

ON THE NATURE OF ELECTRIC AND GRAVITATIONAL FIELDS

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**Abstract.** Based on the fundamental laws of statics – Newton's and Coulomb's – generalized to the case of dynamics (motion - the interaction of mechanical masses and electric masses (charges)), an attempt was made to explain the physical essence of electric and gravitational fields. as specific forces per unit of main mass. In theoretical exercises, the finite velocity of propagation of the field is taken into account. The veil has been lifted somewhat on the hitherto unknown unity of both fields through the units of LMTI dimensions. Such a deepening into the world of two disciplines – electricity and mechanics – is useful for an in-depth understanding of physical processes, and at the same time for their quantitative identification.

**Key words:** Newton's and Coulomb's laws of universal gravitation, generalized to the case of motion, the natural essence of electric and gravitational fields as specific forces per unit of mass.

1. Introduction.

We are indebted to Michael Faraday (1791-1867) for the concept of a field in electricity and, at the same time, in gravity. But isn't he who owes the idea to his peer and countryman, the romantic poet John Keats (1795-1821), in particular his sonnet "To him who lived in the city as in captivity"?

For those who lived in the city as if in captivity,  
It is so nice to go out into the silence of the field  
I live smilingly in the heights  
Send a prayer to heaven and fate.

But don't we, experienced scientists, breaking out of the tight embrace of the elements of electric circuits with concentrated parameters into the boundless spaces of the electric field, feel the same? We can confidently say about those who break out of such embraces of mechanical mechanisms and devices into the boundless spaces of the gravitational field.

Thus, there arises a natural need to look into the depth of the physical essence of both fields – electric and gravitational, as the main force characteristics of the Universe.

This topic has been discussed for a long time. We will not delve into those times when fields were tried to be represented by all possible lines, vortices, springs, etc. Let us start with how they were described by space-time vector functions. But a lot of time still passed before it was agreed that this was how fields should be interpreted - as

functions of spatial coordinates and time [1]. But this by no means removes the problem of discussions about the deep physical essence of fields. This is exactly what will be discussed in our research.

Delving into the world of the two disciplines – electricity and mechanics as similar physical substances - can be used with benefit to understand many physical processes that occur in them both separately and as a result of mutual interaction [2,3]. It is important that all mathematical exercises will be performed in our usual flat Euclidean space and physical time, which is also important in terms of observing the basic condition of the modern theory of cosmological inflation [4].

From a cognitive point of view, this study is a continuation of a number of theoretical works published on the pages of this journal, at least from the recent ones [5, 6].

**The goal of the work.** To reveal the physical essence of electric and gravitational fields on a strict mathematical basis, based on the general principles of the theory of electrogravitation [2, 3, 7].

2. Equations of electrical and mechanical state.

Let us base it on the fundamental laws of nature, which, as a rule, are established only experimentally, because the human mind is still far from knowing the deep secrets of the Universe. Therefore, even great scientists have to steal heads from the hearth of universal Truth for the sake of the advancement of humanity.

Let us start with the laws of statics - Isaac Newton (1643–1727) and Charles Coulomb (1736–1806):

$$\mathbf{F}_{12} = G \frac{m_1 m_2}{r^2} \mathbf{r}_{12} ; \tag{1}$$

$$\mathbf{F}_{12} = k \frac{q_1 q_2}{r^2} \mathbf{r}_{12} , \tag{2}$$

where  $\mathbf{F}_{12}$  is the force vector;  $q, m$  – interacting electric ( $q$ ) (charges) or mechanical ( $m$ ) masses;  $\mathbf{r}_{12}$  is the instantaneous distance between the centers of mass;  $\mathbf{r}_{12}$  is a unit vector directed from the first mass to the second;  $G, k$  are global constants [2]:

$$G = 6,67438 \cdot 10^{-11} \text{ kg}^{-1} \text{ m}^3 \text{ s}^{-2};$$

$$k = 8.98774 \cdot 10^9 \text{ kg m}^3 \text{ A}^{-2} \text{ s}^{-4}.$$

Consider some distribution of electric charges fixed in space  $q_1, q_2, \dots, q_N$ . If we are not interested in the forces of interaction between them, but are interested in their interactions with some other electric charge  $q$  with known coordinates  $x, y, z$ , then this force can be calculated according to (1)

$$\mathbf{F} = \sum_{i=1}^N k \frac{qq_i}{r_i^2} \mathbf{r}_i, \quad (3)$$

where  $r_i$  is the distance from the  $i$ -th charge to point  $x, y, z$ ;  $\mathbf{r}_i$  is the spatial orth.

If we subtract in (3) from the sum  $q$ , we then get

$$\mathbf{F} = q\mathbf{E}, \quad (4)$$

where

$$\mathbf{E} = \sum k \frac{q}{r} \mathbf{r} = \mathbf{E}(x, y, z, t). \quad (5)$$

The vector value (5) is called the electric field intensity vector, it is measured in volt/meter:  $\text{Vm}^{-1}$ . The function  $\mathbf{E}(x, y, z)$  can be calculated at any point in space. Therefore, the question arises: does it characterize a physical substance called an electric field, or is it just a convenient coefficient that is sufficient to multiply by the value of the charge to obtain the value of the force. Now the first opinion is followed, since the electric field vector at an arbitrary point in space makes it possible to foresee a force that will act on an arbitrary charge at that point, and this force is capable of doing work.

If in (4) we take  $q = 1 \text{ C}$ , then we obtain  $\mathbf{F} = \mathbf{E}$ . Consequently, *the electric field intensity vector is equal in value to the force vector with which the electric field acts on a single stationary positive charge in vacuum.*

The same can be done with expression (2) in the gravitational field, if we use analogies between the electrical ( $q$ ) and mechanical ( $m$ ) masses. As a result, we come to the concept of the gravitational field intensity vector (free fall acceleration vector)  $\mathbf{g}$

$$F = mg, \quad (6)$$

where

$$\mathbf{g} = \sum_{i=1}^N G \frac{m_i}{r_i^2} \mathbf{r}_i = \mathbf{g}(x, y, z, t). \quad (7)$$

If we take  $m = 1 \text{ kg}$  in (6), then we obtain  $\mathbf{F} = \mathbf{g}$ . Therefore, *the free-fall acceleration vector  $\mathbf{g}$  is equal in value to the force vector field with which the gravitational acts on a single stationary mass in vacuum.*

In the case of dynamics, according to the theory of electrogravity, laws (1) and (2) become somewhat more complicated and take the form [2, 3]:

$$\mathbf{F}_{12} = G \frac{m_1 m_2}{r^2} \left( 1 + \frac{v^2}{c^2} + 2 \frac{v}{c} \mathbf{v}_0 \cdot \mathbf{r}_0 \right) \mathbf{r}_0; \quad (8)$$

$$\mathbf{F}_{12} = k \frac{q_1 q_2}{r^2} \left( 1 + \frac{v^2}{c^2} + 2 \frac{v}{c} \mathbf{v}_0 \cdot \mathbf{r}_0 \right) \mathbf{r}_0, \quad (9)$$

where  $v$  is the mutual instantaneous velocity of mass movement velocity;  $c$  is the speed of light in vacuum;  $\mathbf{v}_0$  is a single velocity vector.

The modules of both force vectors (8) and (9) can be written componentwise:

$$F_N = G \frac{m_1 m_2}{r^2}; \quad (10)$$

$$F_C = k \frac{q_1 q_2}{r^2}; \quad (11)$$

$$F_{LN} = G \frac{m_1 m_2}{r^2} \frac{v^2}{c^2}; \quad (12)$$

$$F_{LC} = k \frac{q_1 q_2}{r^2} \frac{v^2}{c^2}; \quad (13)$$

$$F_{TN} = 2G \frac{m_1 m_2}{r^2} \left( \frac{v}{c} \mathbf{r}_0 \cdot \mathbf{v}_0 \right); \quad (14)$$

$$F_{TC} = 2k \frac{q_1 q_2}{r^2} \left( \frac{v}{c} \mathbf{r}_0 \cdot \mathbf{v}_0 \right), \quad (15)$$

where  $F_N, F_C$  are Newton's and Coulomb's static forces;  $F_{LN}, F_{LC}$  – velocity tangential components of gravito-magnetic and Lorentz forces;  $F_{TN}, F_{TC}$  – velocity radial components of the force of gravitational and electrical interaction. It is clear that at  $v \rightarrow 0$ , the force interaction modules (12–15) degenerate into (10–11), respectively.

The functional dependence of forces (14) and (15) on the speed of movement is higher than that of forces (12) and (13), because at  $v \leq c$  the multiplier  $v/c$  in (12) and (13) is raised to the second power, and in (14) and (15) – up to the first and then doubled! It is the components of forces (14) and (15) that close the hitherto unknown triune essence of the forces of electrical and gravitational interaction, and it is they that make it possible to look deeper into the essence of the problem set.

We introduced forces (14), (15) into theoretical physics for the first time [2]. Experimental confirmation of their existence was carried out in the process of solving the problem of the braking of space probes in the hitherto

unknown additional solar acceleration, known as "pioneer anomalies" [8]. It turned out [3, 9] that this acceleration is caused precisely by force (14)! Based on the theory of electrogravity, there is no anomaly of flight trajectories. On the contrary, the movement occurs in fording to the basic laws of the universe.

Force (13) represents the force interaction of the so-called magnetic field, known as the Lorentz force

$$\mathbf{F} = q(\mathbf{v} \times \mathbf{B}), \quad (16)$$

where  $\mathbf{B}$  is the magnetic induction vector;

The required proof can be found in [2, 3]. It can also be obtained by the methods of classical electricity, if you use Biot-Savard's law in the form [1]

$$\mathbf{B} = -\frac{\mathbf{v} \times \mathbf{E}}{c^2}. \quad (17)$$

To do this, it is enough to substitute (17) into (16), resulting in

$$\mathbf{F} = -\frac{q}{c^2}(\mathbf{v} \times (\mathbf{v} \times \mathbf{E})). \quad (18)$$

The truth of (18) is most easily illustrated in cylindrical coordinates under standard conditions:  $\mathbf{E} = r_0 E$ ;  $\mathbf{v} = z_0 v$ .

$$\mathbf{F} = -\left(\frac{q}{c^2}(\mathbf{z}_0 v \times (\mathbf{z}_0 v \times r_0 E))\right) = qE \frac{v^2}{c^2} \mathbf{r}_0. \quad (19)$$

If we take into account (4), (5), then expressions (13) and (19) are identical, which had to be shown.

As for component (12), it represents the so-called gravito(electro)magnetic force [10] – the Lorentz force (16) extended on the basis of electromechanical analogies on gravity. Therefore, any proofs are superfluous here.

Thus, on the basis of formulas (8)–(19), we will try to generalize the expressions of the field intensity vectors of both electric and gravitational fields for the case of all possible movements in the range of velocities  $0 \leq v \leq c$ :

$$\mathbf{E} = \sum_{i=1}^N k \frac{q_i}{r_i^2} \left( 1 + \frac{v^2}{c^2} + 2 \frac{v}{c} \mathbf{v}_0 \cdot \mathbf{r}_0 \right) \mathbf{r}_i = \mathbf{E}(x, y, z, v, t) \quad (20)$$

$$= \mathbf{E}(x, y, z, v, t).$$

$$\mathbf{g} = \sum_{i=1}^N G \frac{m_i}{r_i^2} \left( 1 + \frac{v^2}{c^2} + 2 \frac{v}{c} \mathbf{v}_0 \cdot \mathbf{r}_0 \right) \mathbf{r}_i = \quad (21)$$

$$= \mathbf{g}(x, y, z, v, t).$$

Vectors (20), (21) are the defining characteristics of the electric and gravitational fields in the broadest sense – taking into account the existing motion ( $\mathbf{v}_0$ ) of the involved masses, electrical and gravitational. They are those

unifying cosmological values that ensure the integrity of our Universe. And this is under the crushing condition that the total sources of both vector fields of our Universe are equal to zero:

$$Q = 0; \quad W - Mc^2 = 0, \quad (22)$$

where  $Q$ ,  $W$ ,  $M$  are the total charge, energy and mass of the Universe.

Conditions (22) explain why parallel universes (if they exist) are invisible to each other!

From the position of (20), (21), expressions (4) and (6) qualitatively and quantitatively acquire a new, more general meaning, moving from statics to dynamics! Therefore, on their basis we will look for the physical essence of both fields.

Let us write (4) and (6) in a slightly different, more convenient form:

$$\mathbf{E} = \frac{\mathbf{F}}{q} = \mathbf{E}(x, y, z, v, t); \quad (23)$$

$$\mathbf{g} = \frac{\mathbf{F}}{m} = \mathbf{g}(x, y, z, v, t). \quad (24)$$

As you can see, both vectors  $\mathbf{E}$  and  $\mathbf{g}$  are specific force characteristics per unit of mass that generates them – electrical ( $q$ ) or mechanical ( $m$ ). It is clear that they act on the corresponding main masses.

It is important that both vectors  $\mathbf{E}$  and  $\mathbf{g}$  comprehensively describe the force effect of electric and gravitational fields on the available masses at a given point in space and a given time. We draw your attention to the fact that in (20), (21), (23), (24) the concept of the magnetic field of the vector  $\mathbf{B}$  does not appear anywhere, as it is physically unreal, although in the mathematical interpretation it is very valuable, since it allows you to simplify the mathematical support of the theory as much as possible electricity, and at the same time gravity. If we approach the problem from the perspective of understanding the physical essence, then the force interaction of the so-called magnetic field in electricity and gravito(electro)magnetic in gravity are represented by components (12), (13)!

It is interesting that the electric and mechanical fields come into contact with a person through the same actions, which are force  $F$ , work  $A$ , power  $P$ . Regardless of whether we come to them from the vector of electric field intensity vector (20) or gravitational one (21).

This coincidence is not as simple as it might seem at first glance. It testifies to the profound unity of the main power characteristics of nature. We can only think: to what extent we have not got known this unity yet! Its presence is currently illustrated by the international system of electromechanical units of measurement LMTI (L –

length, M – mass, T – time, I – current). Against its background, the obvious presence of mechanical units of measurement in electrical ones is clearly visible:

$$[E] = \text{LMT}^{-3}\text{I}^{-1}; \quad [g] = \text{LT}^{-2}; \quad [u] = \text{L}^2\text{MT}^{-3}\text{I}^{-1};$$

$$[F] = \text{LMT}^{-2}; \quad [A] = \text{L}^2\text{MT}^{-2}; \quad [P] = \text{L}^2\text{MT}^{-3},$$

where  $u$  is the voltage, integral characteristic of the electric field.

Recalculation of dimensions of electromechanical analogies of gravitational and electric fields  $\lambda_m, \lambda_q$  can be carried out with the help of a multiplier  $\xi$  [2, 3]

$$\lambda_m = \xi \lambda_q, \quad \xi = \text{MT}^{-1}\text{I}^{-1} (\text{kg/C}). \quad (25)$$

The multiplier  $\xi$  can be used as  $\xi^{-1}$  or even  $\xi^2$  when referring to environment parameters.

Based on the available mathematical results (20), (21), (23), (24), we can begin at least to substantiate, in the first approximation, the answer to the main question posed in the purpose of the article. But in order to get to the essence more meticulously, it is worth looking into the philosophical aspect of the modern perception of consciousness and existence.

It is interesting that the essence of the mathematical exercises proposed above fits into one of the aspects of the modern dualistic perception of the world. Poincaré once wrote (it is unlikely that the greatest mind on the planet could be wrong): *"Does the harmony the human intelligence thinks it discovers in nature exist outside of this intelligence? No, beyond doubt, a reality completely independent of the mind which conceives it, sees or feels it, is an impossibility. Such an external world, if it even existed, would never be accessible to us. But what we call objective reality is ultimately what is common to several thinking beings and could be common to all. This common side can only be harmony expressed by mathematical laws. Therefore, it is precisely this harmony that is the only objective reality, the only truth that we can achieve."*

Modern philosophy [8] is close to that: *"Being encompasses the very foundations of the subjective-objective relationship and at the same time inscribes a person into the structure of the universe, making his consciousness a fundamental condition for the identification of forms of being... On the other hand, existence seems to stand behind us and is a priori given to us as a total quality."*

In addition to (4), (6), (20), (21), we artificially divided the fundamental forces (F) of the interaction of physical masses ( $q$  i  $m$ ) into two factors - the actual mass and intensity ( $\mathbf{E}$  i  $\mathbf{g}$ ) of the field. If we divided these forces into additions, and not into multipliers, then the question of the physical existence of the field would be beyond doubt. And for now, according to laws (8), (9),

physical force arises in a pair of interacting masses. The field is considered to be generated by individual isolated masses. The last statement is by no means legalized, but, as was said above, postulated by M. Faraday. The existence of the field is still the result of an agreement in the sense of perception of being by consciousness according to H. Poincaré. In this regard (in the case of statics), R. Feynman writes [1]: "... the quantity  $\mathbf{E}$  exists at the point  $R$  regardless of whether there is a charge there or not (if only all other charges were in their places... the more complex the forces, the the field is more real, and our separation technique becomes less and less artificial." And what if it is not present at point  $R$ , but arrives with the appearance of an acceptor?

There is one more fact in favor of what R. Feynman said. This is that the field is almost independent of the objects that generate it. A typical example can be relic radiation that has been roaming the universe for billions of years. But this phenomenon has a simple explanation – the force field does not spread instantaneously, but with a finite speed, therefore it is dependent on the history of the process!

Once again, we remind you that expressions (20), (21) are precisely obtained under the condition of a finite speed of propagation of the force interaction, that is why they are the basis of the analysis, which could not be done on the basis of (5), (7).

As a result of thinking about "the only objective reality that we can achieve according to Poincaré, as harmony expressed by mathematical laws", given the physical existence of a force field, conclusions are suggested.

### 3. Conclusions

1. An electric and gravitational field is a specific force field per unit of parent mass, electrical or mechanical, interaction of fluctuations in which propagates in space with the speed of light.

2. The concept of an electric and gravitational field is actually a veiled force interaction of physical masses, electrical or mechanical, in accordance with the fundamental laws of the Universe.

3. The presence of a field at a given space-time point  $R(x, y, z, v, t)$  in the absence of a mass-acceptor is justified by a philosophical agreement, as useful for the mathematical practice of constructing the theory of electricity and gravity. But here a reasonable question may arise, and since the field is not a physical reality, how then do the masses of donors and acceptors find out about each other's existence? – But here there is an equivalent answer such that all the masses of the universe, electrical and gravitational, are in eternal interaction with each other. The value of which is determined by the values of the masses themselves, their relative speed and the distance between them,

taking into account the time delay of signal propagation in the field (see (20), (21)).

4. A comprehensive answer about the nature of the electric and gravitational field can be given when the answer about the corresponding nature of the force is known. Unfortunately, according to R. Feynman [1], we only know "one of its most important characteristics – its material origin, but this property cannot be considered a definition."

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## ПРО ПРИРОДУ ЕЛЕКТРИЧНОГО І ГРАВІТАЦІЙНОГО ПОЛЯ

**Чабан Василь**

На підставі узагальнених на випадок динаміки (руху) фундаментальних законів статички – Нью-тона і Кулона – взаємодії механічних мас і електричних мас (зарядів), зроблено спробу пояснити фізичну суть електричного й гравітаційного полів як питомих силових, що припадають на одиницю маси. У теоретичних вправах враховано скінченну швидкість пропagaції поля. Відслонено дещо завісу на не пізнану досі єдність обох полів через одиниці розмірностей ЛМТІ. Таке заглиблення у світ двох дисциплін – електрики і механіки – корисне для поглибленого розуміння фізичних процесів, а заодно їх кількісного виявлення.



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