DYNAMICS OF MOTION OF ELECTRON IN ELECTRICAL FIELD

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Abstract. Nowadays, the function of the law of interaction of moving charged bodies has been taken over entirely by the theory of relativity, being covered by a pseudo slogan about the inability of Galileo transformations. In contrast, the article adapts Coulomb's law in the case of moving charges in all possible speeds in the usual three-dimensional Euclidean space and physical time. This takes into account the finite speed of propagation of the electric field and the law of conservation of the charge.

On this basis, the dynamics of the free motion of an electron in a non-uniform electric field are simulated. For qualitative and quantitative evaluations of the manifestation of the relativistic effect on the dynamics of motion, the duplicate time functions of velocities and coordinates obtained by classical Coulomb's law are given. Electromechanical analogies of electric and gravitational fields have been made.

Key words: Coulomb's law; Law of conservation of the charge; Relativistic velocity; Finite velocity of propagation of an electric field; Dynamics of motion of a free electron in a non-uniform electric field.

1. Introduction

The interaction of moving electrons with the electric field is a major process in all electronic devices. The laws of motion of a single electron in a homogeneous electric field with a known approximation can be applied to the motion of it in an electron flux if neglected by their repulsion. In most cases, the electric field is heterogeneous and very complex in its structure. Therefore, the research of electron motion in inhomogeneous electric fields is very difficult and relates to the field of electronics called electronic optics. Many scientific publications are devoted to the dynamics of electron motion in the electric field, but all of them cover the range of pre-relativistic velocities. For moving masses in such a range, the Coulomb's law of electrical interaction is a sufficient precision – the basic law of electrostatics, which determines the magnitude and direction of the force of interaction between two fixed point charges. At sub-relativistic velocities, Coulomb's law inadmissibly distorts the real process. Therefore, one has to resort to the complex equations of relativity, which are not always applicable and which in most cases cannot be used in practice. So there is a reasonable question, why not simplify the task by adapting the Coulomb's law to the case of moving bodies in the usual three-dimensional space and physical time.

It is clear that such a solution to the problem was not in favor of the relativists, which is why they were at one time has recognized as outlawed the transformations of Galileo, despite the reservations made over a hundred years ago by Henry Poincare on the Lorentz transformations [1]: "This does not mean that they were forced to do so; they think the new deal is more convenient – that's all. And those who do not hold their minds and do not want to give up their old habits can rightfully keep the old agreement. Speaking between us, I think they will continue to do so for a long time".

In [1] we read further: "Poincare's particular view of the new theory was not given serious importance. Much later, already in the second half of the XX century, it became apparent that Poincare was entirely correct in claiming that no physical experience could confirm the truth of some transformations and reject others as inadmissible. The origins of the misunderstanding of Poincare's views lie in the disclosure of the conditional nature of simultaneity.

As a result, it became possible to misunderstand this theory, which focused on the "failure" of Galileo's transformations. This misunderstanding is reflected in the accepted logic of constructing the theory of relativity when new properties of motion at high speeds are deduced from the relativistic properties of space and time".

Far more radical in a hundred years is expressed by [2]: The statements of relativists about the inability of classical physics as a whole, as well as the law of Newton's gravity to describe dynamic processes are erroneous. The adaptation of Newton's law to the field of dynamic fields only requires a correct account of the finite speed of propagation of the gravitational field. At the same time, in the region of low velocities, corresponding coefficients appear, and at the transition to the velocity of light nonlinear effects appear, which are described by transcendental equations – something that can never be described either in the framework of the Special Theory of Relativity or the General Theory of Relativity ... In principle, the inability of relativism in

describing dynamic processes just arises from the conditions under which their basic formulas appeared… The consequence is its complete inability to answer real-time questions. The continuation of the addition of new and new non-obvious assumptions and assertions is increasingly pushing scientists away from the actual study of processes in the universe. Only a return to the original three-dimensional linear space plus the time of classical physics will return scientists to the path of studying precisely physical processes, not juggling symbols and searching for nonexistent covariance.

An attempt to return from relativism in the electric field to the Maxwell equations in 4-D space-time is considered in [3], and in 3-D space and physical time in [4].

The idea of the article rooted in the works [1–2], being under their direct influence.

2. The Equation of Dynamics

The law of electrical interaction of point-tuned bodies Ch. Coulomb experimentally established in 1785. Coulomb's theory laid the foundations of electrostatics. The law describes the electrical force of interaction of fixed charged bodies:

$$\mathbf{F} = k\frac{q_1 q_2}{r^2}\mathbf{r} \qquad (1)$$

Here **F** is the vector of forces of the interacting charged bodies with the charges q_1 i q_2; r is the distance between the electrical centers of the bodies; k is electrical constant; r is a single vector.

The condition of statics of the interacted charges can be interpreted by the propagation of the electric field at unlimited speed, or the so-called instantaneous electrical interaction. In fact, according to modern ideas, both electric and gravitational fields propagate with the maximum possible physical velocity c = 3.108 m/s. Therefore, to adapt the law (1) to the real conditions, it is enough to consider the fact of temporary electrical delay! Otherwise, at a frozen moment in time t, the distance will be taken not to the actual finding of the interacting bodies, but to the point of the trajectory taking into account the time delay Δt.

It was performed such an adaptation in the general vector case. But in this case, a much simpler problem is explored – the dynamics of free interaction (in the absence of other force fields), when the electrical centers of the charged interacting bodies are on one line. Therefore, the analysis is greatly simplified. At a frozen time *t,* the distance r between the interacting charged bodies will be defined as:

$$R = (c \mp v)\Delta t \qquad (2)$$

Here v is the instantaneous speed of movement of the charged body; the sign "–" indicates a rapprochement, and the sign "+" indicates the distancing of bodies.

It was denoted the charge of the body generating the field by a capital letter Q and the line of the moving body by a small letter q. It was defined as the real distance between the electric centers of the charged bodies according to (2) as:

$$r = c\Delta t = \frac{R}{1 \mp \frac{v}{c}} \qquad (3)$$

Substituting (3) into (1), the expression of the adapted law (1) in the scalar record for the case of free interaction of the charges q i Q with the account of the electrical delay was deduced:

$$F = k\frac{qQ}{R^2}\left(1 \mp \frac{v}{c}\right)^2 \qquad (4)$$

Therefore, when $v = 0$, expression (4) degenerates and simplifies to (1) because it must be so. When moving closer to the natural speed at its limit ($v = c$), the electrical interaction disappears itself ($F \to 0$). When braking (against electrical action ($v = -v$)) the force increases four times ($F \to 4F$). This explains the effects of electrical delay.

The balance of the free attracting forces of charged point bodies can be written based on Newton's second law:

$$m\frac{dv}{dt} = k\frac{qQ}{R^2}\left(1 - \frac{v}{c}\right)^2. \qquad (5)$$

As a result, a differential equation is received:

$$\frac{dv}{dt} = \frac{q}{m}\frac{kQ}{R(x)^2}\left(1 - \frac{v}{c}\right)^2. \qquad (6)$$

To apply equation (6), it is necessary to specify a nonlinear function $R(x)$

$$R = r_e + x\ . \qquad (7)$$

Here r_e, x are the radius of the body generating the field and the distance between the interacting bodies, respectively. Substituting (7) in (6), obtain:

$$\frac{dv}{dt} = \frac{q}{m}\frac{kQ}{(r_e + x)^2}\left(1 - \frac{v}{c}\right)^2 \qquad (8)$$

The coordinate equation is familiar:

$$\frac{dx}{dt} = -v \qquad (9)$$

The range of variables in (8), (9) is for velocity: $v_0 \le v \le c$; for coordinate: $x_0 \ge x \ge 0$, where v_0, x_0 are

initial conditions. An electric field can disperse a charged particle by pulling or pushing it and may break if it moves inertia against the forces of the field, which is reproduced by the signs "–", "+", that correspond to approaching or moving away.

Almost the same can be considered the case of the motion of a charged particle across the electric field. Then, equation (4) is modified to:

$$F = k\frac{qQ}{R^2}\left(1+\frac{v^2}{c^2}\right). \qquad (10)$$

Formula (10) sheds light on the epistemological principles of electricity. Let's consider:

$$F = q\left(E + E\frac{v^2}{c^2}\right), \qquad (11)$$

where E is the modulus of the electric field intensity vector E:

$$E = k\frac{Q}{R^2}. \qquad (12)$$

Taking into account (10), the orthogonality of vectors of velocity and electric field, it can be written the Biot-Savart law [3,7]:

$$B = \mu_0(v\times\varepsilon_0 E) = \frac{vE}{c^2}; \quad c^2 = \frac{1}{\mu_0\varepsilon_0}, \qquad (13)$$

where B is the module of the vector of magnetic field B; ε_0, μ_0 are electrical and magnetic constants. According to (11)–(13), it is defined as the modulus of Lorentz's force:

$$F = q(E + vB). \qquad (14)$$

Thus, we have confirmed the forgotten truth that a magnetic field as a physical substance does not exist. It is just a relativistic effect in an electric field!

In the general case of oblique motion of the charged particle to the force action of the electric field, the equations (4), (10) take a vector form:

$$\mathbf{F} = k\frac{qQ}{R^2}\left(1+\frac{v^2}{c^2}+2\frac{v}{c}\mathbf{v}\cdot\mathbf{r}\right)\mathbf{r}, \qquad (15)$$

where **v** is a single velocity vector. The expression (14) in vector form according to (15) takes the known form

$$\mathbf{F} = q\left(\mathbf{E}+\mathbf{v}\times\mathbf{B}\right), \qquad (16)$$

Based on electromechanical analogies, we can also write Newton's law of gravity adapted to moving masses

$$\mathbf{F} = \gamma\frac{mM}{R^2}\left(1+\frac{v^2}{c^2}+2\frac{v}{c}\mathbf{v}\cdot\mathbf{r}\right)\mathbf{r}, \qquad (17)$$

here m, M are the gravity masses. Law (17) was tested at relativistic velocities in the dynamics of celestial mechanics. In particular, the formula of the gravitational radius is obtained, which coincides with the received one based on the Schwarzschild metric in curvilinear Riemann space [5–6], and the dynamics of free gravitational fall on the GRO J0422 + 32/V518 per collapser (black hole) is simulated.

3. Example

An electromechanical process of free electron attraction in a non-uniform electric field of a charged ball with radius r_e and positive charge Q is simulated, considering an electron as a material point. Recall that an electron is a particle with a negative electric charge, the value of which is = –1,6.10–19 C. Electron mass m = 91.10–31 kg. Other parameters: $Q = +3.16\cdot10^{-4}$ C; $r_g = 0.10$ m; $k = 8.99\cdot10^9$ Nm^{2}s^{-2}; $c = 2{,}99\cdot10^8$ ms^{-1}. Initial conditions are $v_0 = 0$; $x_0 = 10$ m.

Simulation results. The results of joint integration of differential equations (8), (9) at the above given values of the coefficients and initial conditions are shown in Fig. 1 and Fig. 2. For the purpose of qualitative and quantitative evaluation of the manifestation of the relativistic effect on the dynamics of electron motion in a non-uniform electric field, the duplicate time functions obtained by classical Coulomb's law (1) are given.

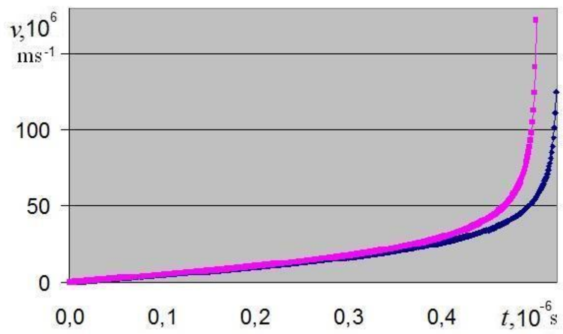

Fig. 1. The dependence of velocity on time v = v (t): the higher curve is obtained from classical Coulomb's law, lower one – from the adapted law of moving charges

Basing on the analysis of the obtained results, it becomes possible to quantify the conclusion of classical electronics that in the ordinary electro vacuum devices the electron velocity does not exceed 0.1 c, so the mass of the electron can be considered constant. To be critical of these words, one should cite again [2]: "Physical simulation refutes the myth of mass growth. The conditions of the interaction of the masses themselves, including the distance between them, change". We fully share the truth of aforesaid that is convincingly proved by expression (10). Because here, no relativistic coefficient (which is in parentheses) can be driven into

the moving charge, as it was done by the relativists with the moving mass.

The main reason is the following. There exists a fundamental law of charge conservation as an obstacle! Analysis of digital data of Fig. 1 demonstrates that at a speed of 0.1 c the difference in the speeds of 4600 km/s, or a relative error of 16 %, is determined. Such a striking error can be attributed only to the specific unevenness of the electric field.

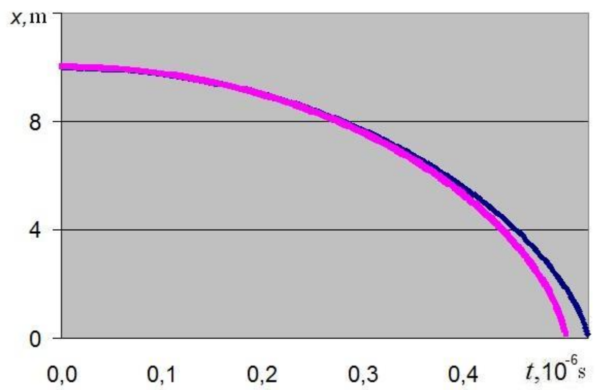

Fig. 2. Time dependence of the trajectory of motion x = x (t). The lower curve is the result obtained by the classical Coulomb's law, the higher curve is by the adapted law of the moving charges

4. Conflict of Interest

An author claims that there are no possible financial or other conflicts over the work.

5. Conclusions

1. The law of Coulomb's electrical interaction was adapted for the case of moving bodies in the range of real possible velocities [0, c]. The adaptation was carried out bypassing the theory of relativity in real three-dimensional space and physical time. This takes into account the finite rate of propagation of the electric field and the law of conservation of charge. Electro-mechanical analogies of electric and gravitational fields are given.

2. Basing on this adaptation, the dynamics of the free motion of an electron in a non-uniform electric field is simulated. To assess the manifestation of the relativistic effect on the dynamics of electron motion, duplicating time functions obtained by Coulomb's classical law are simulated.

3. The received results confirm the forgotten truth that a magnetic field is only a relativistic effect in an electric field.

4. Significant simplification of the analysis of the dynamics of the motion of charged bodies in an electric field initiates the prospects of new high-speed metrology of charged particles.

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6. Conflict of Interests

There is no conflict of interest while writing, preparing, and publishing the article.

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