Symmetrization of Maxwell-Lorenz equations

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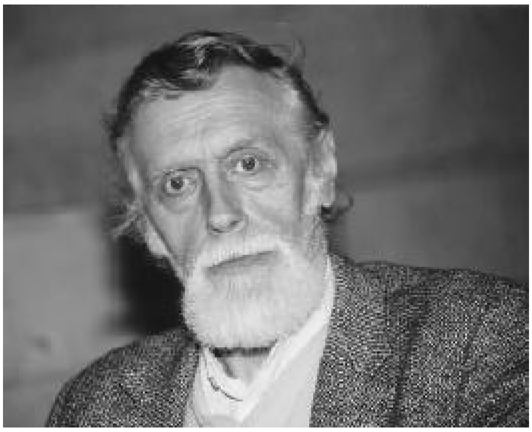

"I could say that Maxwell's followers had changed letters in his equations... Of course, we shouldn't be surprised that anything could be added to these equations, but we should be much more surprised that the additions to the equations are very small."

L. Bolzman,
From notes to Maxwell's work "On physical force lines" 1898 [1]

History of the problem of longitudinal waves in vacuum

A detailed analysis of statistical and dynamic Maxwell's equations for moving and fixed coordinates is presented in this article. The incompleteness of this system is given. The necessity of introduction of one more dynamic equation is proved.

Two new wave equations for densities of electric currents and charges are derived on the basis of new equation. It is shown that new equations together with wave equations for potentials **describe longitudinal waves in free space.** An expression for the density of longitudinal wave energy flow is obtained. The analysis of physical sense of longitudinal waves and method of their producing is given.

"Tractate on electricity and magnetism" by James Clerk Maxwell (1831-1879) appeared in 1873. According to Zommerfield's [3] point of view: "Its main achievement is the discovery of relation between optics and electrodynamics". Maxwell himself wrote about it: "Equations of electromagnetic field derived from experimental facts show that only transversal oscillations can propagate. If we leave the limits of experimental knowledge and assume a certain density of substance, which we could call electrical liquid, and choose glass or tarred electricity as representatives of this liquid, then we could have longitudinal oscillations propagating in space depending on this density. But we have no data in relation to the density of electricity, and we even don't know, should we consider glass electricity as a substance or absence of substance. Therefore, science on electromagnetism leads to the same conclusions as optics does in relation to the direction of disturbances, which can propagate through a field. Both these sciences state the transverse character of these oscillations and both of them give the same speed of propagation. From the other hand, both sciences are powerless to answer the question of proof or denial of existence of the longitudinal oscillations" [1]. The Hertz's experiments proved the conclusion made by Maxwell on the transverse character of electromagnetic waves.

Further Maxwell's consideration of longitudinal waves was forgotten, and lasting opinion on possibility of only longitudinal waves in vacuum was established in electrodynamics. Obviously, judging by literature, there were no attempts to discover longitudinal waves in vacuum, and above all there were no theoretical premises.

(Editor's note: it is correct in academician science, but there are known Tesla's works and other research results on longitudinal waves).

The following paradigm established in electrodynamics: "Since macroscopic electrodynamics has been a theory of Maxwell's equations, it is a typical axiomatically organized discipline, which does not allow any principally discoveries in physics. Universality of main electrodynamics laws expressed by Maxwell's equations and their fullness hardly can call any doubt in foreseeable future. Thus, if not to speak about investigation of properties of various mediums, then in essence there will be no place for experiment in electrodynamics: you know, it is practically possible to get an answer on any question on a deductive way. It is enough only to formulate and solve appropriate (usually boundary-value) problem for Maxwell's equations"; V. Nikolsky stated it in "On modern problem statement in electrodynamics" [4]. However, sometimes the idea of longitudinal waves was considered formally. It was, for example, in the problem of resolution of electrostatic field by flat waves [7].

Wave equations for electrical potential (φ and magnetic vector potential $\overline{A}$) are quite applicable for longitudinal waves. **But till recently it was considered that these values are simply comfortable for mathematical calculations and nothing more.** The last achievements in the area of quantum mechanics denied this opinion and led to **a conclusion that scalar and vectorial potentials are fundamental values** [8, 10]. This entered into evident contradiction with electrodynamics paradigm.

It is shown in the given work that Maxwell's equations have a high extent of symmetry. Oliver Heavyside [2] repeatedly paid attention on this fact. In 1885 he re-wrote Maxwell's equations in double form so "electrical and magnetic aspects of electromagnetism are symmetrically presented and related". Besides, he considered this symmetry as a supporting mean for calculations based on Maxwell's equations: "This interpretation method of Maxwell's electromagnetic scheme used in the text (it was firstly introduced by O. Heavyside in the article "Electromagnetic induction and its propagation" of January 3, 1885) can possibly be called "duplex-method" as it is characterized by detection of electrical, magnetic and electromagnetic correlations in double form, which is symmetrical relatively to electrical and magnetic aspects. But it is not only the method of detection of correlations previously latent by means of introduction of vector-potential and incidental formulas. It is a working method as well".

The symmetry of Maxwell's equations becomes most apparent in their splitting separately on static and dynamic equations in relation to time as well as relatively to space. Such detailed table of equations immediately detects the presence of system of equations incompleteness. Vacant place in the table requires filling it. I'll do it further in the text of this article.

Editor's note: In original text of the article the author goes on with the following equations

- *Equation of static fields in fixed coordinate system*
- *Equation of dynamic fields in fixed coordinate system*
- *Equations of static fields in moving coordinate system*
- *Derivation of the equation for displacement current*
- *Derivation of the equation for induction charge*
- *Wave equations for transverse wave*
- *Derivation of wave equations for longitudinal wave*
- *Complete system of Maxwell-Lorenz equations*
- *Equation of energy flow density of the transversal wave*
- *Equation of energy flow density of the longitudinal wave*

Conditions for longitudinal waves' radiation

What are the conditions for longitudinal waves' radiation? It is obvious that as distinct from transverse-wave transmitters (dipoles) having cylindrical symmetry, longitudinal-waves transmitters should have spherical symmetry, i.e. they should be monopoles.

Let's compare the mechanisms of transverse-wave and longitudinal-wave radiation. As an example we take two simplest transmitters, charged plane condenser (analog to dipole) (Fig. 1) and charged solitary sphere (Fig. 2). If the charged condenser has the energy W with the volume V, then **the accelerated decrease of plane condenser volume** will leads to the accelerated decrease of energy content (at the constant charge), i.e. to its radiation:

$$\frac{\partial^2 W}{\partial t^2} = w \cdot \frac{\partial^2 V}{\partial t^2} \quad (1)$$

where $w = \frac{W}{V}$ is the density of condenser field energy.

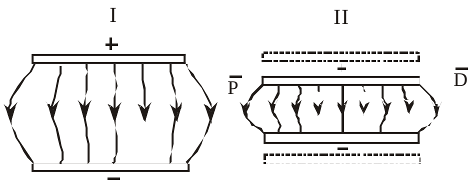

Fig. 1

Energy of condenser field forced out with acceleration by the plate of condenser will be radiated in surrounding space as a transversal wave, since energy flow goes perpendicular the force lines of the field.

With the change of volume taken by solitary charged sphere, Fig.2, the energy of field displaced by this sphere with acceleration from the previous volume will be radiated as a **longitudinal wave since direction of energy flow is along the force lines of the field.** The power radiated in both cases will be equal to the speed of change of the field energy in these systems.

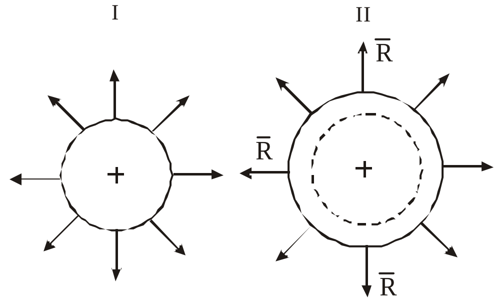

Fig. 2

Other mechanisms of longitudinal waves' radiation are possible. For example, on the basis of equation

$$r = -c^{-2}\overline{V} \cdot \overline{J} \quad (2)$$

To do this it is necessary to pass alternating current in a coil of wire, which is rotating on its axis. That will lead to appearance of alternating induction charge. And to separate the longitudinal wave from concomitant transversal wave, we should place the coil into the conductive screen. This screen will serve as a barrier for transversal wave, but it cannot prevent passing of longitudinal wave through it. The more the square of the coil, number of its turns and speed of its rotation are, the more intensive the radiation of longitudinal wave will be. Sizes of the coil will be limited by chosen frequency of radiation.

Possible physical sense of longitudinal waves

By analysis of known physical fields, more of them manifest only in small volumes near the sources. They are: nuclear field, field of weak interaction, electrostatic and magnetostatic fields, though the latter can spread at the distance of about Galaxy sizes. However, really long-distance fields are only two kinds of fields, electromagnetic waves and gravitational field. Only these fields penetrate the entire visual Universe. And both fields decrease by analogous law, i.e. inversely to the square of distance.

It naturally leads to the thought, if gravitational field is wave field like electromagnetic field. But, unlike the latter, it is some other class of waves, but not transverse, may be longitudinal waves.

In such case the longitudinal waves will be disturbed with pulsation of atomic nuclei. These waves will lead to the exchange with energy between the nuclei and their interaction, which is analogous to Van der Vaals forces due to zero energy

$$W_0 = \frac{1}{2} h n_0$$

But in this case there is another law of force decrease with distance. It is not only mechanism of interaction between bodies with participation of longitudinal waves. Pulsations of macrobodies will lead to modulation of nuclei radiation and, therefore, to additional frequencies in the spectrum of oscillations, which are radiated and absorbed by bodies in the process of gravitational interaction. Most likely, the spectrum of radiation of longitudinal waves by atomic nuclei is discrete, but assembly of macrobodies' atoms may give continuous spectrum analogous to heat radiation. Probably, there is a linear spectrum in the area of low frequencies besides continuous spectrum. Linear spectrum is connected with pulsations of macrobodies. Then in gravitational fields typically wave phenomena are possible, they are diffraction and interference.

To our opinion, the example of observation of gravitational field diffraction phenomena is the case of solar eclipse observation of February 15, 1961 in Yaroslavl city, Russia. It was made by the group of researchers under the leadership of V.V. Radzievsky by means of double horizontal pendulum [9]. The following fact got in experiment can serve as the evidence of gravitational field diffraction: the obtained effect of gravitational eclipse exceeded the estimated calculated effect on 1-2 orders. The duration of the effect was too small and after the end of partial eclipse some additional maximum of pendulum deviation occurred. A possibility of longitudinal waves' connection with the phenomenon of gravitational interaction of bodies requires more detailed consideration of the observed anomalous structures and effects in the Universe since there are big resources of unexpected phenomena, which can appear due to interference and diffraction of gravitational field.

References

1. James Clerk Maxwell. Selected works on the theory of electromagnetic field. GITT L., M., 1952.
2. James Clerk Maxwell. Speeches and articles. "Nauka", M., 1963.
3. A. Zommerfield. Electrodynamics. I., L., M., 1958.
4. A.T. Grygoryan, A.N. Vyaltsev. Henry Hertz. "Nauka", M., 1968.
5. Mary-Antuanette Tonella. Principles of electromagnetism and theory of relativity. I. L. M., 1962.
6. A.N. Matveev. Electrodynamics and theory of relativity. "Vysshaya Shkola", M., 1964.
7. L.D. Landau, E.M. Livshitz. Theory of field. Fismatgiz, M., 1960.
8. R. Feinman, R. Leyton, M. Sands. Feinman's lectures in physics. Vol. 6. Electrodynamics. "Mir", M., 1977.
9. I.I. Kagalnikova, V.V. Radzievsky, Yu.A. Chernikov, V.I. Chernyshev, V.V. Shuvalov. On observation of solar eclipse gravitational effect of February 15, 1961 in Yaroslavl. VAGO bulletin, #31, 1962.
10. I.M. Dmitriev. Quantum effects in superconductivity. New facts in the life of science and techniques. Series Physics and Astronomy, #3. "Znanie", M., 1968.
11. P.S. Kudryavtsev. History of physics. Vol. II, Uchpedgiz, M., 1956.
12. O.D. Hvolson. Course of physics. Vol. 5 RSFSR GIZ. Berlin, 1923.
13. K.P Butusov. Diffraction of gravitational field. Materials of International scientific conference "New ideas in natural science". Saint Petersburg, 1996.
14. K.P. Butusov.interference of gravitational field of the Sun and planets. Works of the Congress-98 "Fundamental problems of natural science". Saint Petersburg, 1999.

Editorial notes: You can order the full variant of this article from the author or from Faraday Labs Ltd. Full variant includes 15 pages and 58 formulas.