THE REMARKS TO PAPER "VARIATION OF PHYSICAL CONSTANTS, REDSHIFT AND THE ARROW OF TIME"

V.V. Karbanovski†, V.N. Markov‡, D.A. Shchipkov

Murmansk State Pedagogical University
Egorova-street, 15, 183720, Murmansk, Russia

(Received September 9, 2009)

Some remarks to paper of M. Kafatos *et al.* are given.

PACS numbers: 31.30.Jr, 12.20.Ds, 95.30.Dr.

In paper [1] authors consider the modification of the Maxwell equations including small (non-zero) conductivity of vacuum. By analogy with work [2], they have formulated the following equations:

$$\mathrm{div}\ \vec{E} = 0\,, \tag{1}$$

$$\mathrm{curl}\ \vec{H} = \sigma\vec{E} + \epsilon_0\chi_e\frac{\partial\vec{E}}{\partial t}\,, \tag{2}$$

$$\mathrm{div}\ \vec{H} = 0\,, \tag{3}$$

$$\mathrm{curl}\ \vec{E} = \mu_0\chi_m\frac{\partial\vec{H}}{\partial t}\,, \tag{4}$$

where μ_0 — the vacuum permeability constant, χ_e — the relative dielectric constant, χ_m — the relative permeability constant.

Using system (1)–(4) the authors have obtained equation

$$\Delta\vec{E} = -\frac{\epsilon_0\chi_e\chi_m\mu_0}{c^2}\frac{\partial^2\vec{E}}{\partial t^2} + \sigma\mu_0\chi_m\frac{\partial\vec{E}}{\partial t}\,. \tag{5}$$

However, it is important to note that equations (1)–(4) take place only for homogeneous and isotropic vacuum and for conductivity independent of

† `Karbanovski_V_V@mail.ru`
‡ `Markov_Victor@mail.ru`

time. Besides, in equation (4) a sign "$-$", which "usual" Maxwell equations contain (in accordance with the Faraday law and the Lenz rule), is absent. In paper [1] authors do not give a justification for such choice of sign.

Further, the form of equation (1) suggests absence of charges, as field sources. But the quantity

$$\vec{j} = \sigma \vec{E} \tag{6}$$

is usually interpreted as the density of electric current. According to standard definition, an electric current is the ordered motion of charges. However, from equation (1) follows that such charges are absent. Therefore, we have a contradiction between equations (1) and (2). Besides it is important to note that conductivity σ can be defined only in presence of charges.

Further, from conditions $j_0 = \rho c = 0$ (ρ — a charge density), which is a consequence of equation (1) follows an impossibility of interpretation $j = (\vec{j}, j_0)$ as the 4-vector of electric current. It turns out non-covariant relatively to Lorentz transformations. Thus we can conclude that the form of equations (1)–(4) is defined by choice of framework (in difference from "usual" Maxwell equations).

Let us consider now the equation (5). It obviously contains a misprint: a relation $\epsilon_0 \mu_0 = \frac{1}{c^2}$ is taken into account twice. Besides, using equation (4) we obtain not (5), but

$$\Delta \vec{E} = -\mu_0 \chi_m \left(\sigma \frac{\partial \vec{E}}{\partial t} + \epsilon_0 \chi_e \frac{\partial^2 \vec{E}}{\partial t^2} \right) . \tag{7}$$

Correction of sign in (4) leads to change of sign in the last equation. Thus equation (5) appears non-true.

In summary we shall discuss a question about interpretation of term $\frac{\partial \vec{E}}{\partial t}$ as the one responsible for the energy dissipation when the photon propagates in vacuum. For this purpose it is necessary to prove that the condition $\frac{\partial \vec{E}}{\partial t} < 0$ is fulfilled. Otherwise, the energy of the photon could increase in mentioned process.

Thus we conclude that physical meaning of research in work [1] is doubtful.

REFERENCES

[1] M. Kafatos *et al.*, *Acta Phys. Pol. B* **36**, 3139 (2005).

[2] B. Lehnert, S. Roy, *Extended Electromagnetic Theory: Space-Charge in Vacuo and the Rest Mass of the Photon*, World Scientific, Singapore 1998.