Space Time Interval for All Fundamental Forces

Bhushan Poojary[1]
[1](NIMS University, India)

Abstract
This paper uses complex plane to unify all 4 fundamental forces by finding equation for space time curvature of each force and grand unified force. In the end all fundamental forces are due to curvature in space time.

Keywords – *Grand Unification Theory, General Theory of Relativity, Fundamental Forces*

I. INTRODUCTION

Objective to start with would to space time interval into complex plane to unify all 4 fundamental forces.

II. SPACE TIME INTERVAL IN COMPLEX PLANE

From paper Certainty principle using complex plane [1], we know that we can express position and time in complex plane. In Minkowski spacetime [2], space time interval is expressed in form of real numbers as shown below

$$s^2 = x_r^{\ 2} + y_r^{\ 2} + z_r^{\ 2} - (ct_r)^2$$

Similarly in complex plane space time interval can be expressed as.

$$S^2 = X^2 + Y^2 + Z^2 - (CT)^2$$

Where

$$X = \sqrt{x_r^{\ 2} + x_i^{\ 2}}$$
$$Y = \sqrt{y_r^{\ 2} + y_i^{\ 2}}$$
$$Z = \sqrt{z_r^{\ 2} + z_i^{\ 2}}$$
$$T = \sqrt{t_r^{\ 2} + t_i^{\ 2}}$$

Similarly complex space time can be written in form of 8 dimensions as.

$$S^2 = x_r^{\ 2} + y_r^{\ 2} + z_r^{\ 2} + (ct_r)^2 + x_i^{\ 2} + y_i^{\ 2} + z_i^{\ 2} + (ct_i)^2$$

Minkowski tensor [3] is expressed as.

$$\eta = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}$$

Similarly in complex plane matric can be expressed as.

$$\overset{c}{\eta} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \end{bmatrix}$$

The above matrix can also be expressed in form of

$$\overset{c}{\eta} = \begin{bmatrix} \overset{rr}{\eta} & \overset{ri}{\eta} \\ \overset{ir}{\eta} & \overset{ii}{\eta} \end{bmatrix}$$

$$s^2 = \overset{c}{\eta}\,\alpha_\mu \alpha_\nu$$

Where $\overset{rr}{\eta}, \overset{ri}{\eta}, \overset{ir}{\eta}$ and $\overset{ii}{\eta}$ are 4X4 matrices ($\overset{ir}{\eta}$ is transpose of $\overset{ir}{\eta}$).

Minkowski space-time is actually part of this matrix and can be expressed as

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

III. COMPLEX SPACE TIME IN FORM OF QUATERNIONS AS PAIRS OF COMPLEX NUMBERS

Let C^2 be a two-dimensional vector space over the complex numbers.

$$C = cT + Xi + Yj + Zk$$
$$where$$
$$T = t_r + it_i$$
$$X = x_r + ix_i$$
$$Y = y_r + iy_i$$
$$Z = z_r + iz_i$$
$$C = (cT + Xi)1 + (Y + Zi)j$$

IV. GRAND UNIFIED FORCE

We know that gravity is given by curvature of space time [3] in real plane which is

$$s^2 = g_{\mu\nu} x_\mu x_\nu = \overset{rr}{\eta}_{\mu\nu} x_\mu x_\nu$$

$$where \ g_{\mu\nu} = \overset{rr}{\eta}_{\mu\nu}$$

$$s^2 = \begin{bmatrix} g_{00} & g_{01} & g_{02} & g_{03} \\ g_{10} & g_{11} & g_{12} & g_{13} \\ g_{20} & g_{21} & g_{22} & g_{23} \\ g_{30} & g_{30} & g_{32} & g_{23} \end{bmatrix} \begin{bmatrix} x^2{}_r \\ y^2{}_r \\ z^2{}_r \\ c^2 t_r \end{bmatrix}$$

Einstein used this curvature of space time to find Gravitational force. Similarly grand force will be curvature of complex space time matrix $\overset{c}{\eta}$.

$$\overset{c}{\eta} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \end{bmatrix}$$

Above matrix is flat space time matrix when there are no forces. When there is curvature matrix won't look as shown above. It can be generalized in form of

$$s^2 = \overset{c}{C}_{\mu\nu} x_\mu x_\nu$$

V. NUCLEAR FORCE

Nuclear force is strongest force of all 4 fundamental forces and it acts at very short region hence space time curvature of this force should be $\overset{ii}{\eta}$.

$$\overset{ii}{\eta} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix}$$

This is flat space time would be

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

x_μ and x_ν is combination of imgaginary spaces only

$$s^2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} x^2{}_i \\ y^2{}_i \\ z^2{}_i \\ c^2 t^2{}_i \end{bmatrix}$$

Curvature in above matrix produces nuclear forces which acts only at a very short distances.

VI. ELECTRO WEAK FORCE

We have covered two forces space time curvature Gravity and Nuclear forces. Electro weak forces are combination of electromagnetic force and weak nuclear force. This force can be calculated using space time curvature of $\overset{ri}{\eta}$ matrix.

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

$$s^2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} x_r x_i \\ y_r y_i \\ z_r z_i \\ c^2 t_r t_i \end{bmatrix}$$

Curvature of $\overset{ri}{\eta}_{\mu\nu}$ matrix produces Electro weak forces.

VII. ELECTROMAGNETIC AND WEAK FORCE SEPARATE MATRIX

Let us assume new dimensions to remove the cross term of two different dimensions.

$$\alpha = \alpha_r + i\alpha_i$$
$$\beta = \beta_r + i\beta_i$$
$$\gamma = \gamma_r + i\gamma_i$$
$$\tau = \tau_r + i\tau_i$$
$$\alpha^2 = \alpha_r{}^2 + \alpha_i{}^2 = x_r x_i$$
$$\beta^2 = \beta_r{}^2 + \beta_i{}^2 = y_r y_i$$
$$\gamma^2 = \gamma_r{}^2 + \gamma_i{}^2 = z_r z_i$$
$$\tau^2 = \tau_r{}^2 + \tau_i{}^2 = t_r t_i$$

$\overset{ri}{\eta}_{\mu\nu}$ Matrix can be written as in terms of α, β and λ

$$s^2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} \alpha_r^{\,2} + \alpha_i^2 \\ \beta_r^{\,2} + \beta_i^2 \\ \gamma_r^{\,2} + \gamma_i^2 \\ c^2(\tau_r^{\,2} + \tau_i)_i \end{bmatrix}$$

This can be written as

$$s^2 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} \alpha_r^{\,2} \\ \beta_r^{\,2} \\ \lambda^2{}_r \\ c^2\tau_r^{\,2} \\ \alpha_i^2 \\ \beta_i^2 \\ \lambda_i^{\,2} \\ c^2\tau_i^{\,2} \end{bmatrix}$$

This matrix can be called as $\overset{c1}{\eta}$ notation one denotes first split of mix matrix.

VIII. ELECTRO STATIC FORCEs MATRIX

$\overset{c1}{\eta}$ Similar to $\overset{c}{\eta}$ can be written as

$$\overset{c1}{\eta} = \begin{bmatrix} \overset{rr1}{\eta} & \overset{ri1}{\eta} \\ \overset{ir1}{\eta} & \overset{ii1}{\eta} \end{bmatrix}$$

Curvature of matrix $\overset{rr1}{\eta}$ will give us electro static forces, space time curvature for electro static forces can be written as.

$$s^2 = \overset{rr1}{\eta}_{\mu\nu}\, \alpha_\mu \alpha_\nu \text{ --------Eq 1}$$

IX. MAGNETIC FORCES MATRIX

Curvature of matrix $\overset{ii1}{\eta}$ will give us electro static forces, space time curvature for magnetic forces can be written as.

$$s^2 = \overset{ii1}{\eta}_{\mu\nu}\, \alpha_\mu \alpha_\nu \text{ --------Eq 2}$$

X. ELECTROMAGNETIC WAVES PHOTON

Electromagnetic waves are basically curvature of space time (which is flat space time in mix matrix $\overset{ri}{\eta}_{\mu\nu}$ (But this appears to be curved space in our real plane because of cross term)).

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

XI. WEAK FORCES MATRIX

Curvature of matrix $\overset{ri1}{\eta}$ will give us electro static forces, space time curvature for magnetic forces can be written as.

$$s^2 = \overset{ri1}{\eta}_{\mu\nu}\, \alpha_\mu \alpha_\nu \text{ --------Eq 3}$$

We can go on splitting mix matrix to find new forces and particles but we need to stop at plank length.

XII. COMPLEX SPACE TIME MATRIX IN FORM OF 4 FUNDAMENTAL FORCES

Complex space time matrix can be written as

$$s^2 = \overset{rr}{\eta}_{\mu\nu}\, x_\mu x_\nu + \overset{ii}{\eta}_{\mu\nu}\, x_\mu x_\nu + \overset{rr1}{\eta}_{\mu\nu}\, \alpha_\mu \alpha_\nu + \overset{ii1}{\eta}_{\mu\nu}\, \alpha_\mu \alpha_\nu + \overset{ri1}{\eta}_{\mu\nu}\, \alpha_\mu \alpha_\nu$$

First term is for gravity, second term is for strong forces, third term is for electrostatic forces, fourth term is of magnetic forces and last term is of weak nuclear forces.

XIII. CONCLUSION

All fundamental forces are due to space time curvature.

REFERENCES

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