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REGARDING THE CLARIFICATION OF THE BASIC EQUATIONS OF ELECTRODYNAMICS

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Annotation

The article explains that Maxwell's equations, which are the main equations of electrodynamics, can be solved on the basis of Maxwell's equations, just as any problem about the mechanical movement of bodies can be solved using Newton's equations.

Key words: *Electrodynamics, field theory, vector function of the field, spatial derivative, space point, closed surface.*

Maxwell's equations, considered one of the basic equations of electrodynamics, are laws of nature of great importance, like the laws of Newtonian mechanics and the main laws of thermodynamics. Just as any problem about the mechanical motion of bodies can be solved using Newton's equations, a number of problems in electrodynamics can be solved using Maxwell's equations.

In the process of teaching physics in technical higher education institutions, it is appropriate to give students elementary information from the vector analysis course before covering Maxwell's equations. In this regard, it is appropriate to use the textbook "Field Theory" [1] by R.H. Mallin. In this literature, the issue of quantitative expression of the change of field functions around a

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given point is considered, and concepts of spatial derivatives obtained from the vector function of the field are introduced.

We know two different integrals of the field vector function obtained over a closed surface surrounding a space point:

$$\oint \left(\vec{a}\, d\vec{S} \right) \quad \text{and} \quad \oint \left[d\vec{S}\, \vec{a} \right]$$

We construct the ratio of these integrals to the volume bounded by the closed surface surrounding the space point:

$$\frac{\oint \left(\vec{a}\, d\vec{s} \right)}{V}, \qquad \frac{\oint \left[d\vec{s}\, \vec{a} \right]}{V}$$

A scalar quantity representing the limit of the first relation $\vec{a}$ if it is the divergence of a vector at a given point, it is a vector quantity representing the limit of the second ratio $\vec{a}$ is called the product of a vector at a given point. So, by definition:

$$div\,\vec{a} = \lim_{v \to 0} \frac{\oint \left(\vec{a}\, d\vec{s} \right)}{V}, \qquad rot\,\vec{a} = \lim_{v \to 0} \frac{\oint \left[d\,\vec{s}\,\vec{a} \right]}{V}$$

That is, the basic information acquired from the course of vector analysis helps to form a complete scientific view and knowledge system about the electromagnetic field.

We would like to discuss one more point. Taking into account the propagation of electromagnetic waves with a finite speed s, Maxwell's equations are practically written in differential form, that is, these equations are relevant for a very small area of space, more precisely, for a "point" of space. That is, it refers to a point in space at a moment in time the change of the magnetic field around this point at the same time $\vec{E}$ shows the effect of the electric field on the change. Maxwell's equations mean that any change in the field, the wave travels over long distances based on point-to-point transmission, elementary time is needed for the wave to be transmitted to an elementary distance, and a finite time interval is necessary for its transmission to a finite distance. Taking into account the above, we can write Maxwell's equations in the following form:

$$rot\vec{E} = -\frac{\partial \vec{B}}{\partial t}, \qquad rot\vec{B} = \varepsilon_0 \mu \frac{\partial \vec{E}}{\partial t} + \mu_0 \vec{j}$$

$$div\vec{E} = \frac{\rho}{\varepsilon_0}, \qquad div\vec{B} = 0$$

When necessary, Ohm's law is added to these equations

$$\vec{j} = \lambda \vec{E}$$

and the law of motion of a charged particle $m\frac{d^2\vec{r}}{dt^2} = q\vec{E} + q\left[\vec{v}\vec{B}\right]$

equations are attached.

Maxwell's equations contain all the information related to electromagnetic phenomena, therefore the entire classical electrodynamics could be studied based on the postulation of these equations. That is, there would be no need for Coulomb, Bio-Savar-Laplace and other laws, because they are all "hidden" in the above equations. Only then it would be enough to understand the physical meaning of the quantities in the expressions. In this sense, Maxwell's equations could be considered laws of nature and called the laws of electrodynamics, as a number of Methodists pointed out.

Let's consider some of the possibilities of these equations:

1. Charging $\rho\left(\vec{r}_0, t_0\right)$ and vines $j\left(\vec{r}_0, t_0\right)$ electricity at any point in space knowing its distribution $\vec{E}\left(\vec{r}, t\right)$ va magnet $\vec{B}\left(\vec{r}, t\right)$ areas can be identified and studied. Here $\vec{r}_0$ – Density ρ and $\vec{j}$ charge and current are located accordingly dV_0 cohaning radius – vectors; $\vec{r}$ - while $\vec{E}$ and $\vec{B}$ vectors are of interest dV matching radius vectors; t_0- field dV_0 charge and current densities at respectively ρ and $\vec{j}$ moment of time in case; t- time t_0 moments dV_0 of the area generated by the volume of charge and currents dV moment of occurrence in volume.

If we assume that the electromagnetic field propagates with speed s, $t \neq t_0$ and $t - t_0 = \frac{\left|\vec{r} - \vec{r}_0\right|}{c}$ attitude is appropriate. This relatively occurring time interval is called the lag time and its meaning dV_0 electromagnetic field generated in the volume dV it is the time required to reach the volume.

2. $\vec{E}\left(\vec{r}_0, t_0\right)$ and $\vec{B}\left(\vec{r}_0, t_0\right)$ in that place (more precisely, at that "point") knowing $\rho\left(\vec{r}_0, t_0\right)$ too, $\vec{j}\left(\vec{r}_0, t_0\right)$ too $\vec{E}$ and $\vec{B}$ can be determined based on the differentiation of It should be noted that the main ideas of electrodynamics are reflected in these Maxwell equations, because about the electromagnetic field $\vec{E}$ and $\vec{B}$ Even if you don't know anything other than the concepts, you can understand the following according to the equations:

a) Electric field $\vec{E}$ can be generated due to uncompensated charges, as well as a time-varying magnetic field $\vec{B}$ can also be formed with $div\,\vec{E} = \frac{\rho}{\varepsilon_0}$ and $rot\,\vec{E} = -\frac{\partial \vec{B}}{\partial t}$.

б) $rot\,\vec{B} = \varepsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial t} + \mu_0 \vec{j}$ it can be seen from the equation, $\vec{B}$ magnetic field $\vec{j}$ current and time-varying electric field based on

c) If we take into account that any electric field is created by charges, then there is no doubt that all electric and magnetic fields are the source of charges.

d) Representing the behavior of electric and magnetic fields in space and time $rot\,\vec{E} = -\frac{\partial \vec{B}}{\partial t}$ and $rot\,\vec{B} = \varepsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial t} + \mu_0 \vec{j}$ in each of the equations $\vec{E}$ and $\vec{B}$ s participation means that, $\vec{E}$ ва $\vec{B}$ s cannot exist in isolation, so we talk about them not individually, but as a single electromagnetic field $\vec{E}$, $\vec{B}$ it is necessary to talk about.

д) $\vec{E}$ and $\vec{B}$ s in the time-const case $\frac{\partial \vec{E}}{\partial t} = 0$ ва $\frac{\partial \vec{B}}{\partial t} = 0$ is appropriate, and the equations in point "g" take the following form:

$$rot\,\vec{E} = 0, \quad rot\,\vec{B} = \mu_0 \vec{j}\,.$$

In each of these equations, or $\vec{E}$, or $\vec{B}$ is participating, which in this case $\vec{E}$ and $\vec{B}$ means that it is possible to think about their independent, separate existence.

e) As can be seen from Maxwell's equations (the equations at point "g" are enough for thinking), the electric field at some point in space $\vec{E}$ the faster it changes ($\frac{\partial \vec{E}}{\partial t}$ the greater), the magnetic field generated around this point $\vec{B}$ the greater the circulation ($rot\,\vec{B}$ becomes larger), that is, it varies more strongly from point to point. By time $\vec{B}$ caused by changes in area $\vec{E}$ The above idea can be repeated about the area.

It is impossible to say that the content of Maxwell's equations, its "core" has been fully revealed with the above ideas, its possibilities are very, very wide.

USED LITERATURE:

1. Маллин Р.Х. Майдон назарияси. Т., Ўқитувчи,1983.

2. Савельев И.В. Курс обшей физики. Т.2.-М., Наука,1989

3. Sheraliyev S.S.,Irkabaev Dj.U., Sulaymanova D. and Abduganieva Y. Electronic learning complex in physics and introduction of the section"Vibrations and Waves" // Cite as: AIP Conference Proceedings 2432, 030090 (2022); https://doi.org/10.1063/5.0091221 Published Online: 16 June 2022. https://aip.scitation.org/doi/abs/10.1063/5.0091221.

4. Sheraliyev S.S., Irkabayev Dj.U., "Fizikani o'qitishda innovatsion texnologiyalarini joriy etishning ilmiy-uslubiy va amaliy jihatlari" // Texnika oliy ta'lim muassasalarining o'quv rejasidagi I-blok (majburiy fanlar)dagi barcha ta'lim yo'nalishlari bakalavrlar uchun o'quv qo'llanma. 2022 y. TDTUOF. 2022. 130 б. Olmaliq sh.