Alternative to the Maxwell Equations

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Based on the law of conservation and transformation of energy in nonequilibrium multivariate systems, maxwell-like equations of the processes of mutual transformation of force fields are found that do not require any hypotheses and postulates and cover a wider range of phenomena. The equations do not contain field operators and are extremely simple. Their application allows us to overcome the limited nature of Maxwell's equations by closed currents and also fields of vector nature, and are free from a number of inherent contradictions. The tensor nature of magnetic fields and the ability of the moment of Lorentz forces to do work are proved. The meaning of the vector magnetic potential as a function of the speed of rotation of the charge is revealed and the presence of a divergent component of a scalar nature is revealed. The necessity of taking into account the convective components of the bias currents is shown, and the applicability of maxwell-like equations to gravitational fields is substantiated.

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I. INTRODUCTION

One often hears that Maxwell's equations "contain all electrodynamics" [1]. Meanwhile, a theory based on these equations does not provide a satisfactory answer to elementary questions about what an electric charge is and what causes the appearance of attractive and repulsive forces in it, how the conductivity and bias currents differ, or the vortex electric and vortex-free magnetic fields, what the mechanism of their transformation, what is the physical meaning of the vector magnetic potential and how to avoid the postulation of the Lorentz force, etc., etc. Many phenomena have been discovered, the explanation of which runs into insurmountable e difficulties. Some of them are quite well-known, for example, the demarcation of Maxwell's electromagnetic field theory with electromechanics, the inapplicability of Maxwell's equations for open currents; violation of Newton's 3rd law for cross currents; strange exceptions to the flow rule and features of the Faraday unipolar motor, violation of the energy conservation law by a pulsating electromagnetic field, the existence of a non-vortex component of the magnetic field and radiation of a non-electromagnetic nature, etc. [2].

All this gives rise to a natural desire to find more reliable foundations of electrodynamics. Such a basis, in our opinion, is a unified theory of the processes of transfer and conversion of any form of energy, called energy dynamics for brevity [3]. This theory differs from other fundamental disciplines in that it takes into account the heterogeneity of the systems under study and the presence of the vibrational form of energy, offering the most general form of the law of conservation of energy. In this article, we will try to set out its features in the shortest possible way and, on its basis, eliminate the paralogisms that are found in the analysis of the postulates put by Maxwell at the base of his equations [4].

II. ENERGY DYNAMICS AS A UNIFIED THEORY OF ENERGY CONVERSION PROCESSES

The object of the study of energy dynamics [3] is multivariate systems that have any properties and can be described as a whole by a finite number of state parameters Θ_i such as the mass of k-substances Mk, their charge Q_k, entropy S_k, momentum $\boldsymbol{P}_k$, etc.). Moreover, it proceeds from the concept of short-range action, according to which the energy of the system U does not just disappear at some points in space and appears at others, but is transferred through its boundaries by some energy carrier Θi through thermal conductivity, electrical conductivity, diffusion, radiation, etc. For such systems, the law of energy conservation in the form proposed by the Russian scientist N. Umov (1873) [5] is valid:

$$dU/dt + \oint \boldsymbol{j}_u\, d\boldsymbol{f} = 0, \qquad (1)$$

where U is the internal energy of the system; $\boldsymbol{j}_u$ is the density of its flow through the vector element $d\mathbf{f}$ of the closed surface of the fixed system of constant volume V in the direction of the external normal $\boldsymbol{n}$ (Figure 1).

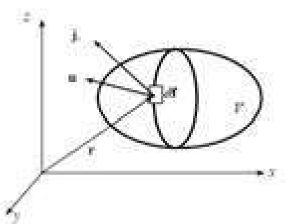

Figure 1: Energy flow across system borders

According to the concept of short-range incorporated into this equation, the energy U does not just disappear at some points in space and appears at others, but is transferred by energy carriers Θ_i through the boundaries of the system. This form of the law of conservation of energy takes into account the kinetics of real processes, without making any assumptions about the mechanism of energy transfer and the internal structure of the system, i.e., considering it to be a continuous medium.

We now take into account that the energy flux $\boldsymbol{j}_u$ is composed of the $\boldsymbol{j}_{uk}$ flows of the "partial" energy of the k-th type U_k, each of which is in turn expressed by the product of the energy flux $\boldsymbol{j}_k$ and its potential ψ_k (specific energy), that is, $\boldsymbol{j}_{uk} = \psi_k \boldsymbol{j}_k = \psi_k \rho_k \boldsymbol{v}_k$, where $\boldsymbol{v}_i$ is the rate of transfer of the k-th energy carrier through the fixed boundaries of the system, $\rho_k = d\Theta_k/dV$ is its density. Then

$$\boldsymbol{j}_u = \Sigma_k \boldsymbol{j}_{uk} = \Sigma_k \psi_k \boldsymbol{j}_k \qquad (2)$$

Using the Gauss-Ostrogradsky theorem, expression (1) can be converted to the form $dU/dt + \int \nabla \cdot \boldsymbol{j}_u dV = 0$, which, after decomposing $\nabla \square (\psi_k \boldsymbol{j}_k)$ into independent components $\Sigma_k \psi_k \nabla \square \boldsymbol{j}_k + \Sigma_k \boldsymbol{j}_k \square \nabla \psi_k$ leads to the law of conservation of energy in the form:

$$dU/dt + \Sigma_k \int \psi_k \nabla \cdot \boldsymbol{j}_k dV + \Sigma_k \int \boldsymbol{j}_k \cdot \nabla \psi_k dV = 0 \qquad (3)$$

If the average value $\bar{\Psi}_k$ of the potential ψ_k and the average value $\boldsymbol{X}_k \equiv \overline{\nabla \Psi_k}$ of the gradient of the potential $\nabla \psi_k$ are taken out of the integral sign, equation (3) can be expressed in terms of the parameters of the system as a whole, as is customary in classical thermodynamics:

$$dU/dt + \Sigma_k \bar{\psi}_k J_k + \Sigma_k \boldsymbol{X}_k \boldsymbol{J}_k = 0, \text{(Вт} \qquad (4)$$

Here $J_k = \oint \boldsymbol{j}_k\, d\mathbf{f} = \int \nabla \cdot \boldsymbol{j}_k dV$ is the scalar flow of the k-th energy carrier through the system boundaries; $\boldsymbol{J}_k = \int \rho_k \boldsymbol{v}_k dV = \Theta_k \bar{\boldsymbol{v}}_k$ is the vector flow of the same energy carrier, having the meaning of its momentum; $\rho_k = d\Theta_k/dV$, $\bar{\boldsymbol{v}}_k$ is the energy carrier density and the average rate of its transfer.

A more detailed picture of the processes occurring in heterogeneous systems can be obtained by expanding the velocity $\boldsymbol{v}_i$ into independent translational $\boldsymbol{u}_i$ and rotational $\boldsymbol{w}_i = \boldsymbol{\omega}_k \times \boldsymbol{r}_k$ components.

$$\boldsymbol{v}_k = \boldsymbol{u}_k + \boldsymbol{\omega}_k \times \hat{\boldsymbol{r}}_k \qquad (5)$$

where $\boldsymbol{\omega}_k$ is the angular velocity of rotation of a unit volume of the system; $\vec{r}_k$ is the instantaneous radius of rotation of a unit volume of the system.

Then, along with the forces $\boldsymbol{F}_k$ in the equation of the law of conservation of energy, their torques $\boldsymbol{M}_k$ = = $\boldsymbol{F}_k\times \vec{r}_k$ appear, and the law of conservation of energy takes a more general form:

$$dU/dt+\Sigma_k \overline{\psi}_k J_k+ \Sigma_k\boldsymbol{F}_k\cdot\boldsymbol{u}_k+\Sigma_k\boldsymbol{M}_k\cdot\boldsymbol{\omega}_k= 0 \qquad (6)$$

In this case, the energy exchange of the system with the environment is carried out in three ways, corresponding to its three sums. The first characterizes the transfer of partial energy $U_k = \int\psi_k\rho_k dV$ through the boundaries of the system *without changing its shape* [3]. The second and third sums (6) are associated with the movement and reorientation of the energy carrier Θ_k, i.e., with the work of W_k as a quantitative measure of the transformation of the energy of the k-th form U_k into some j-th form U_j.

As follows from the expanded form of the law of conservation of energy (6), *the number of arguments of energy U as a function of the state of the system is equal to the number of independent processes taking place in it.* Moreover, for each form of internal (intrinsic) energy U_k there exists and can be found an independent energy carrier Θ_k and its potential ψ_k as its extensive and intensive measures. In the internal equilibrium (homogeneous) state, these energy carriers are uniformly distributed over its volume V. However, in an inhomogeneous state, the radius vector of their center $\boldsymbol{R}_k$ shifts from its initial position, which coincides with the center occupied by the volume system, by a certain amount $\Delta\boldsymbol{r}_k = \boldsymbol{u}_k dt$, and in more in the general case, it rotates by the spatial angle $d\boldsymbol{\varphi}_i = \boldsymbol{\omega}_i dt$. If the state of internal equilibrium is taken as the zero point of the displacement vector $\boldsymbol{R}_k$, then when the system deviates from it, "distribution moments" of energy carriers $\boldsymbol{Z}_k = \Theta_k\boldsymbol{R}_k$ with shoulder $\boldsymbol{R}_k$ occur, the time derivatives of which determine the energy carrier flows $\boldsymbol{J}_k = d\boldsymbol{Z}_k/dt = \Theta_k \bar{\boldsymbol{\upsilon}}_k$. Then the energy of the system as a function of its state takes the form $U = \Sigma_k U_k(\Theta_k, \boldsymbol{r}_k, \boldsymbol{\varphi}_r)$, which allows us to give equation (6) the character of enhanced equality (identity):

$$dU \equiv \Sigma_k\Psi_k d\Theta_k+\Sigma_k\boldsymbol{F}_k\cdot d\boldsymbol{r}_k+\Sigma_k\boldsymbol{M}_k\cdot d\boldsymbol{\varphi}_k \qquad (7)$$

where $\Psi_k \equiv \partial U/\partial\Theta_k$; $\mathbf{F}_k \equiv \partial U/\partial\mathbf{r}_k$; $\mathbf{M}_k \equiv \partial U/\partial\boldsymbol{\varphi}_k$ are generalized potentials, forces and their torques in their general physical understanding [3]. With this approach, it becomes especially obvious that the thermodynamic forces $\mathbf{X}_k$, found under the constancy of all other variables, including Θ_k, represent the specific value of the force $\mathbf{F}_k$ in its general physical sense and have the meaning of the strength of the corresponding force field $\mathbf{X}_k = \mathbf{F}_k/\Theta_k$. This confirms that any force fields represent the stress state of the material system. Moreover, any forces $\mathbf{X}_k$ and flows $\mathbf{J}_k$ in any disciplines that operate on these concepts are given unambiguous meaning of the average gradient of the corresponding potential $\mathbf{X}_i \equiv \bar{\nabla}\psi_k$ and the average momentum $\mathbf{J}_k = \Theta_k \bar{\boldsymbol{\upsilon}}_k$ of the vibrational, translational and rotational and motion of the k-th energy carrier. It follows that the first sum (6) characterizes the equilibrium energy transfer U_k through the boundaries of the system while maintaining its shape, and its 2nd and 3rd sums are the nonequilibrium part of energy exchange associated with its transformation. At the same time, it becomes obvious that, in view of the equality of the displacement vector $d\mathbf{r}_k$ to the displacement of the energy carrier $d\mathbf{r}$ in the Cartesian coordinate system, any force $\mathbf{F}_k = (\partial U_k/\partial\mathbf{r}) = \nabla U_k$, i.e., it represents the gradient of the corresponding energy form Ui, and the force fields are generated by the inhomogeneous energy distribution Θ_k in space.

It is characteristic that with this (systemic and phenomenological) approach, equations (6) do not turn into inequalities, despite the explicit inclusion of the non-static (irreversibility) of the processes under consideration in them. This solves the most important "problem of thermodynamic inequalities", which still hinders the application of thermodynamics to real (occurring at a finite speed) processes. It is also important that identity (7) covers all possible processes in an isolated system involving any substances. All this makes identity (7) the most complete (today) expression of the law of conservation of energy and the definition of the concept of energy and its arguments, excluding their free interpretation.

III. ENERGY DYNAMICS AS AN ALTERNATIVE BASIS FOR ELECTRODYNAMICS

We apply the mathematical apparatus of energy dynamics to "current-carrying" systems with the processes of polarization, magnetization and the conversion of electrical energy into any other form in it. This apparatus eliminates the need to search for the physical meaning of the parameters used by electrodynamics. For such systems, $U_e = U_e(Q, \boldsymbol{r}_e, \boldsymbol{\varphi}_e)$, where Q, $\boldsymbol{r}_e$, $\boldsymbol{\varphi}_e$ is the electric charge, its displacement vector and its spatial angle in the reference frame associated with the center of the volume occupied by the system. The remaining parameters in accordance with equation (7) acquire the meaning of the electric potential $\varphi \equiv \partial U/\partial Q$, the moment of charge distribution $\boldsymbol{Z}_e = Q\boldsymbol{R}_e$, current $\boldsymbol{I} = Q\boldsymbol{v}_e$, electric field strength $\boldsymbol{X}_e = \boldsymbol{E} = \partial U/\partial \boldsymbol{Z}_e$, electric force $\boldsymbol{F}_e = Q\boldsymbol{E}$ and its torque $\boldsymbol{M}_e = \partial U/\partial \boldsymbol{\varphi}_e$. This makes the laws of electrodynamics a special case of general physical principles that are valid for the processes of conversion of any form of energy, making it possible to obtain its basic laws in a more direct and short way.

One of the main issues concerns the work carried out by the current-carrying system. It is generally accepted that "a magnetic field, as opposed to an electric field, does not work on the charges moving in it (since the force acting on the charge is perpendicular to its speed." [6]. Therefore, modern electrodynamics cannot give an intelligible answer to the question, what are the forces they rotate the rotors of numerous electric motors, electromagnetic lifts, etc. The answers to these questions are given by energy dynamics.

According to identity (7), an electric charge is capable of performing three independent types of work $đW_e$ [1], corresponding to three sums (7). Such are the work of introducing a charge into any region of the system with potential φ, described by the expression:

$$đW_e' = \varphi dQ, \tag{8}$$

the work of charge redistribution over the volume of the system associated with its polarization and the appearance of a charge displacement vector $d\boldsymbol{r}_e = \boldsymbol{u}_e dt$

$$đW_e'' = \boldsymbol{X}_e\cdot d\boldsymbol{Z}_e = \boldsymbol{F}_e\cdot d\boldsymbol{r}_e = -\,Qd\varphi \tag{9}$$

and the work of reorienting this vector $d\boldsymbol{Z}_e = Q(d\boldsymbol{\varphi}_e \times \boldsymbol{R}_e)$ in space (rotation through an angle $d\boldsymbol{\varphi}_e$)

$$đW_e''' = \boldsymbol{F}_e\cdot(d\boldsymbol{\varphi}_e \times \boldsymbol{R}_e) = -\,\boldsymbol{M}_e\cdot d\boldsymbol{\varphi}_e \tag{10}$$

For substances with a "congenital" ordered charge movement (for example, permanent magnets), another energy carrier appears, which is the charge momentum $Q\boldsymbol{v}_e$, usually called the "molecular current") and the associated magnetic component $U_м$ of electrokinetic energy U_e. The vector nature of the current **I** as an energy carrier leads to the fact that the potential $\psi_м = (\partial U/\partial \Theta_м)$ acquires a vector character and the meaning of the speed of the ordered charge motion $\boldsymbol{v}_e$:

$$\boldsymbol{\psi}_м \equiv (\partial U/\partial \boldsymbol{I})_q = \boldsymbol{v}_e \tag{11}$$

In this case, the magnetic field strength $\mathbf{X}_м$ takes on the meaning of a vector gradient of the charge velocity:

$$\mathbf{X}_м \equiv \mathrm{Grad}\, \boldsymbol{v}_e \equiv \nabla \boldsymbol{v}_e. \tag{12}$$

This "magnetomotive" force $\mathbf{X}_м$ is a 2nd-rank tensor that can be decomposed into the scalar component $X_м' = \nabla\cdot\boldsymbol{v}_e$ (trace of the tensor) and two components of vector nature: symmetric (vortex-free) $\boldsymbol{X}_м'' = (\nabla \boldsymbol{v}_e)^s$ and antisymmetric (vortex) $\boldsymbol{X}_м''' = (\nabla \boldsymbol{v}_e)^a$. The moment of their

[1] The sign of incomplete differential "đ" emphasizes that elementary work $đW$ depends on the process path.

current distribution $\mathbf{Z}_м$, acquires the same tensor rank, which is defined in this case as the external product of current vectors $\boldsymbol{I} = Q\boldsymbol{v}_e$ and current displacement $\Delta\boldsymbol{R}_м$, i.e. $d\mathbf{Z}_м = Q\boldsymbol{v}_e\times\boldsymbol{R}_м$, as well as the magnetic $\mathbf{J}_м = d\mathbf{Z}_м/dt = \boldsymbol{I}\times\boldsymbol{v}_м$. This circumstance determines the specificity of the magnetic field $\mathbf{X}_м$, arising due to the ordering of molecular currents and their redistribution over the volume during magnetization of ferromagnets, as well as due to the inhomogeneous distribution of current over the cross section of conductors (such as a skin-effect).

However, in electrodynamics, a magnetic field is traditionally introduced as a rotor of the vector potential $\boldsymbol{B} = \nabla\times\boldsymbol{A}$ [1]:

$$\boldsymbol{A} = (\mu_o/4\pi)\int(\boldsymbol{j}_e/R_e)dV, \qquad (13)$$

where μ_o is the magnetic permeability of the medium; R_e - the removal of the field point from the current $\boldsymbol{j}_e$.

The physical meaning of this potential and its relationship with the work done by the magnetic field remains unclear until recently, and attempts to break free of its ambiguity by imposing additional conditions (calibrations) of Coulomb, Poincare, Lorentz, the brothers London, Weil, Fock - Schwinger, Landau and etc. - unsatisfactory [1]. The reason for these difficulties is that its vortex component $\boldsymbol{X}_м''' = (\nabla\boldsymbol{v}_e)^a$, which is proportional to the angular velocity of the charge $\boldsymbol{\omega}_e$, is taken as a magnetic field $\boldsymbol{B}$. Such a" reduction "of the magnetic field (lowering its tensor rank) excludes its divergent part $\nabla\cdot\boldsymbol{A}$ from consideration (Nikolaev's strength) [7] and distorts the physical meaning of the field strength $\boldsymbol{H}$, which in reality is the vortex-free component of the magnetic field and is proportional to the current I and the potential $\boldsymbol{X}_м''= (\nabla\boldsymbol{v}_e)^s$. Landau also pointed to the vortex-free nature of this quantity the fact that it "should have been sought in the form $\boldsymbol{H} = -\nabla\psi$, since rot$\boldsymbol{H}$ is equal to zero." [5]. The fact that the quantity $\boldsymbol{A}$ does not correspond to the concept of potential is at least indicated by the fact that this quantity is proportional to the total current $\boldsymbol{I} = \int\boldsymbol{j}_e dV$ is an extensive parameter of the system, which is not characteristic of any of the potentials ψ_i. As we see, the true vector magnetic potential is the charge velocity $\boldsymbol{v}_e$ or its vector components $\boldsymbol{w}_e$ and $\boldsymbol{u}_e$. [6].

If we take into account the tensor character of the magnetic field $\mathbf{X}_м$, then the work of the magnetic field is expressed by the internal product (convolution) of the tensors $\mathbf{X}_м$ and $\mathbf{Z}_м$. This work can also be decomposed into three components corresponding to three sums (8). According to (8), the first of them, $đW_м'$, occurs when the energy carrier $\boldsymbol{I}$ is introduced into the space region with the potential υe under the conditions of constancy of all other independent variables, including the charge Q. It is determined by the expression.

$$đW_м' = \boldsymbol{v}_e\cdot d\boldsymbol{I} = Qdv_e^2/ \qquad (14)$$

and is expressed in strengthening the disordered (vibrational or rotational) molecular motion of a free or bound charge. It is this work that "charges" the body and raises the petals of the electroscope.

To find other types of magnetic work, $đW_м''$ и and $đW_м'''$, we decompose the displacement velocity of the" current tubes $\boldsymbol{u}_м = d\boldsymbol{R}_м/dt$ similarly to (5), into the translational um and rotational $\boldsymbol{w}_м = \boldsymbol{\omega}_м\times\boldsymbol{R}_м$ component. The first of them, $đW_м''$, characterizes the shift of the current elements $d\boldsymbol{I}$ during its redistribution over the system during the polarization of magnets (creating an inhomogeneous current distribution in them). It is expressed by the scalar product of the force $\mathbf{X}_м'' = \boldsymbol{H}$ by the "translational" component $d\boldsymbol{Z}_м'' = \boldsymbol{I}\times\boldsymbol{u}_м dt$ tensor $d\boldsymbol{Z}_м$ and is determined by the expression:

$$đW_м'' = \mathbf{X}_м''\cdot d\mathbf{Z}_м'' = \boldsymbol{F}_м\cdot d\boldsymbol{r}_м, \qquad (15)$$

where $d\boldsymbol{r}_м = \boldsymbol{u}_м dt$; $\boldsymbol{F}_м = \boldsymbol{I}\times\boldsymbol{H}$ is the magnetic component of the Lorentz force. This work is accomplished, for example, in the process of magnetization of the material (creation of the "north" and "south" poles of the magnet) or when the current is displaced into the surface layer of the conductor ("skin effect").

The last of the magnetic works, $đW_м'''$, occurs when the magnetization is reoriented, for example, when a ferromagnet rotates in a magnetic field $\boldsymbol{H}$. It is expressed by the product of the vortex component $\boldsymbol{X}_м''' = \boldsymbol{B}$. In the force $\boldsymbol{X}_м$ by the same component $d\boldsymbol{Z}_м''' = \boldsymbol{I}\times d\boldsymbol{\varphi}_м$, where $d\boldsymbol{\varphi}_м = \boldsymbol{w}_м dt$. If we follow the generally accepted definition of the magnetic induction vector $\boldsymbol{B} = \mu_o\boldsymbol{H}$, this work is determined by the expression (15) similar to:

$$đW_м''' = \boldsymbol{X}_м'''\cdot d\boldsymbol{Z}_м''' = \mu_o(\boldsymbol{I}\times\boldsymbol{H})d\varphi_м\boldsymbol{u}_м dt = \mu_o\boldsymbol{F}_м\cdot(d\varphi_м\times\boldsymbol{R}_м) = -\boldsymbol{M}_м\cdot d\varphi_м \tag{16}$$

where $\boldsymbol{M}_м = \mu_o\boldsymbol{F}_м\times\boldsymbol{R}_м$ is the torque of the Lorentz force $\boldsymbol{F}_м = \boldsymbol{I}\times\boldsymbol{H}$.

As we see, finding the Lorentz force does not require either postulation or the involvement of GR. This force differs from other forces only in that it is normal with respect to the current, since it is displaced in the transverse direction. When this displacement takes on the character of rotation, the work is performed by the torque of the Lorentz magnetic forces. This refutes the conventional wisdom that magnetic forces do not work, because they are always perpendicular to the current [6].

Thus, energy dynamics eliminates the difficulties of electrodynamics associated with the uncertainty of the concept of a vector potential, with the exception of its divergent component, the determination of the magnetic field based on it, the need to postulate the Lorentz force, the impossibility of its work and the existence of a vortex-free component of the magnetic field. Moreover, it reveals the reasons why Maxwell's equations could not be obtained from its primary principles [7].

IV. AN ALTERNATIVE FORM OF MAXWELL'S EQUATIONS

From the law of conservation of energy (4) under conditions of isolation of the system ($dU/dt = 0$, $J_k = 0$), its 2nd sum directly vanishes:

$$\Sigma_k \boldsymbol{X}_k\cdot\boldsymbol{J}_k = 0 \tag{17}$$

The forces $\boldsymbol{X}_k$ included in this expression characterize the strength of the corresponding field, which leads to an unambiguous interpretation of the force field as the stress state of the medium. According to (16), in the process of converting some i-th form of the ordered energy of the system U_i to the j-th U_j, the relation

$$\boldsymbol{X}_i\cdot\boldsymbol{J}_i = -\boldsymbol{X}_j\cdot\boldsymbol{J}_j. \tag{18}$$

It follows, in particular, that in the process of converting the energy of an irrotational electric field $\boldsymbol{X}_e = \boldsymbol{E}$ into an irrotational magnetic field $\boldsymbol{X}_м = \boldsymbol{H}$, the relation

$$\boldsymbol{J}_m/\boldsymbol{X}_e = -\boldsymbol{J}_e/\boldsymbol{X}_m, \tag{19}$$

In electrodynamics, following Faraday, the magnetic flux $\boldsymbol{J}_m$ is the total time derivative of the "magnetic coupling flux" $\boldsymbol{J}_m = d\boldsymbol{B}/dt$, and $\boldsymbol{J}_e$ is the "total current" as the sum of the Maxwell bias current $\boldsymbol{J}_e^c = (\partial\boldsymbol{D}/\partial t)$ and current conductivity $\boldsymbol{J}_e^{"}$ as a convective component $(\boldsymbol{v}_e\cdot\nabla)$ $\boldsymbol{D}$ of the total derivative of the electric induction vector

$$d\boldsymbol{D}/dt = (\partial\boldsymbol{D}/\partial t)_r + (\boldsymbol{v}_e\cdot\nabla)\boldsymbol{D} \tag{20}$$

If we now denote the ratio $\boldsymbol{J}_e/\boldsymbol{X}_m$ by the coefficient L_{em}, and $\boldsymbol{J}_m/\boldsymbol{X}_e$ - by the coefficient L_{me}, then relation (19) will appear as a pair of equations:

$$L_{em}\boldsymbol{E} = -d\boldsymbol{B}/dt. \tag{21}$$

$$L_{me}\boldsymbol{H} = d\boldsymbol{D}/dt. \tag{22}$$

The first of them reflects the Faraday law of electromagnetic induction, according to which the deflection of the galvanometer needle (a value proportional to the field $\boldsymbol{E}$) is determined by the rate of change of the magnetic flux (expressed by the number of magnetic field lines). From the corresponding Maxwell equation

$$\nabla\times\boldsymbol{E} = -\partial\boldsymbol{B}/\partial t \tag{23}$$

expression (21) differs in that it does not postulate the existence of a "vortex" electric field, which is why $\boldsymbol{E} \neq -\nabla\varphi$, and does not exclude the "convective" component $(\boldsymbol{v}_m \cdot \nabla)$ $\boldsymbol{B}$ of the bias in the expression of the total differential of the magnetic induction vector:

$$d\boldsymbol{B}/dt = (\partial \boldsymbol{B}/\partial t)_r + (\boldsymbol{v}_m \cdot \nabla)\boldsymbol{B}, \qquad (24)$$

which is due to the redistribution of current over the conductor cross section and is responsible, in particular, for the skin effect.

Equally, equation (22) differs from the second Maxwell equation

$$\nabla \times \boldsymbol{H} = \boldsymbol{J}_e^{p} + \partial \boldsymbol{D}/\partial t \qquad (25)$$

by replacing the "rot" operator by the coefficient L_{me} and the fact that it does not exclude the presence in the term $(\boldsymbol{v}_e \cdot \nabla)$ $\boldsymbol{D}$ along with the conduction current $\boldsymbol{J}_e^{p}$ (taking into account the charge motion relative to the conductor), the "convective current" $\boldsymbol{J}_e^{\kappa}$ associated with the movement of the conductor or dielectric in the magnetic field . Taking this component into account makes it possible to explain, for example, the appearance of a magnetic field during rotation of an electrically neutral metal disk (the Rowland – Eichenwald and Rentgen – Eichenwald effects), as well as the polarization of the dielectric plate when it moves in a magnetic field (Wilson – Barnett effect) [1]. The movement of the charge along with the disk or plate also explains why in unipolar Faraday motors the emf arises where the $\partial \boldsymbol{B}/\partial t$ "flux" does not change, and does not occur where this flux changes. This eliminates the need to use different laws of force for the case of a moving contour and a changing field, noted by R. Feynman [9]. Thus, two pairs of equations: (21), (22), and (20), (24), along with their extreme simplicity, non-propulsive nature and complete symmetry, cover a wider range of phenomena than Maxwell's equations. This makes them alternative to these equations.

On the other hand, the "Maxwell-like" equations (20) and (21) reveal the reasons why Maxwell had to resort to a number of postulates. The fact is that the equations of the law of conservation of mechanical and internal energy that existed at that time did not contain any specific parameters of the "electrotonic" state and could not serve as the basis for obtaining relations (19). They were a consequence of energy transformation law (4), in which the forces $\boldsymbol{X}_i$ and flows $\boldsymbol{J}_i$ are of a vector nature. This circumstance corresponds to the universal Curie symmetry principle, according to which only phenomena of the same tensor rank can interact [10]. Therefore, Maxwell's equations (23) and (25), in principle, cannot connect the vortex magnetic field of the 2nd tensor rank $\mathbf{X}_m$ with the electric field of the 1st tensor rank $\boldsymbol{E}$.

Only vortex or vortex-free components of these fields can interact, which required the postulation of the vortex nature of the electric field. This necessitated the introduction of a bias current, which would shorten the conduction currents to create a closed loop with current and made it possible to express this field with a rotor. Hence the assumption of a bias current flowing equal to the conduction current in vacuum, as well as the limited nature of the Maxwell equations by closed currents. Meanwhile, the bias currents do not continue the conduction currents, but are directed towards them, which causes, in particular, the disappearance of their sum at the end of the capacitor charging process [10]. We no longer touch upon the contradictions associated with the interpretation of electromagnetic waves in a vacuum as light [12]. All this makes the replacement of Maxwell's equations with "Maxwell-like" equations (21.22) and (20.24) very, very than appropriate, especially considering their applicability to any natural phenomena.

V. MAXWELL-LIKE GRAVITY EQUATIONS

The idea of the unity of the description of the relationship between electromagnetic and gravitational fields, laid down in the law of conservation of energy (7), was first realized in the equations of gravitoelectromagnetism (GEM) by O. Heaviside (1893) when he reformulated the original Maxwell equations [13]. In them, as an analogue of the charge density ρ_e, current density $\rho_e \boldsymbol{v}_e$, electric strength $\boldsymbol{E}$ and magnetic fields $\boldsymbol{B}$, etc., the same parameters of the gravitational field (with the index "g") were considered, that is ρ_g, $\rho_g \boldsymbol{v}_g$, $\boldsymbol{E}_g$, $\boldsymbol{B}_g$ etc. In this case, the gravitational force, like the Lorentz force, was assumed to consist of two components, one of which, $\rho_g \boldsymbol{E}_g$, was responsible for the acceleration of particles, and the other, $\rho_g \boldsymbol{v}_g \times \boldsymbol{B}_g$, for their rotation. Owing to this, the Heaviside equations for the GEM had the same form as for the EMF.

However, for this, he had to assume the possibility of converting a relatively weak gravitational field into an electromagnetic (and vice versa) and neglect the fundamental difference between the gravitational field from electric and magnetic fields, which are characterized by both attraction and repulsion. Finally, we also had to admit the presence of a vortex component in the gravitational field and the equality of the propagation velocity of gravity cg of the speed of light c. All this in those days had no experimental grounds and only strengthened the postulate nature of Maxwell's equations themselves.

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All this can be avoided by applying relations (19), which follows from the law of conservation of energy and therefore is valid for any of its forms and any components of gravitational and electromagnetic fields of the same tensor rank. In particular, for the vortex (axial) components $\boldsymbol{X}_m''$ and $\boldsymbol{X}_g$ of gravitational and electromagnetic and fields, relation (19) is more conveniently written on the basis of expression (6) through the corresponding torques $\boldsymbol{M}_e$, $\boldsymbol{M}_g$ and angular velocities $\boldsymbol{\omega}_e$ and $\boldsymbol{\omega}_g$:

$$\boldsymbol{M}_e/\boldsymbol{M}_g = - \boldsymbol{\omega}_g/\boldsymbol{\omega}_e. \qquad (26)$$

This expression directly implies the fundamental possibility of tornadoes, tornadoes, cyclones and anticyclones, storms and hurricanes in the atmosphere of our planet when our planet moves in outer space with different vorticity of the "hidden matter" of the Universe. It is possible that these cosmo physical factors are responsible for other geophysical phenomena on Earth [14].

VI. AN ALTERNATIVE TO MAXWELL'S WAVE EQUATIONS

As follows from the energy conservation law (6), the partial energy U_k of any energy carrier Θ_k is a function of time t and the position $\boldsymbol{r}_k$ of its center, i.e., $U_k = U_k(t, \boldsymbol{r}_k)$.In this case, its complete change in time includes two components

$$dU_k/dt = \partial U_k/\partial t + (\boldsymbol{v}_k \cdot \nabla) U_k. \qquad (27)$$

At its core, this expression corresponds to the wave equation in its so-called "single-wave" approximation. Unlike the "dynamic" second- order equation corresponding to Maxwell's equations, it describes a wave propagating in only one direction (from the source). This kind of wave equation is often called "kinematic" [15]. Its belonging in the wave equations becomes especially evident if expression (27) is represented in the form of a wave (with the damping (or excitation) function $\Phi(\boldsymbol{r}, t) = dU_k/dt$:

$$\partial U_k/\partial t + \boldsymbol{v}_k \cdot (\partial U_k/\partial \boldsymbol{r}) = \Phi(\boldsymbol{r}, t), \qquad (28)$$

where $\boldsymbol{v}_k$ is the phase velocity of the wave.

This equation is based on the law of conservation of energy and, therefore, is valid for describing the vibrational motion of any energy carrier Θ_k. For nonlinear media with dispersion at low frequencies, it is known as the Klein – Gordon equation, and with dispersion at high frequencies it is known as the Korteweg – de Vries equation [15]. It is applicable to describe the radiation of energy into the environment of the system. According to (7), $(\partial U_k/\partial \boldsymbol{r}) = \boldsymbol{F}_k = \Theta_k \mathbf{X}_k$, so that the second term in (27) characterizes the vibration power of the kth energy carrier Θ_k in the system.

Under stationary conditions ($\partial U_k/\partial t$ = 0), this oscillatory process is supported by the excitation source $\Phi(\boldsymbol{r}, t)$ and is accompanied by radiation with a certain frequency spectrum ν. The power of this radiation dU_k/dt is expressed similarly to other types of work $đW_e/dt = \mathbf{X}_k \cdot \boldsymbol{J}_k$, где $\boldsymbol{J}_k = \Theta_k \boldsymbol{v}_k$, where $\boldsymbol{J}_k = \Theta_k \boldsymbol{v}_k$.

Only the medium, the interaction of which with the substance does not depend on its structure and any other properties besides mass (amount of substance), can transfer this energy in space of countless k-elements and their compounds. This is the only - gravitational - energy whose carrier (called "ether", "hidden mass", "primary", "unstructured", "dark", "non-baryonic" matter, "dark energy", etc.) is current data at least 95% of the mass of the entire universe. Now that a lot of non-electromagnetic radiation and longitudinal waves have been detected, but no magnetic component of the electromagnetic field (EMF) has been found, which is equal in electric power, there is no reason to consider this field to be a carrier of radiant energy [12]. This is all the more true that the notion of EMF as a material medium, detached from its source and transferring energy "after it has left one body and has not yet reached another" [4], violates the law of conservation of energy due to the in-phase variation of the vectors E and H in the expression of EMF energy $U = \varepsilon_o \boldsymbol{E}^2/2 + \mu_o \boldsymbol{H}^2/2$ [2].

Thus, there is an alternative to the Maxwell wave equations, which at one time played an outstanding role in the development of radio engineering and electronics, but are currently becoming a brake on the development of the latest energy and information transfer technologies.

REFERENCES

1. Whittaker E. History of the theory of ether and electricity. - Moscow - Izhevsk, 2001.
2. Kann K.B. Electrodynamics of common sense,-Lamb.Acad.Publ., 2014 (in Russian).
3. Etkin V. Energy dynamics (Thermodynamic Fundamentals of Synergetics) .- N.Y., 2011; .Etkin V.A. Energy dynamics (synthesis of theories of energy transfer and transformation) St. Petersburg, Nauka, 2008. (in Russian).
4. Maxwell J. Treatise on Electricity and Magnetism.- London, 1873.
5. Umov N.A. Selected Works. M.L., 1950. (in Russian).
6. Landau LD, Livshits EM. Theoretical Physics. T.8. Electrodynamics of continuous media.- M., Nauka, 1982.
7. Nikolaev G.V. Consistent electrodynamics. Theories, experiments, paradoxes. TPU, 1997. (in Russian).
8. Etkin V.A. Thermodynamic Derivation of Maxwell's Electrodynamic Equations. // Global Journal of Physics, 3 (1) .2015). 1-8.
9. Feynman R., Leighton R., Sands M. The Feynman lectures on physics. V.2, London, 1964.
10. Curie P. On symmetry in physical phenomena: symmetry of electric and magnetic fields // Pierre Curie. Selected Works, M., 1966. p. 95-113 (in Russian).
11. Etkin V.A. Paralogisms in Maxwell's theory. // Research in the field of applied sciences. (Sat. proceedings of scientific conf.). Arad (Israel), 2015.
12. Etkin V.A. To the non-electromagnetic theory of light. // World Scientific News, 80 (2017).
13. Heaviside O. A gravitational and electro-magnetic analogy. The Electrician, 1893.
14. Schnol S. E. Cosmophysical factors in random processes. - Stockholm, Svenska fysikarkivat, 2009.
15. Crawford F. Berkeley Physics course. V. 3. Waves.- McGraw-Hill, 1968.

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