Journal of Scientific Exploration, Vol. 22, No. 2, pp. 227–232, 2008 0892-3310/08

ESSAY

"Scalar Wave Effects according to Tesla"[3] and "Far Range Transponder"[4] by K. Meyl

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Abstract—In the recent past a hypothetical waveform, longitudinal electric or magnetic waves, shortly denoted electric scalar waves or simply scalar waves, is discussed. To give a theoretical proof of the existence of such longitudinal electric waves K. Meyl starts with an approach that he calls a ''new and dual field approach''(3,4) and that should be more general than Maxwell's equations. In the following commentary we discuss the cogency of the theoretical considerations presented in Meyl's two articles(3,4) in order to answer the question of whether this approach really gives an indication of the existence of longitudinal electric waves. It is shown that this ''new and dual field approach'' actually consists of the very special relations describing plane transverse electromagnetic waves. The ''Fundamental Field Equation'' presented in Meyl's articles also does not have any solution in the form of longitudinal electric waves. A general weakness of the two articles is that Meyl does not present any solutions or a clue related to possible solutions of the partial differential equations he presents. Thus, for example, the discussion following the ''Fundamental Field Equation'' (key words: A possible world equation, quantization of the field) lacks any foundation. The model Meyl starts from describes the propagation of electromagnetic fields through media with special properties and does not include any sources responsible for the emission of electromagnetic radiation. Hence, the equations he obtained do not describe the near field behavior of electromagnetic waves. The consequence is that the properties he ascribed to the near field are also without any foundation.

Keywords: Near field as a vortex field—vortex model of the scalar waves—phenomenology—antenna noise caused by Lorentz contraction of vortices and vortex works as a frequency converter

1. Introduction

Plane electromagnetic waves traveling in free space are transverse, i.e., electric and magnetic field are perpendicular to the direction of propagation, as is well known as a result of Maxwell's equations.

In the recent past a hypothetical waveform is discussed, especially in the alternative scientific community. It is called longitudinal electric or magnetic waves, sometimes shortly denoted as electric scalar waves or simply scalar waves. The direction of the electric or magnetic field of scalar waves, as distinct from transverse waves, should be parallel to the direction of propagation. Various unusual properties are ascribed to those longitudinal electric waves. They are expected to propagate with superluminal velocity, to cause dangerous electromagnetic pollution, e.g., of mobile phone radiation, and to cause various positive effects in medicine. The newest version is that those longitudinal electric waves are considered to be the physical basis for far range transponders.[3,4] But up to now any experimental evidence for the existence of such scalar waves has not been given.

A strong indication of the existence of longitudinal electric waves in free space would be a theoretically substantiated deduction. K. Meyl has attempted to give such a theoretical proof in a vast number of publications (cf. his web page and references given therein[1]). A critical review[2] of the theoretical part of some of those publications has shown that there was no indication of the existence of scalar waves. Recently two further publications have been appeared.[3,4] Instead of Maxwell's equation an approach was used that was called the "new and dual field approach." The aim of this commentary is to discuss the cogency of the theoretical considerations presented in Meyl's articles[3,4] in order to answer the question of whether this approach really gives an indication of the existence of longitudinal electric waves.

2. Meyl's "New and Dual Field Approach"

To give a theoretical proof of the existence of longitudinal electric waves Meyl starts with a new approach.[3,4] The so-called "new and dual field approach" consists of two equations according, to Meyl,[3,4] going back to M. Faraday[3, p. 83;4, p. 257, eqs. 2.1 and 2.3].

$$\boldsymbol{E} = \boldsymbol{v} \times \boldsymbol{B} \tag{1}$$

$$\boldsymbol{H} = -\boldsymbol{v} \times \boldsymbol{D} \tag{2}$$

Equations 1 and 2 should be more general than Maxwell's equations and comprise them. Equation 1 describes the electric field $\boldsymbol{E}$ induced in a conductor moving with velocity $\boldsymbol{v}$ in a magnetic flux density $\boldsymbol{B}$, as Meyl discussed it by the example of the unipolar generator. Equation 2 is introduced according to the rules of some duality, which, however, is not explained. It should be emphasized that $\boldsymbol{v}$ denotes the velocity of a moving conductor, hence, with speed less than the speed of light.

From Equations 1 and 2 it is evident that $\boldsymbol{E}$ is perpendicular to both $\boldsymbol{v}$ and $\boldsymbol{B}$, and $\boldsymbol{H}$ is perpendicular to $\boldsymbol{v}$ and $\boldsymbol{D}$. Inserting Equation 2 into Equation 1 and using the constitutive relations for the electric displacement $\boldsymbol{D}$,

$$\boldsymbol{D} = \varepsilon \boldsymbol{E} \tag{3}$$

and for the magnetic field $\boldsymbol{H}$

$$\boldsymbol{B} = \mu \boldsymbol{H} \tag{4}$$

with $\varepsilon = \varepsilon_0\ \varepsilon_r$, $\mu = \mu_0\ \mu_r$, we deduce the equation

$$\boldsymbol{E}\left(1 - \frac{|\boldsymbol{v}|^2}{c^2}\right) = 0 \tag{5}$$

where $c = 1/\sqrt{\varepsilon\mu}$ denotes the speed of light. By Equation 5 the Equations 1 and 3 are only consistent if the magnitude of the velocity vector introduced in Equations 1 and 2 equals the speed of light, contradicting the original meaning of $\boldsymbol{v}$ in Equations 1 and 2. And if we assume $|\boldsymbol{v}| = c$, then Equations 1 and 2 are just the relations required by Maxwell's equations for plane electromagnetic waves (see, e.g., Jackson[5]), that is,

$$\boldsymbol{E} = \boldsymbol{E}(ct \pm \boldsymbol{rn}) \quad \boldsymbol{B} = \boldsymbol{B}(ct \pm \boldsymbol{rn}) \tag{6}$$

where $\boldsymbol{n}$ denotes the unit vector of the propagation. As is evident from Equations 1 and 2, with $\boldsymbol{v} = c\boldsymbol{n}$ those waves are transverse, i.e., the field vectors $\boldsymbol{E}$ and $\boldsymbol{B}$ are perpendicular to the direction of propagation $\boldsymbol{n}$, and in addition, electric and magnetic fields are mutually perpendicular. Hence, this "new and dual field approach" actually consists of the very special relations describing plane transverse electromagnetic waves!

In order to derive Maxwell's equations from Equations 1 and 2 it is assumed for incomprehensible reasons in Meyl's articles[3,4] that $\boldsymbol{E}$ and $\boldsymbol{B}$ depend on time-varying position coordinates $\boldsymbol{r}(t)$ rather than on time and position (see equations 3.6 and 3.7 in Meyl[3,4]). This inadmissible assumption enables Meyl to apply the relations

$$(\boldsymbol{v}\ \mathrm{grad})\boldsymbol{B} = \frac{\mathrm{d}\boldsymbol{B}}{\mathrm{d}t} \quad (\boldsymbol{v}\ \mathrm{grad})\boldsymbol{E} = \frac{\mathrm{d}\boldsymbol{E}}{\mathrm{d}t} \tag{7}$$

$\boldsymbol{v} = \mathrm{d}\boldsymbol{r}/\mathrm{d}t$, in order to obtain the equations curl $\boldsymbol{E} = -\,\mathrm{d}\boldsymbol{B}/\mathrm{d}t + \boldsymbol{v}$ div $\boldsymbol{B}$, curl $\boldsymbol{H} = \mathrm{d}\boldsymbol{D}/\mathrm{d}t + \boldsymbol{j}$ (see equations 3.8 and 3.9 in Meyl[3,4]). Those look like Maxwell's equations; however, they contain ordinary time derivatives instead of partial time derivatives, as needed for Maxwell's equation. These shortcomings do not surprise us; since Equations 1 and 2 describe the special case of plane transverse electromagnetic waves given in Equation 6, it is impossible to deduce Maxwell's equations from Equations 1 and 2.

In addition, it is noticeable that in Meyl's articles ordinary and partial time derivatives are mixed up frequently (for example, in equations 2.2, 3.8, 3.9, 3.14, and 3.16 and in the wave equation 4.6 in Meyl[3,4]).

3. Meyl's "Fundamental Field Equation"

Summarizing, we have seen that the "new and dual field approach" in Meyl's articles cannot give proof of the existence of longitudinal electric or longitudinal magnetic waves. So there is no need for further discussions about the other statements in his articles. Even so, we want to take a closer look at the "fundamental field equation" and "possible world equation" in his works. There one assumes additionally that div $\boldsymbol{B} \neq 0$ (cf. equation 3.15 with equation 3.10 in Meyl[(3,4)]), i.e., the magnetic field is not free of sources (magnetic charges or monopoles). This is not new (consequences of this assumption have been discussed before, for example in Jackson[(5)]). However, up to now there is no experimental evidence of the existence of magnetic monopoles. Meyl calls the term $\boldsymbol{v}$ div $\boldsymbol{B}$ the potential vortex, despite the fact that div $\boldsymbol{B}$ describes the source density of the vector field $\boldsymbol{B}$ and there is no relation to any potential and vortex.

From Maxwell's equations generalized in this way Meyl derives in his articles[(3,4)] an equation that he calls the "fundamental field equation" (see equation 4.5 in Meyl[(3,4)]).

$$\frac{\partial^2 \boldsymbol{E}}{\partial t^2} + \left(\frac{1}{\tau_1} + \frac{1}{\tau_2}\right)\frac{\partial \boldsymbol{E}}{\partial t} + \frac{1}{\tau_1 \tau_2}\boldsymbol{E} = -\boldsymbol{c}^2 \text{curl curl } \boldsymbol{E} \tag{8}$$

with $\tau_1 = \varepsilon/\sigma$, σ is the electric conductivity and τ_2 is the magnetic counterpart to τ_1. To prove that this equation describes longitudinal electric waves we use a trial solution of longitudinal plane waves,

$$\boldsymbol{E} = \boldsymbol{E}(ct \pm \boldsymbol{rn}) \tag{9}$$

where we now assume that $\boldsymbol{E}$ is parallel to $\boldsymbol{n}$. Inserting Equation 9 into Equation 8 with curl$\boldsymbol{E}(ct \pm \boldsymbol{rn}) = \pm \boldsymbol{n} \times d\boldsymbol{E}(s)/\mathrm{d}s = \pm \mathrm{d}/\mathrm{d}s(\boldsymbol{n} \times \boldsymbol{E}(s)) = 0$, where $s = ct \pm \boldsymbol{rn}$, we get

$$\frac{\partial^2 \boldsymbol{E}}{\partial t^2} + \left(\frac{1}{\tau_1} + \frac{1}{\tau_2}\right)\frac{\partial \boldsymbol{E}}{\partial t} + \frac{1}{\tau_1 \tau_2}\boldsymbol{E} = 0 \tag{10}$$

The solutions of Equation 10 are exponentially decaying functions, i.e., there are no wave solutions in contradiction to the trial solution Equation 9. Consequently, Equation 8 does not give any evidence of longitudinal plane electric waves, and there is nothing "fundamental" in Equation 8.

It should be noted that Meyl does not give in his articles[(3,4)] any hint of solutions of the partial differential equations he presents. It seems that he believes that special solutions can be ascribed to the individual differential operator terms of partial differential equations. He ascribed the 1st term on the left-hand side and the term on the right-hand side in Equation 8 to electromagnetic waves, the 2nd term to an eddy current, the 3rd term to a potential vortex and the 4th to Ohm's law (see equation 4.5 in Meyl[(3,4)]). Such an interpretation is definitely not valid. Crucial to the properties of the electromagnetic field described by this and the other differential equations presented are their solutions. Thus, the discussions after equation 4.5 in Meyl's articles[(3,4)] (key words: A possible world equation, quantization of the field) are without any foundation; they are pure speculations.

4. Meyl's General Wave Equation

In the equation

$$\boldsymbol{v}^2 \text{grad div} \boldsymbol{B} - \boldsymbol{c}^2 \text{curl curl} \boldsymbol{B} = \frac{d^2\boldsymbol{B}}{dt^2} \tag{11}$$

(see equation 4.9 of Meyl[3,4]), Meyl calls it the ''general wave equation'' in his articles), Meyl ascribes $\boldsymbol{c}^2$ curl curl $\boldsymbol{B}$ to a transverse wave propagating with speed c, $\boldsymbol{v}^2$ grad div $\boldsymbol{B}$ to a longitudinal wave propagating with velocity $\boldsymbol{v}$ and $d^2\boldsymbol{B}/dt^2$ as wave velocity of propagation. His interpretation of this differential equation reads: ''The wave equation (equation 4.9) can be divided into longitudinal and transverse wave parts, which however can propagate with different velocity''[3,4]. Such an interpretation is definitely not valid. Again it should be emphasized that the solution of this partial differential equation is crucial to whether there are longitudinal waves or not. Again, we have no clue on explicit solutions of this equation, not even of the existence of such solutions.

Some final remarks:

1. On a first glance the change of the meaning of the velocity $\boldsymbol{v}$ is stumping. In Equations 1 and 2 (Meyl equations 2.1 and 2.3[3,4]), $\boldsymbol{v}$ was the velocity of a moving conductor; in Equation 7 the velocity along a not more closely defined trajectory $\boldsymbol{r}$(t) (equations 3.6 and 3.7 in Meyl[3,4]); and in Equation 11 (equation 4.9 of Meyl[3,4]), an arbitrary phase velocity of longitudinal waves.
2. As mentioned before, Meyl does not present any solution or a clue of a possible solution of Equation 11 (equation 4.9 in Meyl[3,4]). Hence, the discussion of properties of the far and near field that follows equation 4.9 in Meyl's articles is also without any foundation.
3. This applies in particular to the near field. The model Meyl started from describes the propagation of electromagnetic fields through media with special properties. He did not include any sources responsible for the emission of electromagnetic radiation, like oscillating charges, currents or dipoles, etc. Hence, the equations he obtained do not describe radiation processes and thus the near field behavior of electromagnetic waves is not included. The consequence is that the properties he ascribed to the near field (key words: Near field as a vortex field, vortex model of the scalar waves, antenna noise caused by Lorentz contraction of vortices and vortex works as a frequency converter) are nothing but highly fanciful speculations.

The résumé is that Meyl's articles do not deliver any clue for the existence of longitudinal electric waves in free space. This comment should be concluded with a citation of Meyl's interpretation for a longitudinal wave (chapter 4 in Meyl[3], p. 86 and in Meyl[4], p. 268): ''Completely different is the case for the longitudinal wave. Here the propagation takes place in the direction of an oscillating field pointer, so that the phase velocity permanently is changing and merely an average group velocity can be given for the propagation.''

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