fundamentally important role in the dynamics of electrically charged bodies.

The equations of motion of the electron do not go beyond Newton's classical law

$$\mathbf{F} = m\frac{d\mathbf{v}}{dt}; \quad \frac{d\mathbf{r}}{dt} = \mathbf{v}, \tag{2}$$

where r is the spatial radius vector; m is the mass of electron.

Equations (2) need to be explained, because it may be about the near to speed of light. The functional dependence $m = m(v)$ is one of the annoying misunderstandings of special theory of relativity (STR), far from mathematical, but incorrect physical interpretation. The fact is that the Lorentz coefficient refers to the force interaction of the masses (see (1)), and not the masses themselves! This crystallizes out in the process of taking into account the finite rate of field propagation.

The equations of the electromechanical state of the electron-proton pair are constructed on the basis of the balance of forces of electrical interaction (1) and mechanical interaction (2).

This balance is simplest when the motion of an electron and a proton occurs in a straight line passing through their geometric centers. Then the problem is solved in 1D space and the balance of forces (1) and (2) is significantly simplified

$$\frac{dv}{dt} = -\frac{kqQ}{mr^2}\left(1 \pm \frac{v}{c}\right)^2; \qquad \frac{dr}{dt} = v. \tag{3}$$

But most practical problems are successfully solved in 2D space, if a system of spatial coordinates is skillfully chosen. In this case, the balance of forces (1), (2) in Cartesian coordinates in comparison with (3) is complicated

$$\frac{dv_x}{dt} = -\frac{kQq\,r_x}{mr^3}\left(1 + \frac{v^2}{c^2} + 2\frac{r_x v_x + r_y v_y}{cr}\right);$$
$$\frac{dv_y}{dt} = -\frac{kqQ\,r_y}{mr^3}\left(1 + \frac{v^2}{c^2} + 2\frac{r_x v_x + r_y v_y}{cr}\right); \tag{4}$$
$$\frac{dr_x}{dt} = v_x; \qquad \frac{dr_y}{dt} = v_y,$$

and

$$r = \sqrt{r_x^2 + r_y^2}; \qquad v = \sqrt{v_x^2 + v_y^2}. \tag{5}$$

If necessary, system (4) can be written in 3D space. To do this, it is enough to add the equations of the third projections v_z, r_z, and to complicate the third term in brackets

$$2\frac{r_x v_x + r_y v_y + r_z v_z}{cr},$$

it is clear that radicals (5) will also be complicated by one projection.

Expressions (4), (5) form a complete system of nonlinear differential equations of the electromechanical state of the electrically and mechanically interacting pair "electron-proton". The uniqueness of their solution is provided by the corresponding initial conditions:

$$v_x(+0), v_y(+0), r_x(+0), r_y(+0).$$

It should be noted that the transient processes are too sensitive to the initial conditions! Therefore, their choice is one of the most important stages in the practical analysis.

We are interested not so much in transient processes as in steady-state ones. The steady state in terms of the costs of brain labour is easiest to obtain by differentiation (4) up to the attenuation of the transient process. But such a path is unacceptable due to the fact that the transient process may be too long, and the accumulation of errors in numerical integration may distort the end result. Therefore, in practice, one tries to find such initial conditions that exclude the transient reaction. For this purpose, there have been developed reliable general methods for finding such conditions based on the equations of the first variation of the equations of the electromechanical state. But this can only be discussed in a separate study. Here we consider a separate analytical case related to the circular orbital motion of an electron around a proton ($\mathbf{r}_0 \cdot \mathbf{v}_0 = 0$) – the most common case in the practice of the microworld.

In this case, in the polar coordinate system (1) is greatly simplified

$$F_r = -\frac{kqQ}{mr^2}\left(1 + \frac{v^2}{c^2}\right), \tag{6}$$

where F_r is the radial component of the force (1).

The expression of the mechanical radial force in this case has the form

$$F_r = \frac{mv^2}{r}. \tag{7}$$

Based on the balance of forces (6), (7), we obtain the desired expression, which connects the orbital linear velocity with the radius of the trajectory

$$v=\sqrt{\frac{a}{br-d}}, \tag{8}$$

where *a, b, d* are the constant coefficients

$$a=kqQc^2;\quad b=mc^2;\quad d=kqQ. \tag{9}$$

An important feature of formula (8) is that it takes into account both classical forces – Coulomb and Lorentz. To neglect the Lorentz force, it is sufficient, in (8), in the root expression, to divide the numerator and denominator by c^2 and make a boundary transition. Then we come to the classic result

$$v=\sqrt{\frac{d}{mr}}. \tag{10}$$

For the pair "electron-proton" coefficients (9) take numerical values

$$a=20.735435\cdot 10^{-12};\ b=81.871112\cdot 10^{-15};$$
$$d=23.070425\cdot 10^{-29}.$$

Formula (8) makes it possible to calculate the orbital linear velocity for a given radius of the circular orbit of an electron. Such velocities and radii, being used as initial conditions for differential equations of state (4), in the process of their integration exclude the transient reaction. Thus, we enter directly into a steady state.
In the case of any stationary circular orbits of an electron in an atom, then, up to fifth decimal place, expression (8) can be replaced by a simpler one.

$$v=\frac{15.91455}{\sqrt{r}}\cdot 10^5. \tag{11}$$

If we are talking about stable quantum orbits of an electron in a hydrogen atom with quantum numbers $n1, n2, n3\ldots$, then (11) is further simplified

$$v=\frac{21.8773}{n}\cdot 10^5, \tag{12}$$

where *n* are the main quantum numbers.

Units of measurement are given in the SI.

Based on (12), the orbital linear velocities of the electron are obtained for all the main four quantum orbits of hydrogen:

$$v_1=21.8773\cdot 10^5,\ v_2=10.9386\cdot 10^5,$$
$$v_3=7.2924\cdot 10^5,\ v_4=5.4693\cdot 10^5\ (\mathrm{ms}^{-1}).$$

These values correspond to observations. If we use (10), ignoring the Lorentz force, then, for example, for the main orbit (Bohr radius) we have: $v_1=21.8767\cdot 10^5$. Such a small deviation was to be expected, because at the given velocities the relativistic effect is negligible.

Let experts in quantum physics not be surprised with their prohibitions. We work in the field of neoclassical physics, which guards the unity of the universe at all its levels. Therefore, we can raise the question of an electromechanical black hole similar to the gravitional one in celestial mechanics [4, 5]. Its radius is obtained in the same usual way. To do this, it is sufficient to make a balance of forces (6) and (7) at the speed of light ($v = c$). Under conditions (9) we obtain

$$r_{em}=2\frac{d}{b}=5.635791\cdot 10^{-15}. \tag{13}$$

It is clear that outside $r<r_{em}$ the laws of electricity and mechanics are collapsing.

Examples. Let's simulate some interesting surreal (in terms of total prohibitions of quantum physics of the microworld) situations of the dynamics of "electron-proton" pair. Starting numerical information for integrating differential equations of state (4) for the orbit $n = 4$:

$$Q=1.602\cdot 10^{-19};\ q=-Q;\ k=8.988\cdot 10^9;$$
$$m=9.109\cdot 10^{-31};\ r_x(0)=0;\ r_y(0)=8.467\cdot 10^{-10};$$
$$v_x(0)=5.469\cdot 10^5;\ v_y(0)=0.$$

The initial conditions that exclude the transient reaction was obtained by expression (12).

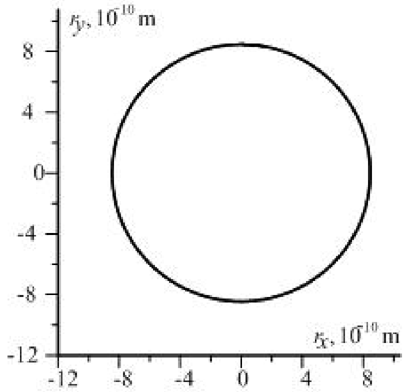

Fig. 1. Hodograph of the radius r = r (t) of the capture by a proton of hydrogen of a moving electron into a stable circular quantum orbit n = 4.

Fig. 1 shows a hodograph of the trajectory of the electron of the atomic nucleus, which came out by analyzing digital data almost on a circular quantum (n = 4) orbit with a classical radius r = 8.464.10^{-10} m and an orbital linear velocity v = 5.469,105 m/s. According to the simulation data $r = 8.457\cdot 10^{-10}$ m, $v = 5{,}473\cdot 10^5$ m/s.

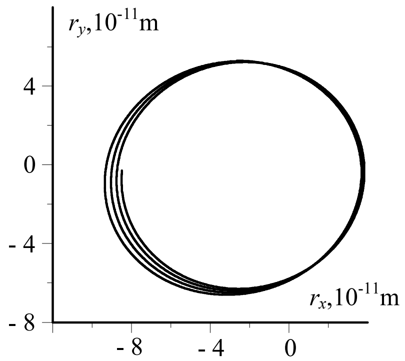

Fig. 2. Hodograph of the radius r = r(t) of the capture of a moving electron into a circular quantum orbit n =1 of the nucleus of a hydrogen atom at imbalance of the initial conditions excluding the transient reaction.

And the fact that in the electromechanical process of Fig. 1 there is no transient reaction only testifies that incredible accuracy of experimental measurements that a person is able to perform on an invisible physical object! It is enough to make a small deviation from the experimental initial conditions, and a transient process cannot be avoided, with it being rather protracted in time. If we are talking about a circular quantum (n = 1) orbit with a classical radius r = 0.529 $\cdot 10^{-10}$ m and an orbital linear velocity v = 21.877$\cdot 10^5$ m/s, then it was enough to shift the initial condition to the left by half an atomic radius and a transient process claimed its right to exist (see Fig. 2).

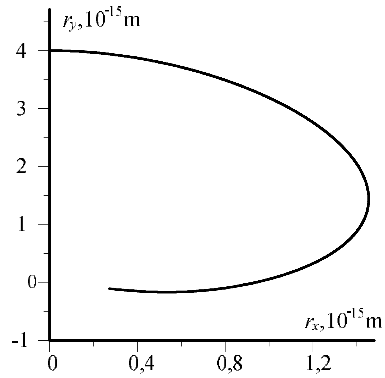

Fig. 3. Hodograph of the radius r = r(t) of the collapse of the electron trajectory inside the electromechanical black hole in the field of force action of the proton.

In the process of researching the electromechanical processes of the electron-proton pair, it became possible to look beyond the critical limit (13) of Coulomb's law ($r < r_{em}$). The results of the simulation are shown in Fig. 3 and Fig. 4. Indeed, there was discovered a collapse not only of the electrical interaction but also mechanical one. This is convincingly demonstrated by the curve of the electron velocity deep into the unreal matter, which has crossed the threshold of the speed of light. But something else is interesting: a computer program as a sign of mathematical solidarity with the physics of process also "explodes" – it stops due to numerical overflow. So, how well thought out this world is!

The transients shown in Fig. 2–4, are impossible to solve by the methods of classical physics. Having solved these problems, we thereby maintained the unity of the fundamental laws of nature inherent in all levels of the mega-, macro- and megaworld. But this by no means denies the existence of specific laws of nature inherent in each of these levels, in particular, quantum ones in the microworld [3]!

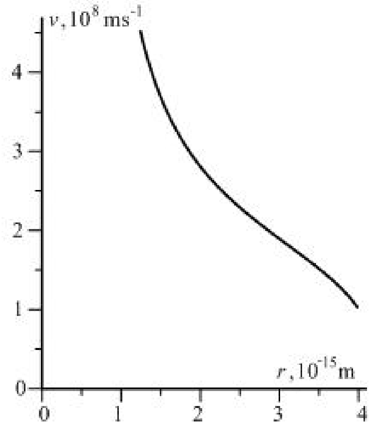

Fig. 4. The dependence v = v(r), which demonstrates the collapse of the laws of electricity and mechanics in the depths of matter.

3. Conclusions

1. The graphically presented results of calculations of model transients of the force interaction of the electron-proton pair clearly illustrate the possibilities of the neoclassical approach in solving a number of fundamental problems of electromechanical equilibrium of moving charged bodies, not feasible by the methods of classical physics.

2. The fact that the methods of classical physics were unconditionally forced out of the theory of the microworld should still be considered a premature act. As the theoretical and illustrative material of the article shows, neoclassical approaches neutralize almost all the main claims to this or that failure of classical appro-aches.

3. The theoretical and simulation results obtained in the work are not only of purely scientific interest, but also epistemological in favor of the unity of the universe at all its levels - mega-, macro- and microworld.

PS. The fact that in the labyrinths of the theory we came across such concepts as the radius of a black hole r_{em} and the singularity of the velocity $v > c$ in the space

$r < r_{em}$, obliges the author not to remain silent about this. Let us call on the cited thoughts taken from [6] to help, so as not to give the impression that scientists do not think about it.

Firstly. Based on Gödel's theorem on the incompleteness of our knowledge, “there are more and more reasons to believe that it is difficult to do without the concept of other universes”. In the literature, one can even find the idea that these universes are not elsewhere, but in elementary particles. “And the channels of communication (*with them*) can be the singularities that in our universe take place in the case of black holes. It is possible that the barriers of space-time that separate us from other universes are not so impregnable. It is possible that in time they will eventually be overcome by science and bring our ideas about the universe to a qualitatively new level”. In this case, the singularity of velocity, and with it, according to (1), the singularity of force interaction in such a miracle-microworld are simply inevitable.

Secondly. This is the velocity threshold c, established experimentally as the speed of light in vacuum. The impossibility of transgressing it is a well-known postulate of the special theory of relativity. That is why the Lorentz radical rests on it. And the radical was named after none other than the genius Poincaré himself. At the same time, he himself treated this postulate with a certain caveat [7].

But it is not for us to judge such truths in an unknown world. Time will tell about them. We are still staying and will stay on this side of the threshold for a long time, because we do not know how to live in any other way. Another thing is to talk, because such conversations activate our brain..

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ЕЛЕКТРИЧНА ВЗАЄМОДІЯ ТАНДЕМУ “ЕЛЕКТРОН-ПРОТОН”

Василь Чабан

На основі адаптованого закону Кулона на випадок рухомих мас з урахуванням скінченної швидкости поширення електричного поля одержано диференціальні рівняння електромеханічного стану тандема “електрон-протон”. Просимульовано реальні стани, а також низку нереальних перехідних станів захоплення електрона протоном на власну орбіту. Наперекір заборонам квантової фізики в полі мікросвіту введено математичне поняття електромеханічної чорної діри з радіусом $r_{em} = 5.6358 \cdot 10^{-15}$ на кшталт тієї, що існує в небесній механіці. Просимульовано перехідні процеси, що засвідчують колапс законів електрики і механіки за порогом $r(t) < r_{em}$. З цього приводу розпочато дискусію.

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