Physical and methodological errors in the works of Landau

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Abstract

By all is well known this phenomenon as rainbow. To any specialist in the electrodynamics it is clear that the appearance of rainbow is connected with the dependence on the frequency of the phase speed of the electromagnetic waves, passing through the drops of rain. J. Heaviside R. Vul assumed that this dispersion was connected with the frequency dispersion (dependence on the frequency) of the dielectric constant of water. Since then this point of view is ruling. However, this approach is physical and methodological error, that also is shown in this article. This error occurred because of the fact that during the record of current in the material media they were entangled integral and the derivative of the harmonic function, which take the identical form and are characterized by only signs.

Keywords: plasma, dielectric, dielectric constant, the dispersion of dielectric constant, harmonic function,

1. Introduction

By all is well known this phenomenon as rainbow. To any specialist in the electrodynamics it is clear that the appearance of rainbow is connected with the dependence on the frequency of the phase speed of the electromagnetic waves, passing through the drops of rain. Since water is dielectric, with the explanation of this phenomenon J. Heaviside R. Vull assumed that this dispersion was connected with the frequency dispersion (dependence on the frequency) of the dielectric constant of water. Since then this point of view is ruling [1-6].

however very creator of the fundamental equations of electrodynamics Maxwell considered that these parameters on frequency do not depend, but they are fundamental constants. As the idea of the dispersion of dielectric and magnetic constant was born, and what way it was past, sufficiently colorfully characterizes quotation from the monograph of well well-known specialists in the field of physics of plasma [1]: "J. itself. Maxwell with the formulation of the equations of the electrodynamics of material media considered that the dielectric and magnetic constants are the constants (for this reason they long time they were considered as the constants). It is considerably later, already at the beginning of this century with the explanation of the optical dispersion phenomena (in particular the phenomenon of rainbow) of J. Heaviside R. Vull showed that the dielectric and magnetic constants are the functions of frequency. But very recently, in the middle of the 50's, physics they came to the conclusion that these values depend not only on frequency, but also on the wave vector. On the essence, this was the radical breaking of the existing ideas. It was how a serious, is characterized the case, which occurred at the seminar l. D. Landau into 1954. During the report A. I. Akhiezer on this theme of Landau suddenly exclaimed, after smashing the speaker: " This is delirium, since the refractive index cannot be the function of refractive index". Note that this said l. D. Landau - one of the outstanding physicists of our time" (end of the quotation).

It is incomprehensible from the given quotation, that precisely had in the form Landau, voicing this point of view; however, its subsequent publications speak, that it accepted this concept [2].

Looking ahead, it should be noted that Maxwell was right,, who considered that the dielectric and magnetic constant of material media on frequency they do not depend. However, in a number of fundamental works on electrodynamics [2-6] are committed conceptual, systematic and physical errors, as a result of which in physics they penetrated and solidly in it were fastened such metaphysical concepts as the frequency dispersion of the dielectric constant of material media and, in particular, plasma. The propagation of this concept to the dielectrics led to the fact that all began to consider that also the dielectric constant of dielectrics also depends on frequency. These physical errors penetrated in all spheres of physics and technology. They so solidly took root in the consciousness of specialists, that many, until now, cannot believe in the fact that the dielectric constant of plasma is equal to the dielectric constant of vacuum, but the dispersion of the dielectric constant of dielectrics is absent. There is the publications of such well-known scholars as the Drudes, Vull, Heaviside, Landau, Ginsburg, Akhiezer, Tamm [1-6], where it is indicated that the dielectric constant of plasma and dielectrics depends on frequency. This is a systematic and physical error. This systematic and physical error became possible for that reason, that without the proper understanding of physics of the proceeding processes occurred the substitution of physical concepts by mathematical symbols, which appropriated physical, but are more accurate metaphysical, designations, which do not correspond to their physical sense. But if we examine the purely mathematical point of view, then Landau, and following it and other authors entangled integral and derivative of harmonic function, since they forgot, that the derivative and integral in this case take the identical form, and they are characterized by only signs.

2 Plasmo-like media

By plasma media we will understand such, in which the charges can move without the losses. To such media in the first approximation, can be related the superconductors, free electrons or ions in the vacuum (subsequently conductors). In the absence magnetic field in the media indicated equation of motion for the electrons takes the form:

$$\text{of } m\frac{d\vec{v}}{dt} = e\vec{E}\,, \tag{1}$$

where m - mass electron, e - the electron charge, $\vec{E}$ - the tension of electric field, $\vec{v}$ - speed of the motion of charge.

In the work [6] it is shown that this equation can be used also for describing the electron motion in the hot plasma. Therefore it can be disseminated also to this case.

Using an expression for the current density

$$\vec{j} = ne\vec{v} \tag{2}$$

from (1) we obtain the current density of the conductivity

$$\vec{j}_L = \frac{ne^2}{m}\int \vec{E}\;dt\,. \tag{3}$$

In relationship (2) and (3) the value of n represents electron density. After introducing the designation of

$$L_k = \frac{m}{ne^2} \tag{4}$$

we find

$$\vec{j}_L = \frac{1}{L_k}\int \vec{E}\;dt\,. \tag{5}$$

In this case the value L_k presents the specific kinetic inductance of charge carriers [7-11]. Its existence connected with the fact that charge, having a mass, possesses inertia properties. Pour on $\vec{E} = \vec{E}_0 \sin\omega t$ relationship (5) it will be written down for the case of harmonics:

$$\vec{j}_L = -\frac{1}{\omega L_k}\vec{E}_0 \cos\omega t \tag{6}$$

For the mathematical description of electrodynamic processes the trigonometric functions will be here and throughout, instead of the complex quantities, used so that would be well visible the phase relationships between the vectors, which represent electric fields and current densities.

from relationship (5) and (6) is evident that $\vec{j}_L$ presents inductive current, since. its phase is late with respect to the tension of electric field to the angle $\frac{\pi}{2}$.

If charges are located in the vacuum, then during the presence of summed current it is necessary to consider bias current

$$\vec{j}_\varepsilon = \varepsilon_0 \frac{\partial \vec{E}}{\partial t} = \varepsilon_0 \vec{E}_0 \cos \omega t .$$

is evident that this current bears capacitive nature, since. its phase anticipates the phase of the tension of electrical to the angle $\frac{\pi}{2}$. Thus, summary current density will compose [8-10]

$$\vec{j}_\Sigma = \varepsilon_0 \frac{\partial \vec{E}}{\partial t} + \frac{1}{L_k} \int \vec{E}\, dt ,$$

or

$$\vec{j}_\Sigma = \left(\omega \varepsilon_0 - \frac{1}{\omega L_k} \right) \vec{E}_0 \cos \omega t . \qquad (7)$$

If electrons are located in the material medium, then should be considered the presence of the positively charged ions. However, with the examination of the properties of such media in the rapidly changing fields, in connection with the fact that the mass of ions is considerably more than the mass of electrons, their presence usually is not considered.

In relationship (7) the value, which stands in the brackets, presents summary susceptance of this medium σ_Σ and it consists it, in turn, of the the capacitive σ_C and by the inductive σ_L the conductivity

$$\sigma_\Sigma = \sigma_C + \sigma_L = \omega \varepsilon_0 - \frac{1}{\omega L_k} .$$

Relationship (7) can be rewritten and differently:

$$\vec{j}_\Sigma = \omega \varepsilon_0 \left(1 - \frac{\omega_0^2}{\omega^2} \right) \vec{E}_0 \cos \omega t ,$$

where $\omega_0 = \sqrt{\frac{1}{L_k \varepsilon_0}}$ - plasma frequency.

And large temptation here appears to name the value

$$\varepsilon^*(\omega) = \varepsilon_0 \left(1 - \frac{\omega_0^2}{\omega^2} \right) = \varepsilon_0 - \frac{1}{\omega^2 L_k} ,$$

By the depending on the frequency dielectric constant of plasma, that also is made in all existing works on physics of plasma. But this is incorrect, since. this mathematical symbol is the composite parameter, into which simultaneously enters the dielectric constant of vacuum and the specific kinetic inductance of charges. It is clear from the previous examination that the parameter $\varepsilon^*(\omega)$ gives the possibility in one coefficient to combine derivative and the integral of harmonic function, since they are characterized by only signs and thus impression is created, that the dielectric constant of plasma depends on frequency. It should be noted that a similar error is perfected by such well-known physicists as Akhiezer, Tamm, Ginsburg [3-5].

This happened still and because, beginning to examine this question, Landau introduced the determinations of dielectric constant only for the static pour on, but he did not introduce this lopredeleniya for the variables pour on. Let us introduce this determination.

if we examine any medium, including plasma, then current density (subsequently we will in abbreviated form speak simply current) it will be determined by three components, which depend on the electric field. The current of resistance losses there will be [sinfazen] to electric field. The permittance current, determined by first-order derivative of electric field from the time, will anticipate the tension of electric field on the phase to $\frac{\pi}{2}$. This current is called bias current. The conduction current, determined by integral of the electric field from the time, will lag behind the electric field on the phase to $\frac{\pi}{2}$. All three components of current indicated will enter into the second Maxwell equation and others components of currents be it cannot. Moreover all these three components of currents will be present in any nonmagnetic regions, in which there are losses. Therefore it is completely natural, the dielectric constant of any medium to define as the coefficient, confronting that term, which is determined by the derivative of electric field by the time in the second Maxwell equation. In this case one should consider that the dielectric constant cannot be negative value. This connected with the fact that through this parameter is determined energy of electrical pour on, which can be only positive.

Without having introduced this clear determination of dielectric constant, Landau begins the examination of the behavior of plasma in the ac fields . In this case is not separated separately the bias current and conduction current, one of which is defined by derivative, but by another integral, is written as united bias current. It makes this error for that reason, that in the case of harmonic oscillations the form of the function, which determine and derivative and integral, is identical, and they are characterized by only sign. Performing this operation, Landau does not understand, that in the case of harmonic electrical pour on in the plasma there exist two different currents, one of which is bias current, and it is determined by the dielectric constant of vacuum and derivative of electric field. Another current is conduction current and is determined by integral of the electric field. these two currents are antiphase. But since both currents depend on frequency, moreover one of them depends on frequency linearly, and another it is inversely proportional to frequency, between them competition occurs. The conduction current predominates with the low frequencies, the bias current, on the contrary, predominates with the high. However, in the case of the equality of these currents, which occurs at the plasma frequency, occurs current resonance.

Let us emphasize that from a mathematical point of view to reach in the manner that it entered to Landau, it is possible, but in this case is lost the integration constant, which is necessary to account for initial conditions during the solution of the equation, which determines current density in the material medium.

The obviousness of the committed error is visible based on other example.

Relationship (7) can be rewritten and differently:

$$\vec{j}_{\Sigma}=-\frac{\left(\frac{\omega^2}{\omega_0^2}-1\right)}{\omega L}\ \vec{E}_0\cos\omega t$$

and to introduce another mathematical symbol

$$L^*(\omega)=\frac{L_k}{\left(\frac{\omega^2}{\omega_0^2}-1\right)}=\frac{L_k}{\omega^2 L_k\varepsilon_0-1}\ .$$

In this case also appears temptation to name this bending coefficient on the frequency kinetic inductance.

Thus, it is possible to write down:

$$\vec{j}_{\Sigma}=\omega\varepsilon^*(\omega)\ \vec{E}_0\cos\omega t,$$

or

$$\vec{j}_{\Sigma}=-\frac{1}{\omega L^*(\omega)}\ \vec{E}_0\cos\omega t\ .$$

But this altogether only the symbolic mathematical record of one and the same relationship (7). Both equations are equivalent. But view neither $\varepsilon^*(\omega)$ nor $L^*(\omega)$ by dielectric constant or inductance are from a physical point. The physical sense of their names consists of the following:

$$\varepsilon^*(\omega)=\frac{\sigma_X}{\omega}\ ,$$

i.e. $\varepsilon^*(\omega)$ presents summary susceptance of medium, divided into the frequency, and

$$L_k{*}(\omega)=\frac{1}{\omega\sigma_X}$$

it represents the reciprocal value of the work of frequency and susceptance of medium.

As it is necessary to enter, if at our disposal are values $\varepsilon{*}(\omega)$ and $L{*}(\omega)$, and we should calculate total specific energy. Natural to substitute these values in the formulas, which determine energy of electrical pour on

$$W_E=\frac{1}{2}\varepsilon_0 E_0^2$$

and kinetic energy of charge carriers

$$W_j=\frac{1}{2}L_k j_0^2, \tag{8}$$

is cannot simply because these parameters are neither dielectric constant nor inductance. It is not difficult to show that in this case the total specific energy can be obtained from the relationship

$$W_\Sigma=\frac{1}{2}\cdot\frac{d\left(\omega\varepsilon{*}(\omega)\right)}{d\omega}E_0^2 \ , \tag{9}$$

from where we obtain

$$W_\Sigma=\frac{1}{2}\varepsilon_0 E_0^2+\frac{1}{2}\ \frac{1}{\omega^2 L_k}\ E_0^2=\frac{1}{2}\varepsilon_0 E_0^2+\frac{1}{2}L_k j_0^2 \ .$$

We will obtain the same result, after using the formula

$$W=\frac{1}{2}\ \frac{d\left[\dfrac{1}{\omega L_k{*}(\omega)}\right]}{d\omega}\ E_0^2 .$$

The given relationships show that the specific energy consists of potential energy of electrical pour on and to kinetic energy of charge carriers.

With the examination of any media by our final task appears the presence of wave equation. In this case this problem is already practically solved. Maxwell's equations for this case take the form:

$$rot\ \vec{E}=-\mu_0\frac{\partial\ \vec{H}}{\partial\ t},$$
$$rot\ \vec{H}=\varepsilon_0\frac{\partial\ \vec{E}}{\partial\ t}+\frac{1}{L_k}\int\vec{E}\ dt \ , \tag{10}$$

where of and - dielectric and magnetic constant of vacuum.

System of equations (6.10) completely describes all properties of nondissipative conductors. From it we obtain

$$rot\ rot\ \vec{H}+\mu_0\varepsilon_0\frac{\partial^2\vec{H}}{\partial\ t^2}+\frac{\mu_0}{L_k}\vec{H}=0\,. \tag{11}$$

For the case pour on, time-independent, equation (2.11) passes into the equation of London [12]

$$rot\ rot\ \vec{H}+\frac{\mu_0}{L_k}\vec{H}=0\ ,$$

where $\lambda_L{}^2=\frac{L_k}{\mu_0}$ - London depth of penetration.

Thus, it is possible to conclude that the equations of London being a special case of equation (11), and do not consider bias currents on medium. Therefore they do not give the possibility to obtain the wave equations, which describe the processes of the propagation of electromagnetic waves in the superconductors.

Pour on wave equation in this case it appears as follows for the electrical:

$$rot\ rot\ \vec{E}+\mu_0\varepsilon_0\frac{\partial^2\vec{E}}{\partial\ t^2}+\frac{\mu_0}{L_k}\vec{E}=0\,.$$

For constant electrical pour on it is possible to write down

$$rot\ rot\ \vec{E}+\frac{\mu_0}{L_k}\vec{E}=0\,.$$

Consequently, dc fields penetrate the superconductor in the same manner as for magnetic, diminishing exponentially. However, the density of current in this case grows according to the linear law of

$$\vec{j}_L=\frac{1}{L_k}\int\vec{E}\ dt\,.$$

The carried out examination showed that the dielectric constant of this medium was equal to the dielectric constant of vacuum and this permeability on frequency does not depend. The accumulation of potential energy is obliged to this parameter. Furthermore, this medium is characterized still and the kinetic inductance of charge carriers and this parameter determines the kinetic energy, accumulated on medium.

Thus, are obtained all necessary given, which characterize the process of the propagation of electromagnetic waves in conducting media examined. However, in contrast to the conventional procedure [2-4] with this examination nowhere was introduced polarization vector, but as the basis of examination assumed equation of motion and in this case in the second Maxwell equation are extracted all components of current densities explicitly.

in radio engineering exists the simple method of the idea of radio-technical elements with the aid of the equivalent diagrams. This method is very visual and gives the possibility to present in the form such diagrams elements both with that concentrated and with the distributed parameters. The use of this method will make it possible better to understand, why were committed such significant physical errors during the introduction of the concept of that depending on the frequency dielectric constant.

3. Physical processes in the parallel resonant circuit

In order to show that the single volume of conductor or plasma according to its electrodynamic characteristics is equivalent to parallel resonant circuit with the lumped parameters, let us examine parallel resonant circuit. The connection between the voltage U, applied to the outline, and the summed current I_Σ, which flows through this chain, takes the form

$$I_\Sigma = I_C + I_L = C\frac{dU}{dt} + \frac{1}{L}\int U\ dt,$$

where $I_C = C\frac{dU}{dt}$ - current, which flows through the capacity, and $I_L = \frac{1}{L}\int U\ dt$ - current, which flows through the inductance.

For the case of the harmonic stress $U = U_0 \sin\omega t$ we obtain

$$I_\Sigma = \left(\omega C - \frac{1}{\omega L}\right) U_0 \cos\omega t\ . \qquad (12)$$

In relationship (12) the value, which stands in the brackets, presents summary susceptance σ_Σ this medium of of and it consists it, in turn, of the the capacitive σ_C and by the inductive σ_L the conductivity

$$\sigma_\Sigma = \sigma_C + \sigma_L = \omega C - \frac{1}{\omega L}.$$

In this case relationship (12) can be rewritten as follows:

$$I_\Sigma = \omega C\left(1 - \frac{\omega_0^2}{\omega^2}\right) U_0 \cos\omega t,$$

where $\omega_0{}^2 = \frac{1}{LC}$ - the resonance frequency of parallel circuit.

And here, just as in the case of conductors, appears temptation, to name the value

$$C^*(\omega) = C\left(1 - \frac{\omega_0^2}{\omega^2}\right) = C - \frac{1}{\omega^2 L} \qquad (13)$$

by the depending on the frequency capacity. Conducting this symbol it is permissible from a mathematical point of view; however, inadmissible is awarding to it the proposed name, since. this parameter of no relation to the true capacity has and includes in itself simultaneously and capacity and the inductance of outline, which do not depend on frequency. is accurate another point of view. Relationship (12) can be rewritten and differently:

$$I_{\Sigma}=-\frac{\left(\frac{\omega^2}{\omega_0^2}-1\right)}{\omega L}\ U_0\cos\omega t,$$

and to consider that the chain in question not at all has capacities, and consists only of the inductance depending on the frequency

$$L^*(\omega)=\frac{L}{\left(\frac{\omega^2}{\omega_0^2}-1\right)}=\frac{L}{\omega^2 LC-1}. \qquad (14)$$

but, just as $C^*(\omega)$, the value of $L^*(\omega)$ cannot be called inductance, since this is the also composite parameter, which includes simultaneously capacity and inductance, which do not depend on frequency.

Using expressions (13) and (14), let us write down:

$$I_{\Sigma}=\omega C^*(\omega)\ U_0\cos\omega t, \qquad (15)$$

or

$$I_{\Sigma}=-\frac{1}{\omega L^*(\omega)}\ U_0\cos\omega t. \qquad (16)$$

The relationship (15) and (16) are equivalent, and separately mathematically completely is characterized the chain examined. But view neither $C^*(\omega)$ nor $L^*(\omega)$ by capacity and inductance are from a physical point, although they have the same dimensionality. The physical sense of their names consists of the following:

$$C^*(\omega)=\frac{\sigma_X}{\omega},$$

i.e. $C^*(\omega)$ presents the relation of susceptance of this chain and frequency, and

$$L^*(\omega)=\frac{1}{\omega\sigma_X},$$

it is the reciprocal value of the work of summary susceptance and frequency.

Accumulated in the capacity and the inductance energy, is determined from the relationships

$$W_C=\frac{1}{2}CU_0^{\ 2} \qquad (17)$$

$$W_L = \frac{1}{2} L I_0^{\,2}. \qquad (18)$$

How one should enter for enumerating the energy, which was accumulated in the outline, if at our disposal are $C^*(\omega)$ and $L^*(\omega)$? Certainly, to put these relationships in formulas (17) and (18) cannot for that reason, that these values can be both the positive and negative, and the energy, accumulated in the capacity and the inductance, is always positive. But if we for these purposes use ourselves the parameters indicated, then it is not difficult to show that the summary energy, accumulated in the outline, is determined by the expressions:

$$W_\Sigma = \frac{1}{2}\,\frac{d\sigma_X}{d\omega}\,U_0^{\,2}, \qquad (19)$$

or

$$W_\Sigma = \frac{1}{2}\,\frac{d\left[\omega C^*(\omega)\right]}{d\omega}\,U_0^{\,2}, \qquad (20)$$

or

$$W_\Sigma = \frac{1}{2}\,\frac{d\left(\dfrac{1}{\omega L^*(\omega)}\right)}{d\omega}\,U_0^{\,2}. \qquad (21)$$

If we paint equations (19) or (20) and (21), then we will obtain identical result, namely:

$$W_\Sigma = \frac{1}{2} C U_0^{\,2} + \frac{1}{2} L I_0^{\,2},$$

where U_0 - amplitude of stress on the capacity, and I_0 - amplitude of the current, which flows through the inductance.

If we compare the relationships, obtained for the parallel resonant circuit and for the conductors, then it is possible to see that they are identical, if we make $E_0 \to U_0$, $j_0 \to I_0$, $\varepsilon_0 \to C$ and $L_k \to L$. Thus, the single volume of conductor, with the uniform distribution of electrical pour on and current densities in it, it is equivalent to parallel resonant circuit with the lumped parameters indicated. In this case the capacity of this outline is numerically equal to the dielectric constant of vacuum, and inductance is equal to the specific kinetic inductance of charges.

Now let us visualize this situation. In the audience, where are located specialists, who know radio engineering and of mathematics, comes instructor and he begins to prove, that there are in nature of no capacities and inductances, and there is only depending on the frequency capacity and that just she presents parallel resonant circuit. Or, on the contrary, that parallel resonant circuit this is the depending on the frequency inductance. View of mathematics will agree from this point. However, radio engineering they will calculate lecturer by man with the very limited knowledge. Specifically, in this position proved to be now those scientists and the specialists, who introduced into physics the frequency dispersion of dielectric constant.

Thus, are obtained all necessary given, which characterize the process of the propagation of electromagnetic waves in the media examined, and it is also shown that in the quasi-static regime the electrodynamic processes in the conductors are similar to processes in the parallel resonant circuit with the lumped parameters. However, in contrast to the conventional procedure [5-7] with this examination nowhere was introduced polarization vector, but as the basis of examination assumed equation of motion and in this case in the second Maxwell equation are extracted all components of current densities explicitly.

4. Physical and methodological errors in the works of Landau

Based on the example of work [2] let us examine a question about how similar problems, when the concept of polarization vector is introduced are solved for their solution. Paragraph 59 of this work, where this question is examined, it begins with the words: “We pass now to the study of the most important question about the rapidly changing electric fields, whose frequencies are unconfined by the condition of smallness in comparison with the frequencies, characteristic for establishing the electrical and magnetic polarization of substance” (end of the quotation). These words mean that that region of the frequencies, where, in connection with the presence of the inertia properties of charge carriers, the polarization of substance will not reach its static values, is examined. With the further consideration of a question is done the conclusion that “in any variable field, including with the presence of dispersion, the polarization vector of $\vec{P}=\vec{D}-\varepsilon_0\vec{E}$ (here and throughout all formulas cited they are written in the system SI) preserves its physical sense of the electric moment of the unit volume of substance” (end of the quotation). Let us give the still one quotation: “It proves to be possible to establish (unimportantly - metals or dielectrics) maximum form of the function $\varepsilon(\omega)$ with the high frequencies valid for any bodies. Specifically, the field frequency must be great in comparison with “the frequencies” of the motion of all (or, at least, majority) electrons in the atoms of this substance. With the observance of this condition it is possible with the calculation of the polarization of substance to consider electrons as free, disregarding their interaction with each other and with the atomic nuclei” (end of the quotation).

Further, as this is done and in this work, is written the equation of motion of free electron in the ac field

$$m\frac{d\vec{v}}{dt}=e\vec{E},$$

from where its displacement is located

$$\vec{r}=-\frac{e\vec{E}}{m\omega^2}.$$

Then is indicated that the polarization $\vec{P}$ is a dipole moment of unit volume and the obtained displacement is put into the polarization

$$\vec{P}=ne\vec{r}=-\frac{ne^2\vec{E}}{m\omega^2}.$$

In this case point charge is examined, and this operation indicates the introduction of electrical dipole moment for two point charges with the opposite signs, located at a distance

$$\vec{p}_e=-e\vec{r},$$

where the vector $\vec{r}$ is directed from the negative charge toward the positive charge. This step causes bewilderment, since the point electron is examined, and in order to speak about the electrical dipole moment, it is necessary to have in this medium for each electron another charge of opposite sign, referred from it to the distance $\vec{r}$. In this case is examined the gas of free electrons, in which there are no charges of opposite signs. Further follows the standard procedure, when introduced thus illegal polarization vector is introduced into the dielectric constant

$$\vec{D}=\varepsilon_0\vec{E}+\vec{P}=\varepsilon_0\vec{E}-\frac{ne^2\vec{E}}{m\omega^2}=\varepsilon_0\left(1-\frac{1}{\varepsilon_0 L_k\omega^2}\right)\vec{E},$$

and since plasma frequency is determined by the relationship

$$\omega_p{}^2=\frac{1}{\varepsilon_0 L_k},$$

the vector of the induction immediately is written

$$\vec{D}=\varepsilon_0\left(1-\frac{\omega_p{}^2}{\omega^2}\right)\vec{E}.$$

With this approach it turns out that constant of proportionality

$$\varepsilon(\omega)=\varepsilon_0\left(1-\frac{\omega_p{}^2}{\omega^2}\right),$$

between the electric field and the electrical induction, illegally named dielectric constant, depends on frequency.

Precisely this approach led to the fact that all began to consider that the value, which stands in this relationship before the vector of electric field, is the dielectric constant depending on the frequency, and electrical induction also depends on frequency. And this it is discussed in all, without the exception, fundamental works on the electrodynamics of material media [2-6]. But, as it was shown above this parameter it is not dielectric constant, but presents summary susceptance of medium, divided into the frequency. Thus, traditional approach to the solution of this problem from a physical point of view is erroneous, although formally this approach is permitted from a mathematical point of view. However, it is not possible to take into account the initial conditions in calculating the integral in the ratios that determine the conduction current.

Further into §61 of work [2] is examined a question about the energy of electrical and magnetic field in the media, which possess by the so-called dispersion. In this case is done the conclusion that relationship for the energy of such pour on

$$W=\frac{1}{2}\left(\varepsilon E_0^2+\mu H_0^2\right), \tag{22}$$

that making precise thermodynamic sense in the usual media, with the presence of dispersion so interpreted be cannot. These words mean that the knowledge of real electrical and magnetic pour on on Wednesday with the dispersion insufficiently for determining the difference in the internal energy per unit of volume of substance in the presence pour on in their absence. After such statements is given the [ugadannaya] formula, which gives correct result for enumerating the specific energy of electrical and magnetic pour on when the dispersion ofis present,

$$W=\frac{1}{2}\frac{d\left(\omega\varepsilon(\omega)\right)}{d\omega}E_0^2+\frac{1}{2}\frac{d\left(\omega\mu(\omega)\right)}{d\omega}H_0^2\,. \tag{23}$$

But if we compare the first part of the expression in the right side of relationship (23) with relationship (9), then it is evident that they coincide. This means that in relationship (23) this term presents the total energy, which includes not only potential energy of electrical pour on, but also kinetic energy of the moving charges. On what base is recorded last term in the relationship (23) not at all clearly.

Therefore conclusion about the impossibility of the interpretation of formula (22), as the internal energy of electrical and magnetic pour on in the media with the dispersion it is correct. However, this circumstance consists not in the fact that this interpretation in such media is generally impossible. It consists in the fact that for the definition of the value of specific energy as the thermodynamic parameter in this case is necessary to correctly calculate this energy, taking into account not only electric field, which accumulates potential energy, but also current of the conduction electrons, which accumulate the kinetic kinetic energy of charges (8). The conclusion, which now can be made, consists in the fact that, introducing into the custom some mathematical symbols, without understanding of their true physical sense, and, all the more, the awarding to these symbols of physical designations unusual to them, it is possible in the final analysis to lead to the significant errors, that also occurred in the work.

5. Conclusion

By all is well known this phenomenon as rainbow. To any specialist in the electrodynamics it is clear that the appearance of rainbow is connected with the dependence on the frequency of the phase speed of the electromagnetic waves, passing through the drops of rain. J. Heaviside R. Vull assumed that this dispersion was connected with the frequency dispersion (dependence on the frequency) of the dielectric constant of water. Since then this point of view is ruling. However, this approach is physical and methodological error, and this error is committed in the works of Landau. This error occurred because of the fact that during the record of current in the material media they were entangled integral and the derivative of the harmonic function, which take the identical form and are characterized by only signs.

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