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Extension of Maxwell's Equations for Determination of Relativistic Electric and Magnetic Field

Chandra Bahadur Khadka

Abstract**:** ***This paper presents the transformation of four Maxwell's equation into relativistic electromagnetism via the partial differential equation of electric and magnetic field with respect to spatial and temporal coordinates. The relativistic form of magnetic field $\vec{B} = \vec{B}_0/\sqrt{1-v^2/c^2}$ is developed based on Gauss's law for magnetism and Ampere's law while the relativistic form of electric field $\vec{E} = \vec{E}_0/\sqrt{1-v^2/c^2}$ is developed based on Gauss's law for electricity and Faraday's law, where B_0 and E_0 are rest magnetic and electric field. We can easily explain theoretically about the various properties of electromagnetic waves (EM waves) with help of this relativistic formula such as; 1) Why EM waves are not deflected by electric and magnetic field as they have both oscillating electric and magnetic field? ;2) why can't light travel faster than the speed of light? In this highly interesting topic, the particular purpose is not to enter into the merits of existing theory of relativistic electromagnetism, but rather to present a succinct and carefully reasoned account of new aspect of Maxwell's equation which properly describe the relativistic nature of magnetic and electric Field.***

Keywords**:** ***Electric Field, Electromagnetic wave, Magnetic Field, Maxwell's Equation, partial Differential Equation, Special Relativity.***

I. INTRODUCTION

James Clerk Maxwell successfully unified theories of light and electromagnetism through a series of papers published from the 1850s through to the 1870s [1-4] which is one of the great unifications in physics [4]. On the basis of Maxwell's equations, the relationships among electricity, Magnetism and the speed of the light can be summarized by the modern equation [5],

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

The left-hand side is the speed of the light and the right–hand side is a quantity related to the constants that appear in the equations governing electricity and magnetism. Establishment of this relationship provided convincing evidence that light is an electromagnetic wave. Maxwell's equation [6, 7] are well known to provide an accurate mathematical description of all electromagnetic phenomenon. However, the current form of Maxwell's equation cannot provide mathematical answer of some interesting questions about EM waves as follows; 1) Why do not EM waves deflect by electric and magnetic field as they have both electric and magnetic field? 2)Why cannot particle travel faster than the speed of light? Therefore, current form of Maxwell's equations has to be modified to give satisfactory theoretical explanation of these questions and improve the previous existing results of Maxwell's equation. In this paper, we plan to provide an accurate mathematical expression to describe these behaviors of the EM waves. Our results will answer the above problem more completely and improve the previous existing result of the Maxwell's equations. The partial differentiation is used as a main tool to achieve modified version of Maxwell's equations in relativistic form.

Maxwell's equations, when they were first stated in their complete form in 1885, would turn out to be compatible with special relativity [8, 9]. The theory of special relativity plays an important role in the modern theory of classical electromagnetism. The constancy of speed of light determined via Maxwell's equations of electromagnetism is a fundamental expression for formulation of Einstein's special theory of relativity [10, 11]. Therefore, the same relativistic formula of magnetic and electric field as that of time, space and mass in special relativity is expected. Derivations of relativistic electromagnetic field through the Lorentz space coordinate transformation [12, 13] are presented in several excellent books, including Elektrodynamik-relativistiche physic [14] (sec.360-365). In order to demonstrates the transformation of fields between frames, Chow [15] considered relativistic form of both electric and magnetic field via the use of ordinary Lorentz space-time coordinate transformation. Articles [16], [17], [18] presents research on the special theory of relativity on De-Broglie wavelength of a particle and on electric permittivity and magnetic permeability of electromagnetic wave. The work [19] develops an original derivation of Lorentz transformation in three-dimensional space, while work [20] shows the variation of mass in gravitational field with the use of formula $E = mc^2$. There are numerous publications conducted on theory of relativity with a universal frame of reference [21] and all possible experiments to falsify these theories were conducted in [22]. During past few decades, many authors have written extensively on the subject of Lorentz transformation in Maxwell's equation (see [23-28] and reference cited there in).

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***Correspondence Author(s)**
Chandra Bahadur Khadka*, Department of Physics, Tri-Chandra Multiple Campus, Tribhuvan University, Kathmandu, Nepal. Email: chandrabahadur9988@gmail.com, ORCID ID: 0000-0002-3703-2706.

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However, it is noticed that relativistic form of electromagnetic field has not been mathematically derived without use of Lorentz space coordinates transformations. Hence, this paper extends the range of applicability of four Maxwell's equation through the partial differentiation of electric and magnetic field to provide the accurate description of various behavior of electromagnetic waves.

The structure of the remainder of this paper is organized as follows. In section2, relativistic form of electric permittivity and magnetic permeability is mathematically revealed with use of velocity of light in vacuum $c = 1/\sqrt{\mu_\circ \epsilon_\circ}$. Following this, relativistic form of electric and magnetic field for electromagnetic waves have been derived by using four Maxwell's equation of electromagnetism for different value of separation constant. Partial differentiation is used as main mathematical tool to achieve relativistic form of electromagnetic field. In the subsequent section, overall relativistic form of electric and magnetic field is presented which is completely compatible with all properties EM waves. In the section thereafter, concluding remarks are outlined.

II. METHODS

A. Relative Form of Electric and Magnetic Field

The speed of light in vacuum c depends on two fundamental quantities the permittivity (ϵ_0) and permeability of free space (μ_0). The speed of light is given by,

$$c = \frac{1}{\sqrt{\mu_\circ \epsilon_\circ}} \tag{1}$$

or, $$c = \frac{1}{\sqrt{\frac{\mu_\circ}{\sqrt{1-\frac{v^2}{c^2}}}\epsilon_\circ\sqrt{1-\frac{v^2}{c^2}}}}$$

or, $$c = \frac{1}{\sqrt{\mu_1 \epsilon_1}} \tag{2}$$

Where, $$\mu_1 = \frac{\mu_\circ}{\sqrt{1-\frac{v^2}{c^2}}} \tag{3}$$

$$\epsilon_1 = \epsilon_\circ\sqrt{1-\frac{v^2}{c^2}} \tag{4}$$

The main assumption of this paper is that electric permittivity ($\epsilon_\circ$)and magnetic permeability (μ_0) are relative physical parameter. Therefore, electric field intensity (E) due to a charge q at a distance r is given by,

$$\vec{E} = \frac{q}{4\pi\epsilon_1 r^2}$$

Using equation (4)

$$\vec{E} = \frac{q}{4\pi\epsilon_\circ r^2\sqrt{1-\frac{v^2}{c^2}}} \tag{5}$$

The relationship between electric field (E) and magnetic field (B) in electromagnetic wave is given by,

$$\vec{E} = \vec{B}C$$

or, $$\vec{B} = \frac{\vec{E}}{c}$$

or, $$\vec{B} = \frac{q}{4\pi\epsilon_1 r^2 c}$$

Using equation (4)

or, $$\vec{B} = \frac{q}{4\pi\epsilon_\circ r^2 c\sqrt{1-\frac{v^2}{c^2}}}$$

Using $\epsilon_\circ = \frac{1}{\mu_\circ c^2}$ we get,

or, $$\vec{B} = \frac{\mu_\circ q c}{4\pi r^2\sqrt{1-\frac{v^2}{c^2}}} \tag{6}$$

Again, from equation (2)

$$c = \frac{1}{\sqrt{\mu_1\epsilon_1}}$$

squaring both sides, we get,

$$c^2 = \frac{1}{\mu_1\epsilon_1}$$

or, $$c^2 = \frac{1}{\frac{\mu_1 q}{4\pi r^2}\times\frac{4\pi\epsilon_1 r^2}{q}}$$

or, $$\frac{\mu_1 q c^2}{4\pi r^2}\times\frac{4\pi\epsilon_1 r^2}{q} = 1$$

Substituting values of μ_1 *and* ϵ_1 from equation (3) and (4), we get

$$\frac{\mu_0 q c^2}{4\pi r^2\sqrt{1-\frac{v^2}{c^2}}}\times\frac{4\pi\epsilon_0 r^2\sqrt{1-\frac{v^2}{c^2}}}{q} = 1$$

or $$\frac{\mu_0 q c^2}{4\pi r^2\sqrt{1-\frac{v^2}{c^2}}} = \frac{q}{4\pi r^2\epsilon_0\sqrt{1-\frac{v^2}{c^2}}}$$

Using equations (5) and (6), we get

$$\vec{B}c = \vec{E}$$

Hence, it reveals that the relation between electric field (E) and magnetic field (B) in electromagnetic wave is true whenever permittivity and permeability is relative for electromagnetic wave. Further, from equation (5)

$$\vec{E} = \frac{q}{4\pi\epsilon_0 r^2\sqrt{1-\frac{v^2}{c^2}}}$$

From equation (5) at v=0,

$$\vec{E} = \frac{q}{4\pi\epsilon_0 r^2} = \vec{E}_0 \text{ (say)}$$

This values of electric field E_0 is called rest electric field. Hence, equation (5) becomes,

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$$\vec{E} = \frac{\vec{E}_o}{\sqrt{1-\frac{v^2}{c^2}}} \quad (7)$$

Similarly, from equation (6) at v=0,

$$\vec{B} = \frac{\mu_0 qc}{4\pi r^2} = \vec{B}_o$$

This value of magnetic field $\vec{B}_o$ is called rest magnetic field. Hence, equation (6) becomes,

$$\vec{B} = \frac{\vec{B}_o}{\sqrt{1-\frac{v^2}{c^2}}} \quad (8)$$

B. Separation of Variable in Maxwell's equation

The well-established formulas namely equation (7) and (8) involve the variance of total electric and magnetic field of charge with its speed. In order to conform this variation formulas, Maxwell's equations of electromagnetism play an important role i.e. Maxwell's equation in differential form,

i. Faraday's Law: $\vec{\nabla} \times \vec{E} = -\frac{\delta \vec{B}}{\delta t}$ (9)

ii. Ampere's Law: $\vec{\nabla} \times \vec{B} = -\frac{\mu_o \epsilon_o \delta \vec{E}}{\delta t}$ (10)

iii. Gauss's Law for electro statistics: $\vec{\nabla} . \vec{E} = \frac{\rho}{\epsilon_o}$ (11)

iv.Gauss's Law for Magnetism: $\vec{\nabla} . \vec{B} = 0$ (12)

From Faraday's Law,

$$\vec{\nabla} \times \vec{E} = -\frac{\delta \vec{B}}{\delta t}$$

Taking divergence on both sides,

$$\vec{\nabla} . \vec{\nabla} \times \vec{E} = -\frac{\delta \vec{\nabla} . \vec{B}}{\delta t}$$

By the property of scalar product

$$\vec{A}.(\vec{B} \times \vec{C}) = \vec{B}.(\vec{C} \times \vec{A})$$

Hence above equation becomes,

$$\vec{E} . \vec{\nabla} \times \vec{\nabla} = -\frac{\delta \vec{\nabla} . \vec{B}}{\delta t}$$

or, $0 = -\frac{\delta \vec{\nabla} . \vec{B}}{\delta t}$

or, $\delta \vec{\nabla} . \vec{B} = 0$

or, $\vec{\nabla} . \vec{B}$ = constant

Taking this constant as zero we get,

$$\vec{\nabla} . \vec{B} = 0$$

Also, from Gauss's Law for Magnetism (12),

$$\vec{\nabla} . \vec{B} = 0$$

Taking Derivative with respect to time,

$$\frac{\delta \vec{\nabla} . \vec{B}}{\delta t} = 0$$

Let us consider one dimensional motion along y-axis with velocity v = y/t. Dividing both sides by v on above equation,

$$-\frac{1}{v} \frac{\delta \vec{\nabla} . \vec{B}}{\delta t} = 0$$

or, $-\frac{1}{v} \frac{\delta \vec{\nabla} . \vec{B}}{\delta t} = \vec{B}.(\vec{\nabla} \times \vec{\nabla})$ (13)

The cross product of any vector with itself is zero.

Hence, $\vec{\nabla} \times \vec{\nabla} = 0$

or, $\vec{B}.\vec{\nabla} \times \vec{\nabla} = 0$

From scalar triple product

$$\vec{A}.(\vec{B} \times \vec{C}) = \vec{B}.(\vec{C} \times \vec{A}) = \vec{C}.(\vec{A} \times \vec{B})$$

$$\vec{B}.(\vec{\nabla} \times \vec{\nabla}) = \vec{\nabla}.(\vec{\nabla} \times \vec{B}) = \vec{\nabla}.(\vec{B} \times \vec{\nabla})$$

Hence, above equation (13) becomes,

$$-\frac{1}{v} \frac{\delta \vec{\nabla} . \vec{B}}{\delta t} = \vec{\nabla}.(\vec{\nabla} \times \vec{B})$$

Removing divergence from both sides,

$$-\frac{1}{v} \frac{\delta \vec{B}}{\delta t} = (\vec{\nabla} \times \vec{B})$$

For one dimensional motion along y-axis,

$$\vec{\nabla} \times \vec{B} = \frac{\delta \vec{B}}{\delta y}$$

Above equation becomes,

$$-\frac{1}{v} \frac{\delta \vec{B}}{\delta t} = \frac{\delta \vec{B}}{\delta y}$$

or, $-\frac{\delta \vec{B}}{\delta t} = v \frac{\delta \vec{B}}{\delta y}$

or, $-\frac{\delta \vec{B}}{\delta t} = \frac{y}{t} \frac{\delta \vec{B}}{\delta y}$

or, $-t \frac{\delta \vec{B}}{\delta t} = y \frac{\delta \vec{B}}{\delta y}$

Multiplying both sides by $\frac{(c^2-v^2)}{v^2 \vec{B}}$,

$$-\frac{(c^2-v^2)t}{v^2 \vec{B}} \frac{\delta \vec{B}}{\delta t} = \frac{(c^2-v^2)y}{v^2 \vec{B}} \frac{\delta \vec{B}}{\delta y}$$

Here, the left-hand side and right-hand side term of above equation has no unit. Since, LHS is function of time derivative alone and RHS is a function of space derivative alone. Hence, the variables are separated. Thus, in this form, it may be separated into two independent equations, each involving space (y) and time (t) derivative of magnetic field. Let k be separation constant, then, above equation becomes,

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$$-\frac{(c^2-v^2)t}{v^2\vec{B}}\frac{\delta\vec{B}}{\delta t} = \frac{(c^2-v^2)y}{v^2\vec{B}}\frac{\delta\vec{B}}{\delta y} = k \quad (14)$$

Thus, the above equation gives the time derivative of magnetic field of the form,

$$-\frac{(c^2-v^2)t}{v^2\vec{B}}\frac{\delta\vec{B}}{\delta t} = k$$

or, $$\frac{\delta\vec{B}}{\delta t} = \frac{-kv^2\vec{B}}{(c^2-v^2)t}$$

or, $$\frac{\delta\vec{B}}{\delta t} = \frac{-v\vec{B}ky}{(c^2-v^2)t^2} \quad (15)$$

Again, the equation (14) gives the space derivative of magnetic field of the form,

$$\frac{(c^2-v^2)y}{v^2B}\frac{\delta\vec{B}}{\delta y} = k$$

or, $$\frac{\delta\vec{B}}{\delta y} = \frac{kv^2\vec{B}}{(c^2-v^2)\,y}$$

or, $$\frac{\delta\vec{B}}{\delta y} = \frac{kv\vec{B}y}{(c^2-v^2)yt}$$

or, $$\frac{\delta\vec{B}}{\delta y} = \frac{kV\vec{B}}{(c^2-v^2)t} \quad (16)$$

Where k be a separation constant which appears in Maxwell equation as follows.

$$\vec{\nabla}\times\vec{B} = k\frac{\mu_o\epsilon_o\delta\vec{E}}{\delta t}$$

Therefore, the value of k must be equal to ± 1 to satisfy Maxwell's equation.

C. Separation Constant $K = 1$

The value of separation constant k = 1 gives relative form of total magnetic field. Equations (15) and (16) for k = 1 become,

$$\frac{\delta\vec{B}}{\delta t} = -\frac{v\vec{B}y}{(c^2-v^2)t^2} \quad (17)$$

$$\frac{\delta\vec{B}}{\delta y} = \frac{kv\vec{B}}{(c^2-v^2)t} \quad (18)$$

Now solving (17)

or, $$\frac{\delta\vec{B}}{\vec{B}\,\delta t} = -\frac{vy}{(c^2-v^2)t^2}$$

or, $$\frac{\delta\log\vec{B}}{\delta\vec{B}}\frac{\delta\vec{B}}{\delta t} = \frac{vy}{(c^2-v^2)}\frac{\delta t^{-1}}{\delta t}$$

or, $$\frac{\delta\log\vec{B}}{\delta t} = \frac{v}{(c^2-v^2)}\frac{\delta}{\delta t}\left(\frac{y}{t}\right)$$

or, $$\frac{\delta\log\vec{B}}{\delta t} = \frac{v}{(c^2-v^2)}\frac{\delta v}{\delta t}$$

or, $$\frac{\delta\log\vec{B}}{\delta t} = \frac{2v}{2(c^2-v^2)}\frac{\delta v}{\delta t}$$

Or, $$\frac{\delta\log\vec{B}}{\delta t} = \frac{1}{2(c^2-v^2)}\frac{\delta v^2}{\delta v}\frac{\delta v}{\delta t}$$

or, $$\frac{\delta\log\vec{B}}{\delta t} = \frac{1}{2(c^2-v^2)}\frac{\delta v^2}{\delta t}$$

or, $$\frac{\delta\log\vec{B}}{\delta t} = -\frac{1}{2(c^2-v^2)}\frac{\delta(-v^2)}{\delta t}$$

or, $$\frac{\delta\log\vec{B}}{\delta t} = -\frac{1}{2(c^2-v^2)}\frac{\delta(c^2-v^2)}{\delta t}$$

Since, $\frac{\delta c^2}{\delta t} = 0$

Hence, $$\frac{\delta\log\vec{B}}{\delta t} = -\frac{\delta\log(c^2-v^2)}{2\,\delta(c^2-v^2)}\frac{\delta(c^2-v^2)}{\delta t}$$

or, $$\frac{\delta\log\vec{B}}{\delta t} = -\frac{\delta\log(c^2-v^2)}{2\,\delta t}$$

or, $$\frac{\delta\log\vec{B}}{\delta t} = 0 - \frac{\delta\log(c^2-v^2)^{\frac{1}{2}}}{\delta t} + 0$$

or, $$\frac{\delta\log\vec{B}}{\delta t} = \frac{\delta\log\vec{B}_O}{\delta t} - \frac{\delta\log(c^2-v^2)^{\frac{1}{2}}}{\delta t} - \frac{\delta\log c}{\delta t}$$

Since rest magnetic field $\vec{B}_o$ and velocity of light c are constant parameter. Thus, their time derivative is zero. Removing time derivative of both sides,

or, $\log\vec{B} = \log\vec{B}_O - \log(c^2 - v^2)^{\frac{1}{2}} - \log c$

or, $\log\vec{B} = \log\vec{B}_O - \log\frac{(c^2-v^2)^{\frac{1}{2}}}{c}$

or, $\log\vec{B} = \log\vec{B}_O - \log\left(\frac{c^2-v^2}{c^2}\right)^{\frac{1}{2}}$

or, $\log\vec{B} = \log\vec{B}_O - \log\sqrt{1-\frac{v^2}{c^2}}$

or, $\log\vec{B} = \log\frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}}$

Removing log on both sides,

$$\vec{B} = \frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}} \quad (19)$$

This Equation gives the relative form of magnetic field derived by using the time derivative namely equation (17). Let us solve space derivative of magnetic field (18).

$$\frac{\delta\vec{B}}{\delta y} = \frac{v\vec{B}}{(c^2-v^2)t}$$

or, $$\frac{1}{\vec{B}}\frac{\delta\vec{B}}{\delta y} = \frac{v}{(c^2-v^2)t}\frac{\delta y}{\delta y}$$

or, $$\frac{1}{\vec{B}}\frac{\delta\vec{B}}{\delta y} = \frac{v}{(c^2-v^2)}\frac{\delta}{\delta y}\left(\frac{y}{t}\right)$$

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or, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta y} = \frac{v}{(c^2-v^2)}\frac{\delta v}{\delta y}$

or, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta y} = -\frac{-2v}{2(c^2-v^2)}\frac{\delta v}{\delta y}$

or, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta y} = -\frac{1}{2(c^2-v^2)}\frac{\delta(-v^2)}{\delta v}\frac{\delta v}{\delta y}$

or, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta y} = -\frac{1}{2(c^2-v^2)}\frac{\delta(-v^2)}{\delta y}$

Since, $\frac{\delta c^2}{\delta t} = 0$

Hence, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta y} = -\frac{1}{2(c^2-v^2)}\frac{\delta(c^2-v^2)}{\delta y}$

or, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta y} = -\frac{\delta \log(c^2-v^2)}{\delta(c^2-v^2)}\frac{\delta(c^2-v^2)}{\delta y}$

or, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta y} = -\frac{\delta \log(c^2-v^2)}{2\delta y}$

or, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta y} = -\frac{\delta}{\delta y}\frac{1}{2}\log(c^2-v^2)$

or, $\frac{1}{\vec{B}}\frac{\delta}{\delta y}\vec{B} = -\frac{\delta}{\delta y}\log(c^2-v^2)^{\frac{1}{2}}$-0

or, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta y} = 0 - \frac{\delta}{\delta y}\log(c^2-v^2)^{\frac{1}{2}}$ -0

or, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta y} = \frac{\delta}{\delta y}\log\vec{B}_0 - \frac{\delta}{\delta y}\log(c^2-v^2)^{\frac{1}{2}} - \frac{\delta \log c}{\delta y}$

Since rest magnetic field $\vec{B}_o$ and velocity of light c are constant parameter. Thus, their space derivative is zero.

or, $\frac{\delta \log\vec{B}}{\delta \vec{B}}\frac{\delta \vec{B}}{\delta y} = \frac{\delta \log\vec{B}_0}{\delta y} - \frac{\delta}{\delta y}\log\frac{(c^2-v^2)^{\frac{1}{2}}}{c}$

or, $\frac{\delta \log\vec{B}}{\delta y} = \frac{\delta \log\vec{B}_0}{\delta} - \frac{\delta}{\delta y}\log\sqrt{1-\frac{v^2}{c^2}}$

or, $\frac{\delta \log\vec{B}}{\delta y} = \frac{\delta}{\delta y}\log\frac{\vec{B}_0}{\sqrt{1-\frac{v^2}{c^2}}}$

Removing space derivative and log from both sides, we get

$$\vec{B} = \frac{\vec{B}_0}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (20)$$

This equation gives relative form of magnetic field derived by using space derivative namely equation (18).

D. Separation Constant $K = -1$

The value of separation constant K = -1 gives magnetic field spread in vicinity for interaction such as field to produce force of attraction and repulsion. Equation (15) and (16) becomes,

$$\frac{\delta \vec{B}}{\delta t} = \frac{vy\vec{B}}{(c^2-v^2)t^2} \qquad (21)$$

$$\frac{\delta \vec{B}}{\delta y} = \frac{-v\vec{B}}{(c^2-v^2)t} \qquad (22)$$

Now Solving (21), we get

or, $\frac{1}{\vec{B}}\frac{\delta \vec{B}}{\delta t} = \frac{vy}{(c^2-v^2)t^2}$

or, $\frac{\delta \log\vec{B}}{\delta \vec{B}}\frac{\delta \vec{B}}{\delta t} = \frac{vy}{(c^2-v^2)}t^{-2}$

or, $\frac{\delta \log\vec{B}}{\delta \vec{B}}\frac{\delta \vec{B}}{\delta t} = \frac{-vy}{(c^2-v^2)}\frac{\delta(t^{-1})}{\delta t}$

or, $\frac{\delta \log\vec{B}}{\delta \vec{B}}\frac{\delta \vec{B}}{\delta t} = \frac{-v}{(c^2-v^2)}\frac{\delta}{\delta t}\left(\frac{y}{t}\right)$

or, $\frac{\delta \log\vec{B}}{\delta t} = \frac{-2v}{2(c^2-v^2)}\frac{\delta v}{\delta t}$

or, $\frac{\delta \log\vec{B}}{\delta t} = \frac{1}{2(c^2-v^2)}\frac{\delta - v^2}{\delta v}\frac{\delta v}{\delta t}$

or, $\frac{\delta \log\vec{B}}{\delta t} = \frac{1}{2(c^2-v^2)}\frac{\delta(C^2-v^2)}{\delta v}\frac{\delta v}{\delta t}$

Since c is constant and its derivative is zero.

or, $\frac{\delta \log\vec{B}}{\delta t} = \frac{1}{2(c^2-v^2)}\frac{\delta(C^2-v^2)}{\delta t}$

or, $\frac{\delta \log\vec{B}}{\delta t} = \frac{1}{2}\frac{\delta \log(C^2-v^2)}{\delta(c^2-v^2)}\frac{\delta(C^2-v^2)}{\delta t}$

or, $\frac{\delta \log\vec{B}}{\delta t} = o + \frac{1}{2}\frac{\delta \log(C^2-v^2)}{\delta t} - 0$

Since rest magnetic field $\vec{B}_o$ and velocity of light c are constant parameter. Thus, their time derivative is zero.

or, $\frac{\delta \log\vec{B}}{\delta t} = \frac{\delta}{\delta t}\log\vec{B}_0 + \frac{\delta}{\delta t}\log(c^2-v^2)^{\frac{1}{2}} - \frac{\delta \log c}{\delta t}$

or, $\frac{\delta \log\vec{B}}{\delta t} = \frac{\delta \log\vec{B}_0}{\delta t} + \frac{\delta}{\delta t}\log\frac{(c^2-v^2)^{\frac{1}{2}}}{c}$

or, $\frac{\delta \log\vec{B}}{\delta t} = \frac{\delta \log\vec{B}_0}{\delta t} - \frac{\delta}{\delta t}\log\sqrt{\frac{c^2-v^2}{c^2}}$

or, $\frac{\delta \log\vec{B}}{\delta t} = \frac{\delta \log\vec{B}_0}{\delta t} + \frac{\delta}{\delta t}\log\sqrt{\frac{c^2-v^2}{c^2}}$

or, $\frac{\delta \log\vec{B}}{\delta t} = \frac{\delta}{\delta t}\log\vec{B}_0\sqrt{1-\frac{v^2}{c^2}}$

Removing time derivative and log from both sides, we get

$$\vec{B} = \vec{B}_0\sqrt{1-\frac{v^2}{c^2}} \qquad (23)$$

This equation gives the relative form of magnetic field derived by using the time derivative namely equation (21). Let us solve space derivative of magnetic field namely equation (22).

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or, $\frac{\delta \vec{B}}{\delta y} = -\frac{v\vec{B}}{(c^2-v^2)t}$

or, $\frac{\delta \log \vec{B}}{\delta \vec{B}}\frac{\delta \vec{B}}{\delta y} = -\frac{v}{(c^2-v^2)t}\frac{\delta y}{\delta y}$

or, $\frac{\delta \log \vec{B}}{\delta y} = -\frac{v}{(c^2-v^2)}\frac{\delta}{\delta y}\left(\frac{y}{t}\right)$

or, $\frac{\delta \log \vec{B}}{\delta y} = -\frac{v}{(c^2-v^2)}\frac{\delta v}{\delta y}$

or, $\frac{\delta \log \vec{B}}{\delta y} = \frac{-2v}{2(c^2-v^2)}\frac{\delta v}{\delta y}$

or, $\frac{\delta \log \vec{B}}{\delta y} = \frac{1}{2(c^2-v^2)}\frac{\delta(-v^2)}{\delta v}\frac{\delta v}{\delta y}$

or, $\frac{\delta \log \vec{B}}{\delta y} = -\frac{1}{2(c^2-v^2)}\frac{\delta(c^2-v^2)}{\delta v}\frac{\delta v}{\delta y}$

or, $\frac{\delta \log \vec{B}}{\delta y} = -\frac{1}{2(c^2-v^2)}\frac{\delta(c^2-v^2)}{\delta v}\frac{\delta v}{\delta y}$

or, $\frac{\delta \log \vec{B}}{\delta y} = -\frac{1}{2(c^2-v^2)}\frac{\delta(c^2-v^2)}{\delta y}$

or, $\frac{\delta \log \vec{B}}{\delta y} = \frac{1}{2}\frac{\delta \log (c^2-v^2)}{\delta(c^2-v^2)}\frac{\delta(c^2-v^2)}{\delta y}$

or, $\frac{\delta \log \vec{B}}{\delta y} = \frac{\delta \log (c^2-v^2)}{2\delta y}$

or, $\frac{\delta \log \vec{B}}{\delta y} = 0 + \frac{\delta}{\delta y}\log (c^2 - v^2)^{\frac{1}{2}} + 0$

Since rest magnetic field $\vec{B}_o$ and velocity of light c are constant parameter. Thus, their space derivative is zero.

or, $\frac{\delta \log B}{\delta y} = \frac{\delta}{\delta y}\log B_o + \frac{\delta}{\delta y}\log (c^2 - v^2)^{\frac{1}{2}} - \frac{\delta \log c}{\delta y}$

or, $\frac{\delta \log \vec{B}}{\delta y} = \frac{\delta}{\delta y}[\log \vec{B}_o + \log (c^2 - v^2)^{\frac{1}{2}} - \log c]$

Removing space derivative on both sides,

or, $\frac{\delta \log \vec{B}}{\delta \vec{B}} = \log \vec{B}_o + \log \frac{(c^2-v^2)^{\frac{1}{2}}}{c}$

or, $\log \vec{B} = \log \vec{B}_o + \log \sqrt{\frac{c^2-v^2}{c^2}}$

or, $\log \vec{B} = \log \vec{B}_o + \log \sqrt{1 - \frac{v^2}{c^2}}$

or, $\log \vec{B} = \log \vec{B}_o \sqrt{1 - \frac{v^2}{c^2}}$

or, $\vec{B} = \vec{B}_o \sqrt{1 - \frac{v^2}{c^2}}$ (24)

This equation gives the relative form of magnetic field for k = -1 derived by using space derivative namely equation (22).

III. RESULTS AND DISCUSSIONS

In previous section, the relativistic form of magnetic field for two different value of separation constant k=+1, -1 is accounted form Maxwell's equation of magnetism especially Ampere's law and Gauss law of magnetism. In order to deduce the corresponding relativistic form of electric field, we need to exactly repeat same process on Maxwell's equation of electricity especially Faraday's law and Gauss's law for electrostatics, then we will have simply,

For separation constant k = 1,

$\vec{B} = \frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}}$ and $\vec{E} = \frac{\vec{E}_O}{\sqrt{1-\frac{v^2}{c^2}}}$ (25)

And for separation constant k = -1,

$\vec{B} = \vec{B}_O\sqrt{1 - \frac{v^2}{c^2}}$ and $\vec{B} = \vec{B}_O\sqrt{1 - \frac{v^2}{c^2}}$ (26)

The expression for electric and magnetic field of equation (25) is for the total field of charge system while the field of equation (26) is responsible for spreading electric field and magnetic field in vicinity to produce force of attraction and repulsion. In order to understand the actual meaning of these two relativistic forms namely equation (25) and (26), we should understand about the distribution of total electric and magnetic field of a charge system in surrounding and it is distributed only for two purposes as follows.

1) for propagation of system in space such as electromagnetic waves that use their own electric and magnetic field to propagate in space.

2) for interaction which is distributed in vicinity to create force of attraction and repulsion such as electron, proton.

In other word, total electric and magnetic field of a charge particle is equal to sum of field spread in vicinity for interaction and field utilize for propagation of charge particle i.e.

Total field (B) = field spread in vicinity for interaction $(\vec{B}_I)$ + field for propagation $(\vec{B}_P)$ (27)

or, field for propagation (B_P) = Total field (B) – field for interaction ($\vec{B}_I$) (28)

Total magnetic field of charge particle is given by equation (25),

$$\vec{B} = \frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}}$$

And magnetic field spread in vicinity for interaction is given by equation (26),

$$\vec{B}_I = \vec{B}_O\sqrt{1 - \frac{v^2}{c^2}}$$

Substituting value of B and (B_I) in equation (28), we get

$$\vec{B}_P = \vec{B} - \vec{B}_I$$

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or, $$\vec{B}_P = \frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}} - \vec{B}_O\sqrt{1-\frac{v^2}{c^2}}$$

or, $$\vec{B}_P = \frac{\vec{B}_O - \vec{B}_O\left(1-\frac{v^2}{c^2}\right)}{\sqrt{1-\frac{v^2}{c^2}}}$$

or, $$\vec{B}_P = \frac{\vec{B}_O\left(\frac{v^2}{c^2}\right)}{\sqrt{1-\frac{v^2}{c^2}}}$$

or, $$\vec{B}_P = \frac{v^2}{c^2}\frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (29)$$

This is required expression of magnetic field for propagation such as electromagnetic wave use this value of magnetic field to propagate in space. Now, substituting value of B, B_I and B_p in equation (27), we get,

Total field (B) = field spread in vicinity for interaction (B_I) + field propagation (B_P)

$$\frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}} = \vec{B}_O\sqrt{1-\frac{v^2}{c^2}} + \frac{v^2}{c^2}\frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (30)$$

Similarly, corresponding expression for electric field is

Total electric field ($\vec{E}$) = electric field spread in surrounding for interaction ($\vec{E}_I$) + electric field propagation ($\vec{E}_P$)

or, $$\frac{\vec{E}_O}{\sqrt{1-\frac{v^2}{c^2}}} = \vec{E}_O\sqrt{1-\frac{v^2}{c^2}} + \frac{v^2}{c^2}\frac{\vec{E}_O}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (31)$$

The expression of magnetic and electric field of equations (30) and (31) derived from the relative postulates describe overall properties of electromagnetic wave and charge particle. These equations are valid for charge particle that uses their electric and magnetic field to propagate in space without need of interaction with other charge particle such as electromagnetic wave. Let us consider different cases to understand the nature of electromagnetic waves.

Case (1): v = 0 indicates that charge is at rest. Hence, equation (30) becomes,

Total field (B) = field spread in vicinity for interaction (B_I) + field propagation (B_P)

or, $$\frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}} = \vec{B}_O\sqrt{1-\frac{v^2}{c^2}} + \frac{v^2}{c^2}\frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}}$$

or, $$\frac{\vec{B}_O}{\sqrt{1-\frac{0^2}{c^2}}} = \vec{B}_O\sqrt{1-\frac{0^2}{c^2}} + \frac{0^2}{c^2}\frac{\vec{B}_O}{\sqrt{1-\frac{0^2}{c^2}}}$$

or, $$\vec{B}_O = \vec{B}_O + 0$$

Comparing this equation with initial word equation i.e.

Total field = field spread in vicinity for interaction + field propagation

Form above comparison, it is clearly seen that total magnetic field (left side) is B_O at rest which is completely spread out in surrounding. Therefore, magnetic field spread in vicinity (first term in right side) is B_O. Therefore, last term in above comparison represents magnetic field remain for propagation of wave which is zero. Hence, charge particle is at rest.

Case (2): $v = c$ indicates that charge particle is moving at speed of light. Hence, equation (30) becomes,

Total magnetic field = magnetic field spread in surrounding + magnetic field for propagation

or, $$\frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}} = \vec{B}_O\sqrt{1-\frac{v^2}{c^2}} + \frac{v^2}{c^2}\frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}}$$

or, $$\frac{\vec{B}_O}{\sqrt{1-\frac{c^2}{c^2}}} = \vec{B}_O\sqrt{1-\frac{c^2}{c^2}} + \frac{c^2}{c^2}\frac{\vec{B}_O}{\sqrt{1-\frac{c^2}{c^2}}}$$

or, $$\frac{\vec{B}_O}{\sqrt{1-\frac{c^2}{c^2}}} = 0 + \frac{\vec{B}_O}{\sqrt{1-\frac{c^2}{c^2}}}$$

Comparing this equation with initial equation i.e.

Total field = field spread in vicinity for interaction + field for propagation

From above comparison, it is clearly seen that total magnetic field of charge particle at speed of light such as electromagnetic wave is $\vec{B} = \vec{B}_0/\sqrt{1-c^2/c^2}$ and it is completely used to propagate charge particle in space at velocity of light. Therefore, first term of right-hand side in above comparison represents magnetic field spread in surrounding for interaction which is zero. This is the main reason due to which electromagnetic waves are undeflected in magnetic field, since magnetic field spread in surrounding (first term in right hand side) is zero. Also, there is popular statement nothing moves faster than speed of light. It is because at $v = c$, in above equation, total magnetic field is utilized to propagate particle at speed of light. As a result, no magnetic field (first term in right hand side) is left over to increase speed greater than speed of light. Thus, no particle moves faster than speed of light.

Therefore, total relative magnetic and electric field splits for propagation and interaction to create force of attraction and repulsion in surrounding, the total field being conserved by virtue of equations (30) and (31). The relativistic magnetic and electric field of a charge particle derived from four Maxwell's equation have been discussed in this paper and a few major points have been presented in table (1) for magnetic field and table (2) for electric field.

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Table (1): Relative Form of Magnetic Field

S.N.	Velocity of Particle	Total magnetic field(B)	Split of total magnetic Field	
			Field for Propagation	Field for Interaction
1	Velocity $= v$	$\vec{B} = \frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}}$	$\vec{B}_P = \frac{v^2}{c^2}\frac{\vec{B}_O}{\sqrt{1-\frac{v^2}{c^2}}}$	$\vec{B}_I = \vec{B}_O\sqrt{1-\frac{v^2}{c^2}}$
2	At rest velocity $v = 0$	$\vec{B} = \frac{\vec{B}_O}{\sqrt{1-\frac{0^2}{c^2}}}$ $\vec{B} = \vec{B}_O$	$\vec{B}_P = \frac{0^2}{c^2}\frac{\vec{B}_O}{\sqrt{1-\frac{0^2}{c^2}}}$ $\vec{B}_P = 0$ There is no field for Propagation. Hence, Particle is at rest.	$\vec{B}_I = \vec{B}_O\sqrt{1-\frac{0^2}{c^2}}$ $\vec{B}_I = \vec{B}_O$ Total magnetic field is equal to field for interaction.
3	At velocity of light $(v = c)$ (EM wave)	$\vec{B} = \frac{\vec{B}_O}{\sqrt{1-\frac{c^2}{c^2}}}$	$\vec{B}_P = \frac{c^2}{c^2}\frac{\vec{B}_O}{\sqrt{1-\frac{c^2}{c^2}}}$ $\vec{B}_P = \frac{\vec{B}_O}{\sqrt{1-\frac{c^2}{c^2}}}$ Total magnetic field is equal to field for Propagation. Hence, EM wave moves at speed of light.	$\vec{B}_I = \vec{B}_O\sqrt{1-\frac{c^2}{c^2}}$ $\vec{B}_I = 0$ There is no field for Interaction. Hence, EM wave does not deflect in magnetic field.

Table (2): Relative Form of Electric Field

S.N.	Velocity of Particle	Total electric field(E)	Split of total electric Field	
			Field for Propagation	Field for Interaction
1	Velocity $= v$	$\vec{E} = \frac{\vec{E}_O}{\sqrt{1-\frac{v^2}{c^2}}}$	$\vec{E}_P = \frac{v^2}{c^2}\frac{\vec{E}_O}{\sqrt{1-\frac{v^2}{c^2}}}$	$\vec{E}_I = \vec{E}_O\sqrt{1-\frac{v^2}{c^2}}$
2	At rest velocity $v = 0$	$\vec{E} = \frac{\vec{E}_O}{\sqrt{1-\frac{0^2}{c^2}}}$ $\vec{E} = \vec{E}_O$	$\vec{E}_P = \frac{0^2}{c^2}\frac{\vec{E}_O}{\sqrt{1-\frac{0^2}{c^2}}}$ $\vec{E}_P = 0$ There is no field for Propagation. Hence, Particle is at rest.	$\vec{E}_I = \vec{E}_O\sqrt{1-\frac{0^2}{c^2}}$ $\vec{E}_I = \vec{E}_O$ Total electric field is equal to field for interaction.
3	At velocity of light $(v = c)$ (EM wave)	$\vec{E} = \frac{\vec{E}_O}{\sqrt{1-\frac{c^2}{c^2}}}$	$\vec{E}_P = \frac{c^2}{c^2}\frac{\vec{E}_O}{\sqrt{1-\frac{c^2}{c^2}}}$ $\vec{E}_P = \frac{\vec{E}_O}{\sqrt{1-\frac{c^2}{c^2}}}$ Total electric field is equal to field for Propagation. Hence, EM wave moves at speed of light.	$\vec{E}_I = \vec{E}_O\sqrt{1-\frac{c^2}{c^2}}$ $\vec{E}_I = 0$ There is no field for Interaction. Hence, EM wave does not deflect in electric field.

IV. CONCLUSION

The aim of this paper is to open a discussion towards new way of transforming the expression of four Maxwell's equation into the relativistic form of electric and magnetic field. One of the central predictions is that electric permittivity and magnetic permeability depends upon the motion between inertial frames which means vary with velocity of charge particles and it is governed by equation $\epsilon' = \epsilon_\circ/\sqrt{1-v^2/c^2}$ and $\mu' = \mu_\circ/\sqrt{1-v^2/c^2}$. The development of mathematical model to reveal relativistic properties of electric permittivity and magnetic permeability is completely new. The developed mathematical model is based on the partial differential equation of magnetic and electric field with respect to space (y) and time (t) coordinates. On the basis of new mathematical results, a completely new formulas for relativistic magnetic and electric field have been displayed as follows.

Total field = Field for interaction + Field for propagation

$$\frac{\vec{B}_\circ}{\sqrt{1-\frac{v^2}{c^2}}} = \vec{B}_\circ\sqrt{1-\frac{v^2}{c^2}} + \frac{v^2}{c^2}\frac{\vec{B}_\circ}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$\frac{\vec{E}_\circ}{\sqrt{1-\frac{v^2}{c^2}}} = \vec{E}_\circ\sqrt{1-\frac{v^2}{c^2}} + \frac{v^2}{c^2}\frac{\vec{E}_\circ}{\sqrt{1-\frac{v^2}{c^2}}}$$

On making the substitution $v = c$ for electromagnetic wave, we can clearly see that total electric and magnetic field is utilized for propagation of wave and there is no field to interact with other charge particles. consequently, EM waves do not interact with charge particles. Hence, they do not deflect in electric and magnetic field. The primary purpose here has been to lay down the basic equations for relativistic form of electric and magnetic to make perfect agreement with observed properties of electromagnetic waves. The formulas elucidated here will have many uses in other areas of theoretical physics to describe Maxwell's equation and their corresponding transformation to relativistic electric and magnetic field. We hope experiment to verify this theory can be carried as soon as possible.

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AUTHORS PROFILE

Chandra Bahadur Khadka is from Nepal. He presently lives in Kathmandu, the capital city of Nepal. He has been writing various research articles related to new theoretical discoveries in special relativity.

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