A review on possible physical meaning of elastic-electromagnetic mathematical equivalences

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Abstract

It is known, despite special theory of relativity has been widely accepted, in our recent draft submitted to this journal it is shown that some experiments have been carried out suggesting superluminal wave propagation, which make Minkowski lightcone not valid anymore. Therefore, it seems worth to reconsider the connection between elastic wave and electromagnetic wave equations, as in their early development. In this paper we will start with Maxwell-Dirac isomorphism, then we will find its connection with elastic wave equations.

Keywords: elasto-electromagnetic wave equations; realism interpretation; Maxwell-Dirac isomorphism.

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1. Introduction

In its earliest development, electromagnetic equations of Maxwell have elastic wave properties. As Ikelle noted :

"Ether was held to be invisible, without odour, and of such a nature that it did not interfere with the motions of bodies through space. The concept was intended to connect the elastic wave theory with Maxwell's field theory. However, all attempts to demonstrate the existence of ether, most notably the experiment reported by Michelson & Morley (1887), produced negative results and stimulated a vigorous debate that was not ended until the special theory of relativity, proposed by Einstein (1905), became accepted."

Despite special theory of relativity has been widely accepted, in our recent draft submitted to this journal, it is shown that some experiments have been carried out suggesting superluminal wave propagation, which make Minkowski lightcone not valid anymore:

$$ds^2 = dr^2 - c^2.dt^2 \qquad (1)$$

setting ds=0, we got:

$$dr^2 = c^2.dt^2 \qquad (2)$$

then

$$dr/dt = c \qquad (3)$$

while experiments showing superluminal propagation are abound. This result may be not surprising, along with some discussions on the meaning of empty spacetime [5], but it leads us to consider again the connection between elastic wave equations and electromagnetic wave equations.

2.   An expression of Maxwell-Dirac isomorphism

First of all, let us point out that there are some papers in literature which concerned with the formal connection between classical electrodynamics and wave mechanics, especially there are some existing proofs on Maxwell-Dirac isomorphism. Here the author will review a derivation of Maxwell-Dirac isomorphism i.e. by Hans Sallhofer and Volodimir Simulik.

3.   Sallhofer's method

Summing up from one of Sallhofer's papers[1], he says that under the sufficiently general assumption of periodic time dependence the following connection exists between source-free electrodynamics and wave mechanics:

$$\sigma \cdot \left[\begin{array}{l} rotE + \dfrac{\mu}{c}\dfrac{\partial}{\partial t}H = 0 \\ rotH - \dfrac{\varepsilon}{c}\dfrac{\partial}{\partial t}H = 0 \\ \quad div\varepsilon E = 0 \\ \quad div\mu H = 0 \end{array} \right]_{divE=0} \equiv \left[(\gamma \cdot \nabla + \gamma^{(4)}\partial_4)\Psi = 0 \right] \tag{4}$$

In words: Multiplication of source-free electrodynamics by the Pauli-vector yields wave mechanics.[1] In simple terms, this result can be written as follows:

$$P \cdot M = D, \tag{5}$$

Where:

        P = Pauli vector,

        M = Maxwell equations,

        D = Dirac equations.

We can also say: Wave mechanics is a solution-transform of electrodynamics. Here one has to bear in mind that the well-known circulatory structure of the wave functions, manifest in Dirac's hydrogen solution, is not introduced just by the Pauli-vector.[1]

4.   Possible connection with elastic wave equations

Now it would be certainly more interesting to connect the above equations further to elastic wave equations, as discussed by Ikelle [4]:

$$-\Delta^+_{ijkl}\partial_j \tilde{H}_{kl}(x,t,x_s) + \partial_t D_i(x,t,x_s) = -J_i(x,t,x_s),$$
$$\Delta^-_{nmpq}\partial_p \tilde{E}_q(x,t,x_s) + \partial_t \tilde{B}_{nm}(x,t,x_s) = -\tilde{K}_{nm}(x,t,x_s). \tag{6a-b}$$

Assuming that equation (6a-b) are equivalent to elastic wave equations, then we can write :

$$\sigma \cdot \begin{bmatrix} rotE + \dfrac{\mu}{c}\dfrac{\partial}{\partial t}H = 0 \\[2mm] rotH - \dfrac{\varepsilon}{c}\dfrac{\partial}{\partial t}H = 0 \\[2mm] div\varepsilon E = 0 \\[2mm] div\mu H = 0 \end{bmatrix}_{divE=0} \equiv \begin{bmatrix} -\Delta^{+}_{ijkl}\partial_j \tilde{H}_{kl}(x,t,x_s) + \partial_t D_i(x,t,x_s) = -J_i(x,t,x_s) \\[2mm] \Delta^{-}_{nmpq}\partial_p \tilde{E}_q(x,t,x_s) + \partial_t \tilde{B}_{nm}(x,t,x_s) = -\tilde{K}_{nm}(x,t,x_s) \end{bmatrix} \quad (7)$$

Then, if put the same equivalence from (7) to Sallhofer's version of Dirac-Maxwell isomorphism, then we obtained:

$$\left[(\gamma\cdot\nabla+\gamma^{(4)}\partial_4)\Psi=0\right] \equiv \begin{bmatrix} -\Delta^{+}_{ijkl}\partial_j \tilde{H}_{kl}(x,t,x_s) + \partial_t D_i(x,t,x_s) = -J_i(x,t,x_s) \\[2mm] \Delta^{-}_{nmpq}\partial_p \tilde{E}_q(x,t,x_s) + \partial_t \tilde{B}_{nm}(x,t,x_s) = -\tilde{K}_{nm}(x,t,x_s) \end{bmatrix} \quad (8)$$

The above equations suggest that there is not only mathematical correspondence between Dirac-Maxwell equations but also between elastic wave and Maxwell equations. Their implications should be investigated by experiments.

5.   Concluding remarks

Despite its wide acceptance, special theory of relativity is not without problems, like the meaning of empty spacetime. Does empty spacetime have their own mechanical properties? In this paper we discuss link between elasto-electromagnetic wave equations, then we link them with Sallhofer's approach of Maxwell-Dirac isomorphism. This paper was inspired by an old question: Is there a consistent and realistic description of wave function, both classically and quantum mechanically? It can be expected that the above discussions will shed some lights on such an old problem especially in the context of physical meaning of quantum wave function. This is reserved for further investigations.

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