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Fundamental Forces Depends on the Spacetime Curvature

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Abstract: ***Scientists have realized over the past hundred years that electricity and magnetism are manifestations of the same force. Only within the last 25 years, however, have scientists understood that even the weak force can be treated as a manifestation of the same force. The Nobel Prize in 1979 was awarded to 3 physicists (Steven Weinberg, Sheldon Glashow and Abdus Salam) who showed how to unite the weak and the electromagnetic forces into one force, called the "electro-weak" force. Similarly, Physicists now believe that another theory (called the GUT or "Grand Unified Theory") may unite the electro-weak force with the strong-interactions.***

Keywords: space-time curvature

1. Discussion

GUT defines that not only gravity but any kind of forces depends upon the space-time curvature and a general equation of unified force is suggested.

Let, S is a position in space, of a particle of mass 'm' at a time t=t, then its velocity after a time interval of 'dt' will be as follows if $\frac{d^i s}{dt^i}$ = constant.

$[s]_{t=t+dt} = [s]_{t=t} + \frac{ds}{dt}\frac{t}{1!} + \frac{d^2s}{dt^2}\frac{t^2}{2!} + \ldots + \frac{d^is}{dt^i}\frac{t^i}{i!}$, for $\frac{d^is}{dt^i}$ = constant.

Now, $[\frac{ds}{dt}]_{t=t+dt} = [\frac{ds}{dt}]_{t=t} + \frac{d^2s}{dt^2}\frac{t}{1!} + \frac{d^3s}{dt^3}\frac{t^2}{2!} + \frac{d^4s}{dt^4}\frac{t^3}{3!} + \ldots\ldots\ldots + \frac{d^is}{dt^i}\frac{t^{(i-1)}}{(i-1)!}$ .... [1]

Thus, $[\frac{d^{(i-1)}s}{dt^{(i-1)}}]_{t=t+dt} = [\frac{d^{(i-1)}s}{dt^{(i-1)}}]_{t=t} + \frac{d^is}{dt^i}\frac{t}{1!}$, and,

Finally, $\frac{d^is}{dt^i}$ = constant.

Now,

Force, F = m $\{\frac{d^is}{dt^i} + \frac{d^{(i-1)}s}{dt^{(i-1)}} + \ldots\ldots + \frac{d^2s}{dt^2}\}$ = m $[\frac{d^is}{dt^i}\{1+\frac{t}{1!}+\frac{t^2}{2!}+\ldots+\frac{t^{(i-2)}}{(i-2)!}\} + \frac{d^{(i-1)}s}{dt^{(i-1)}}\{1+\frac{t}{1!}+\frac{t^2}{2!}+\ldots+\frac{t^{(i-3)}}{(i-3)!}\}+\ldots+\frac{d^2s}{dt^2}]$... [2]

Assume, f = $1+\frac{t}{1!}+\frac{t^2}{2!}+\ldots+\frac{t^n}{n!}$.

$\therefore \frac{df}{dt} = 1+\frac{t}{1!}+\frac{t^2}{2!}+\ldots\ldots\ldots+\ldots\ldots+\frac{t^{(n-1)}}{(n-1)!}$ = f - $\frac{t^n}{(n)!}$.

Now integrating, f = ft - $\frac{t^{(n+1)}}{(n+1)!}$ + C. C – Is a constant.

If, t = 0, and C=f,

Thus, ft = $\frac{t^{(n+1)}}{(n+1)!}$ or, f = $\frac{t^n}{(n+1)!}$.

$\therefore$Force, F = m $[\frac{d^is}{dt^i}\frac{t^{(i-2)}}{(i-1)!} + \frac{d^{(i-1)}s}{dt^{(i-1)}}\frac{t^{(i-3)}}{(i-2)!} + \ldots + \frac{d^3s}{dt^3}\frac{t}{2!} + \frac{d^2s}{dt^2}]$.

Now, if, F = constant, it will be independent of 't' $\rightarrow \frac{d^2s}{dt^2}$ = constant.

$\therefore \frac{d^3s}{dt^3} = 0$. So, F = m $\frac{d^2s}{dt^2}$.

Now, if, $\frac{dF}{dt}$ = constant, it will be independent of 't' $\rightarrow \frac{d^3s}{dt^3}$ = constant.

$\therefore \frac{d^4s}{dt^4} = 0$. So, F = m $[\frac{d^3s}{dt^3}\frac{t}{2!} + \frac{d^2s}{dt^2}]$ and so on.

Now, if, $\frac{d^is}{dt^i}$ = constant, then $\frac{d^{(i-2)}F}{dt^{(i-2)}}$ = constant.

And F = m $[\frac{d^is}{dt^i}\frac{t^{(i-2)}}{(i-1)!} + \frac{d^{(i-1)}s}{dt^{(i-1)}}\frac{t^{(i-3)}}{(i-3)!} + \ldots\ldots + \frac{d^3s}{dt^3}\frac{t}{2!} + \frac{d^2s}{dt^2}]$.

Or, F = $m\sum_{k=2}^{i}\frac{d^ks}{dt^k}.\frac{t^{(k-2)}}{(k-1)!}$. Or, F = $m\sum_{k=0}^{i}\frac{d^kf}{dt^k}.\frac{t^k}{(k+1)!}$, where f = $\frac{d^2s}{dt^2}$. ....[3]

Now, for any kind of force field $\frac{d^2s}{dt^2}$ = f = $\frac{c}{d^2}$.

Where, c = Constant depending upon the intensity of force field and d = distance.

$\therefore$ F = $\lim_{i\to\infty} m\sum_{k=0}^{i}\frac{d^kf}{dt^k}.\frac{t^k}{(k+1)!}$. Where, f = $\frac{d^2s}{dt^2} = \frac{c}{d^2}$.

If a particle creating force field having mass 'M', electric charge 'Q' and magnetic intensity 'm_1', then,

c = GM (for Gravitational Field)

= KQ (for Electric Field)

= $\frac{\mu m_1}{4\pi}$ (for Magnetic Field)

Now, for f = $\frac{c}{d^2}$ if initial velocity u = 0,

$\frac{df}{dt} = (\frac{-2c}{d^3})$.u = 0 (as u =0)

$\frac{d^2f}{dt^2} = [\frac{3!c}{d^4}]u^2 + (\frac{-2c}{d^3})$ f = $(\frac{-2c}{d^3})(\frac{c}{d^2})$.

$\frac{d^3f}{dt^3} = (\frac{2.5c^2}{d^6})$ u = 0.

$\frac{d^4f}{dt^4} = 0 + (\frac{2.5c^2}{d^6})(\frac{c}{d^2}) = (\frac{2.5c^2}{d^6})(\frac{c}{d^2})$ and so on.

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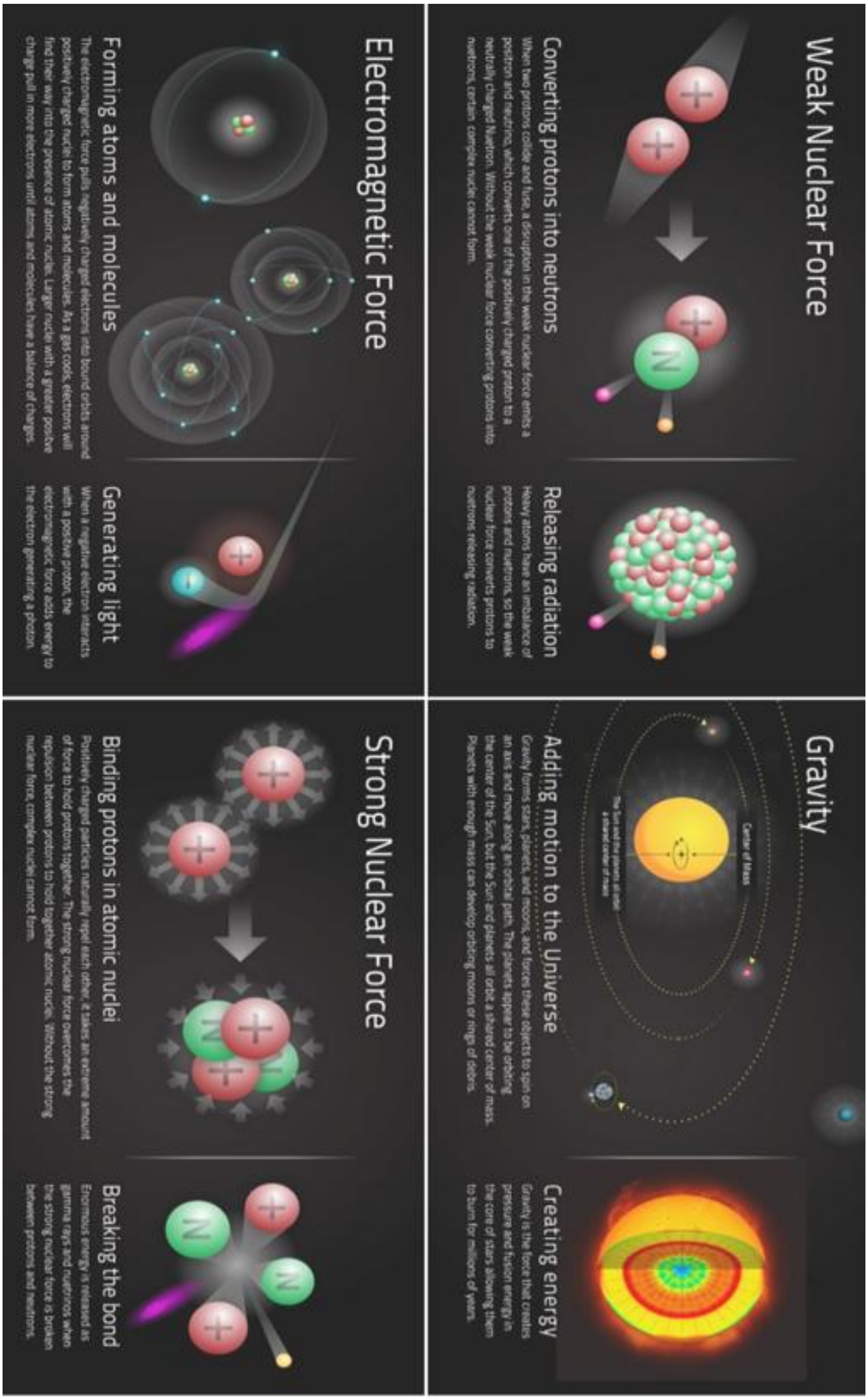

So, for k = 2n,

$$\frac{d^{2n}f}{dt^{2n}} = (-1)^{n+1} \prod_0^n (3n-1) \frac{c^{(n+1)}}{d^{(3n+2)}} \text{.........} (1)$$

Now, $F=\lim_{i\to\infty} m \sum_{n=0}^{i} \frac{d^{2n}f}{dt^{2n}} \frac{t^{2n}}{(2n+1)!}$. .....[4]

$\therefore F = \lim_{i\to\infty} m \sum_{n=o}^{i} \{(-1)^{n+1} \prod_0^n (3n -$ 1)cn+1d3n+2}*t2n2n+1!*........ (Substitute the value of equation 1)

$$\text{Now, } F=\lim_{i\to\infty} \frac{m}{d^2} \sum_{n=0}^{i} (-1)^{n+1} \frac{\prod_0^n (3n-1)}{(2n+1)!} (GM)^{(n+1)} \frac{t^{2n}}{d^{3n}} (2)$$

This is for gravitational field only where force depending upon $\frac{t^2}{d^3}$ (space-time) curvature with n^{th}power. Similarly, for electric and magnetic fields also forces depend upon $\frac{t^2}{d^3}$ (space-time) curvature with n^{th} power.

For, electric field, on a particle having charge ‘q’,

$$F=\lim_{i\to\infty} \frac{q}{d^2} \sum_{n=0}^{i} (-1)^{n+1} \frac{\prod_0^n (3n-1)}{(2n+1)!} (KQ)^{(n+1)} \frac{t^{2n}}{d^{3n}} \text{....} (3)$$

For, magnetic field, on a particle having magnetic intensity 'm_2',

$$F = \lim_{i\to\infty} \frac{m_2}{d^2} \sum_{n=0}^{i} (-1)^{n+1} \frac{\prod_0^n (3n-1)}{(2n+1)!} \left(\frac{\mu m_1}{4\pi}\right)^{(n+1)} \frac{t^{2n}}{d^{3n}} \ldots (4)$$

So, if $\bar{F}$ is the unified force applied by object 1(having mass M, electric charge Q, magnetic intensity m_1) upon a stationary object 2(having mass m, charge q, magnetic intensity m_2) whose initial velocity u =0, then,

$$\bar{F} = \lim_{i\to\infty} \frac{1}{d^2} \sum_{n=0}^{i} (-1)^{n+1} \frac{\prod_0^n (3n-1)}{(2n+1)!} \frac{t^{2n}}{d^{3n}} \{m(GM)^{(n+1)} + q\,(KQ)^{(n+1)} + m_2 \left(\frac{\mu m_1}{4\pi}\right)^{(n+1)}\}.$$

$$\therefore \bar{F} = \lim_{i\to\infty} \frac{1}{d^2} \sum_{n=0}^{i} C \frac{t^{2n}}{d^{3n}} \{m(GM)^{(n+1)} + q\,(KQ)^{(n+1)} + m_2 \left(\frac{\mu m_1}{4\pi}\right)^{(n+1)}\}$$

Where, $C = (-1)^{n+1} \frac{\prod_0^n (3n-1)}{(2n+1)!}$ = f (n).

2. Conclusion

So, we can see that not only gravity, but any kind of force depends on the space-time curvature.

References

[1],[2],[3] – Gravitation And Cosmology –by Steven Weinberg.
[4]- J Larmor, Mathematical and physical papers (Cambridge University Press)2015, Vol.2.

Author Profile

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