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Strictly as per the compliance and regulations of:

Scalar-Vector Potential and Lagrange Function of the Moving and Fixed Charge

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I. Introduction

In the mechanic by Lagrange's function the particles understand the difference between its kinetic and potential energy

$$L = \frac{mv^2}{2} - U \ .$$

Least-action principle and Lagrange formalism can be disseminated also to the moving charge. Let us give in regard to this endurance from the well known course on theoretical physics [1]:

"Equation of motion takes the form

$$\frac{d}{dt}\frac{mv}{\sqrt{1-\frac{v^2}{c^2}}} = e\ grad\left\{\frac{(\mathbf{Av})}{c} - \varphi\right\} - \frac{e}{c}\frac{d\mathbf{A}}{dt} \qquad (23.9)$$

(in this relationship m, e, $\mathbf{v}$ - mass, charge and velocity of particle, c - the speed of light, φ, $\mathbf{A}$ - scalar and vector potential).

This equation of motion can be considered as Lagrange's equation, if Lagrange's function takes the form

$$L = -mc^2\sqrt{1-\frac{v^2}{c^2}} - e\varphi + \frac{e}{c}(\mathbf{Av}) \qquad (23.10)$$

Actually, in this case the generalized momentum

$$\mathbf{P} = \frac{\partial L}{\partial v} = \frac{mv}{\sqrt{1-\frac{v^2}{c^2}}} + \frac{e}{c}\mathbf{A} = \mathbf{p} + \frac{e}{c}\mathbf{A} \qquad (23.11)$$

Respectively generalized force

$$\mathbf{Q} = \frac{\partial L}{\partial r} = \frac{e}{c} grad(\mathbf{Av}) - e\ grad\varphi$$

Lagrange's equation says:

$$\frac{d}{dt}\frac{\partial L}{\partial v} = \frac{\partial L}{\partial r}$$

or

$$\frac{d}{dt}\mathbf{P} = \mathbf{Q} \qquad (23.12)$$

Substitution $\mathbf{P}$ and $\mathbf{Q}$ in (23.12) again brings us k (23.9).

In the nonrelativistic approximation Lagrange's function takes the form

$$L \approx -mc^2\left(1-\frac{v^2}{2c^2}\right) + \frac{e}{c}(\mathbf{Av}) - e\varphi = \frac{mv^2}{2} - e\varphi + \frac{e}{c}(\mathbf{Av}) \qquad (23.13)$$

In this case we lowered constant $(-mc^2)$, since into Lagrange's equation they enter only derivatives L, and most L it is determined only to the complete time derivative.

Comparing Lagrange's function particle in the electromagnetic field with the expression for Lagrange's function in the usual field of the forces

$$L = \frac{mv^2}{2} - U \ .$$

We see that during the motion in the field Lagrange's function contains still member, depending on speed and vector potential. "Therefore even in the relativistic approximation Lagrange's function in the electromagnetic field cannot be represented in the form differences in the kinetic and potential energy". (end of the quotation).

Last phrase causes bewilderment, it follows from it that the description of the properties of the charge, which moves in the electromagnetic field, cannot be described within the framework Lagrange

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formalism, and, therefore, to it cannot be applied least-action principle.

It will be shown below that this assertion is erroneous.

II. Law Of Magnetoelectric Induction In The Classical Electrodynamics

The basic task of the laws of induction consists in the explanation of the reasons for appearance in the space of induction electrical pour on, and, therefore, also the forces of those acting on the charge, at the particular point spaces. This is the primary task of the laws of induction, since. only electric fields, generated other one or method or another, exert power influences on the charge. Such fields can appear with a change in the arrangement of other charges around the given point of space. If around the point in question is some static configuration of charges, then the tension of electric field will be at the particular point determined by the relationship $\mathbf{E}=-grad\ \varphi$, where φ the scalar potential at the assigned point, determined by the assigned configuration of charges. If we change the arrangement of charges, then this new configuration will correspond other values of scalar potential, and, therefore, also other values of the tension of electric field. But, making this, it is necessary to move charges in the space, and this displacement in the required order is cmbined with their acceleration and subsequent retarding. Acceleration or retarding of charges also can lead to the appearance in the surrounding space of induction electrical pour on.

Faraday law, who for the vacuum is written as follows, is considered as the fundamental law of induction in the classical electrodynamics:

$$\oint \mathbf{E}\ d\mathbf{l}=-\frac{\partial \Phi_B}{\partial t}=-\mu\int \frac{\partial \mathbf{H}}{\partial t}\ d\mathbf{s}=-\int \frac{\partial \mathbf{B}}{\partial t}\ d\mathbf{s} \qquad (1.1)$$

where $\mathbf{B}=\mu\mathbf{H}$ - magnetic induction vector, $\Phi_B=\mu\int \mathbf{H}\ d\mathbf{s}$ - flow of magnetic induction, and μ - magnetic permeability of medium.

It follows from this law that the circulation integral of the vector of electric field is equal to a change in the flow of magnetic induction through the area, which this outline covers. It is immediately necessary to emphasize the circumstance that the law in question presents the processes of mutual induction, since. for obtaining the circulation integral of the vector $\mathbf{E}$ we take the strange magnetic field, formed by strange source. This law is integral and does not give the local connection between the magnetic and electric field. From relationship (1.1) obtain the first equation of Maxwell

$$rot\ \mathbf{E}=-\frac{\partial \mathbf{B}}{\partial t}. \qquad (1.2)$$

Let us immediately point out to the terminological error. Faraday law should be called not the law of electromagnetic, as is customary in the existing literature, but by the law of magnetoelectric induction, since. a change in the magnetic pour on it leads to the appearance of electrical pour on, but not vice versa.

Let us introduce the vector potential $\mathbf{A}_H$, which satisfies the equality $\mu\oint \mathbf{A}_H\ d\mathbf{l}\Phi=_B$, where the outline of the integration coincides with the outline of integration in relationship (1.1), and the vector $\mathbf{A}_H$ is determined in all its sections, then

$$\mathbf{E}=-\mu\frac{\partial \mathbf{A}_H}{\partial t}. \qquad (1.3)$$

Introduced thus vector $\mathbf{A}_H$ determines the local connection between it and by electric field, and also between the gradients this vector and the magnetic field. Consequently, knowing the derivatives of a vector $\mathbf{A}_H$ on the time and on the coordinates, it is possible to determine the induced electrical and magnetic fields. It is not difficult to show that introduced thus vector $\mathbf{A}_H$, is connected with the magnetic field with the following relationship:

$$rot\ \mathbf{A}_H=\mathbf{H}. \qquad (1.4)$$

Thus the vector $\mathbf{A}_H$ is more universal concept than the vector of magnetic field, since gives the possibility to define both magnetic and electric fields.

If there is a straight conductor with the current, then around it also there is a field of vector potential, the truth in this case $rot\ \mathbf{A}_H\neq 0$ in the environments of this conductor is, therefore, located also the magnetic field, which changes with a change of the current in the conductor. The section of wire by the length dl, over which flows the current I, generates in the distant zone (it is thought that the distance r considerably more than the length of section) the vector potential

$$d\mathbf{A}_H(r)=\frac{Id\mathbf{l}}{4\pi r}.$$

This relationship can be rewritten and differently:

$$d\mathbf{A}_H(r)=\frac{q\mathbf{v}}{4\pi r},$$

where q - the charge, which falls per unit of the length of the conductor, over which flows the current.

Let us note the circumstance that the vector potential in this case diminishes as $\frac{1}{r}$, and according to the same law, in accordance with relationship (1.3), diminish the induced electric fields. However, magnetic

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fields, since $\mathbf{H}=rot\ \mathbf{A}_H$, they diminish, as $\frac{1}{r^2}$, at large distances them can be disregarded. Thus, at large distances the law of induction continues to work; however, the induced electric fields already completely depend only on vector potential and, which is very important, they diminish no longer as $\frac{1}{r^2}$, as in the case of scalar potential, but as $\frac{1}{r}$, which is characteristic for the radiating systems.

Until now, resolution of a question about the appearance of electrical pour on in different inertial moving systems (IMS) it was possible to achieve in two ways. The first - consisted in the calculation of the Lorentz force, which acts on the moving charges, the alternate path consisted in the measurement of a change in the magnetic flux through the outline being investigated. Both methods gave identical result. This was incomprehensible. In connection with the incomprehension of physical nature of this state of affairs they began to consider that the unipolar generator is an exception to the rule of flow [2]. Let us examine this situation in more detail.

In order to answer the presented question, should be somewhat changed relationship (1.3), after replacing in it partial derivative by the complete:

$$\mathbf{E}'=-\mu\frac{d\mathbf{A}_H}{dt}. \qquad (1.5)$$

Prime near the vector $\mathbf{E}$ means that this field is determined in the moving coordinate system, while the vector $\mathbf{A}_H$ it is determined in the fixed system. This means that the vector potential can have not only local, but also convection derivative, i.e., it can change both due to the change in the time and due to the motion in the three-dimensional changing field of this potential. In this case relationship (1.5) can be rewritten as follows:

$$\mathbf{E}'=-\mu\frac{\partial\mathbf{A}_H}{\partial t}-\mu(\mathbf{v}\nabla)\mathbf{A}_H,$$

where $\mathbf{v}$ - speed of the prime system.

Consequently, the extra force, which acts on the charge in the moving system, will be written down

$$\mathbf{F}'_{v,1}=-\mu e(\mathbf{v}\nabla)\mathbf{A}_H.$$

This force depends only on the gradients of vector potential and charge rate.

the charge, which moves in the field of the vector potential $\mathbf{A}_H$ with the speed $\mathbf{v}$, possesses potential energy [2]

$$W=-e\mu(\mathbf{v}\mathbf{A}_H).$$

Therefore must exist one additional force, which acts on the charge in the moving coordinate system, namely:

$$\mathbf{F}'_{V,2}=-grad\ W=e\mu\ grad(\mathbf{v}\mathbf{A}_H).$$

Thus, the value $\mu(\mathbf{v}\mathbf{A}_H)$ plays the same role, as the scalar potential φ, whose gradient also gives force. Consequently, the composite force, which acts on the charge, which moves in the field of vector potential, can have three components and will be written down as

$$\mathbf{F}'=-e\mu\frac{\partial\mathbf{A}_H}{\partial t}-e\mu(\mathbf{v}\nabla)\mathbf{A}_H+e\mu\ grad(\mathbf{v}\mathbf{A}_H). \qquad (1.6)$$

The first of the components of this force acts on the fixed charge, when vector potential changes in the time and has local time derivative. Second component also determines changes of the vector potential with time, but they are connected already with the motion of charge in the three-dimensional changing field of this potential. Entirely different nature in force, which is determined by last term of relationship (1.6). It is connected with the fact that the charge, which moves in the field of vector potential, it possesses potential energy, whose gradient gives force. From relationship (1.6) follows

$$\mathbf{E}'=-\mu\frac{\partial\mathbf{A}_H}{\partial t}-\mu(\mathbf{v}\nabla)\mathbf{A}_H+\mu\ grad(\mathbf{v}\mathbf{A}_H). \qquad (1.7)$$

This is a complete law of mutual induction. It defines all electric fields, which can appear at the assigned point of space, this point can be both the fixed and that moving. This united law includes and Faraday law and that part of the Lorentz force, which is connected with the motion of charge in the magnetic field, and without any exceptions gives answer to all questions, which are concerned mutual magnetoelectric induction. This law without any exceptions gives answer to all questions, which are concerned mutual magnetoelectric induction. It is significant, that, if we take rotor from both parts of equality (1.7), attempting to obtain the first equation of Maxwell, then it will be immediately lost the essential part of the information, since. rotor from the gradient is identically equal to zero.

If we IMS late those forces, which are connected with the motion of charge in the three-dimensional changing field of vector potential, and to consider that

$$\mu\ grad(\mathbf{v}\mathbf{A}_H)-\mu(\mathbf{v}\nabla)\mathbf{A}_H=\mu[\mathbf{v}\times rot\mathbf{A}_H],$$

that from (1.6) we will obtain

$$\mathbf{F}'_V=e\mu[\mathbf{v}\times rot\mathbf{A}_H]. \qquad (1.8)$$

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Taking into account (1.4), let us write down:

$$\mathbf{F}'_V = e\mu[\mathbf{v}\times\mathbf{H}] \qquad (1.9)$$

or

$$\mathbf{E}'_V = \mu[\mathbf{v}\times\mathbf{H}]. \qquad (1.10)$$

and it is final

$$\mathbf{F}' = e\mathbf{E} + e\mathbf{E}'_V = -e\frac{\partial \mathbf{A}_H}{\partial t} + e\mu[\mathbf{v}\times\mathbf{H}]. \qquad (1.11)$$

Can seem that relationship (1.11) presents Lorentz force; however, this not thus. In this relationship the field $\mathbf{E}$, and the field $\mathbf{E}'_V$ are induction: the first is connected with a change of the vector potential with time, the second is obliged to the motion of charge in the three-dimensional changing field of this potential. In order to obtain the total force, which acts on the charge, necessarily for the case, when system is not electrically neutral, to the right side of relationship (1.11) to add the term $-e\ grad\ \varphi$:

$$\mathbf{F}'_\Sigma = -e\ grad\ \varphi + e\mathbf{E} + e\mu[\mathbf{v}\times\mathbf{H}],$$

where φ - scalar potential, created at the observation point by the uncompensated charges.

In this case relationship (1.7) can be rewritten as follows:

$$\vec{E}' = -\mu\frac{\partial \mathbf{A}_H}{\partial t} - \mu(\mathbf{v}\nabla)\mathbf{A}_H + \mu\ grad(\mathbf{v}\mathbf{A}_H) - grad\ \varphi \qquad (1.12)$$

or, after writing down the first two members of the right side of relationship (1.12) as the derivative of vector potential on the time, and also, after introducing under the sign of gradient two last terms, we will obtain

$$\mathbf{E}' = -\mu\frac{d\mathbf{A}_H}{dt} + grad(\mu(\mathbf{v}\mathbf{A}) - \varphi). \qquad (1.13)$$

If both parts of relationship (1.13) are multiplied by the magnitude of the charge, then will come out the total force, which acts on the charge. From Lorentz force it will differ in terms of the force $-e\mu\frac{\partial \mathbf{A}_H}{\partial t}$. From relationship (1.13) it is evident that the value $(\mu\mathbf{v}\mathbf{A}) - \varphi$ plays the role of the generalized scalar potential. If we take rotor from both parts of relationship (1.13) and take into account that $rot\ grad = 0$, then we will obtain:

$$rot\ \mathbf{E}' = -\mu\frac{d\mathbf{H}}{dt}.$$

If we in this relationship replace total derivative by the quotient, i.e., to consider that the fields are determined only in the assigned inertial system, then we will obtain the first equation of Maxwell. previously Lorentz force was considered as the fundamental experimental postulate, not connected with the law of induction. By calculation to obtain last term of the right side of relationship (1.11) was only in the framework of the special theory of relativity (SR), after introducing two postulates of this theory. In this case all terms of relationship (1.11) are obtained from the law of induction, using the conversions of Galileo. Moreover relationship (1.11) this is a complete law of mutual induction, if it are written down in the terms of vector potential. This is the very thing rule, which gives possibility, knowing fields in one IMS, to calculate fields in another inertial system, and there was no this rule, until now, in the classical electrodynamics.

The structure of the forces, which act on the moving charge, is easy to understand based on the example of the case, when the charge moves between two parallel planes, along which flows the current (Fig. 1).

Let us select for the coordinate axis in such a way that the axis z would be directed normal to planes, and the axis y was parallel axis. Then for the case, when the distance between the plates considerably less than their sizes (in this case on the picture this relationship not observed), the magnetic field H_x between them will be equal to the specific current I_y, which flows along the plates.

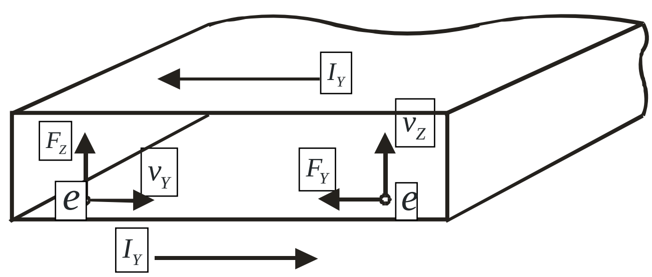

Fig. 1: Forces, which act on the charge, which moves in the field of vector potential.

If we putt hat the vector potential on the lower plate is equal to zero, then its y - the component, calculated off the lower plate, will grow according to the law $A_y = I_y z$.

If charge moves in the direction of the axis y near the lower plate with the speed v_y, then the force F_z, which acts on the charge, is determined by last term of relationship (1.6) and it is equal

$$F_z = e\mu v_y I_y. \qquad (1.14)$$

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Is directed this force from the lower plate toward the upper.

If charge moves along the axis of z from the lower plate to the upper with the speed $v_z = v_y$, then for finding the force should be used already second term of the right side of relationship (1.6). This force in the absolute value is again equal to the force, determined by relationship (1.14), and is directed to the side opposite to axis. With any other directions of motion the composite force will be the vector sum of two forces, been last terms of relationship (1.6). However, the summary amount of this force will be determined by relationship (1.11), and this force will be always normal to the direction of the motion of charge. Earlier was considered the presence of this force as the action of the Lorentz force, whose nature was obscure, and it was introduced as experimental postulate. It is now understandable that it is the consequence of the combined action of two forces, different in their nature, whose physical sense is now clear. However, in this case one basic problem appears. As we already spoke, from the point of view of third Newton's law, if force acts on the charge, then it must be and resultant it force and place the application of this force must be known. The concept of the magnetic field of answer to this question does not give, since the magnetic field, and vector potential come out as the independent substance, with which occurs such an interaction.

Understanding the structure of forces gives to us the possibility to look to the already known phenomena from other side. With which is connected existence of the forces, which do extend loop with the current? In this case this circumstance can be interpreted not as the action of Lorentz force, but from an energy point of view. The current, which flows through the element of annular turn is located in the field of the vector potential, created by the remaining elements of this turn, and, therefore, it has it stored up potential energy. The force, which acts on this element, is caused by the presence of the potential gradient energy of this element and is proportional to the gradient to the scalar product of the current strength to the vector potential at the particular point. Thus, it is possible to explain the origin of ponderomotive (mechanical) forces. If current broken into the separate current threads, then they all will separately create the field of vector potential. Summary field will act on each thread individually, and, in accordance with last term of the right side of relationship (1.6), this will lead to the mutual attraction.

One should emphasize that in relationship (1.8) and (1.9) all fields have induction origin, and they are connected first with hp of the local derivative of vector potential, then hp by the motion of charge in the three-dimensional changing field of this potential. If fields in the time do not change, then in the right side of relationships (1.8) and (1.9) remain only last terms, and they explain the work of all existing electric generators with moving mechanical parts, including the work of unipolar generator. Relationship (1.7) gives the possibility to physically explain all composing tensions electric fields, which appears in the fixed and that moving the coordinate systems. In the case of unipolar generator in the formation of the force, which acts on the charge, two last addend right sides of equality (1.7) participate, introducing identical contributions. It is now clear that the idea of the law of induction in the terms of vector potential this is that „the basic principle", the absence of which is mentioned in the work [2].

The examination of the action of magnetic field to the moving charge has already been noted its intermediary role and absence of the law of the direct action between the moving charges. Introductions of vector potential also does not give answer to this question, this potential as before plays intermediary role and does not answer a question about the concrete place of application of force.

Now let us show that the relationships, obtained by the phenomenological introduction of magnetic vector potential, can be obtained and directly from the Faraday law. with conducting of experiments Faraday established that in the outline is induced the current, when in the adjacent outline direct current is switched on or is turned off or adjacent outline with the direct current moves relative to the first outline. Therefore in general form Faraday law is written as follows:

$$\oint \mathbf{E}' d\mathbf{l}' = -\frac{d\Phi_B}{dt}. \qquad (1.15)$$

This writing of law indicates that during the record of the circulation integral of the vector $\mathbf{E}$ in moving (prime) IMS near $\mathbf{E}$ and $d\mathbf{l}$ should be placed the primes, which indicate that that the flow is determined in one IMS, and field in another. But if circulation is determined in the fixed coordinate system, then primes near and be absent, but in this case to the right in expression (1.15) must stand particular time derivative.

Complete time derivative in relationship (1.15) indicates the independence of the eventual result of appearance electromotive force in the outline from the method of changing the flow. Flow can change both due to the local derivative of magnetic flux on the time and because IMS, in which is measured the circulation $\oint \mathbf{E}' d\mathbf{l}'$, it moves in the three-dimensional changing field $\mathbf{B}$. We calculate the value of magnetic flux in relationship (1.15) with the aid of the expression:

$$\Phi_B = \int \mathbf{B} d\mathbf{s}', \qquad (1.16)$$

where the magnetic induction $\mathbf{B} = \mu \mathbf{H}$ is determined in the fixed coordinate system, and the element $d\mathbf{s}'$ is determined in the moving system.

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Taking into account (1.15), we obtain from (1.16)

$$\oint \mathbf{E}'d\mathbf{l}' = -\frac{d}{dt}\int \mathbf{B}d\mathbf{s}' .$$

since $\frac{d}{dt}=\frac{\partial}{\partial t}+\mathbf{v}\ \ grad$, let us write down:

$$\oint \mathbf{E}'d\mathbf{l}' = -\int \frac{\partial \mathbf{B}}{\partial t}\ d\mathbf{s}' - \oint[\mathbf{B}\times\mathbf{v}]d\mathbf{l}' - \int \mathbf{v}\ \ div\mathbf{B}\ \ d\mathbf{s}' . \quad (1.17)$$

In this case contour integral is taken on the outline $d\mathbf{l}'$, which covers the area $d\mathbf{s}'$. Let us immediately note that entire following presentation will be conducted under the assumption the validity of the conversions of Galileo, i.e., $d\mathbf{l}'=d\mathbf{l}$ and $d\mathbf{s}'=d\mathbf{s}$. Since $div\mathbf{B}=0$, from (1.17) we obtain the relationship

$$\mathbf{E}'=\mathbf{E}+[\mathbf{v}\times\mathbf{B}]. \quad (1.18)$$

From which follows that during the motion in the magnetic field the additional electric field, determined by last term of relationship appears (1.18). Let us note that this relationship is obtained not by the introduction of postulate about the Lorentz force, or from the conversions of Lorenz, but directly from the Faraday law, moreover within the framework the conversions of Galileo. Thus, Lorentz force is the direct consequence of the law of magnetoelectric induction.

From the Ampere law it is possible to obtain the relationship:

$$\mathbf{H}=rot\mathbf{A}_H .$$

Then pour on relationship (1.17) for those induced it is possible to rewrite

$$\mathbf{E}'=-\mu\frac{\partial \mathbf{A}_H}{\partial t}+\mu[\mathbf{v}\times rot\mathbf{A}],$$

and further

$$\mathbf{E}'=-\mu\frac{\partial \mathbf{A}_H}{\partial t}-\mu(\mathbf{v}\nabla)\mathbf{A}_H+\mu\ \ grad(\mathbf{v}\mathbf{A}_H). \quad (1.19)$$

Again came out relationship (1.7), but it is obtained directly from the Faraday law. The examination of the laws of induction from the point of view of magnetic vector potential and its complete record is for the first time demonstrated in the works [3-7]. True, and this way thus far not shedding light on physical nature of the origin of Lorentz force, since the true physical causes for appearance and magnetic field and vector potential to us nevertheless are not thus far clear.

III. Law Of Electromagnetic Induction In The Classical Electrodynamics

Faraday law shows, how a change in the magnetic pour on it leads to the appearance of electrical pour on. However, does arise the question about that, it does bring a change in the electrical pour on to the appearance of any others pour on and, in particular, magnetic? Maxwell gave answer to this question, after introducing bias current into its second equation. In the case of the absence of conduction currents the second equation of Maxwell appears as follows:

$$rot\mathbf{H}=\varepsilon\frac{\partial \mathbf{E}}{\partial t}=\frac{\partial \mathbf{D}}{\partial t},$$

where $\mathbf{D}=\varepsilon\mathbf{E}$ - electrical induction.

From this relationship it is not difficult to switch over to the expression

$$\oint \mathbf{H}d\mathbf{l}=\frac{\partial \Phi_E}{\partial t}, \quad (2.1)$$

where $\Phi_E=\int \mathbf{D}d\mathbf{s}$ the flow of electrical induction.

However for the complete description of the processes of the mutual electrical induction of relationship (1.1) is insufficient. As in the case Faraday law, should be considered the circumstance that the flow of electrical induction can change not only due to the local derivative of electric field on the time, but also because the outline, along which is produced the integration, it can move in the three-dimensional changing electric field. This means that in relationship (1.1), as in the case Faraday law, should be replaced the partial derivative by the complete. Designating by the primes of field and circuit elements in moving IMS, we will obtain:

$$\oint \mathbf{H}'d\mathbf{l}'=\frac{d\Phi_E}{dt},$$

and further

$$\oint \mathbf{H}'d\mathbf{l}'=\int\frac{\partial \mathbf{D}}{\partial t}\ d\mathbf{s}'+\oint[\mathbf{D}\times\mathbf{v}]\ d\mathbf{l}'+\int \mathbf{v}\ \ div\mathbf{D}\ \ d\mathbf{s}' \quad (2.2)$$

For the electrically neutral medium $div\mathbf{E}=0$; therefore the last member of right side in this expression will be absent. For this case relationship (2.2) will take the form:

$$\oint \mathbf{H}'d\mathbf{l}'=\int\frac{\partial \mathbf{D}}{\partial t}\ d\mathbf{s}' + \oint[\mathbf{D}\times\mathbf{v}]d\mathbf{l}' \quad (2.3)$$

If we in this relationship pass from the contour integration to the integration for the surface, then we will obtain:

$$rot\ \ \mathbf{H}'=\frac{\partial \mathbf{D}}{\partial t}+rot[\mathbf{D}\times\mathbf{v}] \quad (2.4)$$

If we, based on this relationship, write down fields in this inertial system, then prime near $\mathbf{H}$ and second member of right side will disappear, and we will obtain the bias current, introduced by Maxwell. But Maxwell introduced this parameter, without resorting to to the law of electromagnetic induction (2.2). If his law of magnetoelectric induction Faraday derived on the basis experiments with the magnetic fields, then experiments on the establishment of the validity of relationship (2.2) cannot be at that time conducted was, since. for conducting this experiment sensitivity of existing at that time meters did not be sufficient.

Pour on from (2.3) we obtain for the case of constant electrical:

$$\mathbf{H}'_V=-\varepsilon\left[\mathbf{v}\times\mathbf{E}\right]. \qquad (2.5)$$

For the vortex electrical pour on it is possible to express the electric field through the rotor of electrical vector potential, after assuming

$$\mathbf{E}=rot\mathbf{A}_E. \qquad (2.6)$$

But the introduction of this relationship is, in fact, the acknowledgement of existence of magnetic currents. Controversy about the presence of such currents and about the possibility of existence of magnetic monopoles in the scientific literature has long ago been conducted. There is no unity of opinion on this question as yet. But the presence of magnetic currents is very easy to understand based on this example. Let us assume that at our disposal there is a long rod, made from magnetic material. If we to one end of the rod place solenoid and to introduce into it current, then the end of the rod will be magnetized. But the magnetization, which arose at the end of the rod, immediately not to appear at its other end. The wave of magnetization will be extended along the rod some by the speed, which depends on the kinetic properties of the very process of magnetization. Thus, magnetic bar itself, in this case, similar to the conductor of electric current, it is the conductor of the magnetic flux, which, as conduction current, can be extended with the final speed.

Relationship (2.4) taking into account (2.6) will be written down:

$$\mathbf{H}'=\varepsilon\frac{\partial\mathbf{A}_E}{\partial t}-\varepsilon\left[\mathbf{v}\times rot\mathbf{A}_E\right].$$

Further it is possible to repeat all those procedures, which has already been conducted with the magnetic vector potential, and to write down the following relationships:

$$\mathbf{H}'=\varepsilon\frac{\partial\mathbf{A}_E}{\partial t}+\varepsilon\left(\mathbf{v}\nabla\right)\mathbf{A}_E-\varepsilon\ grad\left(\mathbf{v}\mathbf{A}_E\right),$$

$$\mathbf{H}'=\varepsilon\frac{\partial\mathbf{A}_E}{\partial t}-\varepsilon\left[\mathbf{v}\times rot\mathbf{A}_E\right],$$

$$\mathbf{H}'=\varepsilon\frac{d\mathbf{A}_E}{dt}-\varepsilon\ grad\left(\mathbf{v}\mathbf{A}_E\right).$$

Is certain, the study of this problem it would be possible, as in the case the law of magnetoelectric induction, to begin from the introduction of the vector $\mathbf{A}_E$, but this way is specially passed traditionally, beginning from the integral law in order to show the identity of processes for two different laws, and the logical sequence of the introduction of the electrical vector of potentials.

IV. Dynamic Potentials And The Field Of The Moving Charges

The path that has been demonstrated in the previous two sections concerning the introduction of complete derivative fields has been traversed in large part by Hertz. True, Hertz did not introduce the concept of vector potentials, and operated only on fields, but this does not detract from his merit. Hertz was mistaken only in that he considered electric and magnetic fields as velocity invariants.

Being located in assigned IMS, us interest those fields, which are created in it by the fixed and moving charges, and also by the electromagnetic waves, which are generated by the fixed and moving sources of such waves. The fields, which are created in this IMS by moving charges and moving sources of electromagnetic waves, we will call dynamic. Can serve as an example of dynamic field the magnetic field, which appears around the moving charges.

As already mentioned, in the classical electrodynamics be absent the rule of the conversion of electrical and magnetic pour on upon transfer of one inertial system to another. This deficiency removes SR, basis of which are the covariant conversions of Lorenz.

In this division will made attempt find the precisely physically substantiated ways of obtaining the conversions pour on upon transfer of one IMS to another, and to also explain what dynamic potentials and fields can generate the moving charges. The first step, demonstrated in the works [2-7], was made in this direction a way of the introduction of the symmetrical laws of magnetoelectric and electromagnetic induction. These laws, in the previous chapters are as shown written as follows:

$$\begin{gathered}\oint\mathbf{E}d\mathbf{l}'=-\int\frac{\partial\mathbf{B}}{\partial t}d\mathbf{s}'+\oint\left[\mathbf{v}\times\mathbf{B}\right]d\mathbf{l}'\\ \oint\mathbf{H}'d\mathbf{l}'=\int\frac{\partial\mathbf{D}}{\partial t}d\mathbf{s}'-\oint\left[\mathbf{v}\times\mathbf{D}\right]d\mathbf{l}'\end{gathered}, \qquad (3.1)$$

or

$$rot\mathbf{E}'=-\frac{\partial\mathbf{B}}{\partial t}+rot\left[\mathbf{v}\times\mathbf{B}\right]$$

$$rot\mathbf{H}' = \frac{\partial \mathbf{D}}{dt} - rot\left[\mathbf{v}\times\mathbf{D}\right] \quad (3.2)$$

For the constants pour on these relationships they take the form:

$$\mathbf{E}' = \left[\mathbf{v}\times\mathbf{B}\right]$$
$$\mathbf{H}' = -\left[\mathbf{v}\times\mathbf{D}\right] \quad (3.3)$$

In relationships (3.1-3.3), which assume the validity of the conversions of Galileo, prime and not prime values present fields and elements in moving and fixed IMS respectively. It must be noted, that conversions (3.3) earlier could be obtained only from the conversions of Lorenz.

Of relationships (3.1-3.3), which present the laws of induction, do not give information about how arose fields in initial fixed IMS. They describe only laws governing the propagation and conversion pour on in the case of motion with respect to the already existing fields.

Of relationship (3.3) attest to the fact that in the case of relative motion of frame of references, between the fields $\mathbf{E}$ and $\mathbf{H}$ there is a cross coupling, i.e., motion in the fields $\mathbf{H}$ leads to the appearance pour on $\mathbf{E}$ and vice versa. From these relationships escape the additional consequences, which were for the first time examined in the work [4]. Электрическое поле $E=\frac{g}{2\pi\varepsilon r}$ за пределами заряженного длинного стержня, на единицу длины которого приходится заряд g, убывает по закону $\frac{1}{r}$, где r - расстояние от центральной оси стержня до точки наблюдения.

If we in parallel to the axis of rod in the field E begin to move with the speed Δv another IMS, then in it will appear the additional magnetic field $\Delta H=\varepsilon E\Delta v$. If we now with respect to already moving IMS begin to move third frame of reference with the speed Δv, then already due to the motion in the field ΔH will appear additive to the electric field $\Delta E=\mu\varepsilon E\left(\Delta v\right)^2$. This process can be continued and further, as a result of which can be obtained the number, which gives the value of the electric field $E'_v(r)$ in moving IMS with reaching of the speed of $v=n\Delta v$, when $\Delta v\to 0$, and $n\to\infty$. In the final analysis in moving IMS the value of dynamic electric field will prove to be more than in the initial and to be determined by the relationship:

$$E'(r,v_\perp)=\frac{gch\frac{v_\perp}{c}}{2\pi\varepsilr}=Ech\frac{v_\perp}{c}.$$

If speech goes about the electric field of the single charge e, then its electric field will be determined by the relationship:

$$E'(r,v_\perp)=\frac{ech\frac{v_\perp}{c}}{4\pi\varepsilon r^2},$$

where $v_\perp$ - normal component of charge rate to the vector, which connects the moving charge and observation point.

Expression for the scalar potential, created by the moving charge, for this case will be written down as follows [4-7]:

$$\varphi'(r,v_\perp)=\frac{ech\frac{v_\perp}{c}}{4\pi\varepsilon r}=\varphi(r)ch\frac{v_\perp}{c}, \quad (3.4)$$

where $\varphi(r)$ - scalar potential of fixed charge.

The potential o $\varphi'(r,v_\perp)$ can be named scalar-vector, since it depends not only on the absolute value of charge, but also on speed and direction of its motion with respect to the observation point. Maximum value this potential has in the direction normal to the motion of charge itself. Moreover, if charge rate changes, which is connected with its acceleration, then can be calculated the electric fields, induced by the accelerated charge.

V. On The Structure Of Lagrange's Function For The Fixed And Moving Charge

Now we can pass to the study of the problem about Lagrange's function from the point of view of scalar- vector potential.

It is accepted to write as follows Lagrange's function for the nonrelativistic charge [1]:

$$L=\frac{mv^2}{2}-e\left(\varphi(1)+\mathbf{vA}\right)$$

where m and e - the mass of charge and its value, $\mathbf{v}$ - charge rate, $\varphi(1)$ - scalar potential field, in which move the charge, $\mathbf{A}$ - the vector potential of magnetic field, in which moves the charge.

In turn, scalar potential $\varphi(1)$ at the assigned point is determined by its all surrounding charges and is determined by the relationship:

$$\varphi(1)=\sum_j\frac{1}{4\pi\varepsilon}\frac{e_j}{r_{1j}}$$

It is not difficult to see that value $\left(\varphi(1)+\mathbf{vA}\right)$ plays the role of the generalized scalar potential with respect to the moving charge. This determination of this

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parameter follows also from the relationship (1.13). Thus, assertion about the fact that Lagrange's function in the electromagnetic field cannot be presented in the form to a difference in the kinetic and potential energy, expressed in the work [1], erroneously.

Is in this work demonstrated new approach to the concept of the scalar potential, which creates the moving charge and it is shown that this potential without taking into account delay depends on speed as follows:

$$\varphi'(r,v_\perp)=\varphi(r)ch\frac{v_\perp}{c},$$

If some quantity of moving and fixed charges surrounds this point of space, then for finding the scalar potential in the given one to point it is necessary to produce the summing up of their potentials:

$$\varphi'(1)=\sum_j \varphi(r_j)ch\frac{v_{j\perp}}{c}=\sum_j \frac{1}{4\pi\varepsilon}\frac{e_j}{r_j}ch\frac{v_{j\perp}}{c}.$$

Earlier it was shown that this determination of the scalar potential of the moving charge excludes the need of using the concept vector potential.

Taking into account this circumstance Lagrangian of the charge e, which is found in the environment of the fixed and moving strange charges can be written down as follows:

$$L=-e\sum_j \frac{1}{4\pi\varepsilon}\frac{e_j}{r_j}ch\frac{v_{j\perp}}{c}. \qquad (4.1)$$

If the charge is moving relative to the selected IMS speed then its Lagrangian is determined by the ratio (4.1), except that as speeds are relative velocities of charges in relation to the charge and adds a member that defines the kinetic energy of the charge.

$$L=\frac{mv^2}{2}-e\sum_j \frac{1}{4\pi\varepsilon}\frac{e_j}{r_j}ch\frac{v_{j\perp}}{c}.$$

This relationship gives the fundamentally new treatment of Lagrange function and indicates that it can be recorded on the basis of the knowledge of the scalar-vector potential of the charges, which surround the assigned charge.

VI. Conclusion

In the article is introduced the concept of scalar-vector potential and on its basis is written Lagrange's function for the moving charge. This procedure of the introduction to function of Lagrange the moving charge earlier is not described. This made possible to write down Lagrangian of fixed charge, which is found in the environment of the strange fixed and moving charges.

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