International Journal of Advanced Research in Physical Science (IJARPS)
Volume 6, Issue 12, 2019, PP 11-13
ISSN No. (Online) 2349-7882
www.arcjournals.org

Unification for Gravity and Electromagnetic Field in Kerr Newman Solution

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Abstract: *Solutions of unified theory equations of gravity and electromagnetism has to satisfy Einstein-Maxwell equation. Specially, solution of the unified theory is generally Kerr-Newman solution in vacuum. We finally found the revised Einstein gravity tensor equation with new term (2-order contravariant metric tensor two times product and the constant matrix) is right in Kerr-Newman solution.*

Keywords: *General relativity theory, Unified Theory; Kerr-Newman solution; 2-order contravariant metric te nsor two times product; The constant matrix*

PACS Number: *04,04.90.+e,41.12*

1. Introduction

This theory's aim is that we discover the revised Einstein gravity equation had Kerr-Newman solution in vacuum..

First, we know the revised Einstein gravity equation[1].

$$R_{\mu\nu}-\frac{1}{2}g_{\mu\nu}R+\Lambda g_{\mu\nu}I(g^{\theta\theta})^2=-\frac{8\pi G}{c^4}T_{\mu\nu}$$

In this time,

$$\Lambda=k\frac{GQ^2}{c^4},\ I=\begin{pmatrix}1&0&0&0\\0&1&0&0\\0&0&-1&0\\0&0&0&-1\end{pmatrix} \tag{1}$$

If Eq(1) take covariant differential operator,

$$(R_{\mu\nu}-\frac{1}{2}g_{\mu\nu}R)_{;\mu}+\Lambda g_{\mu\nu}I2g^{\theta\theta}g^{\theta\theta}{}_{;\mu}=-\frac{8\pi G}{c^4}T_{\mu\nu;\mu}=0 \tag{2-i}$$

$$(R_{\mu\nu}-\frac{1}{2}g_{\mu\nu}R)_{;\nu}+\Lambda g_{\mu\nu}I2g^{\theta\theta}g^{\theta\theta}{}_{;\nu}=-\frac{8\pi G}{c^4}T_{\mu\nu;\nu}=0 \tag{2-ii}$$

In this time, in Kerr-Newman solution

$$g_{\theta\theta}=1/g^{\theta\theta}=\rho^2=r^2+a^2\cos^2\theta$$

$$g^{\theta\theta}{}_{;\rho}=\frac{\partial g^{\theta\theta}}{\partial x^\rho}+2\Gamma^\theta{}_{\sigma\rho}g^{\sigma\theta}=\frac{\partial g^{\theta\theta}}{\partial r}+2\Gamma^\theta{}_{\theta r}g^{\theta\theta}$$

$$=\frac{\partial}{\partial r}(\frac{1}{\rho^2})+2\cdot\frac{r}{\rho^2}\cdot\frac{1}{\rho^2}=-2\frac{1}{\rho^3}\cdot\frac{r}{\rho}+\frac{2r}{\rho^4}=0 \tag{3}$$

$$g^{\theta\theta}{}_{;\rho}=\frac{\partial g^{\theta\theta}}{\partial x^\rho}+2\Gamma^\theta{}_{\sigma\rho}g^{\sigma\theta}=\frac{\partial g^{\theta\theta}}{\partial\theta}+2\Gamma^\theta{}_{\theta\theta}g^{\theta\theta}$$

$$=\frac{\partial}{\partial\theta}(\frac{1}{\rho^2})-2\cdot\frac{1}{\rho^2}\cdot\frac{1}{2}\rho\frac{2a^2}{\rho}\cos\theta\sin\theta\cdot\frac{1}{\rho^2}$$

$$= -2 \cdot \frac{1}{\rho^3} \cdot -\frac{2a^2 \cos\theta \sin\theta}{\rho} - \frac{4a^2}{\rho^4} \cos\theta \sin\theta = 0 \tag{4}$$

If $g^{\theta\theta}{}_{;\rho} = V_\rho$, the vector transformation is

$$0 = V_\rho = \frac{\partial x^{\alpha}}{\partial x^{\rho}} V'_{\alpha}, \; V'_{\alpha} = 0 \tag{5}$$

Therefore, if the coordinate is not the Kerr-Newman's coordinate, the covariant differential of $g^{\theta\theta} = \frac{1}{\rho^2}$ is still zero in the changed coordinates.

2. The Revised Einstein Gravity Equation and Kerr-Newman Solution

In this theory, Eq(1) can change the following equation.

$$R_{\mu\upsilon} = -\frac{8\pi G}{c^4}(T_{\mu\upsilon} - \frac{1}{2} g_{\mu\upsilon} T^{\lambda}{}_{\lambda}) + \Lambda g_{\mu\upsilon} I (g^{\theta\theta})^2 \tag{6}$$

In this time, in vacuum, specially, in Kerr-Newman solution,

$$T_{\mu\upsilon} = 0, \; T^{\lambda}{}_{\lambda} = g^{\mu\upsilon} T_{\mu\upsilon} \neq 0 \tag{7}$$

Therefore, Eq(1) is

$$T_{\mu\upsilon} = 0, -\Lambda g_{\mu\upsilon} I (g^{\theta\theta})^2 = R_{\mu\upsilon} - \frac{1}{2} g_{\mu\upsilon} R = \frac{2G}{c^5}(F_{\mu\rho} F_{\upsilon}{}^{\rho} - \frac{1}{4} g_{\mu\upsilon} F_{\rho\sigma} F^{\rho\sigma})$$

$$= \frac{2G}{c^5}(g_{\mu\upsilon} F_{\upsilon\rho} F^{\upsilon\rho} - \frac{1}{4} g_{\mu\upsilon} F_{\rho\sigma} F^{\rho\sigma}) \tag{8}$$

In this time, According to [2],

$$E = F_{01} = -F_{10} = \frac{Q(r^2 - a^2\cos^2\theta)}{(r^2 + a^2\cos^2\theta)^2} = \frac{Q(r^2 - a^2\cos^2\theta)}{\rho^4}$$

$$B = F_{23} = -F_{32} = \frac{2Qar\cos\theta}{(r^2 + a^2\cos^2\theta)^2} = \frac{2Qar\cos\theta}{\rho^4} \tag{9}$$

Hence,

$$\frac{2G}{c^5}(g_{\mu\upsilon} F_{\upsilon\rho} F^{\upsilon\rho} - \frac{1}{4} g_{\mu\upsilon} F_{\rho\sigma} F^{\rho\sigma})$$

$$= -\frac{G}{c^5} g_{\mu\upsilon} I (B^2 + E^2), \; I = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix}$$

$$= -\frac{G}{c^5} \begin{pmatrix} g_{00} & 0 & 0 & -g_{03} \\ 0 & g_{11} & 0 & 0 \\ 0 & 0 & -g_{22} & 0 \\ g_{30} & 0 & 0 & -g_{33} \end{pmatrix} (B^2 + E^2), B^2 + E^2 = \frac{Q^2}{\rho^4}$$

$$= -\frac{G}{c^5} \begin{pmatrix} g_{00} & 0 & 0 & -g_{03} \\ 0 & g_{11} & 0 & 0 \\ 0 & 0 & -g_{22} & 0 \\ g_{30} & 0 & 0 & -g_{33} \end{pmatrix} \frac{Q^2}{\rho^4} = -\Lambda g_{\mu\upsilon} I (g^{\theta\theta})^2$$

$$\Lambda = k \frac{GQ^2}{c^4} \tag{10}$$

3. Conclusion

We finally found the revised Einstein equation of unified theory (the gravity and electromagnetic field) is right in Kerr-Newman solution.

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Citation: *Sangwha-Yi, (2019). Unification for Gravity and Electromagnetic Field in Kerr-Newman Solution. International Journal of Advanced Research in Physical Science (IJARPS) 6(12), pp.11-13, 2019.*