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Einstein's Notational Equation of Electro-Magnetic Field Equation in Rindler spacetime

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Abstract: *We find Einstein's notational equation of the electro-magnetic field equation and the electro-magnetic field in Rindler space-time. Because, electromagnetic fields of the accelerated frame include in general relativity theory.*

Keywords: *The general relativity theory, The Rindler spacetime, Einstein's notational equation*

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1. Introduction

Our article's aim is that we find Einstein notation's equations in general relativity theory instead of the electro-magnetic field equations in Rindler space-time.

Rindler coordinate are

$$ct = \left(\frac{c^2}{a_0} + \xi^1\right)\sinh\left(\frac{a_0\xi^0}{c}\right)$$

$$x = \left(\frac{c^2}{a_0} + \xi^1\right)\cosh\left(\frac{a_0\xi^0}{c}\right) - \frac{c^2}{a_0} \quad , y = \xi^2, z = \xi^3 \tag{1}$$

The electro-magnetic field equation is in Rindler space-time [1].

$$\vec{\nabla}_\xi \cdot \vec{E}_\xi = 4\pi\rho_\xi\left(1 + \frac{a_0\xi^1}{c^2}\right) \tag{2-i}$$

$$\frac{1}{\left(1 + \frac{a_0\xi^1}{c^2}\right)}\vec{\nabla}_\xi \times \left\{\vec{B}_\xi\left(1 + \frac{a_0\xi^1}{c^2}\right)\right\} = \frac{1}{\left(1 + \frac{a_0\xi^1}{c^2}\right)}\frac{\partial\vec{E}_\xi}{c\partial\xi^0} + \frac{4\pi}{c}\vec{j}_\xi \tag{2-ii}$$

$$\vec{\nabla}_\xi \cdot \vec{B}_\xi = 0 \tag{2-iii}$$

$$\frac{1}{\left(1 + \frac{a_0\xi^1}{c^2}\right)}\vec{\nabla}_\xi \times \left\{\vec{E}_\xi\left(1 + \frac{a_0\xi^1}{c^2}\right)\right\} = -\frac{1}{\left(1 + \frac{a_0\xi^1}{c^2}\right)}\frac{\partial\vec{B}_\xi}{c\partial\xi^0} \tag{2-iv}$$

$$\vec{E}_\xi = (E_{\xi^1}, E_{\xi^2}, E_{\xi^3}), \vec{B}_\xi = (B_{\xi^1}, B_{\xi^2}, B_{\xi^3}), \vec{\nabla}_\xi = \left(\frac{\partial}{\partial\xi^1}, \frac{\partial}{\partial\xi^2}, \frac{\partial}{\partial\xi^3}\right)$$

The Electro-magnetic field $(\vec{E}_{\xi}, \vec{B}_{\xi})$ is defined in Rindler spacetime [1].

$$\vec{E}_{\xi} = -\frac{1}{(1+\frac{a_0\xi^1}{c^2})}\vec{\nabla}_{\xi}\{\phi_{\xi}(1+\frac{a_0\xi^1}{c^2})^2\} - \frac{1}{(1+\frac{a_0\xi^1}{c^2})}\frac{\partial\vec{A}_{\xi}}{c\partial\xi^0}$$

$$\vec{B}_{\xi} = \vec{\nabla}_{\xi}\times\vec{A}_{\xi}$$

In this time, $\vec{\nabla}_{\xi} = (\frac{\partial}{\partial\xi^1}, \frac{\partial}{\partial\xi^2}, \frac{\partial}{\partial\xi^3}), \vec{A}_{\xi} = (A_{\xi^1}, A_{\xi^2}, A_{\xi^3})$ (3)

2. EINSTEIN'S NOTATIONAL EQUATION IN GENERAL RELATIVITY THEORY

Electromagnetic field tensor $F_{\xi}^{\mu\upsilon}$ is in Rindler space-time,

$$F_{\xi}^{\mu\upsilon} = \begin{pmatrix} 0 & E_{\xi^1} & E_{\xi^2} & E_{\xi^3} \\ -E_{\xi^1} & 0 & (1+\frac{a_0\xi^1}{c^2})B_{\xi^3} & -(1+\frac{a_0\xi^1}{c^2})B_{\xi^2} \\ -E_{\xi^2} & -(1+\frac{a_0\xi^1}{c^2})B_{\xi^3} & 0 & (1+\frac{a_0\xi^1}{c^2})B_{\xi^1} \\ -E_{\xi^3} & (1+\frac{a_0\xi^1}{c^2})B_{\xi^2} & -(1+\frac{a_0\xi^1}{c^2})B_{\xi^1} & 0 \end{pmatrix} \quad (4)$$

Electromagnetic field tensor $F_{\xi\,\mu\upsilon}$ is in Rindler space-time,

$$F_{\xi\,\mu\upsilon} = \begin{pmatrix} 0 & -(1+\frac{a_0\xi^1}{c^2})E_{\xi^1} & -(1+\frac{a_0\xi^1}{c^2})E_{\xi^2} & -(1+\frac{a_0\xi^1}{c^2})E_{\xi^3} \\ (1+\frac{a_0\xi^1}{c^2})E_{\xi^1} & 0 & B_{\xi^3} & -B_{\xi^2} \\ (1+\frac{a_0\xi^1}{c^2})E_{\xi^2} & -B_{\xi^3} & 0 & B_{\xi^1} \\ (1+\frac{a_0\xi^1}{c^2})E_{\xi^3} & B_{\xi^2} & -B_{\xi^1} & 0 \end{pmatrix} \quad (5)$$

Hence, Eq(3) is

$$F_{\xi\,\mu\upsilon} = \frac{\partial A_{\xi^{\upsilon}}}{\partial\xi^{\mu}} - \frac{\partial A_{\xi^{\mu}}}{\partial\xi^{\upsilon}}, \quad A_{\xi^{\mu}} = ((1+\frac{a_0\xi^1}{c^2})^2\phi_{\xi}, \vec{A}_{\xi}) \quad (6)$$

Eq(2-i),Eq(2-ii),Eq(2-iii),Eq(2-iv) are

$$F_{\xi}^{\mu\upsilon}{}_{,\upsilon} = \frac{4\pi}{c} j^{\mu}(1+\frac{a_0\xi^1}{c^2}) \quad (7\text{-i})$$

$$F_{\xi\,\mu\upsilon,\lambda} + F_{\xi\,\upsilon\lambda,\mu} + F_{\xi\,\lambda\mu,\upsilon} = 0 \quad (7\text{-ii})$$

Hence, the Lagrangian L_{ξ} of electromagnetic field in Rindller space-time is,

$$L_{\xi} = -\frac{1}{4}F_{\xi}^{\mu\upsilon}F_{\xi\,\mu\upsilon}$$

$$= -\frac{1}{2}(1+\frac{a_0\xi^1}{c^2})(B_\xi^{\ 2} - E_\xi^{\ 2}),$$

$$\vec{E}_\xi = (E_{\xi^1}, E_{\xi^2}, E_{\xi^3}), \vec{B}_\xi = (B_{\xi^1}, B_{\xi^2}, B_{\xi^3}), |\vec{E}_\xi| = E_\xi, |\vec{B}_\xi| = B_\xi \quad (8)$$

3. CONCLUSION

We find Einstein's notational equations of the electro-magnetic field equation in uniformly accelerated frame.

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