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# TOWARDS A RELATION AMONG THE SPACE, TIME, MATTER AND FOUR FUNDAMENTAL FORCES OF NATURE

Physics

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## ABSTRACT

The universe is the combination of space, time and matter. Matter interacts in four fundamental ways: electromagnetic, strong, weak and gravitational interactions. The purpose of this short write-up is simply to establish a relation between four forces of nature with space and time. In the case of space 3-d is sufficient to express it, but in case of time I put 3 components of time establishing a relation with four fundamental forces of nature. So the total number of dimensions becomes six. In this write-up especially particular attention is given to the six dimensional (6-d) metric $\mu\nu g$ on the basis of four fundamental forces of nature. Schwarzschild solution is the simplest solution of Einstein's field equations. So for simplicity I have used this method in the new 6-d line element for the gravitational field and other interactions of an isolated particle. The solution gives us some new interesting results.
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## KEYWORDS

4-d line metric; 6-d metric; four fundamental interactions; e-m, strong & weak

### 1. INTRODUCTION

For flat space space- time the line element according to special relativity is

$$ds^2 = -dx^2 - dy^2 - dz^2 + c^2dt^2 \tag{1}$$

In the absence of any mass point the space-time would be flat so that the 4-d metric in spherical polar co-ordinates would be expressed as

$$ds^2 = -dr^2 - r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2 + c^2dt^2 \tag{2}$$

The presence of the mass point would modify the line element. The mass is considered as static and isolated; the metric would be spatially spherically symmetric about the point mass and is static. The most general form of such a 4-d metric may be expressed as

$$ds^2 = -e^{\lambda}dr^2 - r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2 + e^{\nu}dt^2 \tag{3}$$

In above equation the velocity of light $c$=1 is considered as astronomical unit. In above metric $\lambda$ and $\nu$ are function of $r$ only; since for spherically symmetric isolated particle the field will depend on $r$ alone and not on $\theta$ and $\phi$. The simple solution of the line element (3) was given by Schwarzschild [2] as

$$ds^2 = -\left(1-\frac{2m}{r}\right)^{-1}dr^2 - r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2 + \left(1-\frac{2m}{r}\right)dt^2 \tag{4}$$

Here we have put the integrating constant $B$=−2$m$. This was done in order to facilitate the physical interpretation of m as the mass of the gravitating particle. Schwarzschild established the relation among attracting mass $M$, gravitational constant $G$, velocity of light c and the constant $m$ as

$$m = \frac{GM}{c^2} \tag{5}$$

Thus the solution of the field equations in empty space given by Einstein was first given by Schwarzschild that was later understood to describe a black hole [3] and Kerr [4] in 1963 generalized the solution to rotating black hole. Thus a relation established among the space, time and matter i.e. with gravitational field. But problem arises in case of another three fundamental forces to combine with space, time and gravitational forces. After general relativity Kaluza [5] and later Klein [6] were try to unify the relativity as a geometrical theory of gravity and electromagnetic interaction using five dimensions. But they were also not successful.

The gravitational field of a charged particle or an electron was given first by Nordstrom and then by Jeffery [7]. The metric is,

$$ds^2 = -\gamma^{-1}dr^2 - r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2 + \gamma\, dt^2$$

With $\gamma = 1 - \dfrac{2m}{r} + \dfrac{4\pi\varepsilon^2}{r^2}$

At all points outside the electron the value of $m/r$ is found of the order$10^{-40}$. Thus the gravitational effect of the electrical energy is very small and deviation from flat space time due to the charge of point mass would be negligible. So this theory is also failed to establish a relation e-m field with the gravitational field.

The model of universe was first given by Einstein on the development of his general theory of relativity that later with de-Sitter [8] and finally describe the non-static, isotropic and homogeneous model by Friedmann [9] in 1922 as well as by Robertson [10] and Walker [11] in 1935 known as FRW model.

Since the other three forces or interactions also in the universe and these three interactions play a great role in the universe but they are unable to include in an equation.

Therefore I shall try to establish a relation crudely among space, time, matter and four fundamental forces of matter.

### 2. Assumptions

Change and evolution are fundamental aspects of the universe. These changes occur due to the interaction of the four fundamental interaction of nature. Change and evolution is the description of the medium to experience the time. Now I put some assumptions and these are,

(i) Physical time shows itself as a parameter of processes of change [12, 13].
(ii) The changes occur in the material universe due to the interactions of four fundamental interaction of nature [14, 15].

### 3. Mathematical formulation

The assumption (i) represents that time associate with changing i.e. in other sense changing represents the time. The assumption (ii) gives that changes occur in nature due to the action of four fundamental interaction of nature. This means that time associated with the interaction of the four fundamental interaction of the nature: weak, electromagnetic (e-m), strong or nuclear and gravitational interactions.

All type of fields interacts with matter within specified range such as electromagnetic (e-m) from infinity to cm $10^{-8}$, strong or nuclear at cm $10^{-13}$, weak at cm$10^{-16}$ and finally gravitational interact covering all another interaction range from infinity to cm$10^{-33}$. These ranges of interaction give us that e-m and gravitational interaction interact together up to range, strong and gravitational interaction interact together up to range cm $10^{-13}$, weak and gravitational interaction interact together up to range cm $10^{-16}$, but remaining range up to only interact gravitational alone. This means that changing occur within a specific range due to the combine effect of two interaction or one interaction alone. This means changing is not same with in a specific range with other range. Hence time will be different for different range of interaction by the fundamental interaction.

In gravitational interaction the massive body or particle attracts only and hence force experienced towards the centre of the body (Fig.1). Therefore due to this property let we consider the name of gravitational energy in a new fashion as 'cold energy'.

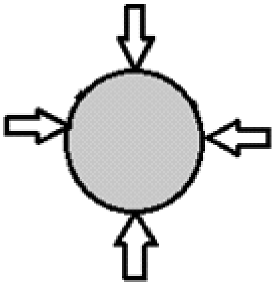


Fig. 1 : Inward direction of gravitational force

Due to weak, e-m and strong interaction when energy released from a body the released energy always moves away (Fig.2) from the massive source in all directions. Because of this property let we consider the name of released energy in a new fashion as 'hot energy'.

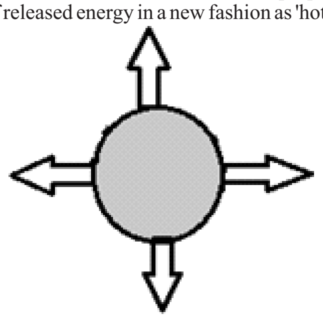


Fig. 2 : Outward direction of the released energy due to weak, e-m and strong nuclear interaction

From the above points of view that direction of released energies from weak, e-m & strong interactions are always in opposite to that of the direction of gravitational energy.

As gravitational force always opposes the changing done by the other three forces i.e. it resists the changing, therefore changes actually occur in the universe in three ways; hence time has three components. The gravitational force among them is very weak and negligible, because each particle has very small quantity of mass, but plays a great role in the large scale mass.

Publishing a paper Velev [16] pointed that special relativity describes space time as a manifold whose metric tensor has a negative eigen value. This corresponds to the existence of a 'time-like' direction means multiple time dimensions.

Therefore the line element would be 6-dimesional and can be written as,

$$ds^2 = -(dx^1)^2 - (dx^2)^2 - (dx^3)^2 + c^2(dt^1)^2 + c^2(dt^2)^2 + c^2(dt^3)^2 \tag{7}$$

The metric (7) can be expressed in Riemannian space as,

$$ds^2 = g_{\mu\nu}\, dx^\mu dx^\nu \qquad (\mu,\nu = 1,2,3,4,5,6) \tag{8}$$

Comparing Equation (8) with (7) gives the elements of the tensor $g_{\mu\nu}$ are

$$g_{11} = g_{22} = g_{33} = -1 \text{ and } g_{44} = g_{55} = g_{66} = c^2$$

The aim is to find the line element in the empty space surrounding a gravitating point particle. This will correspond to the field of an isolated particle continually at rest at the origin. In flat-space time the interval referred to spherical polar coordinate is

$$ds^2 = -dr^2 - r^2 d\theta^2 - r^2\sin^2\theta\, d\phi^2 + (dt^1)^2 + (dt^2)^2 + (dt^3)^2 \tag{9}$$

Here $c$ is taken as an astronomical unit i.e $c$=1 Putting the relation of time components as

$(dt)^2 = \{(dt^1)^2 + (dt^2)^2 + (dt^3)^2\}$ the (9) becomes as

$$ds^2 = -dr^2 - r^2 d\theta^2 - r^2\sin^2\theta\, d\phi^2 + (dt)^2$$

This is nothing but the original 4-dimensional metric for flat space-time.

The isolated particle is assumed to be spherically symmetric and hence the field will depend on $r$ alone and not on $\theta, \phi$. Let the author [14] try to solve this metric like Schwarzschild. Therefore the most general possible form of the line element (9) may be taken as,

$$ds^2 = -e^{\lambda}dr^2 - r^2 d\theta^2 - r^2\sin^2\theta\, d\phi^2 + e^{\nu_1}(dt^1)^2 + e^{\nu_2}(dt^2)^2 + e^{\nu_3}(dt^3)^2 \tag{10}$$

Here $\lambda$ and $\nu$ are functions of $r$ only. The gravitational field (i.e. the disturbance from flat-space time) due to a particular diminishes indefinitely as we go to an infinite distance. It means that the line element (10) must take the form of line element like equation (9) at $r=\infty$. For this we must have $\lambda=\nu_1=\nu_2=\nu_3=0$ at $r=\infty$

The equation (10) compare with (8) the co-ordinates are.

$$x^1 = r,\ x^2 = \theta,\ x^3 = \phi,\ x^4 = t^1,\ x^5 = t^2,\ x^6 = t^3$$

$$\therefore\ g_{\mu\nu} = \begin{bmatrix} -e^{\lambda} & 0 & 0 & 0 & 0 & 0 \\ 0 & -r^2 & 0 & 0 & 0 & 0 \\ 0 & 0 & -r^2\sin^2\theta & 0 & 0 & 0 \\ 0 & 0 & 0 & e^{\nu_1} & 0 & 0 \\ 0 & 0 & 0 & 0 & e^{\nu_2} & 0 \\ 0 & 0 & 0 & 0 & 0 & e^{\nu_3} \end{bmatrix} \tag{11}$$

This gives

$$g_{11} = -e^{\lambda},\ g_{22} = -r^2,\ g_{33} = -r^2\sin^2\theta,\ g_{44} = e^{\nu_1},\ g_{55} = e^{\nu_2},\ g_{66} = e^{\nu_3}$$
$$\&\ g_{12} = g_{23} = ...... = 0 \text{ for } \mu \neq \nu$$

And,

$$g^{11} = -e^{-\lambda},\ g^{22} = -r^{-2},\ g^{33} = -r^{-2}\sin^{-2}\theta,\ g^{44} = e^{-\nu_1},\ g^{55} = e^{-\nu_2},\ g^{66} = e^{-\nu_3}$$
$$\&\ g^{12} = g^{23} = ..... = 0, \text{ for } \mu \neq \nu$$

The determinant of $g_{\mu\nu}$ is

$$g = |g_{\mu\nu}| = g_{11}\, g_{22}\, g_{33}\, g_{44}\, g_{55}\, g_{66} = -e^{(\lambda+\nu_1+\nu_2+\nu_3)}\, r^4\sin^2\theta \tag{12}$$

Now the magnitude of $g$ from equation (12) can be written as

$$|g| = e^{(\lambda+\nu_1+\nu_2+\nu_3)}\, r^4\sin^2\theta$$

Therefore, $\sqrt{|g|} = e^{(1/2)(\lambda+\nu_1+\nu_2+\nu_3)}\, r^2\sin\theta$

$$\left.\begin{aligned} &\therefore\ \log\sqrt{|g|} = \frac{1}{2}(\lambda+\nu_1+\nu_2+\nu_3) + 2\log r + \log\sin\theta \\ &\text{and } \frac{\partial}{\partial r}(\log\sqrt{|g|}) = \frac{1}{2}\frac{\partial}{\partial r}(\lambda+\nu_1+\nu_2+\nu_3) + \frac{2}{r} \\ &\text{again } \frac{\partial^2}{\partial r^2}(\log\sqrt{|g|}) = \frac{1}{2}\frac{\partial^2}{\partial r^2}(\lambda+\nu_1+\nu_2+\nu_3) - \frac{2}{r^2} \\ &\frac{\partial}{\partial\theta}(\log\sqrt{|g|}) = \cot\theta\ ;\quad \frac{\partial^2}{\partial\theta^2}(\log\sqrt{|g|}) = -\operatorname{cosec}^2\theta\ ;\quad \frac{\partial}{\partial\phi}(\log\sqrt{|g|}) = 0 \\ &\frac{\partial}{\partial x^4}(\log\sqrt{|g|}) = \frac{\partial}{\partial x^5}(\log\sqrt{|g|}) = \frac{\partial}{\partial x^6}(\log\sqrt{|g|}) = 0 \end{aligned}\right\} \tag{13}$$

The non-vanishing Christoffel's 3-index symbols of second kind are

$$\left.\begin{aligned} &\Gamma^1_{11} = \frac{1}{2}\frac{\partial\lambda}{\partial r};\ \Gamma^1_{22} = -re^{-\lambda};\ \Gamma^1_{33} = -re^{-\lambda}\sin^2\theta\ ; \\ &\Gamma^1_{44} = \frac{1}{2}e^{\nu_1-\lambda}\frac{\partial\nu_1}{\partial r};\ \Gamma^1_{55} = \frac{1}{2}e^{\nu_2-\lambda}\frac{\partial\nu_2}{\partial r};\ \Gamma^1_{66} = \frac{1}{2}e^{\nu_3-\lambda}\frac{\partial\nu_3}{\partial r} \\ &\Gamma^2_{33} = -\sin\theta\cos\theta\ ;\ \Gamma^2_{12} = \Gamma^3_{13} = \frac{1}{r};\ \Gamma^3_{23} = \cot\theta \\ &\Gamma^4_{14} = \frac{1}{2}\frac{\partial\nu_1}{\partial r};\ \Gamma^5_{15} = \frac{1}{2}\frac{\partial\nu_2}{\partial r};\ \Gamma^6_{16} = \frac{1}{2}\frac{\partial\nu_3}{\partial r} \\ &\Gamma^\alpha_{\beta\gamma} = 0,\ \text{for } \alpha \neq \beta \neq \gamma \end{aligned}\right\} \tag{14}$$

The Ricci tensors are

$$R_{11} = \frac{1}{2}\frac{\partial^2}{\partial r^2}(\nu_1+\nu_2+\nu_3) + \frac{1}{4}\left\{\left(\frac{\partial\nu_1}{\partial r}\right)^2 + \left(\frac{\partial\nu_2}{\partial r}\right)^2 + \left(\frac{\partial\nu_3}{\partial r}\right)^2\right\}$$
$$-\frac{1}{4}\frac{\partial\lambda}{\partial r}\frac{\partial}{\partial r}(\nu_1+\nu_2+\nu_3) - \frac{1}{r}\frac{\partial\lambda}{\partial r}$$

$$R_{22}=\left[e^{-\lambda}\left\{1+\frac{1}{2}r\frac{\partial}{\partial r}(\nu_1+\nu_2+\nu_3)-\frac{1}{2}r\frac{\partial\lambda}{\partial r}\right\}-1\right] \tag{16}$$

$$R_{33}=\left[e^{-\lambda}\left\{1+\frac{1}{2}r\frac{\partial}{\partial r}(\nu_1+\nu_2+\nu_3)-\frac{1}{2}r\frac{\partial\lambda}{\partial r}\right\}-1\right]\sin^2\theta \tag{17}$$

$$R_{44}=-\frac{1}{2}e^{\nu_1-\lambda}\left[\frac{\partial^2\nu_1}{\partial r^2}+\frac{1}{2}\left(\frac{\partial\nu_1}{\partial r}\right)^2-\frac{1}{2}\frac{\partial\nu_1}{\partial r}\frac{\partial\lambda}{\partial r}+\frac{2}{r}\frac{\partial\nu_1}{\partial r}\right] \tag{18}$$

$$R_{55}=-\frac{1}{2}e^{\nu_2-\lambda}\left[\frac{\partial^2\nu_2}{\partial r^2}+\frac{1}{2}\left(\frac{\partial\nu_2}{\partial r}\right)^2-\frac{1}{2}\frac{\partial\nu_2}{\partial r}\frac{\partial\lambda}{\partial r}+\frac{2}{r}\frac{\partial\nu_2}{\partial r}\right] \tag{19}$$

$$R_{66}=-\frac{1}{2}e^{\nu_3-\lambda}\left[\frac{\partial^2\nu_3}{\partial r^2}+\frac{1}{2}\left(\frac{\partial\nu_3}{\partial r}\right)^2-\frac{1}{2}\frac{\partial\nu_3}{\partial r}\frac{\partial\lambda}{\partial r}+\frac{2}{r}\frac{\partial\nu_3}{\partial r}\right] \tag{20}$$

Obviously equation (17) is a mere repetition of equation (16).
Einstein's field equations for empty space is given by equation $R_{\mu\nu}=0$ therefore,
$R_{11}=R_{22}=R_{33}=R_{44}=R_{55}=R_{66}=0$. Putting these values in above equations and adding equations (18), (19) and (20),

$$-\frac{1}{2}\frac{\partial^2}{\partial r^2}(\nu_1+\nu_2+\nu_3)-\frac{1}{4}\left\{\left(\frac{\partial\nu_1}{\partial r}\right)^2+\left(\frac{\partial\nu_2}{\partial r}\right)^2+\left(\frac{\partial\nu_3}{\partial r}\right)^2\right\}+\frac{1}{4}\frac{\partial\lambda}{\partial r}\frac{\partial}{\partial r}(\nu_1+\nu_2+\nu_3)-\frac{1}{r}\frac{\partial}{\partial r}(\nu_1+\nu_2+\nu_3)=0 \tag{21}$$

Taking $R_{11}$=0, the equation (15) adding with (21) gives,

$$\frac{1}{r}\frac{\partial\lambda}{\partial r}+\frac{1}{r}\frac{\partial}{\partial r}(\nu_1+\nu_2+\nu_3)=0 \tag{22}$$

Integrating equation (22),

$$-\lambda=(\nu_1+\nu_2+\nu_3) \tag{23}$$

Constant of integration which may be set equal to zero, without any loss of generality, since at $r\to\infty,\lambda=0$ and $\nu_1=\nu_2=\nu_3=0$. Hence,

$$e^{-\lambda}=e^{\nu_1+\nu_2+\nu_3}=e^{\nu_1}e^{\nu_2}e^{\nu_3} \tag{24}$$

Now to find out the value of $e^{\nu 1}, e^{\nu 2}$ & $e^{\nu 3}$ rewriting the equation (16) as,

$$e^{-\lambda}\left\{1+\frac{1}{2}r\frac{\partial}{\partial r}(\nu_1+\nu_2+\nu_3)-\frac{1}{2}r\frac{\partial\lambda}{\partial r}\right\}-1=0$$

And solving,

$$e^{-\lambda}=e^{\nu_1+\nu_2+\nu_3}=e^{\nu_1}e^{\nu_2}e^{\nu_3}=(1-\frac{2m}{r}) \tag{25}$$

It is difficult to determine the individual value of $e^{\nu 1}, e^{\nu 2}$ & $e^{\nu 3}$ from the above solution. Hence only one way to determine the values of above terms considering only one time-components and the other time-components are taken absent, in this way,

$$-\lambda_1=\nu_1,\ -\lambda_2=\nu_2\ \&-\lambda_3=\nu_3 \tag{26}$$

Finally integrating constants are taken as $-2m_1,-2m_2$ & $-2m_3$ to facilitate the physical interpretation of $m_1, m_2$ & $m_3$. Therefore

$$\left.\begin{aligned}g_{44}&=e^{-\lambda_1}=e^{\nu_1}=1-\frac{2m_1}{r}\\ g_{55}&=e^{-\lambda_2}=e^{\nu_2}=1-\frac{2m_2}{r}\\ g_{66}&=e^{-\lambda_3}=e^{\nu_3}=1-\frac{2m_3}{r}\end{aligned}\right\} \tag{27}$$

From equation (25) and (26),

$$-\lambda=-(\lambda_1+\lambda_2+\lambda_3)=(\nu_1+\nu_2+\nu_3) \tag{28}$$

Hence the line element or metric becomes,

$$ds^2=-\left(1-\frac{2m_1}{r}\right)^{-1}\left(1-\frac{2m_2}{r}\right)^{-1}\left(1-\frac{2m_3}{r}\right)^{-1}dr^2-r^2d\theta^2-r^2\sin^2\theta\,d\phi^2+\left(1-\frac{2m_1}{r}\right)(dt^1)^2+\left(1-\frac{2m_2}{r}\right)(dt^2)^2+\left(1-\frac{2m_3}{r}\right)(dt^3)^2 \tag{29}$$

3.1 Evaluations of $m_1, m_2$ & $m_3$:
We know that if there is mass in the universe then there is gravitational force and the massive particles are interacts either electromagnetically or strongly or weakly in their range. Hence at every state it is combination of two forces viz. gravitational force plus e-m force or gravitational force plus strong force or gravitational force plus weak force. For simplicity let I have considered such an ideal particle which is interact electromagnetically, strongly and finally weakly in their ranges. Hydrogen nucleuses are such type of particles. These hydrogen nucleuses are nothing but the protons having charge +e, mass $m_p$. Let consider a massive body as an isolated particle at rest at origin. All type of fields interact within specified range such as electromagnetic at $10^{-8}$cm , strong or nuclear at $10^{-13}$cm , weak at $10^{-16}$cm and finally gravitational interaction cover all forces in the range from infinity to $10^{-33}$cm .

### 3.1.1 Evaluation of $m_1$:

In weak static field at large distance from point particle the equation, $g_{44}=1+(2\phi/c^2)$ gives the value of $g_{\mu\nu}$ in relation with Newtonian potential $\phi$ and the mass $M$ related with constant $m(=GM/c^2)$. For a charge particle after rigorous calculations Jeffery found the relation between gravitational potential and electro-magnetic field as given by (6). The $m$ is identified as the mass associated with the charged particle and $4\pi\varepsilon$ as the charge of the particle. This gives us that $m$ is not only related with gravitational potential $\phi$ but also related with other fundamental forces.

It is very difficult to establish a relation among these interactions due to their nature of field.

I am trying with a crude idea. It is a crude mixture of relativity and quantum mechanics. This idea may not be acceptable for scientist but I want to know what results give it. Because in the year 1924 De Broglie established wave particle duality using the mixture of quantum theory of Planck's and Einstein's special theory of relativity. For our simplicity let consider electromagnetic interaction. For hydrogen nucleus the field due to charge is assumed to be spherically symmetric and the field due to gravitation is also assumed to be spherically symmetric though the gravitational field is very weak.

The e-m coupling constant $\alpha$ is given by

$$\alpha=\frac{e^2}{4\pi\varepsilon_0\hbar c} \tag{30}$$

Here $\hbar$ is Planck's constant, $c$ is velocity of light and $\varepsilon_0$ is permittivity in free space of electrostatic force.

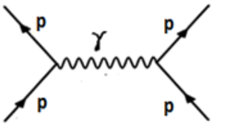



Fig. 3: Feynman diagram for e-m interaction

The hydrogen nucleus is nothing but a proton. When a proton comes to nearer another proton the e-m force is given as,

$$F_{em}=\frac{e^2}{4\pi\varepsilon_o r^2}=\frac{\alpha\hbar c}{r^2} \tag{31}$$


Fig. 4: Gravitational attraction between two proton

And gravitational attractive force is,

$$F_G=\frac{Gm_pm_p}{r^2} \tag{32}$$

When the two protons come nearer to each other they repulse due to e-m force but attract due to gravitational force though it is very weak. Hence the effective force considered $F_2$ which is the combination of gravitational force and e-m force as they are opposite. Therefore the effective force of attraction at a distance $r$ is,

$$F_1 = F_G - F_{em} = \frac{1}{\hat{m}}\left(\frac{Gm_p m_p}{r^2} - \frac{\alpha\hbar c}{r^2}\right) \quad (33)$$

Here $m$ is unit mass.

$$\text{Also} \quad g_{44} = e^{-\lambda_1} = e^{\nu_1} = 1 - \frac{2m_1}{r} \quad (34)$$

The term $g_{44}$ is the coefficient of e-m time component $t^1$ then the coefficient is combined effect of both gravitational and e-m force. Let the field be weak static, so that at large distance from the particle

$$g_{44} = 1 + \frac{2\phi_1}{c^2} \quad (35)$$

Here 1$\phi$ is Newtonian potential, i.e.

$$\frac{2\phi_1}{c^2} = g_{44} - 1 = \left(1 - \frac{2m_1}{r}\right) - 1 = -\frac{2m_1}{r}$$

$$\phi_1 = -\frac{m_1 c^2}{r} \quad (36)$$

But force of attraction at a distance $r$ is $\frac{\partial\phi_1}{\partial r}$ Therefore equating with equation (33)

$$\frac{\partial\phi_1}{\partial r} = \frac{1}{\hat{m}}\left(\frac{Gm_p m_p}{r^2} - \frac{\alpha\hbar c}{r^2}\right) \quad (37)$$

Differentiating equation (36) with respect to $r$ and putting in equation (37) we get,

$$m_1 = \frac{1}{\hat{m}}\left(\frac{Gm_p m_p}{c^2} - \frac{\alpha\hbar c}{c^2}\right) \quad (38)$$

$$\text{And} \quad g_{44} = e^{-\lambda_1} = e^{\nu_1} = 1 - \frac{2}{\hat{m}r}\left(\frac{Gm_p m_p}{c^2} - \frac{\alpha\hbar c}{c^2}\right) \quad (39)$$

The term $g_{44}$ is the coefficient of time component $t^1$ and goes according to e-m interacting speed as gravitational force between two proton is very weak in their domain.

3.1.2 Evaluation of $m_2$:

In case of strong interaction the Feynman diagram is,

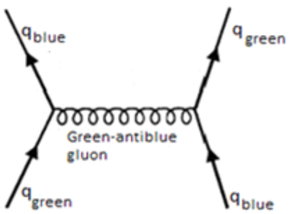


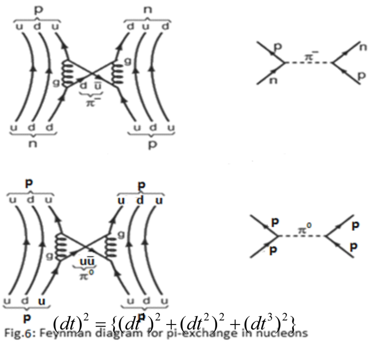

Fig.5: Feynman diagram for quark-quark interaction

The strong coupling constant is,

$$\alpha_s = \frac{g_s^2}{4\pi\hbar c} \quad (40)$$

Here $g_s$ is strong charge or colour charge for strong interaction.

Strong nuclear force is responsible for binding of protons and neutrons in a nucleus within the rangecm $10^{-13}$. In nucleus the $\pi^-$ exchange is nothing but quark-quark interaction we giving here one of the many forms of gluon interaction between nucleon involving up-antiup pair production and annihilation producing a $\pi^-$ bridging the nucleus.



$(dt)^2 = \{(dt^1)^2 + (dt^2)^2 + (dt^3)^2\}$

Fig.6: Feynman diagram for pi-exchange in nucleons

Yukawa coupling constants [17] are unknown. The potential energy between two nucleons is

$$\text{Force} \quad F_s = \frac{\alpha_s\hbar c}{r^2} \quad (41)$$

The time component $t^2$ is due to strong nuclear force in the range $10^{-13}$ cm. But though the small value of masses gravitational force is negligible yet also we consider. Since the individual gluons and quarks are contained within the proton or neutron, the masses attributed to them cannot be used in the range relationship to predict the range of the force. Therefore gravitational force is product of proton-proton mass and inversely proportional to distance between them.

$$F_G = \frac{Gm_p m_p}{r^2} \quad (42)$$

When energy released from the particles in interaction the released energy always moves away from the massive source in all directions. Therefore the effective force of attraction at a distance $r$ is,

$$F_2 = F_G - F_s = \frac{1}{\hat{m}}\left(\frac{Gm_p m_p}{r^2} - \frac{\alpha_s\hbar c}{r^2}\right) \quad (43)$$

Here $m$ is unit mass.

$$\text{Also} \quad g_{55} = e^{-\lambda_2} = e^{\nu_2} = 1 - \frac{2m_2}{r} \quad (44)$$

The term $g_{55}$ is the coefficient of strong interaction time component2 $t$ then the coefficient is combined effect of both gravitational and strong force. Let the field be weak static, so that at large distance from the particle

$$g_{55} = 1 + \frac{2\phi_2}{c^2} \quad (45)$$

Here 2$\phi$ is Newtonian potential, i.e.,

$$\frac{2\phi_2}{c^2} = g_{55} - 1 = \left(1 - \frac{2m_2}{r}\right) - 1 = -\frac{2m_2}{r}$$

This gives,

$$\phi_2 = -\frac{m_2 c^2}{r} \quad (46)$$

But force of attraction at a distance $r$ is $\frac{\partial\phi_2}{\partial r}$ Therefore equating with equation (43)

$$\frac{\partial\phi_2}{\partial r} = \frac{1}{\hat{m}}\left(\frac{Gm_p m_p}{r^2} - \frac{\alpha_s\hbar c}{r^2}\right) \quad (47)$$

Differentiating equation (46) with respect to $r$ and putting in equation (47) gives,

$$m_2 = \frac{1}{\hat{m}}\left(\frac{Gm_p m_p}{c^2} - \frac{\alpha_s\hbar c}{c^2}\right) \quad (48)$$

$$\text{Therefore} \quad g_{55} = e^{-\lambda_2} = e^{\nu_2} = 1 - \frac{2}{\hat{m}r}\left(\frac{Gm_p m_p}{c^2} - \frac{\alpha_s\hbar c}{c^2}\right)$$

3.1.3 Evaluation of $m_3$:

In case of weak interaction many of one interaction is considered

$$n \rightarrow p^+ + e^- + \bar{\nu}_e \quad (50)$$

The Feynman diagram is,

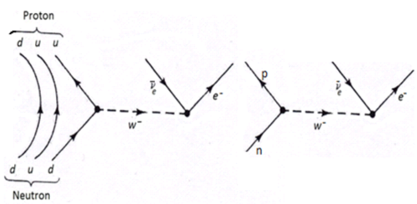



Fig.7: Feynman diagram for weak interaction

The time component $t^3$ is due to weak interaction due to weak charge of the quark of neutron and electron in the range $10^{-15}$cm.

Here $\alpha_w (= \frac{g_w^2}{4\pi\hbar c})$ weak coupling constant and $g_w$ is weak charge (18)

Hence weak force is

$$F_w = \frac{\alpha_w\hbar c}{r^2} \quad (51)$$

But though the small value of masses gravitational force is negligible yet also we consider. Hence gravitational force is,

$$F_G = \frac{Gm_p m_e}{r^2} \quad (52)$$

Therefore the effective force of attraction at a distance $r$ is,

$$F_3 = F_G - F_w = \frac{1}{\hat{m}}\left(\frac{Gm_p m_e}{r^2} - \frac{\alpha_w \hbar c}{r^2}\right) \quad (53)$$

Also $g_{66} = e^{-\lambda_3} = e^{\nu_3} = 1 - \frac{2m_3}{r}$ (54)

The term $g_{66}$ is the coefficient of strong interaction time component[3] $t$then the coefficient is combined effect of both gravitational and weak force. Let the field be weak static, so that at large distance from the particle

$$g_{66} = 1 + \frac{2\phi_3}{c^2} \quad (55)$$

Here $\phi_3$ is Newtonian potential, i.e.,

$$\frac{2\phi_3}{c^2} = g_{66} - 1 = \left(1 - \frac{2m_3}{r}\right) - 1 = -\frac{2m_3}{r}$$

This gives,'

$$\phi_3 = -\frac{m_3 c^2}{r} \quad (56)$$

But force of attraction at a distance $r$ is $\frac{\partial\phi_3}{\partial r}$ Therefore this $\frac{\partial\phi_3}{\partial r}$ equating

$$\frac{\partial\phi_3}{\partial r} = \frac{1}{\hat{m}}\left(\frac{Gm_p m_e}{r^2} - \frac{\alpha_w \hbar c}{r^2}\right) \quad (57)$$

Differentiating equation (56) with respect to $r$ and putting in equation (57) gives,

$$m_3 = \frac{1}{\hat{m}}\left(\frac{Gm_p m_e}{c^2} - \frac{\alpha_w \hbar c}{c^2}\right) \quad (58)$$

Therefore $g_{66} = e^{-\lambda_3} = e^{\nu_3} = 1 - \frac{2}{\hat{m}r}\left(\frac{Gm_p m_e}{c^2} - \frac{\alpha_w \hbar c}{c^2}\right)$ (59)

In equations (39), (49) and (59) the gravitational force is very weak to compare with e-m, strong nuclear and weak force. The isolated particle at rest in origin the mass of the particle considered as $M = \sum_1^N m_p$, (N= 1,2,3,.....) is nothing but the combination of protons. As number of proton increases the mass of the body increases and therefore the value of gravitational coupling constant increases, hence the gravitational coupling constant is a free coupling constant [18]. Finally in equation (29) the constants $m_1, m_2, m_3$ give by the equations (38), (48) and (58).

## 4. RESULTS AND DISCUSSION

The coupling constants of e-m, strong and weak interactions are considered as,

$$\left.\begin{aligned} \alpha &= \frac{e^2}{4\pi\varepsilon_0 \hbar c} = \frac{1}{137.05} \\ \alpha_s &= \frac{g_s^2}{4\pi\hbar c} = 1 \\ \alpha_w &= \frac{g_w^2}{4\pi\hbar c} = 10^{-6} \end{aligned}\right\} \quad (60)$$

The following values are considered for the constants mentioned below:

$$\left.\begin{aligned} c &= 2.9979\times10^{10}\, cm/s \\ \hbar &= 6.5822\times10^{-22}\, MeVs = 1.0546\times10^{-27}\, erg\sec \\ G &= 6.670\times10^{-8}\, dynecm^2/gm^2 \\ m_e &= 0.511003\, MeV/c^2 = 9.10953\times10^{-28}\, gm \\ m_p &= 938.280\, MeV/c^2 = 1.67265\times10^{-24}\, gm \end{aligned}\right\} \quad (61)$$

If we put the values of $\alpha$, $\alpha_s$, $\alpha_w$, $c$, $\hbar$, $G$, $m_e$, $m_p$ from above at a particular value of mass $M$ the value of $m_1$=0. Similarly for at another particular values of $M$ the values $m_1 = m_2$=0 . In general the values of $321,,mmm$ are negative. For a massive interacting particle the negative values of $2m_1$, $2m_2$, $2m_3$ indicates that the particle is dominated by e-m, strong & weak nuclear interaction. Also the maximum values of $m_1 = m_2 = m_2$=0, gives us that in general for a massive particle the value of $r$ is always greater than $m_1$, $m_2$, $m_2$. Interesting case is that when $m_1 = m_2 = m_2$=0 gives the flat space time. At maximum particular masses the three forces viz. e-m, strong and weak interaction will be stopped by gravitational force. The equation (29) becomes,

$$ds^2 = -\left[\left(1 - \frac{2}{rc^2}GM\right)^3\right]^{-1} dr^2 - r^2 d\theta^2 - r^2\sin^2\theta d\phi^2 + \left(1 - \frac{2}{rc^2}GM\right)(dt)^2 \quad (62)$$

Here $(dt)^2 = (dt^1)^2 + (dt^2)^2 + (dt^3)^2$

This means that (29) is exactly same with the Schwarzschild exterior solution.

The time component $t^1$ will be flat in equation (38) when

$$m_1 = \frac{1}{c^2}(GMm_p - \alpha\hbar c) = 0$$

This gives,

$$M = \frac{\alpha\hbar c}{Gm_p} \quad (63)$$

Putting the values from (60) and (61) the mass required to stop e-m interaction is equal to

$$M_{em} = 2.0667735\times10^{12}\, gm$$

Similarly time component $2t$will be flat when

$$m_2 = \frac{1}{c^2}(GMm_p - \alpha_s\hbar c) = 0$$

Gives,

$$M = \frac{\alpha_s \hbar c}{Gm_p} \quad (64)$$

Here mass required to stop strong interaction is equal to

$$M_s = 2.833831\times10^{14}\, gm$$

Similarly time component $t^3$ will be flat when

$$m_3 = \frac{1}{c^2}(GMm_e - \alpha_w\hbar c) = 0$$

Gives,

$$M = \frac{\alpha_w \hbar c}{Gm_e} \quad (65)$$

Putting the values from (60) and (61) the mass required to stop weak interaction is equal to $M_w = 2.833831\times10^8\, gm$

The values of these $M_{em}$, $M_s$, $M_w$ and ,are so large that cannot exist within the range $r\ (=10^{-8}\text{ cm}, 10^{-13}\text{ and } 10^{-16})$ Density will be very high; hence cannot consider such massive particle. Therefore I have considered $M'(=\sum_1^{N'} m_p = N'm_p)$ such as mass $M'$ is required to stop the e- m interaction and R is considered as the radius of the massive body.

Now to determine the values of $M'$ we can write,

$$\frac{GM}{r} = \frac{GM'}{R}$$

This gives for e-m interaction

$$M' = M\left(\frac{R}{r}\right) = \frac{\alpha\hbar c}{Gm_p}\left(\frac{R}{r}\right) \quad (66)$$

Number of proton contains in mass $M$ is $N(=M/m_p)$ and r is interacting range or atomic radius then volume for $N$ atoms is

$$V = \frac{M}{m_p}\times\frac{4}{3}\pi r^3 \quad (67)$$

Therefore density is

$$\rho = \frac{M}{V} = \frac{m_p}{(4/3)\pi r^3} \quad (68)$$

Now

$$M' = \frac{4}{3}\pi R^3\rho = m_p\left(\frac{R}{r}\right)^3 \quad (69)$$

Equating (66) with (69)

$$\frac{R}{r} = \frac{1}{m_p}\left(\frac{\alpha\hbar c}{G}\right)^{(1/2)} \qquad (70)$$

Putting (70) in equation (69)

$$M'_{em} = (1/m_p^2)\left(\frac{\alpha\hbar c}{G}\right)^{(3/2)} \qquad (71)$$

Using the values of $\alpha$, $\hbar$, $c$, $G$ and $m_p$ from (60) and (61) in (71) to stop e-m interaction between two protons,

$$M'_{em} = 2.29701\times10^{30}\, gms = 0.00116\, M_\Theta \qquad (72)$$

Here $M\Theta = 1.99\times10^{33}$ gm is the mass of sun.

Using $\alpha_s$(=1) instead of $\alpha$ in (71) to stop strong nuclear interaction,

$$M'_s = 1.85355\, M_\Theta \cong 1.85\, M_\Theta \qquad (73)$$

Considering $\alpha_w$ (=$10^{-6}$)for weak interaction using (71),

$$M'_w = \frac{\alpha_w\hbar c}{Gm_e}\left(\frac{R}{r}\right) \qquad (74)$$

Putting the value of $\left(\frac{R}{r}\right)$ from equation (70) in (74) then it becomes,

$$M'_w = \frac{1}{m_p m_e}\left(\frac{\alpha_w\hbar c}{G}\right)^{(3/2)} \qquad (75)$$

Using the values of $\alpha_w$, $m_e$, $m_p$, $\hbar$, $c$ and G from (60) and (61) in (75) to stop weak interaction,

$$M'_w = 6.7728\times10^{27}\,\text{gms} = 3.4034\times10^{-6}\, M_\Theta \qquad (76)$$

When stops the weak, e-m and strong interaction the equation (29) becomes like (62), in this condition $M\to M'$, $r\to R$ then considering the time coefficient as zero,

$$\frac{2GM'}{Rc^2} = 1$$

This means,

$$M' = \frac{Rc^2}{2G} \qquad (77)$$

Putting the values of R from (70) and $\alpha\to\alpha_s$ the above equation becomes,

$$M' = \left(\frac{\alpha_s\hbar c}{G}\right)^{1/2}\frac{c^2}{2Gm_p}r \qquad (78)$$

Now putting $\alpha_s$ =2/3, for colour singlet due to quark-quark interaction the value of $\hbar$, $c$, $G$, $m_p$ from (61) and $r = 10^{-13}$cm in the above (78) gives,

$$M' = 2.94 M_\Theta \cong 3\, M_\Theta \qquad (79)$$

## 5. CONCLUSION

To stop weak interaction by gravitational force required mass is $3.4034\times10^{-6}M_\Theta$. Greater than the above mass weak interaction will not occur. To stop weak interaction the mass is just 1.06 times greater than earths mass.

To stop e-m interaction the required mass is $2.29701\times10^{30}\, gms\, (= 0.00116\, M_\Theta)$ When stops e-m interaction between two protons by gravitational force then starts the strong nuclear interaction and a star will born, known as proto-star. The mass of Jupiter planet is $1.898\times10^{30}$gms and the mass required to stop e-m interaction is just 1.21 times greater than Jupiter's mass. So in any planet above this mass life cannot exist, since in that planet e-m interaction will be stopped by the gravity. Since life is nothing but the low energy level e-m interaction.

To stop strong nuclear interaction mass required $1.85M_\Theta$, greater than this mass a star becomes a neutron star. Above the mass $3M_\Theta$ time components will vanish and the star tends to collapse (black hole). Hence the range of neutron star is $1.85M_\Theta$ to $3M_\Theta$. So the mass represents in equations (76), (72), (73) and (79) is nothing but the life history of a star. The result given by equation (73) for maximum mass of white dwarf is $1.85M_\Theta$ and approximately same as given by Chandrasekhar [19] which was $1.72M_\Theta$ . Another result for maximum mass of neutron star given by equations (79) is 3 $M_\Theta$ and approximately same as given by ^Ozel etc.[20] and ^Chamel etc. [21]. The above values of mass will be more accurate if we shall develop the equations for rotating stars.

Equation (29) established a relation among space, time and the four fundamental forces of nature.

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