Electroweak Field Equations

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Abstract

This paper derives the equations for electroweak force using complex affine space. These equations are related to curvature tensor and curvature scalar (electroweak force is space time curvature in complex affine space). Curvature tensor and curvature scalar is related to electromagnetic tensor in absence of weak force.

Keywords – *Electroweak force, Electromagnetic Tensor, Electromagnetic stress–energy tensor, Curvature Tensor, Curvature scalar*

I. INTRODUCTION

In paper Space time interval for all fundamental forces [1], it was shown that electro weak forces are due to space time curvature and its space time interval is given by following equation

$$s^2 = \overset{ri}{\eta}_{\mu\nu}\, x_\mu x_\nu$$

We will use this equation to find field equation of electro weak force using concepts of General Theory of Relativity.

II. ELECTROWEAK FIELD EQUATIONS

Einstein field equation is derived from space time curvature of real part of space time. Space time interval used for deriving Einstein field equation is.

$$s^2 = \overset{rr}{g}_{\mu\nu}\, x_\mu x_\nu$$

And the final Einstein field equation looks like this [2].

$$G_{\mu\upsilon} + g_{\mu\upsilon}\Lambda = \frac{8\pi G}{c^4} T_{\mu\upsilon}$$

Where $G_{\mu\upsilon}$ is

$$G_{\mu\upsilon} = R_{\mu\upsilon} - \frac{1}{2} R g_{\mu\upsilon}$$

where $R_{\mu\upsilon}$, is the Ricci curvature tensor, $g_{\mu\upsilon}$, is the metric tensor, Λ, is the cosmological constant, G, is Newton's gravitational constant, c, is the speed of light in vacuum, R, is the scalar curvature and $T_{\mu\upsilon}$, is the stress–energy tensor.

Similarly we can derive field equations of electromagnetic waves as.

$$M_{\mu\upsilon} - \frac{1}{2} M e_{\mu\upsilon} = K T_{\mu\upsilon} \quad \rightarrow \text{Eq1}$$

Where $M_{\mu\upsilon}$, is Ricci curvature tensor, $e_{\mu\upsilon}$ is metric tensor, M is scalar curvature, K is constant and $T_{\mu\upsilon}$, is the stress–energy tensor.

(M is used to not to confuse gravitational curvature tensor and scalar with electroweak curvature and electroweak curvature scalar)

Excluding weak force from above equation we can write Eq1 for electromagnetic force as.

$$M_{\mu\upsilon} - \frac{1}{2} M e_{\mu\upsilon} = K (T_{EM})_{\mu\upsilon} \quad \rightarrow \text{Eq2}$$

T_{EM} is electromagnetic stress energy tensor.

III. ELECTROMAGNETIC CURVATURE TENSOR AND SCALAR CURVATURE IN TERMS OF ELECTROMAGNETIC TENSOR IN ABSENCE OF GRAVITY

We know that Electromagnetic stress energy tensor in flat space time (no gravity) is given by [3].

$$T_{\mu\nu} = \frac{1}{\mu_o}\left(F_{\mu\alpha} F_\nu{}^\alpha - \frac{1}{4}\eta_{\mu\nu} F^{\alpha\beta} F_{\alpha\beta}\right) \quad \rightarrow \text{Eq3}$$

Where $F_{\mu\alpha}$ is the electromagnetic tensor and where $\eta_{\mu\nu}$ is the Minkowski metric tensor of metric signature (+ - - -).

If we compare Eq2 and Eq3 we get following relationship between curvature tensor and curvature scalar in terms of electromagnetic tensor.

$$M_{\mu\upsilon} = \frac{K}{\mu_o} F_{\mu\alpha} F_\nu{}^\alpha \quad \rightarrow \text{Eq4}$$

$$M = \frac{K}{2\mu_o} \eta_{\mu\nu} e^{\mu\nu} F^{\alpha\beta} F_{\alpha\beta} \quad \rightarrow \text{Eq5}$$

IV. ELECTROMAGNETIC CURVATURE TENSOR AND SCALAR CURVATURE IN TERMS OF ELECTROMAGNETIC TENSOR IN GRAVITY

We know that Electromagnetic stress energy tensor in gravity is given by [4].

$$T_{\mu\nu} = \frac{1}{\mu_o}(F_{\mu\alpha} g_{\alpha\beta} F_{\beta\upsilon} - \frac{1}{4} g_{\mu\nu} F_{\sigma\alpha} g^{\alpha\beta} F_{\beta\rho} g^{\rho\sigma})$$

→Eq6

Where $F_{\mu\alpha}$ is the electromagnetic tensor and where $g_{\mu\nu}$ is the Minkowski metric tensor of metric signature (+ - - -).

If we compare Eq6 with Eq2 we get following relationship between curvature tensor and curvature scalar in terms of electromagnetic tensor in curved space (gravity).

$$M_{\mu\upsilon} = \frac{K}{\mu_o} F_{\mu\alpha} g_{\alpha\beta} F_{\beta\upsilon}$$ →Eq7

$$M = \frac{K}{2\mu_o} e^{\mu\nu} g_{\mu\nu} F_{\sigma\alpha} g^{\alpha\beta} F_{\beta\rho} g^{\rho\sigma}$$ →Eq8

V. ELECTRO WEAK FIELD EQUATION IN COMPRESSED FORM

We can write Eq1 as (Electroweak field equations)

$$E_{\mu\upsilon} = KT_{\mu\upsilon}$$ →Eq9

Where $E_{\mu\upsilon}$ (electroweak tensor) , which can be written as

$$E_{\mu\upsilon} = M_{\mu\upsilon} - \frac{1}{2} Me_{\mu\upsilon}$$

VI. CONCLUSION

Electroweak force too can be expressed in terms of curvature of space time in complex affine space similar to gravity and it its field equation can be expressed as $E_{\mu\upsilon} = KT_{\mu\upsilon}$.

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