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Relative Nature of Electric Permittivity and Magnetic Permeability of Electromagnetic Wave

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***Abstract:** This research is about the special theory of relativity on electric permittivity and magnetic permeability of electromagnetic wave. For this, Four Maxwell's electromagnetic equations play an important role. James Clerk Maxwell suggested that the light travel as electromagnetic wave which require no material medium for propagation. The speed of light (C) in free space is always constant and is independent of the speed of source or observer or the relative motion of the inertial system and has velocity 'C' given by* $C = \frac{1}{\sqrt{\mu_0\epsilon_0}}$. *So velocity of electromagnetic waves depend on obsolute magnetic permeability* (μ_0) *and obsolute electric permittivity* (ϵ_0) *of free space. These two physical quantities rely on relative motion of inertial system. So* μ_0 and ϵ_0 *are not obsolute quantity but are dependent upon the relative motion between the observer and the phenomenon observed. Electric and magnetic field of a charge rely upon the value of obsolute electric permittivity of medium. Concisely,* μ_0 and ϵ_0 *are variant quantity. Consequently electric and magnetic field get relative for electromagnetic wave. That is electric and magnetic field depend on relative motion of inertial system for electromagnetic waves.*

***Keywords:** Electric Permittivity, Electromagnetic Waves, Magnetic Permeability, Relativity*

I. INTRODUCTION

A comprehensive summary of the electrodynamic principle was done by James Clerk Maxwell in four unified equation of electricity and magnetism in 1865. It shows that velocity of light in vacuum is constant and depend on two constant quantity $\epsilon_0 = 8.85 \times 10^{-12} C^2N^{-1}m^{-2}$ and $\mu_0 = 4\pi \times 10^{-7} NA^{-2}$ for vacuum. This constancy of velocity of light and the independence with relative velocity between source and observer gives rise relativistic mechanics. It was discovered by Einstein in 1905. It reveals that space, time and mass depend on motion of inertial system. Likewise, electric permittivity and magnetic permeability are relative for electromagnetic waves.

Velocity of electromagnetic wave $C = \frac{1}{\sqrt{\mu_0\epsilon_0}}$

$$C = \frac{1}{\sqrt{\frac{\mu_0\epsilon_0}{\sqrt{1-\frac{c^2}{v^2}}}\sqrt{1-\frac{c^2}{v^2}}}}$$

The value of electric permittivity and magnetic permeability for total electric and magnetic field of electromagnetic wave is given by,

$$\mu' = \frac{\mu_0}{\sqrt{1-\frac{v^2}{c^2}}} \quad , \epsilon' = \epsilon_0\sqrt{1-\frac{v^2}{c^2}}$$

So, electric Field for Charge is

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

$$\therefore E = \frac{E_{0\circ}}{\sqrt{1-\frac{v^2}{c^2}}} \qquad \left(\frac{q}{4\pi\epsilon_0 r^2} = E_{0\circ}\right)$$

So, magnetic Field for Charge is

$$B = \frac{\mu' qc^2}{4\pi r^2} = \frac{\mu_0 qc^2}{4\pi r^2\sqrt{1-\frac{v^2}{c^2}}}$$

$$\therefore B = \frac{B_{0\circ}}{\sqrt{1-\frac{v^2}{c^2}}} \qquad \left[\because \frac{\mu_0 qc^2}{4\pi r^2} = B_{0\circ}\right]$$

Again, the value of electric permittivity and magnetic permeability for electric and magnetic field spread in vicinity for force of attraction and repulsion is given by,

$$\mu' = \mu_0\sqrt{1-\frac{v^2}{c^2}} \quad , \epsilon' = \frac{\epsilon_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

Electric field for force of attraction and repulsion

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

$$\therefore E = E_0\sqrt{1-\frac{v^2}{c^2}} \qquad \left(\frac{q}{4\pi\epsilon_0 r^2} = E_{0\circ}\right)$$

Magnetic field for force of attraction and repulsion

$$B = \frac{\mu' qc^2}{4\pi r^2} = \frac{\mu_0 qc^2}{4\pi r^2}\sqrt{1-\frac{v^2}{c^2}}$$

$$\therefore B = B_0\sqrt{1-\frac{v^2}{c^2}} \qquad \left[\because \frac{\mu_0 qc^2}{4\pi r^2} = B_{0\circ}\right]$$

II. METHODS

A. Total relative magnetic and electric field

Total relative magnetic and electric field of charge is given by

$$B = \frac{B_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$E = \frac{E_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

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Taking log on both sides,

$$\log E = \log Eo - \log\sqrt{1-\frac{v^2}{c^2}}$$

or, $\log E = \log E_o - (\log\sqrt{c^2-v^2} - \log c^2)$

or, $\log E = \log E_o - (\log(c^2-v^2)^{1/2} - \log c^2)$

or, $\log E = \log E_o - \frac{1}{2}\log(c^2-v^2) + 2\log C \quad (\log a^n = n\log a)$

Differentiating partial with respect to x, we get,

$$\delta\frac{\log E}{\delta x} = \delta\frac{(\log Eo)}{\delta x} - \frac{\delta}{\delta x}(\frac{1}{2}\log(c^2-v^2)) + \frac{\delta}{\delta x}(2\log c)$$

or, $\frac{1}{E}\frac{\delta E}{\delta x} = 0 - \frac{(-2V)}{2(c^2-v^2)}\frac{\delta V}{\delta x} + 0$

or, $\frac{\delta E}{\delta x} = \frac{2VE}{2(c^2-v^2)}\frac{\delta V}{\delta x}$

or, $\frac{\delta E}{\delta x} = \frac{VE}{(c^2-v^2)}\frac{\delta}{\delta x}(\frac{x}{t})$

or, $\frac{\delta E}{\delta x} = \frac{VE}{(c^2-v^2)t}$ (1)

or, $t\frac{\delta E}{\delta x} = \frac{EV}{(c^2-v^2)}$

again, Differentiating partially with respect to x ,

$$t\frac{\delta^2 E}{\delta x^2} = \frac{(c^2-v^2)\frac{\delta}{\delta x}(EV) - EV\frac{\delta}{\delta x}(C^2-V^2)}{2(c^2-v^2)^2}$$

$$= \frac{\frac{E}{t} + \frac{(c^2-v^2)EV^2}{(c^2-v^2)t} - EV(\frac{-2V\delta V}{\delta x})}{(c^2-v^2)^2}$$

$$= \frac{\frac{E(c^2-v^2)}{t} + \frac{EV^2}{t} + (\frac{2EV^2}{t})}{(c^2-v^2)^2}$$

$$t\frac{\delta^2 E}{\delta x^2} = \frac{Ec^2 - Ev^2 + Ev^2 + 2Ev^2}{(c^2-v^2)^2 t}$$

$$t\frac{\delta^2 E}{\delta x^2} = \frac{Ec^2 - Ev^2 + Ev^2 + 2Ev^2}{(c^2-v^2)^2 t} \quad (2)$$

Now, Differentiating partially with Respect to t,

$$\frac{\delta(\log E)}{\delta t^2} = \frac{\partial}{\partial t}(\log E_0) - \frac{1}{2}\frac{\partial}{\partial t}\log(C^2-V^2) + \frac{\partial}{\partial t}(\log C)$$

$$\frac{1}{E}\frac{\partial E}{\partial t} = 0 - \frac{1}{2}\frac{(-2v)}{(c^2-v^2)}\frac{\partial v}{\partial t} + 0$$

$$\frac{1}{E}\frac{\partial E}{\partial t} = -\frac{v}{(c^2-v^2)}\frac{\partial^{x}/_{t}}{\partial t} = \frac{vx}{(c^2-v^2)}\frac{\partial(x^{-1})}{\partial t}$$

$$\frac{1}{E}\frac{\partial E}{\partial t} = -\frac{vx}{(c^2-v^2)t^2}$$

$$\frac{\partial E}{\partial t} = -\frac{vEx}{(c^2-v^2)t^2} \quad (3)$$

$$-\frac{1}{x}\frac{\partial E}{\partial t} = \frac{vE}{(c^2-v^2)t^2}$$

Again taking partial derivatives with respect to t,

$$-\frac{1}{x}\frac{\partial^2 E}{\partial t^2} = \frac{\partial E}{\partial t}\left(\frac{vE}{(c^2-v^2)t^2}\right)$$

$$= \frac{(c^2-v^2)t^2\left(\frac{\partial(vE)}{\partial t}\right) - vE[\frac{\partial}{\partial t}(c^2-v^2)t^2}{(c^2-v^2)^2 t4}$$

$$= \frac{(c^2-v^2)t^2\left(v\frac{\partial(E)}{\partial t} + E\frac{\partial(v)}{\partial t}\right) - vE[(c^2-v^2)\frac{\partial t^2}{\partial t} + t^2\frac{\partial(c^2-v^2)}{\partial t}]}{(c^2-v^2)^2 t4}$$

$$= \frac{(c^2-v^2)t^2\left[v\left(\frac{-vEx}{((c^2-v^2)t^2)}\right)\right] + E\left(-\frac{x}{t^2}\right) - vE\left[(c^2-v^2)2t + t^2\left(-2v\frac{\partial v}{\partial t}\right)\right]}{(c^2-v^2)^2 t4}$$

$$= \frac{(c^2-v^2)t^2\left[\frac{-v^2Ex}{((c^2-v^2)t^2)} - \frac{Ex}{t^2}\right] - VE[(c^2-v^2)2t + t^2(\frac{2Vx}{t^2})]}{(c^2-v^2)^2 t4}$$

$$= \frac{-v^2Ex - Ex(c^2-v^2) - 2tVE[(c^2-v^2) - 2v^2Ex]}{(c^2-v^2)^2 t4}$$

$$= \frac{-v^2Ex - Exc^2 + Exv^2 - 2tVEc^2 + 2tVEV^2 - 2v^2Ex}{(c^2-v^2)^2 t4} \quad (\because Vt=x)$$

$$\frac{-v^2Ex - Exc^2 + Exv^2 - 2xEc^2 + 2xEV^2 - 2v^2Ex}{(c^2-v^2)^2 t4}$$

$$= \frac{-3Exc^2}{(c^2-v^2)^2 t4}$$

$$\therefore -\frac{1}{x}\frac{\partial^2 E}{\partial t^2} = \frac{-3Exc^2}{(c^2-v^2)^2 t4}$$

$$\therefore \frac{\partial^2 E}{\partial t^2} = \frac{3Ex^2c^2}{(c^2-v^2)^2 t4} \quad (4)$$

Dividing Equation (3) by (1)

$$\frac{\frac{\partial E}{\partial t}}{\frac{\delta E}{\delta x}} = -\frac{VEx}{(C^2-V^2)t^2} \times \frac{(C^2-V^2)t}{VE}$$

$$\frac{\partial E}{\partial t} = -\frac{x}{t}\frac{\delta E}{\delta x}$$

$$\therefore \frac{\partial E}{\partial t} = -v\frac{\delta E}{\delta x} \quad (5)$$

We know that , E =BVsinθ

At V= c E= Bc, sinθ =1 then Equation (5)

$$\frac{\partial(BC)}{\partial t} = -c\frac{\partial E}{\partial x}$$

$$\frac{\partial B}{\partial t} = -\frac{\partial E}{\partial x}$$

i.e , $\nabla\times E = -\frac{\partial B}{\partial t}$

Which is Maxwell's Equation derived from Faraday's law.

Again, Put V=C in Equation (5)

$$\frac{\partial E}{\partial t} = -V\frac{\partial(BV)}{\partial x}$$

$$\frac{\partial E}{\partial t} = -C\frac{\partial(BC)}{\partial x}$$

$$\frac{\partial E}{\partial t} = -C^2\frac{\partial B}{\partial x}$$

$$\frac{\partial B}{\partial x} = -\frac{1}{c^2}\frac{\partial E}{\partial t}$$

$$\frac{\partial B}{\partial x} = -\mu_o\epsilon_o\frac{\partial E}{\partial t}$$

$$\therefore \nabla\times\vec{B} = -\mu_o\epsilon_o\frac{\partial\vec{E}}{\partial t}$$

Taking divergence on both sides;

$$\nabla.(\nabla\times\vec{B}) = -\mu_o\epsilon_o\frac{\partial\,\nabla\vec{E}}{\partial t}$$

For scalar triple product,

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

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Then above equation becomes;

$$\nabla.(\nabla\times\vec{B}) = \nabla.(\vec{B}\times\nabla) = -\mu_o\epsilon_o\frac{\partial \vec{\nabla E}}{\partial t}$$

$$\nabla.(\vec{B}\times\vec{\nabla}) = -\mu_o\epsilon_o\frac{\partial(\Delta.\vec{E})}{\partial t}$$

Removing Divergence from

$$\vec{B}\times\vec{\nabla} = -\mu_o\epsilon_o\frac{\partial\vec{E}}{\partial t}$$

$$-\nabla\times\vec{B} = -\mu_o\epsilon_o\frac{\partial\vec{E}}{\partial t}$$

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

which is Maxwell's equation from equation of continuity

Dividing equation 4 by 2 , we get ,

$$\frac{\frac{\partial^2 E}{\partial t^2}}{\frac{\delta^2 E}{\delta x^2}} = \frac{3Ex^2C^2}{(C^2-V^2)t^4}\times\frac{(C^2-V^2)t^2}{EC^2+2EV^2}$$

$$\frac{\partial^2 E}{\partial t^2} = \frac{3Ex^2C^2}{t^2(EC^2+2EV^2)}\times\frac{\delta^2 E}{\delta x^2}$$

$$\frac{\partial^2 E}{\partial t^2} = \frac{3V^2C^2}{(C^2+2V^2)}\times\frac{\delta^2 E}{\delta x^2}$$

For light V=C then,

or, $\frac{\partial^2 E}{\partial t^2} = \frac{3C^4}{3C^2}\times\frac{\delta^2 E}{\delta x^2}$

or, $\frac{\partial^2 E}{\partial t^2} = C^2\times\frac{\partial^2 E}{\partial t^2}$

$$\nabla^2 E = \frac{1}{c^2}\times\frac{\partial^2 E}{\partial t^2}$$

Similarly,

$$\nabla^2 B = \frac{1}{c^2}\times\frac{\partial^2 B}{\partial t^2}$$

which is the wave equation of electromagnetic wave,

We Know that Maxwell's equation based on Faraday's law is,

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

Taking divergence

$$\nabla.\left(\nabla\times\vec{E}\right) = -\frac{\partial(\nabla.\vec{B})}{\partial t}$$

From scalar triple product,

$$\vec{a}.(\vec{b}\times\vec{c}) = \vec{b}.(\vec{c}\times\vec{a}) = \vec{c}.(\vec{a}\times\vec{b})$$

$$\vec{\Delta}.(\vec{\Delta}\times\vec{E}) = \vec{\Delta}.(\vec{E}\times\vec{\Delta}) = \vec{E}.(\vec{\Delta}\times\vec{\Delta})$$

Above equation becomes,

$$\nabla.(\vec{E}\times\nabla) = -\frac{\partial(\Delta.\vec{B})}{\partial t} \quad (6)$$

$$\vec{E}.(\nabla\times\nabla) = -\frac{\partial}{\partial t}\left(\nabla.\vec{B}\right) \quad (7)$$

From equation 6, we get,

$$\nabla.(\vec{E}\times\nabla) = -\frac{\partial}{\partial t}(\nabla.\vec{B})$$

Removing divergence,

$$\vec{E}\times\nabla = -\frac{\partial(\vec{B})}{\partial t}$$

$$-\nabla\times\vec{E} = -\frac{\partial(\vec{B})}{\partial t}$$

$$\therefore\nabla\times\vec{E} = \frac{\partial(\vec{B})}{\partial t} \quad (8)$$

From Maxwell's equations of Faraday's Law's and equations 8,

$$\nabla\times\vec{E} = \pm\frac{\partial(\vec{B})}{\partial t}$$

We have equation's 7

$$\vec{E}.(\nabla\times\nabla) = -\frac{\partial}{\partial t}(\nabla.\vec{B})$$

$\nabla\times\nabla = 0$ then

$$\frac{\partial}{\partial t}(\nabla.\vec{B}) = 0$$

$$\partial\,(\nabla.\vec{B}) = 0$$

$$\nabla.\vec{B} = \text{Constant}$$

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

This is Maxwell's equations of magnetic induction.

Now Maxwell's equations of Continuity,

$$\nabla\times\vec{B} = \mu_o\epsilon_o\frac{\partial\vec{E}}{\partial t} \quad (9)$$

taking divergence on both side,

$$\nabla.(\nabla\times\vec{B}) = \mu_o\epsilon_o\frac{\partial(\nabla.\vec{E})}{\partial t}$$

From scalar triple product,

$$\vec{a}.(\vec{b}\times\vec{c}) = \vec{b}.(\vec{c}\times\vec{a}) = \vec{c}.(\vec{a}\times\vec{b})$$

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

Above equations becomes

$$\vec{\nabla}.(\vec{B}\times\vec{\nabla}) = \mu_o\epsilon_o\frac{\partial(\nabla.\vec{E})}{\partial t}$$

Removing divergence on both sides,

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

$$-(\vec{\nabla}\times\vec{B}) = \mu_o\epsilon_o\frac{\partial\vec{E}}{\partial t}$$

$$(\vec{\nabla}\times\vec{B}) = -\mu_o\epsilon_o\frac{\partial\vec{E}}{\partial t} \quad (10)$$

From equation (10) and (9), We get,

$$(\nabla\times\vec{B}) = \pm\mu_o\epsilon_o\frac{\partial\vec{E}}{\partial t}$$

Also from triple product,

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

$$\vec{B}.(\vec{\nabla}\times\vec{\nabla}) = \mu_o\epsilon_o\frac{\partial(\Delta.\vec{E})}{\partial t}$$

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

or, $\mu_o \epsilon_o \frac{\partial(\nabla . \vec{E})}{\partial t} = 0$

or, $\partial\ (\nabla . \vec{E}) = 0$

or, $\nabla . \vec{E}$ =Constant $= \frac{\rho}{\epsilon_o}$

which is Maxwell's equation from Guass Law.

Relative ∈ and μ give relative magnetic and electric field Mathematically.

$E = \frac{E_o}{\sqrt{1-\frac{V^2}{C^2}}}$

or, $B = \frac{B_o}{\sqrt{1-\frac{V^2}{C^2}}}$

taking their partial derivatives with respect to x and t , we get four Maxwell's equations,

1) $\nabla . \vec{E} = \frac{\rho}{\epsilon_o}$

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

3) $\nabla \times \vec{E} = -\frac{\partial(\vec{B})}{\partial t}$

4) $\nabla \mathrm{x}\ \vec{B} = \mu_o \epsilon_o \frac{\partial \vec{E}}{\partial t}$

Also electromagnetic equations,

$\frac{\partial^2 \vec{E}}{\partial t} = C^2 \nabla^2 E$

this shows that total electric and magnetic of a charge is relative whenever these charge use their electric and magnetic field to propagate in space as electromagnetic wave. _.

B. Magnetic and electric field spread in vicinity for force of attraction and repulsion

Relative magnetic and electric field spread in vicinity for force of attraction and repulsion is

$B = B_0 \sqrt{1-\frac{v^2}{c^2}}$

$E = E_0 \sqrt{1-\frac{v^2}{c^2}}$

Taking log on both sides,

$\log E = \log Eo + \log \sqrt{1-\frac{v^2}{c^2}}$

or, $\log E = \log E_o + (\log\sqrt{c^2 - v^2} - \log c^2)$

or, $\log E = \log E_o + (\log(c^2 - v^2)^{1/2} - \log c^2)$

or, $\log E = \log E_o + \frac{1}{2}\log(c^2 - v^2) - 2\log C$ $(\log a^n = n\log a)$

Differentiating partial with respect to x, we get,

$\delta\frac{\log E}{\delta x} = \delta\frac{(\log Eo)}{\delta x} + \frac{\delta}{\delta x}(\frac{1}{2}\log\ (c^2\text{-}v^2) - \frac{\delta}{\delta x}(2\log c)$

or, $\frac{1}{E}\frac{\delta E}{\delta x} = 0 + \frac{(-2V)}{2(C^2-V^2)}\frac{\delta V}{\delta x} - 0$

or, $\frac{\delta E}{\delta x} = -\frac{2VE}{2(C^2-V^2)}\frac{\delta V}{\delta x}$

or, $\frac{\delta E}{\delta x} = -\frac{VE}{(C^2-V^2)}\frac{\delta}{\delta x}(\frac{X}{t})$

or, $\frac{\delta E}{\delta x} = -\frac{VE}{(C^2-V^2)t}$ (11)

or, $-t\ \frac{\delta E}{\delta x} = \frac{EV}{(C^2-V^2)}$

again, Differentiating partially with respect to x ,

$-t\ \frac{\delta^2 E}{\delta x^2} = \frac{(C^2-V^2)\frac{\delta}{\delta x}(EV) - EV\frac{\delta}{\delta x}(C^2-V^2)}{2(C^2-V^2)^2}$

$= \frac{(C^2-V^2)\frac{E}{t} + \frac{(C^2-V^2)EV^2}{(C^2-V^2)t} - EV(\frac{-2V\delta V}{\delta x})}{(C^2-V^2)^2}$

$= \frac{\frac{E(C^2-V^2)}{t} - \frac{EV^2}{t} + (\frac{2EV^2}{t})}{(C^2-V^2)^2}$

$-t\ \frac{\delta^2 E}{\delta x^2} = \frac{EC^2 - EV^2 + EV^2 + 2EV^2}{(C^2-V^2)^2 t}$

$t\ \frac{\delta^2 E}{\delta x^2} = \frac{EC^2 - EV^2 - EV^2 + 2EV^2}{(C^2-V^2)^2 t}$

$\frac{\delta^2 E}{\delta x^2} = -\frac{EC^2}{(C^2-V^2)^2 t^2}$ (12)

Now, Differentiating partially with Respect to t,

$\frac{\delta(\log E)}{\delta t^2} = \frac{\partial}{\partial t}(\log E_{0o}) + \frac{1}{2}\frac{\partial}{\partial t}\log(C^2 - V^2) - \frac{\partial}{\partial t}(\log C)$

$\frac{1}{E}\frac{\partial E}{\partial t} = 0 + \frac{1}{2}\frac{(-2v)}{(C^2-V^2)}\frac{\partial V}{\partial t} - 0$

$\frac{1}{E}\frac{\partial E}{\partial t} = -\frac{V}{(C^2-V^2)}\frac{\partial^{x}/_{t}}{\partial t} = -\frac{Vx}{(C^2-V^2)}\frac{\partial(x^{-1})}{\partial t}$

$\frac{1}{E}\frac{\partial E}{\partial t} = \frac{Vx}{(C^2-V^2)t^2}$

$\frac{\partial E}{\partial t} = \frac{VEx}{(C^2-V^2)t^2}$.................................... (13)

$\frac{1}{x}\frac{\partial E}{\partial t} = \frac{VE}{(C^2-V^2)t^2}$

Again taking partial derivatives with respect to t,

$\frac{1}{x}\frac{\partial^2 E}{\partial t^2} = \frac{\partial E}{\partial t}(\frac{VE}{(C^2-V^2)t^2})$

$= \frac{(C^2-V^2)t^2(\frac{\partial(VE)}{\partial t}) - VE[\frac{\partial}{\partial t}(C^2-V^2)t^2}{(C^2-V^2)^2 t4}$

$= \frac{(C^2-V^2)t^2(V\frac{\partial(E)}{\partial t} + E\frac{\partial(V)}{\partial t}) - VE[(C^2-V^2)\frac{\partial t^2}{\partial t} + t^2\frac{\partial(C^2-V^2)}{\partial t}]}{(C^2-V^2)^2 t4}$

$= \frac{(C^2-V^2)t^2\left[V\left(\frac{VEx}{(C^2-V^2)t^2)}\right)\right] + E(-\frac{x}{t^2}) - VE[(C^2-V^2)2t + t^2(-2V\frac{\partial V}{\partial t})]}{(C^2-V^2)^2 t4}$

$= \frac{(C^2-V^2)t^2\left[\frac{V^2Ex}{(C^2-V^2)t^2)} - \frac{Ex}{t^2}\right] - VE[(C^2-V^2)2t + t^2(\frac{2Vx}{t^2})]}{(C^2-V^2)^2 t4}$

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$$=\frac{V^2Ex-Ex(C^2-V^2)-2tVE[(C^2-V^2)-2V^2Ex]}{(C^2-V^2)^2t4}$$

$$=\frac{V^2Ex-ExC^2+ExV^2-2tVEC^2+2tVEV^2-2V^2Ex}{(C^2-V^2)^2t4} \quad (\because Vt=x)$$

$$\frac{V^2Ex-ExC^2+ExV^2-2xEC^2+2xEV^2-2V^2Ex}{(C^2-V^2)^2t4}$$

$$=\frac{2V^2Ex-3ExC^2}{(C^2-V^2)^2t4}$$

$$\therefore \frac{1}{x}\frac{\partial^2E}{\partial t^2}=\frac{2V^2Ex-3ExC^2}{(C^2-V^2)^2t4}$$

$$\therefore \frac{\partial^2E}{\partial t^2}=-\frac{Ex^2(3C^2-2V^2)}{(C^2-V^2)^2t4} \quad (14)$$

Dividing Equation (13) by (11)

$$\frac{\frac{\partial E}{\partial t}}{\frac{\delta E}{\delta x}}=-\frac{VEx}{(C^2-V^2)t^2}\times\frac{(C^2-V^2)t}{VE}$$

$$\frac{\partial E}{\partial t}=-\frac{x}{t}\frac{\delta E}{\delta x}$$

$$\therefore \frac{\partial E}{\partial t}=-v\frac{\delta E}{\delta x}\text{..............................} \quad (15)$$

We know that , E = BVsinθ sinθ

At V= c E= Bc, sinθ =1 then Equation (15)

$$\frac{\partial(BC)}{\partial t}=-c\frac{\partial E}{\partial x}$$

$$\frac{\partial B}{\partial t}=-\frac{\partial E}{\partial x}$$

i.e , $\nabla\times E=-\frac{\partial B}{\partial t}$

Which is Maxwell's Equation derived from Faraday's law.

Again, Put V=C in Equation (15)

$$\frac{\partial E}{\partial t}=-V\frac{\partial(BV)}{\partial x}$$

$$\frac{\partial E}{\partial t}=-C\frac{\partial(BC)}{\partial x}$$

$$\frac{\partial E}{\partial t}=-C^2\frac{\partial B}{\partial x}$$

$$\frac{\partial B}{\partial x}=-\frac{1}{C^2}\frac{\partial E}{\partial t}$$

$$\frac{\partial B}{\partial x}=-\mu_o\epsilon_o\frac{\partial E}{\partial t}$$

$$\therefore \nabla\times\vec{B}=-\mu_o\epsilon_o\frac{\partial\vec{E}}{\partial t}$$

Taking divergence on both sides;

$$\nabla.(\nabla\times\vec{B})=-\mu_o\epsilon_o\frac{\partial\overrightarrow{\nabla E}}{\partial t}$$

For scalar triple product,

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

Then above equation becomes;

$$\nabla.(\nabla\times\vec{B})=\nabla.(\vec{B}\times\nabla)=-\mu_o\epsilon_o\frac{\partial\overrightarrow{\nabla E}}{\partial t}$$

Removing Divergence from

$$\nabla.(\vec{B}\times\vec{\nabla})=-\mu_o\epsilon_o\frac{\partial(\Delta.\vec{E})}{\partial t}$$

$$\vec{B}\times\vec{\nabla}=-\mu_o\epsilon_o\frac{\partial\vec{E}}{\partial t}$$

$$-\nabla\times\vec{B}=-\mu_o\epsilon_o\frac{\partial\vec{E}}{\partial t}$$

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

which is Maxwell's equation from equation of continuity

Dividing equation (14) by (12) , we get ,

$$\frac{\frac{\partial^2E}{\partial t^2}}{\frac{\delta^2E}{\delta x^2}}=-\frac{Ex^2(3C^2-2V^2)}{(C^2-V^2)t^4}\times-\frac{(C^2-V^2)t^2}{EC^2}$$

$$\frac{\partial^2E}{\partial t^2}=\frac{x^2(3C^2-2V^2)}{t^2c^2}\times\frac{\delta^2E}{\delta x^2}$$

$$\frac{\partial^2E}{\partial t^2}=\frac{v^2(3c^2-2v^2)}{c^2}\times\frac{\delta^2E}{\delta x^2}$$

For light V=C then,

or, $\frac{\partial^2E}{\partial t^2}=\frac{c^2(3c^2-2c^2)}{c^2}\times\frac{\delta^2E}{\delta x^2}$

or, $\frac{\partial^2E}{\partial t^2}=C^2\times\frac{\partial^2E}{\partial t^2}$

$$\nabla^2E=\frac{1}{c^2}\times\frac{\partial^2E}{\partial t^2}$$

Similarly,

$$\nabla^2B=\frac{1}{c^2}\times\frac{\partial^2B}{\partial t^2}$$

which is the wave equation of electromagnetic wave,

We know that Maxwell's equation based on Faraday's law is,

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

Taking divergence

$$\nabla.\left(\nabla\times\vec{E}\right)=-\frac{\partial(\nabla.\vec{B})}{\partial t}$$

From scalar triple product,

$$\vec{a}.(\vec{b}\times\vec{c})=\vec{b}.(\vec{c}\times\vec{a})=\vec{c}.(\vec{a}\times\vec{b})$$

$$\vec{\Delta}.(\vec{\Delta}\times\vec{E})=\vec{\Delta}.(\vec{E}\times\vec{\Delta})=\vec{E}.(\vec{\Delta}\times\vec{\Delta})$$

Above equation becomes,

$$\nabla.(\vec{E}\times\nabla)=-\frac{\partial(\Delta.\vec{B})}{\partial t} \quad (16)$$

$$\vec{E}.(\nabla\times\nabla)=-\frac{\partial}{\partial t}\left(\nabla.\vec{B}\right) \quad (17)$$

From equation 16, we get,

$$\nabla.(\vec{E}\times\nabla)=-\frac{\partial}{\partial t}(\nabla.\vec{B})$$

Removing divergence,

$$\vec{E}\times\nabla=-\frac{\partial(\vec{B})}{\partial t}$$

$$-\nabla\times\vec{E}=-\frac{\partial(\vec{B})}{\partial t}$$

$$\therefore \nabla\times\vec{E}=\frac{\partial(\vec{B})}{\partial t} \quad (18)$$

From Maxwell's equation of

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Faraday's Law's and equation (18)

$\nabla \times \vec{E} = \pm \frac{\partial(\vec{B})}{\partial t}$

We have equation's 17

$\vec{E}.(\nabla\times\nabla) = -\frac{\partial}{\partial t}(\nabla . \vec{B})$

$\nabla\times\nabla = 0$ then

$\frac{\partial}{\partial t}(\nabla . \vec{B}) = 0$

$\partial (\nabla . \vec{B}) = 0$

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

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

This is Maxwell's equations of magnetic induction.
Now Maxwell's equations of Continuity,

$$\nabla \times \vec{B} = \mu_o \epsilon_o \frac{\partial \vec{E}}{\partial t} \qquad (19)$$

taking divergence on both side,

$\nabla.(\nabla \times \vec{B}) = \mu_o \epsilon_o \frac{\partial(\nabla.\vec{E})}{\partial t}$

From scalar triple product,

$\vec{a}.(\vec{b}\times\vec{c}) = \vec{b}.(\vec{c}\times\vec{a}) = \vec{c}.(\vec{a}\times\vec{b})$

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

Above equations becomes

$\vec{\nabla}.(\vec{B}\times\vec{\nabla}) = \mu_o \epsilon_o \frac{\partial(\nabla.\vec{E})}{\partial t}$

Removing divergence on both sides,

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

$-(\vec{\nabla}\times\vec{B}) = \mu_o \epsilon_o \frac{\partial \vec{E}}{\partial t}$

$$(\vec{\nabla}\times\vec{B}) = -\mu_o \epsilon_o \frac{\partial \vec{E}}{\partial t} \qquad (20)$$

From equation (20) and (19), We get,

$(\nabla\times\vec{B}) = \pm\mu_o \epsilon_o \frac{\partial \vec{E}}{\partial t}$

Also from triple product,

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

$\vec{B}.(\vec{\nabla}\times\vec{\nabla}) = \mu_o \epsilon_o \frac{\partial(\Delta.\vec{E})}{\partial t}$

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

or, $\mu_o \epsilon_o \frac{\partial(\nabla.\vec{E})}{\partial t} = 0$

or, $\partial(\nabla.\vec{E}) = 0$

or, $\nabla.\vec{E}$ =Constant = $\frac{\rho}{\epsilon_o}$

which is Maxwell's equation from Gauss' Law.
Relative electric and magnetic field spread in vicinity for force of attraction and repulsion is

$E = E_0\sqrt{1-\frac{v^2}{c^2}}$

or, $B = B_0\sqrt{1-\frac{v^2}{c^2}}$

taking their partial derivatives with respect to x and t , we get four Maxwell's equations,

1) $\nabla.\vec{E} = \frac{\rho}{\epsilon_o}$

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

3) $\nabla \times \vec{E} = -\frac{\partial(\vec{B})}{\partial t}$

4) $\nabla \times \vec{B} = \mu_o \epsilon_o \frac{\partial \vec{E}}{\partial t}$

Also electromagnetic equations,

$\frac{\partial^2 \vec{E}}{\partial t} = C^2\nabla^2 E$

this shows that total electric and magnetic field spread in vicinity is relative whenever these charge use their electric and magnetic field to propagate in space as electromagnetic wave.

C. Electric and magnetic field for propagation

Let a charge q propagate in space at velocity v using their electric and magnetic field then force associated with the system is

$F = qE$

$= \frac{qE_o}{\sqrt{1-\frac{V^2}{c^2}}}$

$= \frac{qE_o}{\sqrt{1-\frac{(x)^2}{(tc)^2}}}$

$= \frac{qE_o ct}{\sqrt{(tc)^2-x^2}}$

Linear momentum due to this force,

$F = \frac{\partial P}{\partial t}$

$P = \int F.dt$

$= \int \frac{qE_o ct}{\sqrt{(tc)^2-x^2}}.dt$

$= qE_o \int \frac{ct}{\sqrt{(tc)^2-x^2}}\frac{c}{c}.dt$

$$= \frac{qE_o}{c}\int \frac{ct\, d(ct)}{\sqrt{(tc)^2-x^2}} \qquad (21)$$

Put $(tc)^2 - x^2 = y$

$2c^2 tdt = dy$

$c^2 tdt = \frac{dy}{2}$

equations (21) becomes,

$P = \frac{qE_{0c}}{c}\int \frac{ct\, d(ct)}{\sqrt{(tc)^2-x^2}}$

$= \frac{qE_{0c}}{2c}\int \frac{dy}{y}$

$= \frac{qE_{0c}}{2c}\frac{y^{-\frac{1}{2}+1}}{-\frac{1}{2}+1} + a$

$= \frac{qE_{0c}\sqrt{y}}{c} + a$

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$\therefore$ P = $\frac{qE_{0\circ}}{c}\sqrt{(ct)^2 - x^2}$ + a

$\therefore$ P = $qE_{0\circ}t\sqrt{1-\frac{v^2}{c^2}}$ + a

Linear momentum associated with total electric field of charge is

$$P = qE_{0\circ}t\sqrt{1-\frac{v^2}{c^2}} \qquad (22)$$

Let consider a charge q propagate in space at velocity v then linear momentum associated with electric field spread in vicinity for force of attraction and repulsion is

$$P = \int f.dt$$

$$= \int qEdt$$

$$= \int qE_0\sqrt{1-\frac{v^2}{c^2}}dt$$

$$= \int qE_0\sqrt{1-\frac{x^2}{(ct)^2}}dt$$

$$= \int \frac{qE_0\sqrt{(ct)^2-x^2}\,dt}{ct}\times\frac{c}{c}$$

$$= \frac{qE_0}{c}\int\frac{\sqrt{(ct)^2-x^2}\,d(ct)}{(ct)} \qquad (23)$$

Put $ct = x\sec\theta$

$$d(ct) = x\sec\theta\tan\theta\, d\theta$$

then,

$$(ct)^2 - x^2 = (ct)^2\tan^2\theta$$

$$\int\frac{\sqrt{(ct)^2-x^2}\,d(ct)}{(ct)} = \frac{1}{ct}\int\frac{\sqrt{(ct)^2\tan^2\theta}\,x\sec\theta\tan\theta\,d\theta}{x\sec\theta}$$

$$= \int x\tan^2\theta\, d\theta$$

$$= x\int(\sec^2\theta - 1)\,d\theta$$

$$= x\int\sec^2\theta\,d\theta - x\int d\theta$$

$$= x\tan\theta - x\theta + a$$

$$= x\sqrt{\sec^2\theta - 1} - x\sec^{-1}\left(\frac{c}{v}\right) + a$$

$$\left(\therefore ct = x\sec\theta \Rightarrow \sec\theta = \frac{ct}{x} = \frac{c}{v}\right)$$

$$\int\frac{\sqrt{(ct)^2 - x^2)}}{(ct)}\,d(ct) = x\sqrt{\frac{(ct)^2 - x^2}{x^2}} - x\sec^{-1}\left(\frac{c}{v}\right) + a$$

$$= \sqrt{(ct)^2 - x^2} - x\sec^{-1}\left(\frac{c}{v}\right) + a$$

Now equation (23) becomes

$$P = \frac{qE_{0\circ}}{c}\left[\sqrt{(ct)^2 - x^2} - x\sec^{-1}\left(\frac{c}{v}\right) + a\right] \qquad (24)$$

Total electric field of electromagnetic wave is equal to sum of electric field spread in vicinity for force of attraction and repulsion and electric field for propagation of wave. i.e.

Total electric field = electric field spread in space + electric field for propagation

Electric field for propagation = total electric field – electric field spread in space

From equation (21) and (24)

Moment associated with propagation of wave is

$$= \frac{qE_{0\circ}}{c}\sqrt{(ct)^2 - x^2} - \frac{qE_{0\circ}}{c}\left[\sqrt{(ct)^2 - x^2} - x\sec^{-1}\left(\frac{c}{v}\right)\right]$$

$$= \frac{qE_{0\circ}x}{c}\sec^{-1}\left(\frac{c}{v}\right)$$

Force associated with this linear momentum is

$$F = \frac{\delta p}{\delta t}$$

$$= \frac{\delta}{\delta t}\left[\frac{qE_{0\circ}x}{c}\sec^{-1}\left(\frac{c}{v}\right)\right]$$

$$= \frac{qE_{0\circ}x}{c\sqrt{\frac{c^2}{v^2}-1}}\cdot\frac{v}{c}\cdot\frac{d\left(\frac{c}{v}\right)}{dt}$$

$$\left(\therefore \frac{d}{dx}(\sec^{-1}x) = \frac{1}{x\sqrt{x^2-1}}\right)$$

$$= \frac{qE_0xv^2}{c^2\sqrt{c^2-v^2}}\cdot\left(-\frac{c}{v^2}\right)\frac{dv}{dt}$$

$$= \frac{qE_0xv^2}{c^2\sqrt{c^2-v^2}}\cdot\left(-\frac{c}{v^2}\right)\frac{d\left(\frac{x}{t}\right)}{dt}$$

$$= \frac{qE_0x^2v^2c}{c^2\sqrt{c^2-v^2}\;v^2t^2}$$

$$= \frac{qE_0v^2}{c^2\sqrt{1-\frac{v^2}{c^2}}}$$

So electric field associated with propagation of wave is

$$\frac{v^2E_0}{c^2\sqrt{1-\frac{v^2}{c^2}}}$$

Equation of relative electric field is

Total electric field = Electric field spread in space + electric field for propagation

$$\frac{E_0}{\sqrt{1-\frac{v^2}{c^2}}} = E_0\sqrt{1-\frac{v^2}{c^2}} + \frac{v^2E_0}{c^2\sqrt{1-\frac{v^2}{c^2}}}$$

III. EXPERIMENTAL SECTION

Electromagnetic waves propagate in space by its own oscillating electric and magnetic field without apply of any external force. As a result, it's electric and magnetic field is relative. in an atom, Electric and magnetic field of electron revolving due to electrostatic force is obsolute it is because electron in an atom do not revolve by its own electric and magnetic field as electromagnetic waves. Also charge particle accelerate due to externally applied force in accelerator (LHC,cyclic acceleration and linear accelerator). Relative effect on Coloumb's Force Let us consider on electron of charge 'q' is revolving around nucleus of charge $'Q'$ then electrostatic force of attraction is

$$F = \frac{Qq}{4\pi\epsilon_0r^2}$$

According to relativistic effect, electric permittivity for force of attraction or repulsion should be $\frac{\epsilon_0}{\sqrt{1-\frac{v^2}{c^2}}}$

$$\therefore F = \frac{Qq}{4\pi\epsilon_0r^2}\sqrt{1-\frac{v^2}{c^2}}$$

Experimentally, it is valid whenever electron propagate by its own electric and magnetic field as electromagnetic wave.
Relativistic effect on Biot-Savart Law

According to Biot-Savart law the magnetic field $d\vec{B}$ at a point in the magnetic field of an element $d\vec{l}$ of the current is

$$d\vec{B} = \frac{\mu_0 I dl \sin\theta}{4\pi r^2}$$

According to relativistic effect, magnetic permeability for force of attraction or repulsion should be $u_0\sqrt{1-\frac{v^2}{c^2}}$

$$\therefore d\vec{B} = \frac{u_0 I dl \sin\theta}{4\pi r^2}\sqrt{1-\frac{v^2}{c^2}}$$

Experimentally it is valid whenever charges in current carrying element move by their's own electric and magnetic field as electromagnetic waves.

IV. RESULT AND DISCUSSION

Total electric and magnetic field of electromagnetic wave is divided into two parts.
Total electric field = Electric field force of attraction and repulsion + Electric field for propagation

$$\frac{E_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{v^2 E_0}{c^2\sqrt{1-\frac{v^2}{c^2}}} + E_0\sqrt{1-\frac{v^2}{c^2}}$$

$$\frac{B_0}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{v^2 B_0}{c^2\sqrt{1-\frac{v^2}{c^2}}} + B_0\sqrt{1-\frac{v^2}{c^2}}$$

Case (A): When velocity of charge v = c above equation becomes

$$\frac{E_0}{\sqrt{1-\frac{c^2}{c^2}}} = \frac{c^2 E_0}{c^2\sqrt{1-\frac{c^2}{c^2}}} + E_0\sqrt{1-\frac{c^2}{c^2}}$$

or,

$$\frac{E_0}{\sqrt{1-\frac{c^2}{c^2}}} = \frac{E_0}{\sqrt{1-\frac{c^2}{c^2}}} + 0$$

or,

$$\frac{B_0}{\sqrt{1-\frac{c^2}{c^2}}} = \frac{B_0}{\sqrt{1-\frac{c^2}{c^2}}} + 0$$

Thus at velocity of light whole electric and magnetic field is equal to electric and magnetic field for propagation of charge and there is no electric field for force of attraction and repulsion. So every charge particle including photon moving at velocity of light is underflected in electric and magnetic field.
Case (B): When velocity of particle v = 0 above equation becomes,

$$\frac{E_0}{\sqrt{1-\frac{c^2}{c^2}}} = \frac{0\ E_0}{c^2\sqrt{1-\frac{v^2}{c^2}}} + E_0\sqrt{1-\frac{0}{c^2}}$$

or,

$$E_0 = 0 + E_0$$

Thus, at rest whole electric and magnetic field is equal to the field for force of attraction and repulsion Spread in vicinity. There is no field for propagation of particle. So particle is at rest.

V. CONCLUSION

Total electric and magnetic field of electromagnetic wave is dependent of the relative motion of frame of reference.

$$E = \frac{E_0}{\sqrt{1-\frac{v^2}{c^2}}} \qquad B = \frac{B_0}{\sqrt{1-\frac{v^2}{c^2}}}$$

This total relative field is for two different purposes:
Field spread in space for force of attraction and repulsion = $E_0\sqrt{1-\frac{v^2}{c^2}}$ & $B_0\sqrt{1-\frac{v^2}{c^2}}$

Field for propagation of wave = $\frac{v^2 E_0}{c^2\sqrt{1-\frac{v^2}{c^2}}}$ & $\frac{v^2 B_0}{c^2\sqrt{1-\frac{v^2}{c^2}}}$

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