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Maxwell Equations and the 4th Dimension

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Abstract: ***Maxwell equations is viewed under the 4th dimension Ct. Not with t as an evolution of events seen by Mikowski, but with τ of Planck's inside in 1900. In other words, Cτ as proposed by the Autor in his theory of space in 2021, i.e. the 4th longitudinal dimension lambda; energy´s wavelength Cτ.***

Keywords: Maxwell, theory of space, 4th dimension

1. Introduction

James Clerk Maxwell published in 1861 and 1862 the equations that reveal electricity and magnetism relation with a linked set of 20 differential equations in 20 variables. With this, he consolidated Gauss´s, Ampere´s, and Faraday's initial discoveries. In 1865, he showed the special case of electromagnetic waves [1] and corroborated Faraday´s initial thoughts of light. In 1884, Oliver Heaviside presented them in the modern form reducing the 20 equations down to four partial differential equations in 2 variables. The Author presented in 2021 [2] a novel interpretation of quantum mechanics and in 2023 a new interpretation of the Special Theory of Relativity (STR) [3]. In those papers, the 4th dimension Cτ is treated as the longitudinal dimension of energy. Plank´s time periodicity "τ" [4] gave the beginning of quantum physics and revealed nature´s intimate presence in a discrete way. The so known spacetime is presented as space-energy; energy modifying the scale of space as shown by Albert Einstein in 1915 in his General Theory of Relativity (GTR). In the same way, energy modifies the scale of time in the same manner. Electric and magnetic fields must also have this periodicity presence as seen in the following paragraph.

2. Faraday´s law of induction

One of the great contributions of Faraday is the electromagnetic induction published in 1831.

$$\nabla \times \mathbf{E}(\mathbf{r}, t) = -\partial \mathbf{B}(\mathbf{r}, t)/\partial t \quad [1]$$

At the dimensions of quantum systems, the equation can be expressed as:

$$\nabla \times \mathbf{E} = -\partial C\mathbf{B}/\partial C\tau \qquad \text{for } t = \tau \quad [2]$$

$$\nabla \times \mathbf{E} = -\partial\, i^*C\mathbf{B}/\partial\lambda \qquad \text{where } \lambda = i^*C\tau \quad [3]$$

In equation [3], **E** and C**B** are expressed with the same units (C is the speed of electromagnetic waves; understood in Space theory as the speed of the presence fluctuation). The other interesting feature is that there is the imaginary number "i"; a fundamental issue in relativity $\{(\Delta r)^2 + (\Delta \lambda)^2 = \text{constant} = (\Delta r)^2 - (\Delta Ct)^2\}$. The imaginary number also expresses orthogonality between the fields. The square of the electric field modulus is proportional to the energy, as well, as the magnetic field modulus. In the special case of electromagnetic waves, the square of "i" provides a perfect understanding of why electric and magnetic fields increment and diminish together; a total energy constant during the propagation. Like in a pendulum where kinetic energy varies with the gravitational potential energy (negative or opposed energy to kinetic).

Figure 1 shows that when energy decreases, the modulus of the magnetic field also decreases. Meanwhile lambda increments ($\lambda = h^*C/\text{energy}$), the partial derivative of C**B** shows a positive slope that is modified to negative due to the negative sign. The curl of the electric field **E** also decreases with lower energy and develops a negative slope.

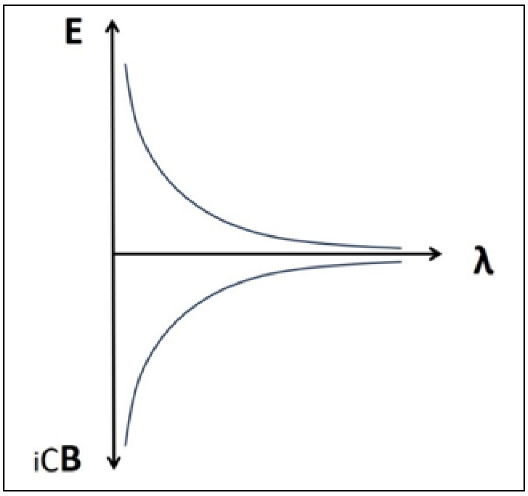

Figure 1

3. Ampere and Maxwell equation

In 1823, Ampere gave the relation between electric current and magnetic field; it was completed by Maxwell in 1865.

$$\nabla \times \mathbf{B}(\mathbf{r}, t) = \mu \mathbf{J} + \mu\varepsilon\, \partial \mathbf{E}(\mathbf{r}, t)/\partial t \quad [4]$$

For the quantum system, t = τ the equation can be expressed as:

$$\nabla \times C\mathbf{B} = \mu\, C\mathbf{J} + \partial \mathbf{E}/\partial C\tau \quad [5]$$

$$\nabla \times i^*C\mathbf{B} = \mu\, i^*C\mathbf{J} - \partial \mathbf{E}/\partial i^*C\tau \quad [6]$$

From equations [3] and [6], the following equation expresses the combined field **E** + i*C**B**:

$$\nabla \times (\mathbf{E} + i^*C\mathbf{B}) = \mu\, i^*C\mathbf{J} - \partial(\mathbf{E} + i^*C\mathbf{B})/\partial\lambda \quad [7]$$

4. Conclusions

At the relativistic level, is better to deal with the field **E** + i*C**B** because it contains both fields; something necessary for the conservation of energy from any inertial frame of reference. In the same way that mass-energy (mC^2) and kinetic energy go together giving a constant total energy independent from any inertial frame of reference. For example, in the case an observer changes from an outside view to the proper frame; it will lose the kinetic energy but will gain mass energy in the exact amount for prevailing the conservation law. In the same way, for a reference frame that deals with a kinetic electric field (current **J**), the magnetic field maintains the total energy. An important issue is that the magnetic energy (carrying the imaginary number) is opposed to the electric energy; as kinetic energy does with mass-energy in Lorentz´s equations (one by the gamma factor and the other by the inverse of gamma).

Declarations

The author declares no conflicts of interest regarding the publication of this paper.

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