Propagation of Electromagnetic Waves in a phase Medium

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Abstract

The physical model of the phase medium and the organization of the structure of Space, based on the holographic principle, allows us to interpret the process of propagation of electromagnetic waves in a new way. The article discusses a physical model that explains the mechanism of formation of the structure of an electromagnetic wave during its free propagation in a phase medium.

Keywords: propagation of electromagnetic waves, holographic principle, phase medium.

Introduction

This article continues the series of works under the general title "Physics of Reality" and is a kind of "bridge" between the theory of the phase medium and applied problems, the solution of which is associated with the processes of generation, emission, propagation and absorption of electromagnetic waves.

The views of modern physics on the phenomena associated with these processes are particularly diverse and inconsistent. Since the Times of Tesla and Hertz, there has been a dispute about the existence of longitudinal electromagnetic waves. Today, a number of practical-scientists are studying the methods of generating and detecting such waves, while official science denies this possibility. Why? The fact is that the process of propagation of a longitudinal wave can be realized only in an elastic medium that allows compression and tension. That is, the physical mechanism of EM wave propagation is inextricably linked with the presence of a structured phase medium. Recent publications with a critical analysis of Maxwell's equations indicate, first of all, that contradictions do exist, and that these contradictions cannot be resolved without a paradigm shift.

8. Electromagnetic phenomena

The existence of electromagnetic waves was theoretically substantiated by the great English physicist J. Maxwell in 1864 [3]. J. Maxwell, proceeding from purely mechanistic premises for describing the environment, obtained mathematically rigorous equations that allow describing the process of propagation of electromagnetic waves (EM - waves). However, Maxwell, recognizing the existence of the ether, did not dare to connect the process of propagation of EM waves with the structure of the medium, noting only that, - "*No matter what difficulties we have to face in the future in our efforts to form a certain idea of the structure of the ether, there is no doubt that interplanetary and interstellar space cannot represent a emptiness - space is filled with a material substance or body, which is the most extensive and, one must think, the most* ***homogeneous*** *of all that we only know*".

That is, according to Maxwell, the structure of space from the point of view of electromagnetic processes is more consistent with "material substance" than empty space, which in particular confirms the identity of the equations for vacuum and for real media. So, according to Maxwell's model, within the framework of mechanistic prerequisites for real media, the vectors of electrical intensity (***E***) and magnetic intensity (***H***) can be juxtaposed with the relative permittivity (ε) and the relative magnetic permeability (μ).

In this case, the influence of the medium in the absence of matter is described in a similar way using the absolute permittivity (ε_0) and absolute magnetic permeability (μ_0). These constants (ε_0) and (μ_0), as well as functions (ε) and (μ), being fundamental constants, describe a mechanistic environment in which electromagnetism sort of to exist. In this case, the specified constants (ε_0) and (μ_0) within the framework of the classical paradigm do not have a physical interpretation, and with their help Maxwell actually postulates a macroscopic emptiness, endowing it with the properties of matter, without going into the essence of the internal structure of this unknown material substance.

That is, it should be recognized that Maxwell's theory is based on some undefined notion that does not have a physical interpretation, and which, for this reason, cannot be associated with a physical model of the EM wave propagation process. Therefore, before considering the process of propagation of EM waves in a phase medium, it is necessary to answer the obvious questions, - *What is a field and what is its structure and physical model within the framework of the Theory of a phase medium? What is the mechanism of mutual induction that ensures the mutual transformation of the energy of the magnetic field into the energy of the electric field and vice versa?*

9. Field structure

In accordance with the holographic principle of organizing the structure of space, the form of existence of physical reality is the materialized projection of the wave matrix in the cyclic process of copying-incarnation. This process unites at the level of fine structure all bodies and particles that thus exist, move and interact with each other exclusively as elements of the phase medium.

In other words, the structure of any object or process, being a projection, repeats the structure of the wave matrix at the object level. This continuous process is controlled by a fractal cyclic algorithm in accordance with the principle of conformal projections. Thus, by acting on the structure of the wave matrix, one can change the properties of the object or process itself. And this effect at resonant frequencies can be carried out in real time by means of a field of any nature, changing the state of the wave matrix of the object by direct action using parametric emitters of longitudinal EM waves.

It is obvious that research in this direction can be carried out provided that the mechanism of formation of field structures is understood within the framework of an adequate physical model. And the theory of the phase environment provides such an opportunity. The electric field of a unit charge can be considered as the simplest physical model that makes it possible to understand the structure of the field. The proposed mechanism for the formation of a hierarchical structure of matter based on the fractal principle of the distribution energy of space can serve as a theoretical basis for such a model [2].

The structure of the electric field within the framework of this model will reflect the structure of a spherical standing longitudinal wave inside the sphere of the frequency funnel of a point charge and will be characterized by **a spatial phase gradient**.

The phase gradient characterizes the degree of compaction of the medium along the propagation vector of a longitudinal spherical wave, this can be reflected in the form of the formula:

$$grad\ \overrightarrow{\varphi} = \frac{\partial v/\partial \overrightarrow{r}}{\partial t}\ ; \qquad (9\text{-}1)$$

here, $\partial v/\partial \overrightarrow{r}$ - is the single increment of the spatial frequency equivalent increase in medium density.

The value of the density of the medium (***ρ***) inside a spherical shell belonging to a unit charge changes according to the law of a power function depending on the radius of the spherical shell, which can be represented in the form of the formula already known from [2]:

$$\rho(r) = k_d \cdot \frac{1}{r^2}\ ; \qquad (9\text{-}2)$$

here, ***r*** - is the radius of the spherical shell; k_d - is the dimension coefficient.

In turn, the strength of the electric field, as was experimentally established by Faraday, is proportional to the magnitude of the charge (***q***) and inversely proportional to the square of the distance (***r***) and can be calculated using a similar formula:

$$E(r) = \frac{q}{4\pi\cdot\varepsilon_0} \cdot \frac{1}{r^2}\ ; \qquad (9\text{-}3)$$

here, ***E*** - is the electric field strength; ***q*** - is the charge; ε_o - absolute dielectric constant of the medium

Thus, as follows from the analysis of the equations for a unit charge, a change in the density of the medium in the direction along the radius of the sphere of the frequency funnel leads to a change in the degree of deformation of the medium, which is detected at the object level as a change in the energy of the electric field. This, in turn, confirms the inconsistency of the assertion imposed by the classical theory about the presence of a special type of matter, that is, a "physical agent" with indefinite properties, with the help of which official science tries to explain the mechanism of force interaction between electric charges.

More specifically, the physical model of the interaction of point electric charges can be described as follows. The electric charge forms around itself a spherical wave of the density gradient of the medium at the frequency corresponding to the resonance frequency of the fundamental mode in the structure of electron (or other charged particle). The value of the phase gradient decreases with increasing distance from the center of the sphere, like the square of the radius.

In the space between charges of the same polarity, interference increases the amplitude of oscillations at the frequency of the fundamental mode in the structure of a charged particle. As a result, an increase in the density gradient of the medium is observed, which leads to the mutual repulsion of charges.

In the case of oppositely polar charges in the space gap at close distances between the charges, mutual compensation of oscillations occurs, and zones of zero density gradient of the medium are formed, which leads to the attraction of charges.

As you know, according to the law of magnetic induction, the movement of an electric charge generates a magnetic field. The law of magnetic induction in the absence of a physical model is another empirical dependence based on experimental data without understanding the mechanisms of induction of magnetic dipoles in space as structural elements of a magnetic field.

Within the framework of the Theory of the Phase Medium, by analogy with the electric field, the process of formation of the structure of the magnetic field will obviously also have a phase nature as its basis. But if the structure of the electric field reflects the structure of a spherical standing longitudinal wave inside the sphere of the frequency funnel of a point charge, then the condition for the formation of the field of an elementary magnetic dipole should be the presence of paired elements of the medium.

The mechanism of the formation of magnetic dipoles at the level of a fine structure is associated with the transformation of the kinetic energy of a moving charge into the energy of a local domain formation consisting of paired elements of the medium with oscillation phases shifted by 180 °.

Each pair of medium elements in such a domain formation can be represented as a single magnetic dipole. The generation of single dipoles is provided by the mechanism of fusion of the elements of the medium, which is due to the resonance at the frequency of the second harmonic of two adjacent elements, which have oscillation phases of the fundamental harmonic +90° and -90°. This mechanism starts and maintains an external electric field of a moving charge. The structure of a single magnetic dipole, after its formation, begins to exhibit dipole properties. That is, a dipole moment appears, which can be interpreted as the **moment of deformation of the medium M_d**.

The presence of a dipole moment forces single dipoles to combine into elementary magnetic dipoles, which in a similar manner combine into magnetic tubes (lines of force). That is, the process of formation of elementary magnetic dipoles is an intermediate phase in the formation of the structure of the magnetic field around a moving charge. In this case, the form of "field lines of force" consisting of single magnetic dipoles takes the form of closed rings, and an elementary magnetic dipole takes the shape of a torus (Fig. 1).

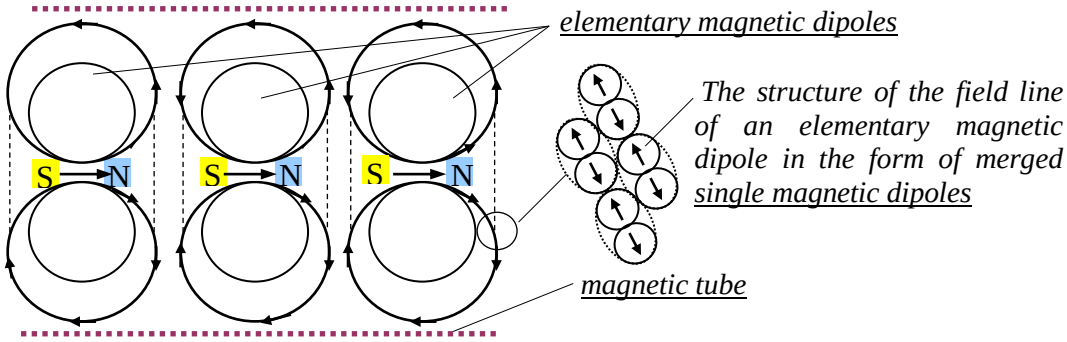

Fig. 1. Fragment of the magnetic field line in the form of a magnetic tube, consisting of elementary magnetic dipoles

The energy of the magnetic field depends on the absolute number of elementary magnetic dipoles and their combination into magnetic tubes, which also form the structure of a magnetic dipole in the form of a torus, but much more powerful. In other words, the magnetic field enhancement mechanism has a quantum nature. The value of the quantum can be tied to the electron charge, as reflected in the Dirac model, and as follows from the proposed mechanism for the creation of an elementary magnetic dipole:

$2e \cdot P_m = 0, \pm1, \pm2, \ldots$ where, P_m - is the magnetic charge of the conditional monopole.

It should be noted that the form of the magnetic tubes (lines of force of the magnetic field) shown in the figure, as it were, repeats and visualizes the holographic structure of the energy-informational field, or from the energy point of view visualizes the picture of the change in the gradient of the density of the medium.

Thus, it can be argued that the **Field**, **Energy** and **density Gradient** of the medium are interconnected phenomena that have a common mechanism associated with the elastic deformation of the elements of the medium.

Then directly the field should be called the structure of the distribution of the density gradient of the medium in the form of areas of compression - stretching of space. The specified structure is formed as a result of interference and nonlinear effects associated with the interaction of resonant frequencies of the medium and structure-forming frequencies that form the structure of the object. That is, interaction occurs at the level of a fine structure, when a holographic structure external to the object interacts with the wave matrix of the object, trying to change its properties.

It is important to note that at the level of the fine structure, the proposed definition unites, by the fact of the existence of a single mechanism, all types of interaction by means of the field: this interaction is electric, magnetic, and gravitational. Apparently, strong interaction, that is, interaction through nuclear forces, will not be considered an exception. Obviously, at the object level, each of the named types of interaction, by definition, must have and has characteristic distinctive properties. In this sense, the study of the phenomenon of electromagnetic waves propagation's allows us to see the connection between the processes occurring at the level of the fine structure of space and physical models that serve to explain the results of real experimental data.

10. Propagation of electromagnetic waves

According to Maxwell's theory, an EM wave is described by equations common to electromagnetic phenomena. Here are the separate equations for determining the electric field strength $\boldsymbol{E}$ and the magnetic field strength $\boldsymbol{H}$:

$$\Delta E - \frac{1}{c^2}\frac{\partial^2 E}{\partial t^2} = 0 \ ; \qquad (10\text{-}1)$$

$$\Delta H - \frac{1}{c^2}\frac{\partial^2 H}{\partial t^2} = 0 \ ; \qquad (10\text{-}2)$$

These two equations have the typical form of wave equations, and their solution will be a superposition of expressions of the following type:

$$\boldsymbol{E} = E_0 \cdot \cos(k \cdot r - \omega t - \varphi) \ ; \qquad (10\text{-}3)$$

$$\boldsymbol{H} = H_0 \cdot \cos(k \cdot r - \omega t - \varphi) \ ; \qquad (10\text{-}4)$$

here, $\boldsymbol{k}$ - is a certain vector, which is called the wave vector,
$\boldsymbol{\omega}$ - is a number called the cyclic frequency, $\boldsymbol{\varphi}$ - phase.

The quantities $\boldsymbol{E_0}$ and $\boldsymbol{H_0}$ are the amplitudes of the electric and magnetic components of the electromagnetic wave. They are mutually perpendicular and equal in absolute value. The energy flux density of the electromagnetic wave $\vec{\boldsymbol{S}}$ is given by the Umov - Poynting vector:

$$\vec{\boldsymbol{S}} = \frac{c}{4\pi} \cdot [\boldsymbol{E} \times \boldsymbol{H}] \ ; \qquad (10\text{-}5)$$

Maxwell introduced the concept of a **vortex electric field** into physics and proposed a new interpretation of the law of electromagnetic induction discovered by Faraday in 1831: "… *any change in the magnetic field generates a vortex electric field in the surrounding space, the lines of force of this field have no beginning and do not end at charges; these lines of force are closed on themselves*." Maxwell also hypothesized the existence of the reverse process: *"... a vortex electric field that changes in time generates a* ***vortex magnetic field*** *in the surrounding space."* The system of Maxwell's equations has nonzero solutions even in the absence of charges and currents, which allows an electromagnetic field to exist far from the source that created it. This is also an experimental fact and indicates the absence in the structure of the EM wave of electric charges and magnetic dipoles.

In this case, from the point of view of physics, Maxwell's equations define the process of propagation of an EM wave as the propagation of two interdependent vortices. Here we should recall such a concept as the dualism of electrical and magnetic phenomena. It is known that the presence of a single electric charge allows us to speak of the quantum nature of most processes in electrodynamics, while the absence of a **magnetic charge** (monopole) violates the principle of symmetry when considering electromagnetic phenomena.

In other words, the absence of a monopole and the impossibility of "finding" it in the structure of the EM wave does not allow explaining the physical mechanism of "conditioning" in the alternation of the electric and magnetic components of the EM wave. Maxwell himself could not understand and explain this mechanism within the framework of his theory and the premises he himself formulated.

However, it can be considered quite indicative that, introducing the concept of a vortex electric field, Maxwell, in fact, **legalized the existence of a phase medium**. Since it is the phase medium that makes it possible to combine the mathematical model of the formation of a vortex field with a physical model of an electromagnetic wave. In addition, the conditionality (dualism) in the alternation of the electric and magnetic components of the vortex field suggests the identity of the formation mechanism of the indicated vortex fields.

According to the official theory, the description of the structure of an EM wave and the propagation process is based more on a mathematical model than on a real picture of the process itself. The graphic representation of an EM wave in the form of a certain flat structure (Fig. 2) once again emphasizes the conventionality of the mathematical model. Which is very difficult to physically interpret in a spatial coordinate system, for example, for a spherical electromagnetic wave.

Therefore, before proposing a mechanism for propagation of an EM wave in a phase medium, it will be appropriate to deal with some of the contradictions of the classical theory of propagation of EM waves. Fig. 2 shows a graphical 3-D image for a freely propagating EM wave according to Maxwell's theory.

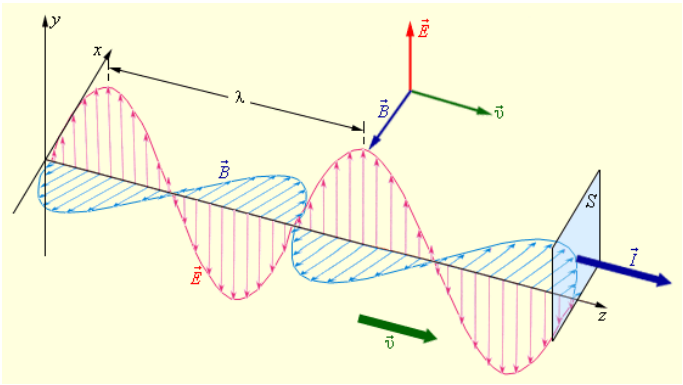

Fig. 2. The view of electromagnetic wave according to the classical theory

As follows from the diagram, during the propagation of an EM wave, the values of the vectors of magnetic induction and electric field strength change according to a sinusoidal law, which is confirmed by the results of experiments and has a theoretical justification.

Below are two Maxwell equations, which are the differential form of writing the laws of Ampere and Faraday:

$$rot\boldsymbol{H} = j + \frac{dD}{dt} \quad ; \qquad (10\text{-}6)$$

$$rot\boldsymbol{E} = -\frac{dB}{dt} \quad ; \qquad (10\text{-}7)$$

here, ***H*** - is the magnetic field strength; ***D*** - electrical induction;

j - is the electric current density; ***E*** - is the electric field strength;

B - magnetic induction.

Now if the three-dimensional image shown in Fig. 2 transform into two-dimensional, it will become obvious that the EM wave does not obey the laws of Ampere and Faraday, and the process of propagation of EM waves does not agree with Maxwell's equations. Since, according to the presented equations, the magnetic field induction in the process of oscillations and the electric field strength cannot simultaneously take on maximum values.

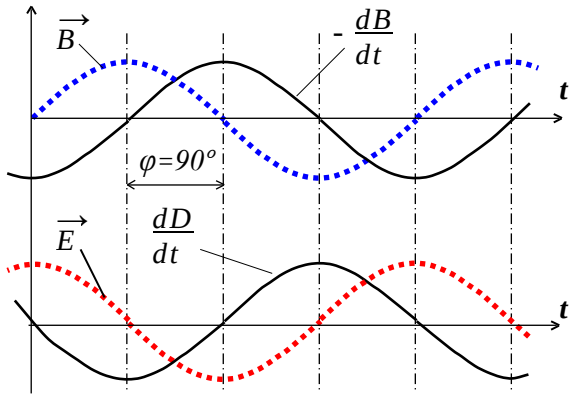

Fig. 3. Graphs illustrating the behavior of variables according to Maxwell's equations in the process of propagation of an EM wave.

In Fig. 3, two pairs of graphs are presented, which reflect the behavior of variables according to formulas (10-6) and (10-7). On the graphs you can see that the phase shift between the magnetic induction vector and the electric field strength vector is not 180º as in Fig. 2, and 90º as required by the equations according to the laws of Ampere and Faraday. In this case, the magnetic induction $\vec{\boldsymbol{B}}$ and the vortex flux of the magnetic field ***rotH*** oscillate in antiphase. In the same way, as the electric field strength $\vec{\boldsymbol{E}}$ and the vortex flow of the electric field ***rotE*** oscillate in antiphase. That is, the error in representing the form of an electromagnetic wave in the classical form lies in the fact that the vector magnetic $\vec{\boldsymbol{B}}$- field is shown on the same graph with the vortex field of electric induction ***dD/dt***, but the latter is presented as a vector electric $\vec{\boldsymbol{E}}$- field.

However, the inconsistency of the graphic display of the EM wave propagation process with Maxwell's equations is not the most important thing. Maxwell's equations, in fact, conflict with the physical essence of the EM wave propagation process. So, according to the equations, the vortex electric ***D***-field induces a vortex magnetic field ***rotH***, but the ***D***-field itself is induced by a nonexistent vector induction $\vec{\boldsymbol{B}}$- field.

Let us consider in more detail a possible mechanism for the formation of vortex fields in a phase medium. As already established, the structure of the magnetic field consists of single magnetic dipoles, which have the ability to combine into elementary magnetic dipoles due to the presence of the moment of the medium deformation's $\boldsymbol{M_d}$ in the "single dipoles". In this case, the form of lines of force of the magnetic field takes the form of closed rings that form elementary magnetic dipoles, which in space acquire the shape of a torus (Fig.1). In turn, elementary magnetic dipoles are combined into magnetic tubes (lines of force), which, having the shape of rings, form a magnetic field structure also in the form of a torus.

From the presented model it follows that the mechanism of creation of elementary magnetic dipoles unambiguously leads to the appearance of a magnetic field in the form of a structure like a torus with pronounced magnetic poles. Taking into account the inertial properties of the medium, the process of the formation of magnetic dipoles cannot be analogous to the mirror process of the formation of a vortex electric field; accordingly, the conclusion suggests itself that elementary magnetic dipoles cannot be structure-forming elements of a vortex magnetic field. This means that only directly synchronized elements of the medium can be the structural elements that form the vortex magnetic field.

Having adopted such a model, it is necessary to resolve one more question, - *How, in the process of propagation and transfer of the angular momentum, to "separate" the elements of the medium with different signs of the magnetic component ± P, respectively, with phases + 90 ° and –90 ° so that these structural elements did not combine into dipoles*? An obvious answer to this question can only be a solution associated with the existence of a mechanism for the time separation of oppositely polar components of the magnetic field.

Such a structure, a characteristic feature of which is the presence of a magnetic charge of only one polarity, can be called a magnetic monopole. In this case, the monopole itself will be a vortex structure with an alternately changing direction of swirling of the magnetic field lines, depending on the polarity of the magnetic charge. As for the vortex electric field, as suggested by Maxwell himself, this field consists directly of lines of force, that is, for our model, of synchronized elements of the medium with the phase of oscillations of the fundamental mode: -180 °

In fig. 4 shows graphs illustrating the behavior of the electric and magnetic components of a longitudinal EM wave during its free propagation in a phase medium. On the graphs, at points ***2***, ***4***, the number of phased elements of the medium participating in the formation of the ***D*** - component is equal to the number of phased elements of the medium ***P*** - components, and at these points the vortex energy as a derivative of the concentrations $\boldsymbol{Q_D}$ and $\boldsymbol{Q_P}$ will simultaneously be maximum. At points ***1***, ***5***, the concentration of the phased elements of the medium ***D*** - component with the oscillation phase of (-180°) will have a maximum value, and for ***P*** - component with the oscillation phase of + 90° (-90°) - the minimum. At points ***3***, ***6***, the opposite situation occurs, when elements ***P*** - components have a maximum concentration, and elements ***D*** - components have a minimum.

In both cases, at these points the derivative of the concentrations $\boldsymbol{Q_D}$ and $\boldsymbol{Q_P}$ is equal to zero, respectively, the vortex fields ***rotH*** or ***rotE*** simultaneously change their direction, passing through the zero energy value. At each moment of time, the energy of the EM wave is made up of the energy of the phased elements of the medium ***D*** - and ***P*** - components and the energy of the corresponding vortex fields.

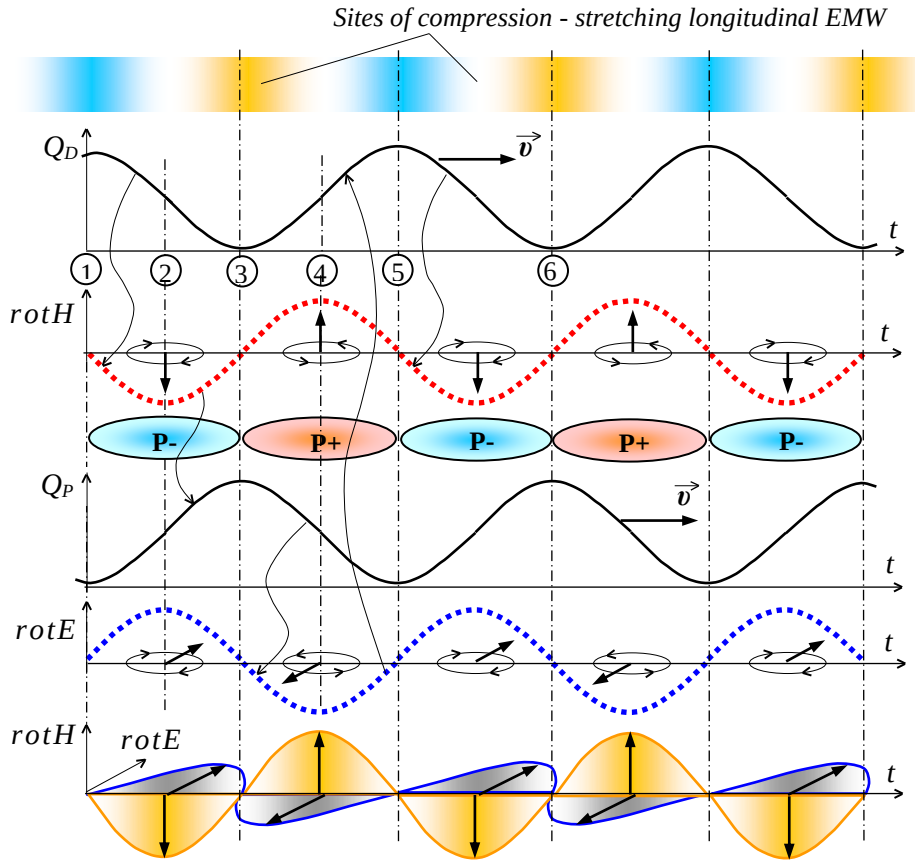

Fig. 4. Graphs illustrating the behavior of the electric and magnetic components of a longitudinal EW wave during its free propagation in a phase medium.

In the diagram: EMW - Electromagnetic Wave;

Q_D and ***Q_P*** are the concentration of phased elements of the medium; respectively electric and magnetic component of the electromagnetic wave;

P + - positive magnetic "charge";

P - - negative magnetic "charge";

rotH – is an induced alternating vortex magnetic field;

rotE - is an induced, alternating vortex electric field.

When the EM wave propagates, the compression - stretching sections alternate with a frequency that is twice the frequency of the EM wave, since during one oscillation period the energy of the EM wave is concentrated either in the energy of the elements of the ***D*** - component, or in the energy of the ***P*** - component.

Figured arrows show the cyclic transformation of the longitudinal wave energy into the energy of the vortex structures of the EM wave:

→ concentration Q_D → ***rotH*** → Q_P → concentration Q_P → ***rotE*** → Q_D → etc.

It can be noted that in the graphs (Fig. 4) the vector electric and vector magnetic fields are absent as such, which is a consequence of the absence of electric charges and magnetic dipoles in the structure of the EM wave. Therefore, the graph shows the curves of the corresponding rotors, that is, the vortex electric and vortex magnetic fields.

To reflect the mechanism of transformation of the energy of a magnetic vortex into the energy of an electric vortex, equation (10-7) must be transformed, and by analogy with electrical induction (***D***), the concept of magnetic charge induction (±***P***) should be introduced. Then equation (10-7) will take the form:

$$rot\boldsymbol{E} = -\frac{dP}{dt} \quad ; \qquad (10\text{-}8)$$

here, ***P*** - is the induction of the magnetic charge (monopole).

At the initial moment, the density gradient of the medium created by the excitation source is transformed into vortex energy. Further, the propagation of the EM wave provides a mechanism for transferring the angular momentum through the phase shift of the structural elements of the medium (the phase: -180° is transformed into the phase: + 90 ° or - 90 ° and vice versa). Thus, a phase shift of 90 ° will correspond to a phase shift between the structural elements of the ***D*** and ***P*** components. In other words, the direction of the rotor of the electric vortex and the polarity of the magnetic charge are determined by the phase of oscillations of the fundamental harmonic of ***m****-cavities* inside each vortex structure of the EM wave.

The structure of an electromagnetic wave in accordance with such a model represents alternating areas of vortex fields. In this case, at each moment of time during the propagation of the EM wave, the energy of the collapsing ***D*** -vortex or ***P*** -vortex is transformed into an increase in the density gradient of the medium through an increase in the concentration, respectively, of the electric $\boldsymbol{Q_D}$ or magnetic $\boldsymbol{Q_P}$ components of the EM wave. In turn, a change in concentration $\boldsymbol{Q_D}$ gives rise to a vortex magnetic field, and a change in concentration $\boldsymbol{Q_P}$ generates a vortex electric field. And Maxwell's equations for a freely propagating EM wave in a phase medium take the following form:

$$rot\boldsymbol{H} = j + \frac{dQ_D}{dt} \quad ; \qquad (10\text{-}9)$$

$$rot\boldsymbol{E} = -\frac{dQ_P}{dt} \quad ; \qquad (10\text{-}10)$$

In formula (10-9) $\boldsymbol{j_D}$ - is the flux density of the phased elements; ***D*** -are the components. That is, the vortex magnetic field is formed not due to "currents", but directly from the phased elements of the medium plus the derivative of the change in the concentration of elements ***D*** - component. In addition, the vortex electric field is not associated with the induction of the magnetic field, but is formed as a derivative of the change in the concentration of elements ***P*** - component with a variable sign ± ***P*** of the monopole charge, which affects the spatial position of the vector rotor ***D*** - vortex. That is, the change in the sign of the magnetic charge makes the rotor vector of the vortex electric field "rotate", resembling the movement of the "gimlet" along the axis of propagation of the EM wave. Thus, the energy flux of the EM wave at each moment of time is made up of the energy of the ***D***-vortex and the ***P***-vortex, as well as the energy of the **longitudinal wave** in the form of the concentration gradient of the phased elements of the medium ***D*** - and ***P*** - components.

The proposed model of EM wave propagation brings us back to the question of the **magnetic monopole**, the existence of which was theoretically predicted by Dirac. Now, this theory can be consistent with the considered mechanism of induction of a vortex electric field through the alternation of magnetic charges of a vortex magnetic field, that is, through an induced monopole. In this case, the monopole of each sign exists for a period equal to half the wavelength of electromagnetic oscillations (see Fig. 4).

When registering an EM wave, magnetic charges ± ***P*** separated in time may well be perceived by the detector as a magnetic alternating vector field, the alternating spatial "vector" of which will be perpendicular to the wave propagation axis. And in this sense, there is nothing surprising in the confusion with the "transverse" EM waves. However, the fact of registration of an alternating magnetic field will not indicate the presence of magnetic dipoles in the structure of the EM wave. And just like a vortex electric field, consisting of lines of force closed on themselves, dispenses with the presence of charges, a vortex magnetic field does without magnetic dipoles.

You should also pay attention to the coincidence of the graphical representation of the propagation of longitudinal EM waves with a similar shape according to the classical theory. It must be assumed that the "error", which has already been mentioned, in the discrepancy between the classical form of the graphical representation of the EM wave and Maxwell's equations, most likely lies not so much in the substitution of the vortex field by the vector field, but in the fact that the generally accepted "picture" essentially reflects the experimental results, not the equations themselves. Therefore, we can say that the presented model only confirms these results with the proviso that this is a longitudinal EM wave formed as a density gradient of the synchronized elements of the medium ***P*** - and ***D*** - components and vortex fields with mutually perpendicular rotors: ***rotH*** and ***rotE***.

In addition, such a model makes it possible to explain the existence of an electromagnetic field even far from the source that created it. As already noted at those times when the energy of the vortex fields is minimal, the concentration of phased elements of the medium, the ***P*** or ***D*** components, will have a maximum value, thereby determining the sequence of alternating sections of compression - stretching along the axis of propagation of the longitudinal EM wave. That is, the mechanism of EM wave propagation is supported by the elasticity of the phase medium. Figuratively speaking, the "packet" of EM waves, which has a beginning and an end and consists of alternating sections of compression - stretching in the form of phased elements of ***P*** or ***D*** components, will somewhat resemble the movement of a "caterpillar" that alternately moves parts of its "body" due to alternation of vortex fields.

Conclusion

Thus, the propagation of an EM wave is a periodic process in which a certain fraction of the elastic deformation energy of the medium, concentrated along the propagation vector of a longitudinal wave in the form of a concentration of phased elements of the magnetic and electrical components, is periodically transformed, respectively, into the energy of a vortex electric field or into the energy of a vortex magnetic fields.

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