An Approach to New Concept of Time on the Basis of Four Fundamental Forces of Nature

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Abstract- The purpose of this short write-up is simply to present a new concept of time, which giving us naturally Lorentz expression in a simple way with simple mathematics and also can be extended for 7-dimensional space-time continuum. In this write-up especially particular attention is given to the seven dimensional metric $g_{\mu\nu}$. In metric or line element we introduced (3+4) dimensions where 3 usual space components and another 4 time components instead of 1, on the basis of the four fundamental forces of nature. Similar to the Lorentz's transformation in 4 dimensional space-time continuums the 7 dimensional continuums also give the same type transformation equations. The fundamental tensors $g_{\mu\nu}$ occur both in the formula for interval and in the formula for trajectory. In the first case it appears as a set of quantities determining the nature of space-time geometry and in the second case the first derivatives of $g_{\mu\nu}$ appears in the Christoffel 3-index symbols.

Notation

The notational history of higher space- times is annoyingly confusing (like that of early tensor calculus), mainly because one normally denotes time as the '0' index and 1, 2, 3 for the space indices. Using '4', '5', '6' as the index for the fifth, sixth and seven dimensions seems to be problematic. Therefore I will use '5' to denote the fifth, '6' to sixth, '7' to seventh dimension, so space and time dimensions will go like 1, 2, 3, 4, 5, 6, 7 as first 1, 2, 3 for space and another 4, 5, 6, 7 for time components. In denoting the full complement of 7 dimensional space time indices I will use the Greek indices (μ , ν = 1, 2, 3, 4, 5, 6, 7).

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Index Terms- 7-dimensional space-time continuum, 4-time components, velocity of changes, changing constant, own energy quanta.

I. Introduction

It is likely that we will have a hard time in answering, in a simple way, the fundamental question 'what is time?' [1]. Interestingly enough, this difficulty in defining in words what time is, is not of great concern to those beginning the study of physics, since we know how to measure it ! Time is what is measured with clock.

In philosophical and fundamental [2] discussions of special theory of relativity it is claimed that relativistic time does not have the same status as time in classical physics; in relativity theory, time – it is said – is much more 'conventional' than its counterpart in classical physics. Relativistic time is more strongly connected with physical phenomena than its classical counterpart, and is therefore not conventional in an interesting sense. For a discussion of the philosophical significance of relativistic time it is important, however, to be clear about the exact nature of the link between the time parameter and physical phenomena and processes.

In 1905, Einstein [3–7] using Lorentz expression established that the fourth dimension of nature is time-axis and denoted as $x_4(=ict)$, where $i=\sqrt{-1}$, c is the velocity of light in vacuum and t is time.

According to Minkowski [6] our world is composed not of points in the Euclidean 3-dimensional space, but of events in 4-dimensional space-time continuum. An event can be considered to have four co-ordinates of which three are space co-ordinates and fourth involves time.

Shortly after Einstein's November 1915 announcement of his general theory of relativity, physicist initiated efforts to generalize it an attempts to develop a unified field theory of the gravitational and electro-magnetic force. Since only two forces [8] are known at that time. Notable [9, 10] among these efforts were those of Weyl (1918) and Kaluza (1921). In 1918, the mathematical physicists Hermann Weyl used an intuitively appealing version of non-Riemannian geometry to embed the entirely of electrodynamics into the affine connection of general relativity. Then in 1919 the Polish-German physicist Theodor Kaluza came up with another idea that employed ordinary Riemannian geometry but with five dimensions (1 time and 4 spaces). Einstein famously lauded Weyl's theory, but quickly withdrew his support when he discovered that the theory was not physical. Einstein similarly praised Kaluza's idea, although Einstein and other prominent physicist of the day were uncomfortable with the idea of a five dimensional world.

In 1926 the Swedish physicist Oskar Klein [11] came up with some major improvements to Kaluza's theory, at which time it became universally known as Kaluza-Klein theory. But the theory languished for decades until the early advent of string theory in the 1970s, when serious interest in extra dimensions experienced resurgence.

The purpose of this article is simply to introduce the basic concept of time looking into the extra dimensions of space-time continuum. Therefore in this work we put here justification for 7-dimensional space-time continuums where 3 space and 4 time components on the basis of the four fundamental forces of nature viz electro-magnetic, strong, weak and gravitational forces.

II. Assumptions

(i) Change and evolution are fundamental aspects of the universe. Change and evolution is the description of the medium to experience the time i.e. time shows itself as a parameter of processes of change [2]. If something were unchanging, we would not have any experience of time in relation to that. It would be like a static picture.

(ii) Physics has already discovered four fundamental forces of nature viz electro-magnetic, strong, weak and gravitational forces whereby our universe is governed. Our universe is constantly being acted upon by these four fundamental forces. Changes occur in four different ways co-responding to four forces. For different ways of change determined the four components of time. Since changes occur, hence time flows in forward direction.

III. Mathematical formulation

Let we consider our assumption (i) that time shows itself is a parameter of process of change and for a particular fundamental force the changing occurs with a constant speed.

i.e. $$\frac{d\vec{r}(x,y,z)}{dt} = c_1$$

Where $\vec{r}(x,y,z)$ is position co-ordinate, t is time and c_1 is a constant but it represent velocity of changes occur due to particular fundamental force.

Let for a small time dt the changes occur as

$$d\vec{r}(x,y,z) = c_1 dt$$
$$\Rightarrow dr^2 = c_1{}^2 dt^2$$
$$\Rightarrow dx^2 + dy^2 + dz^2 = c_1{}^2 dt^2 \qquad (1)$$

Now we consider the particular fundamental force of nature which is electro-magnetic (e-m) force and is responsible for changes in nature especially in molecular and atomic level. Due to this e-m interaction the changes occur with a constant speed c_1 in all level of nature including especially in molecular and atomic level also. But in e-m interaction photon plays a vital role with the speed c as mediator particle and is responsible for changes in both molecular and atomic level. This gives us that the speed c_1 is nothing but the speed c of light, since light is known as photon particle. Hence equation (1) becomes,

$$dx^2 + dy^2 + dz^2 = c^2 dt^2 \qquad (2)$$

The equation (2) is nothing but the Lorentz expression. The interval between two neighbouring event is

$$ds^2 = dx^2 + dy^2 + dz^2 - c^2 dt^2 \qquad (3)$$

And this expression must be independent of the transformation from one system to another. Hence the expression (3) is invariant for Lorentz transformation [5].

According to assumption (ii) that changes occur in our world in four different ways co-responding to four different fundamental forces of nature. Now we consider the changes occur in nature due to the four fundamental forces of nature which gives,

$$\sum_{i=1,2,3,4} \frac{\partial \vec{r}(x,y,z)}{\partial t^i} = \sum_{i=1,2,3,4} c_i \qquad (4)$$

Here i= 1, 2, 3, 4 i.e. t^1, t^2, t^3, t^4 and c_1, c_2, c_3, c_4 are the components of time and changing constants due to e-m, strong, weak, gravitational forces of nature respectively. In equation (4) the units of c_i represents the unit of velocity. Now the changes occur for a small time dt^i the above equation (4) using summation convention,

$$d\vec{r}(x,y,z) = c_i (dt^i)$$
$$\Rightarrow dr^2 = c_i{}^2 (dt^i)^2$$
$$\Rightarrow dx^2 + dy^2 + dz^2 = c_i{}^2 (dt^i)^2 \qquad (5)$$

The interval between two neighbouring event is

$$ds^2 = dx^2 + dy^2 + dz^2 - c_1{}^2 (dt^1)^2 - c_2{}^2 (dt^2)^2 - c_3{}^2 (dt^3) - c_4{}^2 (dt^4) \qquad (6)$$

The above equation (6) can be written as

$$ds^2 = dx^2 + dy^2 + dz^2 - a_1 c^2 (dt^1)^2 - a_2 c^2 (dt^2)^2 - a_3 c^2 (dt^3)^2 - a_4 c^2 (dt^4)^2 \qquad (7)$$

Here $a_1 = (c_1/c)^2 = 1$, since $c_1 = c$;

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$a_2 = (c_2 / c)^2, a_3 = (c_3 / c)^2$ & $a_4 = (c_4 / c)^2$ are other constants.

According to Minkowski [6] an event can be considered to have four co-ordinates (x^1, x^2, x^3, x^4) of which three (x^1, x^2, x^3) are space co-ordinates and the fourth x^4 involves time.

Now consider the assumptions (i) and (ii) which gives that the space time continuum has (3+4) dimensions, 3 space and 4 time co-ordinates. So an event can be considered to have seven co-ordinates $(x^1, x^2, x^3, x^4, x^5, x^6, x^7)$ of which (x^1, x^2, x^3) are space co-ordinates and (x^4, x^5, x^6, x^7) involves time as the physical world changes due to the four fundamental forces of nature.

Let $(x^1, x^2, x^3, x^4, x^5, x^6, x^7)$ and $(x^1 + dx^1, x^2 + dx^2, x^3 + dx^3, x^4 + dx^4, x^5 + dx^5, x^6 + dx^6, x^7 + dx^7)$ be co-ordinates of two neighbouring events in any system than the interval between two events is given by

$$ds^2 = (dx^1)^2 + (dx^2)^2 + (dx^3)^2 + (dx^4)^2 + (dx^5)^2 + (dx^6)^2 + (dx^7)^2 \qquad (8)$$

Now the equation (8) comparing with equation (7) we get,

$$\left.\begin{aligned} dx^1 &= dx \\ dx^2 &= dy \\ dx^3 &= dz \\ dx^4 &= i\sqrt{a_1}\,cdt^1 = icdt \\ dx^5 &= i\sqrt{a_2}\,cdt^2 \\ dx^6 &= i\sqrt{a_3}\,cdt^3 \\ dx^7 &= i\sqrt{a_4}\,cdt^4 \end{aligned}\right\} \qquad (9)$$

Where $i = \sqrt{-1}$

3.1. Lorentz transformation

Let consider a point having co-ordinates ($x, y, z, t^1, t^2, t^3, t^4$) and ($\bar{x}, \bar{y}, \bar{z}, \bar{t}^1, \bar{t}^2, \bar{t}^3, \bar{t}^4$) for S and $\bar{S}$ system respectively such that the $\bar{S}$ system moves in x-direction and time components in t^1 (say) direction similar to Lorentz transformation [5], the transformation becomes,

$$\left.\begin{aligned} \bar{x} &= \beta(x - vt^1) \\ \bar{y} &= y \\ \bar{z} &= z \\ \bar{t}^1 &= \beta\left(t^1 - \frac{vx}{a_1 c^2}\right) \\ \bar{t}^2 &= t^2 \\ \bar{t}^3 &= t^3 \\ \bar{t}^4 &= t^4 \end{aligned}\right\} \qquad (10)$$

Where $\beta = \dfrac{1}{\sqrt{\left(1 - \dfrac{v^2}{a_1 c^2}\right)}}$ and $a_1 = \left(\dfrac{c_1}{c}\right)^2$, for electro-magnetic force and $a_1 = 1$

3.2. Space like and time like intervals

Now consider two events in our 7-dimensional space-time continuum whose co-ordinates are $(x_1, y_1, z_1, t^1{}_1, t^2{}_1, t^3{}_1, t^4{}_1)$ and $(x_2, y_2, z_2, t^1{}_2, t^2{}_2, t^3{}_2, t^4{}_2)$ in *S*-system,

$$s_{12}{}^2 = -[(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2] + c^2[a_1(t^1{}_2 - t^1{}_1)^2 + a_2(t^2{}_2 - t^2{}_1)^2 + a_3(t^3{}_2 - t^3{}_1)^2 + a_4(t^4{}_2 - t^4{}_1)^2] \quad (11)$$

In $\bar{S}$ system, this is transformed to

$$\bar{s}_{12}{}^2 = -[(\bar{x}_2 - \bar{x}_1)^2 + (\bar{y}_2 - \bar{y}_1)^2 + (\bar{z}_2 - \bar{z}_1)^2] + c^2[a_1(\bar{t}^1{}_2 - \bar{t}^1{}_1)^2 + a_2(\bar{t}^2{}_2 - \bar{t}^2{}_1)^2 + a_3(\bar{t}^3{}_2 - \bar{t}^3{}_1)^2 + a_4(\bar{t}^4{}_2 - \bar{t}^4{}_1)^2] \quad (12)$$

Writing equation (12) with the help of equation (10) we have

$$\bar{s}_{12} = s_{12}$$

This proves that the interval s_{12} is Lorentz invariant [4, 6].

If $S_{12} = 0$ then the interval S_{12} given by equation (11) is

$$-[(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2] + c^2[a_1(t^1{}_2 - t^1{}_1)^2 + a_2(t^2{}_2 - t^2{}_1)^2 + a_3(t^3{}_2 - t^3{}_1)^2 + a_4(t^4{}_2 - t^4{}_1)^2] = 0$$

This suggest that

$$ds^2 = -dx^2 - dy^2 - dz^2 + a_1c^2(dt^1)^2 + a_2c^2(dt^2)^2 + a_3c^2(dt^3)^2 + a_4c^2(dt^4)^2$$

This is known as the equation of null cone.

If $s_{12}{}^2 = c^2[a_1(t^1{}_2 - t^1{}_1)^2 + a_2(t^2{}_2 - t^2{}_1)^2 + a_3(t^3{}_2 - t^3{}_1)^2 + a_4(t^4{}_2 - t^4{}_1)^2] > 0$

i.e. $S_{12} > 0 \Rightarrow$ The interval S_{12} is real and called time like intervals.

If $S_{12}{}^2 = -[(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2] < 0$

i.e. $S_{12} < 0 \Rightarrow$ The interval S_{12} is imaginary and called space like intervals.

3.3. Riemannian metric

In Riemannian space [5, 6] of *n* dimensions the metric or line element for the distance between two neighbouring points $(x), (x + dx)$ is

$$ds^2 = g_{\mu\nu} dx^\mu dx^\nu \quad (13)$$

Here $\mu, \nu = 1,2,3.......................n$

Obviously equation (13) may be reduce to (3) in special case. In equation (13)

$$g_{\mu\nu} = \begin{bmatrix} g_{11} & g_{12} & \cdots & \cdots & g_{1n} \\ g_{21} & g_{22} & \cdots & \cdots & g_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ g_{n1} & g_{n2} & \cdots & \cdots & g_{nn} \end{bmatrix} \quad (14)$$

The $g_{\mu\nu}$ are functions of the co-ordinates (x) and may therefore vary from point to point. These functions are symmetrical,

i.e. $g_{\mu\nu} = g_{\nu\mu}$ (15)

The $g_{\mu\nu}$ is a fundamental co-variant tensor of rank –2 obeying transformation law

$$\bar{g}_{\alpha\beta} = \frac{\partial x^{\alpha}}{\partial \bar{x}^{\mu}} \frac{\partial x^{\beta}}{\partial \bar{x}^{\nu}} g_{\mu\nu} \quad (16)$$

Where the quantities carrying bar correspond to the new co-ordinate system.

The fundamental tensor $g_{\mu\nu}$ occur both in the formula for interval and in the formula for trajectory [6]. The functions $g_{\mu\nu}$ called the co-efficient of metric are not necessarily positive but it is always assumed that the determinant

$$g = |g_{\mu\nu}| = \begin{vmatrix} g_{11} & g_{12} & \cdots & \cdots & g_{1n} \\ g_{21} & g_{22} & \cdots & \cdots & g_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ g_{n1} & g_{n2} & \cdots & \cdots & g_{nn} \end{vmatrix} \quad (17)$$

is never zero.

It will be notice that ordinary 3-dimensional space is a particular case of Riemannian space in which

$$\left.\begin{array}{l} g_{11} = g_{22} = g_{33} = 1 \\ g_{12} = g_{23} = g_{31} = g_{21} = g_{32} = \ldots\ldots\ldots\ldots\ldots = 0 \end{array}\right\} \quad (18)$$

The Lorentz space-time continuum in special theory given by equation (3) is also special case given by Riemannian metric for 4-dimensional space-time continuum [5, 6] and hence,

$$\left.\begin{array}{l} g_{11} = g_{22} = g_{33} = -1 \\ g_{44} = c^2 \ \& \ g_{\mu\nu} = 0 (\mu \neq \nu) \end{array}\right\} \quad (19)$$

Now in a similar way our theory given by equation (7) is also special case given by Riemannian metric for 7-dimensional space-time continuum and hence comparing this with equation (13)

$$\left.\begin{array}{l} g_{11}=g_{22}=g_{33}=-1 \\ g_{44}=c^2 \\ g_{55}=a_2c^2, g_{66}=a_3c^2, g_{77}=a_4c^2 \\ \& \; g_{12}=g_{23}=g_{31}=g_{42}=g_{15}=g_{62}=g_{71}=.........=0(\mu\neq\nu) \end{array}\right\} \quad (20)$$

$$\therefore \quad g=\begin{vmatrix} -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & c^2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & a_2c^2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & a_3c^2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & a_4c^2 \end{vmatrix} \quad (21)$$

Hence,

$$\left.\begin{array}{l} g^{11}=g^{22}=g^{33}=-1 \\ g^{44}=\dfrac{1}{c^2}, g^{55}=\dfrac{1}{a_2c^2}, g^{66}=\dfrac{1}{a_3c^2} \; \& \; g^{77}=\dfrac{1}{a_4c^2} \\ \& \; g^{\mu\nu}=0(\mu\neq\nu) \end{array}\right\} \quad (22)$$

A free particle moves along a geodesic [5, 6] the differential equation is given by

$$\frac{d^2x^\alpha}{ds^2}+\frac{dx^\mu}{ds}\frac{dx^\nu}{ds}\Gamma^\alpha_{\mu\nu}=0 \quad (23)$$

Here $\Gamma^\alpha_{\mu\nu}$ is called Christoffel three-index symbols of second kind and is equal to

$$\Gamma^\alpha_{\mu\nu}=\frac{1}{2}g^{\alpha\sigma}\left[\frac{\partial g_{\mu\sigma}}{\partial x^\nu}+\frac{\partial g_{\nu\sigma}}{\partial x^\mu}-\frac{\partial g_{\mu\nu}}{\partial x^\sigma}\right] \quad (24)$$

For α = 1, 2, 3, 4, 5, 6, 7 gives seven equations determining a geodesics.

For flat space-time,

$g_{\mu\nu}=$ Constant $\forall \; \mu,\nu$ and $g^{\mu\nu}=$ Constant $\forall \; \mu,\nu$.

This $\Rightarrow \Gamma^\alpha_{\mu\nu}=0 \;\; \forall \;\; \mu,\nu,\sigma$. Hence,

$$\frac{d^2x}{ds^2}=\frac{d^2y}{ds^2}=\frac{d^2z}{ds^2}=\frac{d^2t}{ds^2}=\frac{d^2t^2}{ds^2}=\frac{d^2t^3}{ds^2}=\frac{d^2t^4}{ds^2}=0 \quad (25)$$

Integrating this we get, $\dfrac{dx^\alpha}{ds}=a^\alpha$.

Again integrating we get, $x^\alpha=a^\alpha s+b^\alpha$ (26)

Where a^{α} and b^{α} are constant of integration. Evidently equation (26) is the type $y = mx + c$ and hence represents straight line.

Referred to spherical polar co-ordinates and time, the line element in flat space-time is given by

$$ds^2 = -dr^2 - r^2 d\theta^2 - r^2(\sin^2\theta)d\phi^2 + a_1(dt^1)^2 + a_2(dt^2)^2 + a_3(dt^3)^2 + a_4(dt^4)^2 \quad (27)$$

Here *c* is taken to be unity in order to use astronomical units and $a_1 = 1 \,\&\, t^1 = t$ for e-m interaction.

IV. Conclusions

In equation (7) the constant $a_1 = 1$ since $c_1 = c$, where *c* is the speed of light in vacuum and other constants a_2, a_3, a_4 are to be determined according to the nature of four fundamental forces.

The natures of the four fundamental forces are not same, which gives us that the constants in equation (7) are not same,

i.e. $a_1 = 1 \neq a_2 \neq a_3 \neq a_4$

Gives us that the another constants

$$c_1 = c \neq c_2 \neq c_3 \neq c_4 \quad (28)$$

Nature has gifted us the eyes which perceive changes by means of light. Light is the particle called photon and a mediator particle of electro-magnetic interaction having energy quanta $E=h\nu$.

Supposing we could look at nature by means of some other mediator particle of any another force than photon, then the 4th dimension of Lorentz expression will be the product of time and the velocity of that particle. In case of strong and weak interaction the changes occur due to the role plays by their mediator particles and therefore c_2, c_3 are the speed of their mediator particles respectively. If c_2, c_3 are the velocity of mediator particles then they must have their own energy quanta according to their own nature of the forces. The strong and weak force confined [12, 13] within the limit 10^{-15} m and 10^{-18} m respectively. Hence in our normal life these two components of time t^2 (for strong) and t^3 (for weak) are not affected. The only t^1 (for electro-magnetic) and t^4 (for gravitational) time components are realizable.

But the problem arises in case of gravitational force. Is there any mediator particle like other forces? No distinct answer. Some authors claimed that gravitational changes occur due to a mediator particle known as graviton [13], a hypothetical particle. But in case of other forces behind the changing there is always a mediator particle, which give us to think that there may have such type of particle having speed c_4 for the gravitational force.

In equation (28) the values of *c*, $c_2, c_3 \,\&\, c_4$ are not equal, but may be greater or less than *c*. If the value of anyone constant is greater than *c* (possibility in case of gravitational mediator particle) supports the existence of tachyons [14].

Other applications of the 7-dimensional space-time continuum left for the forth coming papers.

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