THE ACCELERATION OF THE ELECTRON AND THE LORENTZ EQUATION

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Introduction

In the study of electrostatic and magnetic interaction of charges with the help of numerous experimental data it is established that the appearance of a magnetic component is possible only in the case of their accelerated motions. This interaction is described by the Lorentz equation. From the standpoint of theory, it is interesting to study the case of slow motion charges.

Typology of knowledge

According to ancient Hindu legend, the Earth is placed on the back of an elephant standing on the back of a turtle. This story does not give information about the points of support of the turtle.

In this legend, with all the ridiculousness of the original idea, there is a deep thought that any sequential study of the causes of the physical phenomenon is limited to certain boundaries, depending on the level of physical knowledge. From some stage of the study, it is impossible to answer the question "why?" without further, deeper information. This means that any explanation must be limited to its "turtle".

Today, no one can say when a person first drew attention to the amazing ability of amber: if it is rubbed against wool, it will attract various objects placed nearby. However, it took more than two millennia before a systematic study of the phenomenon of electrification began from a scientific standpoint.

The impetus for this was the already open law of universal gravitation. Cavendish, while studying gravitational forces, also investigated the interaction of electrostatic charges. The law is named after Coulomb since he published it. Coulomb's law strikingly coincides with Newton's law and this made it possible to consider the magnitude of the charge by analogy with mass as a certain amount of electricity [1,2,3,4].

If in Newton's law of gravity

$$\overline{F}_{12} = \gamma \frac{m_1 m_2}{\gamma_{12}} \overline{\gamma}_{12}, \qquad (1)$$

where m_1, m_2 – masses of interacting bodies;

γ – constant;

$\overline{\gamma}_{12}$ – the distance between the bodies, replace the masses of bodies by charges and change the constant, then we get the Coulomb law.

$$\overline{F}_{12} = k \frac{q_1 q_2}{r_{12}} \overline{r}_{12}, \qquad (2)$$

where q_1, q_2 – interacting charges;

r_{12} – distance between charges;

k – constant;

$\overline{r}_{12}$ – orth, directed between bodies or charges;

$\overline{F}_{12}$ – force vector.

Modern physics for understanding the origin and transfer of forces that arise between fixed charges, suggests that there is some kind of physical agent involved in this interaction. An electric field is proposed as such agent [5,6,7,8,9]. And to the question what a field is, the answer is: "When an electric charge appears anywhere, an electric field arises around it. The main property of an electric field is that any other charge placed in this field is subject to force".

This completely omitted the connection between the matter of which the charge is composed, and the matter of which the field is composed. And the existence of such a connection is a prerequisite for the existence of a charge with a field, and vice versa, a field with a charge.

Using the concept of "interaction force", electrical engineering introduces the concept of electric field strength [10,11,12].

If we consider some distribution of fixed electric charges $q_1, q_2, \ldots, q_N$ in space, and if it is necessary to find the interaction of these charges with some electric charge q with the known coordinates x, y, z, then the force is calculated according to (2):

$$\overline{F} = \sum_{i=1}^{N} k \frac{q \cdot q_i}{r_i^2} \overline{r}_i, \qquad (3)$$

where r_i – distance from the i-th charge to the charge with the coordinates x, y, z;

$\bar{r}_i$ – spatial ort.

If we take q out of the sign of the sum, we get

$$\bar{F} = q \cdot \bar{E}, \tag{4}$$

where
$$\bar{E} = \sum_{i=1}^{N} k \frac{q_i}{r_i^2} \bar{r}_i = \bar{E}(x, y, z). \tag{5}$$

The vector quantity (5) is called the electric field intensity vector (unit of measurement *V/m*). The function $\bar{E}$ (*x, y, z*) can be calculated at any point in space. So the question arises: does it characterize a physical substance, called an electric field, or is it just a convenient factor that is enough to multiply by a charge to get the value of force.

Much effort has been spent on geometrically constructing field pictures, but all of them are imperfect because they do not reflect the physical nature.

Introducing the ether would put all dots on "i" and solve virtually all problems of the theory of electric field, but physics still prefers mathematical abstraction – fields are considered as mathematical functions of coordinates and time.

An analysis of electron dynamics. Modern physics, by combining electrostatic interactions with magnetic interactions, called these interactions electromagnetic. The mathematical image of this association is the well-known Lorentz equation [13].

$$\bar{F} = q\left[\bar{E} + \left(\bar{V} \times \bar{B}\right)\right], \tag{6}$$

where $\bar{F}$ – force vector;

$\bar{V}$ – speed of charge movement;

$\bar{B}$ – vector of magnetic induction.

The force of the electric field on a fixed charge in this equation is determined by the first additive, which corresponds to (4).

In the case of a moving charge, this vector receives an additional component due to the intensity of the magnetic field and the speed of motion.

A well-known factor is the emission of an electron only when motion is accelerated or slow, i.e. at $V = var$.

Another example that confirms the presence of a magnetic field due to the acceleration of electrons is the voltage drop across the electric circuit.

Expression (6) for the variable of the charge velocity will look like:

$$\overline{F} = q\left[\overline{E} + \frac{d}{dt}\left(\overline{V} \times \overline{B}\right)\right]. \tag{7}$$

The derivative of the first factor in parentheses is the acceleration:

$$\overline{W} = \frac{d\overline{V}}{dt}. \tag{8}$$

The derivative of the second factor is determined by the second Maxwell equation:

$$\frac{d\overline{B}}{dt} = -vot\overline{E}. \tag{9}$$

Substituting expressions (8) and (9) into expression (7), we obtain the Lorentz equation for static and dynamic fields:

$$\overline{F} = q\left[\overline{E} + \overline{W} \times \left(-rotE\right)\right]. \tag{10}$$

The right-hand side of the Lorentz equation (10) operates a product of charge on the electric field strength.

Summary

The Lorentz equation describes electrostatic and magnetic interactions of charges, the latter being determined by their velocities. Numerous experimental data of physics indicate that the appearance of a magnetic component of charges is possible only in the case of their accelerated motions.

In this publication, the Lorentz equation is extended to cases of accelerated and slow-motion charges.

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