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A Brief Account of the Concepts of Time in the Pre-Relativistic Electrodynamics and STR

Chandramohanan MR

Former Professor of Mathematics, Narayanaguru College of Engineering, Manjalummood, Tamil Nadu, India

ABSTRACT

In this article, we examine the concepts of time such as classical time, local time, retarded time/advanced time and proper time prevalent in the pre-relativistic period and the relativistic concepts of time expounded in Einstein's STR. It is shown that the concept of retarded time/advanced time leads to the proof of Lorentz Transformation whereas the STR leads to a non-linear transformation in which $y \neq y'$ and $z \neq z'$. From the analysis it follows that there is no new concept of time in STR, which contains a faulty use of retarded/advanced time.

***Corresponding author**

Chandramohanan MR, Former Professor of Mathematics, Narayanaguru College of Engineering, 41/2674 (1) Sreenilayam, Manacaud PO, Thiruvananthapuram, Kerala, India.

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Abbreviations

STR/SRT: Special Theory of Relativity
Local Time: t
Proper Time:
LT: Lorentz Transformation

Classical Concept of Time

A system of reference is a coordinate system, serving to indicate the position and time of a particle in space-time, by means of measuring rods and identical clocks showing the same pointer-positions, distributed throughout the space. A frame is said to be inertial, if moving bodies, not acted upon by external forces or acceleration, move with constant velocity. When we consider the motion of a free particle in inertial frame, it will be assumed that the space of the inertial frame is homogeneous and isotropic and the time-coordinate t is assumed homogeneous. Let the space-time event in a system S with origin O be denoted by O (x, y, z, ct) and let S′ be a system O′ (x', y', z', ct') in which O′ moves along the positive x-axis from O with constant velocity v_0, the y' and z' axes being always parallel to the y and z respectively.

The two systems of coordinates are related by the Galilean transformation $x = x' + v_0 t$, $y = y'$, $z = z'$, $t' = t$. In classical dynamics, time is considered absolute, which elapses uniformly, independent of other influences. If clocks of identical structure showing the same pointer-time, running at the same rate, is distributed throughout a reference frame, some measuring device attached to each such point can determine the time of occurrence of any event at that point P. Since v_0 is a constant, both S and S′ are inertial relative to each other but if they are accelerated relative to a third frame, then they are not inertial with respect to the third one. Thus the 'times' of an event are equal in all inertial frames and hence $dt = dt'$ holds. The classical Galilean principle of relativity states that all the laws of classical dynamics are invariant with respect to Galilean transformations and if, the Newton's second law of

motion $\bar{F} = \frac{d\bar{P}}{dt}$ holds in an inertial frame, then it will hold in

all inertial frames. Here $\bar{P}$ is the momentum of a moving body and $\bar{F}$ the external force acting on it. Further, in classical dynamics, the force of inertia between two inter-acting bodies depends only on the spatial distance between the bodies, but not on the time. This means that interactions between bodies take place instantaneously and hence Newton's Law of Gravitation is a static law. It has to be modified to a dynamic form as Lorentz did in the case of electro-dynamics.

Roamer's remarkable studies in 1675 in the eclipses of Jupiter and Saturn made it clear that light takes time to travel, to be propagated from one point in space to another. This fact has been accepted by pre-relativistic physics, long before the relativistic ideas were presented, in the form of retarded time/advanced time. From this principle, the length contraction and time dilation can be proved. These are the basics of the pre-relativistic period. The main contribution of the 19th century is the Maxwell-Lorentz equations of electro-dynamics. According to the theory, the motion of electron differs from the classical mass-particle. By the experiments in electro-magnetism, it is apparently concluded that the electro-magnetic signals/waves propagate in all directions with the same velocity c in empty space irrespective of the motion of the source. This assertion is in disagreement with the classical Galilean principle of relativity and the time relation $dt' = dt$. In other words, the electro-dynamical equations are not co-variant with respect to the Galilean transformation. Maxwell, Lorentz and their contemporaries assumed that there is one privileged frame, the ether frame, in which the above experimental truth holds.

According to the classical Galilean principle of relativity, the addition rule of velocity is $\frac{dx}{dt}=\frac{dx'}{dt'}+v_0$. By letting $\frac{dx}{dt}=c$ we have $\frac{dx'}{dt'}=c-v_0$. Based on this equation it is physically possible to determine the velocity of the earth in its motion through the ether under correct conditions. In 1887, the Michelson-Morley experiment was conducted to ascertain the velocity of ether-wind against the motion of the earth through the ether [1]. The experiment had the severe defect that it was conducted on the surface of the earth, by ignoring entrainment of ether [2-4]. The experiment could not conclude anything in favour or against the existence of ether. However, the experiment led many scientists to suspect the addition rule of velocity and the Galilean transformation.

The apparent null result of the 1887 Michelson-Morley Experiment led Einstein to postulate the constancy of speed of light' as an axiom in his paper on special relativity. The postulate on constancy of speed relative to two real observers in relative motion was severely criticized by later writers. Scientists of European Centre for Nuclear Research (CERL) experimentally found that neutrino particles travel faster than light. The scientists at CERL and the Grand Sasso Laboratory in Italy scrutinised their results for nearly six months, before making this announcement [Website: http://arxiv.org/abs/1109.4897]. Even before the paper of Einstein, H. A. Lorentz and H. Poincare had discussed the concepts and theories, inherent in the 1905 paper of Einstein [5]. Lorentz' Ether Theory came to include all of Einstein's basic findings and is equivalent to the special relativity. Einstein negated the existence of ether in his paper; but he returned to it after his Leiden Conference of 1920 [3,6]. There, he said "according to the general theory of relativity, space without ether is unthinkable" [3]. This return by Einstein to the ether has been well documented by Kostro but M.W. Evans has refuted Einstenian GTR [3,7]. In 1926 Dayton Miller, using what was thought to be the most sensitive interferometer yet built, won a prize from the American Association for the Advancement of Science (AAAS) for finding an ether-drift of 11 km per second. In 2005 Prof. Eugene I Shtyrkov of Kazan Physical-Technical Institute, Russia, in a paper describes that an ether drift of 29.45 km, which is very close to the true average annual velocity of 29.765 km/sec, has been discovered in the process of tracking of a geo-stationary satellite [4]. It can be inferred that entrainment of ether resulted in the failure of Michelson-Morley Experiment and similar experiments conducted on the surface of the earth.

Lorentz developed his concepts and theories now discussed in books on special relativity, from his study of electromagnetism from 1889 to 2004 [5,8]. Poincare spoke from 1899, of what he called 'the principle of relativity'. He said that we cannot determine absolute rest or uniform motion by conducting experiments on the surface of earth. Poincare realized with prophetic precision that Newton's theory has to be drastically modified [5,9]. In June 1905, Poincare wrote two papers entitled 'On the Dynamics of Electron' which contains essentially most of the contents of the 1905 paper of Einstein. Lorentz, Poincare, Minkowski, Eddington etc. based their discussions, without negating the existence of ether.

About a Thought Experiment of STR/SRT

Let O be a real observer situated at the origin of a stationary system S using O (x, y, z, ct); O′ is his hypothetical position when he suspects that he is in motion relative to the stationary system S. For example, O can be the earth-observer with the assumption that earth is not moving and O′ is the same observer when the earth is supposed to be moving in its orbit. The same observer designates him O in the stationary frame S and O′ in the moving frame S′. Thus, the same observer uses O′ (x', y', z', ct') to account for his motion, if any. On the other hand, if possible, assume that O′ is also the origin of a real, independent moving co-ordinate system, such that the velocity of O′ relative to O is v_0; this is the assumption in SRT.

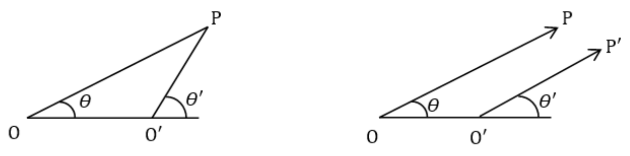

Figure 1 **Figure 2**

Let a ray of light be emitted along OP making an angle θ with the direction of relative motion containing O and O′, when O′ coincided with O. Also let time be measured from the instant of coincidence. The equations of the ray, when it is at P are given by $t=\frac{\text{OP}}{c}\neq\frac{\text{O'P}}{c}=t'$ and $\theta\neq\theta'$ according to figure 1 in which O′ is hypothetical. According to the second figure 2, O and O′ are two real distinct observers who observe a ray of light making a constant inclination to the direction of relative motion, the ray being emitted when O and O′ coincided. This means $\theta\neq\theta'$ or $\sin\theta=\sin\theta'$. This implies $\frac{y}{\text{OP}}=\frac{y'}{\text{OP}'}$; but y = y′ so that OP = OP′. Therefore $ct=ct'$ or $t=t'$. (But $t\neq t'$ when O′ is hypothetical). Hence, Galilean time invariance holds according to the relativistic thought experiment. Now we have the following inferences

(i) A single real observer O emitting a ray of light along OP will estimate (see figure 1) O′P as the hypothetical position of OP, when he is supposed to be moving and will have $\theta\neq\theta'$ and $t=t'$.
(ii) In the relativistic thought experiment two real observers O and O′ are observing a ray of light at a constant inclination with OO′, emitted when O and O′ coincided will have $\theta\neq\theta'$ and $t=t'$.

In our discussion, we retain the first version and figure 1 in which O′ is the apparent position when O is supposedly moving since the possibility of two independent observers emitting a ray at a constant inclination with OO′ cannot be depicted by figure 1. Therefore, of the two positions O and O′, only one is real and the other is the estimated position in a mutually exclusive situation so as to account for the motion of the single real observer. Hence the relativistic assertion that O and O′ are equally valid real observers in all discussions involving LT, is not an experimental truth, but a choice of claim only. In the rest of our discussion, we shall develop all deductions according to the realistic concepts of Lorentz and Poincare contained in the above discussion. Since $t\neq t'$ the two observers (one real and the other hypothetical) in relative motion will apparently have different duration of time. Lorentz calls them 'local time' (*orzeit*). On the other hand, we see the following description of the thought experiment in special relativity. Suppose a ray of light is emitted at the instant of time $t=t'=0$ when O and O′ coincided during the motion of O′ relative to O; then the expression $r^2=c^2t^2$ is transformed into $r'^2=c'^2t'^2$. This argument is illogical; transformation between two systems must be relations between coordinates of a point-event. But here an infinite set is assumed to be transformed into another such set of points. If a ray of light is emitted at some inclination with the common x-axis of the two systems, then the ray will correspond to two straight lines in the two frames, and the transformation must be related to two straight lines and not two spheres/two cones.

Lorentz' Concept of Time and LT

Lorentz developed the Maxwellian electromagnetic theory, applicable to an electron in motion, in the 1890s [8,10]. It is widely recognized within the physics community that the Lorentzian theory of electrodynamics (ether-based underlying preferred frame) is indeed in accord with all that has been observed. Lorentz theory is based on the concept of retarded/advanced time whereas SRT is based on two postulates plus the 'retarded time' concept, at a later stage when motion of electrons in an electromagnetic field, is considered [9,11]. This shows that the relativistic theory and the postulates of SRT are superfluous and, depending on a single concept, Lorentz' theory is superior.

We have earlier noticed that Newtonian dynamics is based on the assumption of instantaneous propagation of interaction and Roamer's studies showed that the velocity of light is finite. Later it was found to be = 2.998x10^8 mps. The potential due to a charge Q at a distant point P (x, y, z) from it can be taken as $\phi = \frac{Q}{r}$ in suitable units. In classical physics, it is considered that the influence of the source charge Q at the field point P is transmitted instantaneously. However, from experiments, instantaneous interaction is impossible; the maximum possible velocity of interaction is, at the speed c of light/graviton/neutrino [12,13].

The solution of Poisson equation $\nabla^2\varnothing = -4\pi\rho$ is $\varnothing = \iiint(\rho/r)dV$ whereas that of $\nabla^2\varnothing - c^{-2}\frac{\partial^2\phi}{\partial t^2} = -4\pi\rho$ is given by $\varnothing = \iiint([\rho]/r)dV$ where [ρ] is evaluated at the retarded time $t-\frac{r}{c}$ and r is the distance between the source and the field point. Lorentz observed that, if any change takes place in one of the interacting charges, it will influence the other charges, only after a lapse of time $\frac{r}{c}$. If P (x, y, z) is a fixed point of S-frame, then $d\left(t-\frac{r}{c}\right) = dt$ [6,9,10]. Hence the local time dt of the S-frame and the retarded time interval are equal. But if P (x, y, z) is a variable point of S then the retarded time interval and the local time interval are not equal. Hence the local time intervals of two frames, in apparent relative motion, also will not be equal. Hence two observers in relative motion, cannot have a common local time. Hence, Lorentz introduced two local times- t,t'

As discussed earlier, let an observer be situated at O of S-frame and a particle of mass m be situated at the moving origin O′ of the S′-frame. Let (x, y, z, ct) be coordinates of an event at P according to S-frame and $(x', y', z', c't')$ the coordinates of the event, relative to the hypothetical observer at the origin O′ of the moving mass.

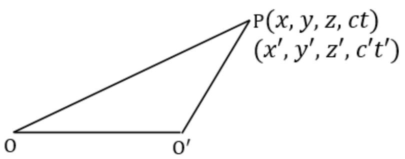

Figure 3

It is further assumed that $t = 0 = t'$ when the origins O′ and O coincided during the motion of the mass particle m. The coordinates (x, y, z, ct) will be true for an observer situated in the immediate vicinity of P but these will be corrected to $\left[x,y,z,c\left(t-\frac{r}{c}\right)\right]$ for an observer situated at O. Hence if (x, y, z, ct) are the coordinates of an event at P then $(x, y, z, ct-r)$ will be the coordinates of the same event relative to O. This shows that observers, who are spatially separated, even if in the same frame of reference, do not observe a given event simultaneously.

After duration of time t, according to the real observer at O and t' according to the hypothetical observer placed at the moving mass at O′, the distances of the mass m in motion will be determined as follows. The projected distance of m or O′ is $v_0 t$, the retarded distance is $v_0 t_r$ and the current/apparent distance of m and the hypothetical

observer O′ at m is $v_0 t'$. Lorentz assumed that the retarded time t_r is given by [9,11]

$$\boldsymbol{t_r} = \boldsymbol{t} - \frac{1}{\boldsymbol{c}}\left|\boldsymbol{r} - \boldsymbol{v}_0\boldsymbol{t_r}\right| \tag{3.1}$$

and then derived the formula

$$\varnothing = \frac{Q}{\sqrt{\left[(x-v_0t)^2/(1-e^2)\right]+y^2+z^2}} \tag{3.2}$$

for the potential at P (x, y, z) due to the moving charge, where $e = \frac{v_0}{c}$. Let $x' = \gamma(x - v_0t), y' = y, z' = z$

$\gamma = 1/\sqrt{1-e^2}$. By changing (x,t) into (x',t') and changing v_0 to $-v_0$ we further have

$$x = \gamma(x' + v_0t')$$

Here is the beginning of LT in electro-magnetism [9]

In this context, we shall modify (3.1) by the equation

$$t_r = t - \frac{1}{c}\left(\left|\boldsymbol{r} - \boldsymbol{v}_0t_r\right|\right) \propto t' - \frac{r'}{c}$$

i.e. the retarded time in the S′-frame is proportional to the estimate of t_r in the S-frame.

$$\therefore t_r = t - \frac{1}{c}\left|\boldsymbol{r} - \boldsymbol{v}_0t_r\right| = \lambda\left|t' - \frac{r'}{c}\right| \tag{3.3}$$

where λ may depend on v_0 and $\lambda \to 1$ as $v_0 \to 0$.

Proposition I

The concept of retarded time represented by (3.3) correctly leads to the full equation set of the Lorentz transformation, and the concept of proper time, whereas the relativistic assumption does not. Let $R = \left|\boldsymbol{r} - \boldsymbol{v}_0t_r\right|$, $r_p = \left|\boldsymbol{r} - \boldsymbol{v}_0t\right|$ and

$r' = |\boldsymbol{r}'| = \sqrt{x'^2 + y'^2 + z'^2}$ and $\boldsymbol{r} = x\boldsymbol{i} + y\boldsymbol{j} + z\boldsymbol{k}$, $v_0 = v_0 i$

From (3.3) we have

$$\left(ct_r - ct\right)^2 = r^2 + v_0^2 t_r^2 - 2\left(\boldsymbol{v}_0 \cdot \boldsymbol{r}\right) t_r$$

$$\therefore t_r^2 - \frac{2\left(t - \boldsymbol{v}_0 \cdot \boldsymbol{r}/c^2\right) t_r}{1-e^2} + \frac{t^2 - r^2/c^2}{1-e^2} = 0 \text{ where } e = v_0/c$$

$$\therefore t_r = \frac{\left(t - \boldsymbol{v}_0 \cdot \boldsymbol{r}/c^2\right)}{1-e^2} - \sqrt{\frac{\left(t - \boldsymbol{v}_0 \cdot \boldsymbol{r}/c^2\right)^2}{\left(1-e^2\right)^2} - \frac{\left(t^2 - r^2/c^2\right)}{1-e^2}} \quad (3.4)$$

omitting plus sign since we discard 'advanced time' in favour of retarded time. Comparing RHS of (3.3) with (3.4), we have

$$t' = \frac{t - \left(\boldsymbol{v}_0 \cdot \boldsymbol{r}/c^2\right)}{\sqrt{1-e^2}} \quad (3.5)$$

$$\gamma = \lambda = \frac{1}{\sqrt{1-e^2}} \text{ and } \frac{r'}{c} = \sqrt{t'^2 - \left(t^2 - r^2/c^2\right)}$$

Here out of several possible values of λ, we chose the one that satisfies symmetry of inverse transformation. The latter gives

$$r'^2 - c^2 t'^2 = r^2 - c^2 t^2 \quad (3.6)$$

In (3.5) interchanging t' and t amounts to changing $\bar{v}_0$ to $-\bar{v}_0$ and $\bar{r}$ to $\bar{r}'$, so that

$$t = \frac{t' + \frac{\bar{v}_0 , \bar{r}'}{c^2}}{\sqrt{1-e^2}}$$

From this last equation and equation (3.5) we get

$$x = \frac{x' + v_0 t'}{\sqrt{1-e^2}}, t = \frac{t' + \frac{v_0 x'}{c^2}}{\sqrt{1-e^2}}$$

$$x' = \frac{x - v_0 t}{\sqrt{1-e^2}}, t' = \frac{t - \frac{v_0 x}{c^2}}{\sqrt{1-e^2}}$$

Also y = y′ and z = z′ since from figure 4, *P* has the same y/z co-ordinates relative to the origins O'_{ret}, O'_{cur}, and O'_{proj}. Thus, we got the full equation set of LT.

Doppler Shift and Aberration Formulae

Now

$$r' = \sqrt{x'^2 + y'^2 + z'^2} = \sqrt{\frac{\left(x - v_0 t\right)^2}{1-e^2} + y^2 + z^2} \quad (3.7)$$

$$= \frac{1}{\sqrt{1-e^2}} \sqrt{|\bar{r} - \bar{v}_0 t|^2 - e^2\left(y^2 + z^2\right)}$$

$$= \frac{1}{\sqrt{1-e^2}} \sqrt{|\bar{r} - \bar{v}_0 t|^2 - e^2 r^2 \sin^2\theta}$$

But $\boldsymbol{v}_0 \cdot \mathbf{R} = \boldsymbol{v}_0 \cdot \left(\boldsymbol{r} - \boldsymbol{v}_0 t_r\right) = \boldsymbol{v}_0 \cdot \boldsymbol{r} - v_0^2 t_r$ and $\mathrm{R} = ct - ct_r$,

$$\therefore \mathrm{R} - \left(\boldsymbol{v}_0 \cdot \mathbf{R}\right)/c = ct - ct_r - \boldsymbol{v}_0 \cdot \boldsymbol{r}/c + v_0^2 t_r/c$$

$$= ct - \left(\boldsymbol{v}_0 \cdot \boldsymbol{r}/c\right) - ct_r\left(1-e^2\right)$$

$$\frac{\mathrm{R} - \left(\boldsymbol{v}_0 \cdot \mathbf{R}/c\right)}{\sqrt{1-\mathrm{e}^2}} = ct' - ct_r\sqrt{1-e^2} = r' \text{ by} \quad (3.3)$$

$$\text{i.e. } r' = \frac{\mathrm{R} - \left(\boldsymbol{v}_0 \cdot \mathbf{R}/c\right)}{\sqrt{1-\mathrm{e}^2}} = \frac{1}{\sqrt{1-e^2}} \mathrm{R}\left(1 - e\cos\theta_r\right) \quad (3.8)$$

where $\theta_r = \left(\boldsymbol{v}_0, \mathbf{R}\right)$. Also, $\mathrm{R} = \left|\boldsymbol{r} - \boldsymbol{v}_0 t_r\right| = \left|\boldsymbol{r} - \boldsymbol{v}_0\left(t - \mathrm{R}/c\right)\right|$

$$\therefore \mathrm{R}^2 = r^2 + v_0^2\left(t - R/c\right)^2 - 2\left(\boldsymbol{v}_0 \cdot \boldsymbol{r}\right)\left(t - R/c\right)$$

$$= r^2 + v_0^2\left(t^2 - \frac{2t\mathrm{R}}{c} + \frac{R^2}{c^2}\right) - 2\left(\boldsymbol{v}_0 \cdot \boldsymbol{r}\right)t + 2\left(\boldsymbol{v}_0 \cdot \boldsymbol{r}\right)\frac{R}{c}$$

$$\text{i.e. } R^2 - v_0^2 R^2/c^2 + 2v_0^2 tR/c - 2\left(\boldsymbol{v}_0 \cdot \boldsymbol{r}/c\right)R = r^2 + v_0^2 t^2 - 2\left(\boldsymbol{v}_0 \cdot \boldsymbol{r}\right)t$$

$$i.e.\left(1-e^2\right)R^2 - 2v_0\frac{\mathrm{R}}{c}\left(x - v_0 t\right) = \left(x - v_0 t\right)^2 + y^2 + z^2$$

$$\therefore \sqrt{1-e^2}\, R = \frac{e\left(x - v_0 t\right)}{\sqrt{1-e^2}} \pm \sqrt{e^2\frac{\left(x - v_0 t\right)^2}{\left(1-e^2\right)} + \left(x - v_0 t\right)^2 + y^2 + z^2}$$

$$\therefore R = \frac{1}{\sqrt{1-e^2}}\left[\frac{e\left(x - v_0 t\right)}{\sqrt{1-e^2}} + \sqrt{\frac{\left(x - v_0 t\right)^2}{\left(1-e^2\right)} + y^2 + z^2}\right]$$

omitting minus sign, since R is positive. By using (3.7), this can be re-written as

$$\mathrm{R} = \frac{r'\left(1 + e\cos\theta'\right)}{\sqrt{1-e^2}} \text{ where } \theta' = \left(\boldsymbol{v}_{0,} \boldsymbol{r}'\right) \quad (3.9)$$

Multiplying (3.8) and (3.9) we get

$$\left(1 - e\cos\theta_r\right)\left(1 + e\cos\theta'\right) = 1 - e^2 \quad (3.10)$$

Equations (3.8), (3.9), (3.10) give the formulae for Doppler shift and aberration, in the general form.

A Check to Confirm LT

From (3.3) and (3.9), we have

$$t_r = t - \frac{r'}{c}\frac{\left(1 + e\cos\theta'\right)}{\sqrt{1-e^2}} = \frac{t' - r'/c}{\sqrt{1-e^2}}$$

$$t\sqrt{1-e^2} - \left(r'/c\right)e\cos\theta' = t'$$

$$\therefore t\sqrt{1-e^2} = t' + \left(v_0 r'/c^2\right)\cos\theta'$$

$$\therefore t = \frac{\left(t' + v_0 r'\cos\theta'/c^2\right)}{\sqrt{1-e^2}} \quad (3.11)$$

(3.5) and (3.11) give

$$\sqrt{1-e^2}\, x \equiv x' + v_0 t', \quad \sqrt{1-e^2}\, x' \equiv x - v_0 t$$

These give

$x^2 - c^2t^2 = x'^2 - c^2t'^2$ But $r^2 - c^2t^2 = r'^2 - c^2t'^2$ by (3.6).

Hence $y^2 + z^2 = y'^2 + z'^2$. This must hold when $z = z' = 0$. Thus we get $y = y'$ and hence $z = z'$. Thus, the postulate of retarded time, correctly leads to the Lorentz transformation and the formulae for aberration and Doppler shift. From the above analysis we have the invertible sets of equations.

(i) $$\mathrm{R} = r'\frac{(1+e\cos\theta')}{\sqrt{1-e^2}} = \frac{(r'+ex')}{\sqrt{1-e^2}}$$

$$x_{\mathrm{R}} = \frac{(x'+er')}{\sqrt{1-e^2}}, \ \tan\theta_r = \sqrt{1-e^2}\left(\frac{\tan\theta'}{1+e\sec\theta'}\right)$$

$$r' = \mathrm{R}(1-e\cos\theta_r)/\sqrt{1-e^2} = \frac{(R-ex_r)}{\sqrt{1-e^2}}$$

$$x' = \frac{(x_r - e\mathrm{R})}{\sqrt{1-e^2}}, \ \tan\theta' = \frac{\sqrt{1-e^2}\tan\theta_r}{(1-e\sec\theta_r)}$$

(ii) $$r_p = r'\sqrt{1-e^2\cos^2\theta'}, \ \tan\theta = \frac{\tan\theta'}{\sqrt{1-e^2}}$$

$$r' = r_p\frac{\sqrt{1-e^2\sin^2\theta}}{\sqrt{1-e^2}}, \ \tan\theta' = \sqrt{1-e^2}\tan\theta$$

(iii) $$r_p = \mathrm{R}\sqrt{1+e^2-2e\cos\theta_r}, \ \tan\theta = \frac{\tan\theta_r}{(1-e\sec\theta_r)}$$

$$\mathrm{R} = r_p\frac{\sqrt{1-e^2\sin^2\theta}+e\cos\theta}{1-e^2}, \ \tan\theta_r = \frac{(1-e^2)\tan\theta}{1+e\sqrt{\sec^2\theta - e^2\tan^2\theta}}$$

These formulae give the space coordinates relative to

(i) Projected position of the origin O′

(ii) Retarded position of the origin O′ and

(iii) The current/apparent position of the origin O′.

It is clear that $\theta_r < \theta' < \theta$; hence O'_{ret} precedes O'_{cur}, which precedes O'_{proj}. Hence if v_0 is the speed of the origin O′, then its projected position v_0t is ahead of current/apparent position v_0t and the current/apparent position v_0t' is ahead of the retarded position v_0t_r.

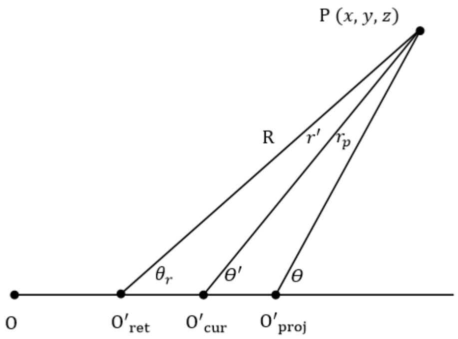

Figure 4

Since $t^2 - r^2/c^2 \equiv t'^2 - r'^2/c^2 = \tau^2$, say, we consider τ as the proper time. More generally

$d\tau = \sqrt{dt^2 - ds^2/c^2} = \sqrt{dt'^2 - ds'^2/c^2}$ is defined as proper time interval associated with the two frames of reference. Minkowski defined $\tau = \int_{t_0}^{t}\sqrt{dt^2 - \left(\frac{dx^2+dy^2+dz^2}{c^2}\right)}$ as proper time [6]. Accordingly, the proper velocity vector is defined by $dr/d\tau$ and acceleration is defined as $d^2r/d\tau^2$. The proper Lagrangian and time-rates can be defined, replacing 'time' by 'proper time'.

Relativistic Concept of Time & LT

We shall begin the discussion by examining the contradictory opinions of a former relativist H. Dingle and two adherents of STR.

(i) Prof. Herbert Dingle in his 1972 book 'Science at the Cross-roads' wrote: 'the question is left by the experimenters to the mathematical specialists, who either ignore it or shroud it in various obscurities' [14]. He continues that 'obviously something must be logically and mathematically wrong with either the LT or the principle of relativity or both, and that to be logically and mathematically consistent, one would have to jettison either LT or the principle of relativity or both'.

(ii) In his book, 'Cranks, Quarks & the Cosmos' (published by Oxford University Press, 1997) the author Jeremy Bernstein points out that "I would insist that any proposal for a radically new theory in physics or science, should contain a clear explanation of why the precedent science worked. Einstein did this as the first page of the paper, 'on the electro-dynamics of moving bodies' illustrates perfectly".

(iii) In the paper 'Special Relativity Invalid?" by Vesselin Petkov, [http://groupkos.com/rnboyd/special-relativity-invalid1.html] the author attempts to convince the readers with a slim hope that, "what I will write below might be helpful to some of the people who have reservations about relativity". The author continues "As a rule those who criticize it, do not see the whole picture – they pick up only individual relativistic results. I know this even from personal experience – for twenty years, all letters/papers claiming to have 'finished' relativity, sent to two departments (where I have worked) have been regularly forwarded to me".

Since the above opinions are conflicting with each other, it is very essential to examine the time-concept of Special Relativity in details.

The first paper on relativity, *viz*. "On the Electrodynamics of Moving Bodies", published in 1905, contains a definition of simultaneity [6,15]. In §1 of the paper, the author considers the following thought experiment. Let there be two observers at A and B in a stationary system having clocks of identical time reading. Let a ray of light start from A at 'A time' t_A towards B, reflected at B at 'B time' t_B back to A, arriving at A time t'_A. The two clocks synchronize if

$$t_B - t_A = t'_A - t_B$$

The author further assumed that $2AB/(t'_A - t_A) = c$, as the velocity of light in empty space. From the above two equations, it is clear that $t_A = t_B - AB/c$, and $t_B = t'_A - AB/c$ i.e. the author has used the concept of retarded/advanced time to explain 'simultaneity'. After this, the paper continues, "It is essential to have time defined by means of stationary clocks in the stationary system, and the time now defined being appropriate to the stationary system, we call it the time of "stationary system". In §1 of the paper, the author has used the idea of retarded time with *c* in the denominator. But in §2 of the paper, dealing with the "relativity of lengths and time", we come across the following postulates of relativity, viz.

Postulate 1: The laws by which the states of physical systems undergo change are not affected, whether these changes of state are referred to one or the other of the two systems of coordinates in uniform translatory motion.

Postulate 2: Any ray of light moves in the stationary system of coordinates with the determined velocity c, whether the ray be emitted by a stationary or by a moving body. Hence,

$\text{velocity} = \frac{\text{light path}}{\text{time interval}}$, where time interval is to be taken in the sense of definition in §1.

Again, the author considers the clock ray emission and reflection experiment with a difference and then assumes

$$t_B - t_A = r_{AB}/(c-v) \text{ and } t'_A - t_B = r_{AB}/(c+v)$$

where A and B are the ends of a moving rod of speed v and r_{AB} is its length in the stationary system. The above equations give

$$t_A = t_B - r_{AB}/(c-v) \text{ and } t_B = t'_A - r_{AB}/(c+v)$$

in which the RHS of each differ from the RHS of t_A and t_B noted earlier.

Again, we see that the author uses the idea of retarded time with different velocities (c-v) and (c+v) in the denominator in contradiction to postulate 2, whereas the correct denominator is c, from Lorentzian time-concept. It is clear that the author wrongly uses the concept of retarded time. In §3, dealing with the derivation of Lorentz transformation the author again uses the concept of retarded time restricted to x-axis, where we read the equation

$$\frac{1}{2}\left\{\tau(0,0,0,t)+\tau\left[0,0,0,t+\frac{x'}{c-v}+\frac{x'}{c+v}\right]\right\}=\tau\left[x',0,0,t+\frac{x'}{c-v}\right]$$

in which τ is the time in the S′ frame (in the place of t' of the Lorentzian theory) Here also, we see that $c + v$ is a velocity greater than the velocity of light. This is contrary to the content of the second postulate of relativity and contrary to the 'principle of retarded time/advanced time'.

From the above analysis, it is clear that there is no new concept of time, in the SRT, which contains a faulty use of retarded/advanced time. In this context we prove the following.

Proposition 2
The postulates of special relativity do not prove the truth of the linear Lorentz transformation; it leads to a non-linear transformation with $y \neq y'$ and $z \neq z'$.

To derive the transformation between S frame and S′ frame referred in the previous discussion, let us take z=0= z′ for convenience. Let z= $x + iy$ be the complex variable. The second postulate leads us to the assumption that the circle $|z| = ct$ is transformed into the circle $|z'| = ct'$. The most general bilinear transformation is

$z'/ct' = e^{i\phi_0}(z - v_0 t)/(ct - \bar{v}_0 z/c)$ where $\bar{v}_0$ is the complex conjugate of v_0. Hence, we may take

$$L'z' = z - v_0 t,\ L'ct' = ct - \bar{v}_0 z/c \quad (4.1)$$

where L′ is constant depending on v_0. Inverting these equations we have

$$z\left(1-v_0^2 c^2\right)/L' = z' + v_0 t' \quad (4.2)$$

$$ct\left(1-v_0^2/c^2\right)/L' = ct' + \bar{v}_0 z'/c$$

which can be written in the form

$$Lz = z' + v_0 t' \quad (4.3)$$

$$Lct = ct' + \bar{v}_0 z'/c \quad (4.4)$$

where $LL' = 1 - v_0^2/c^2$. Thus, L and L′ are complex conjugates with magnitude $\sqrt{1-v_0^2/c^2}$.

Hence, we may take $L = c^{i\varnothing_0}\sqrt{1-v_0^2/c^2}$ and $L' = c^{-i\varnothing_0}\sqrt{1-v_0^2/c^2}$.

Clearly when $\bar{v}_0 = v_0$ is real

$$\tan\varnothing_0 = \frac{y'v_0/c}{ct'+v_0 x'/c} = \frac{yv_0/c}{ct - v_0 x/c} \quad (4.5)$$

This transformation is non-linear and in general $y \neq y'$. Hence the relativistic claim 'since there is no motion of S′-frame along y and z axis, it follows that $y = y'$, $z = z'$ ' is logically false. The fault lies in the assumption "a sphere of light $r^2 = c^2 t^2$ centred at O is transformed into the sphere of light $r'^2 = c^2 t'^2$ centred at O′".

It is meaningful to assume that a ray of light emitted by O′ has equations $x'/\ell' = y'/m' = z'/n'$ in S′ frame and $(x - v_0 t)/\ell = y/m = z/n$ in S frame. Similarly, a ray of light emitted by O has equations $x/L = y/M = z/N$ in S frame and $(x' + v_0 t')/L' = y'/M' = z'/N'$. Now by applying the Lorentzian concepts of retarded time, local time, apparent/present time as detailed in the proof of proposition 1, we get the values of ℓ, m, n, etc., thus obtaining the whole set of Lorentz transformations.

The above analysis shows that postulates of SRT, does not lead to Lorentz transformation, whereas the concept of retarded time correctly leads to Lorentz transformation. From a study of classical dynamics, we see that there are three different principles of relativity [16]. They are

(i) The laws of motion recognize no distinction between rest and uniform motion, known as Galilean relativity (Newton, Fitzgerald and early Poincare).

(ii) The laws of motion do recognize such a distinction but the real (not conceptual) effects of motion such as to make it impossible for anyone to determine his own motion without reference to outside bodies-known as the realistic version of relativity. Stated differently, it is impossible by performing experiments on the surface of the earth to detect uniform motion relative to ether (Lorentz and later Poincare).

(iii) All inertial frames are equivalent, and the speed of light is an absolute constant, known as special theory of relativity. Stated differently, there exists no natural standard of rest that will make it meaningful, so that any single body has motion rather than any other (Einstein) [6,15,16].

According to the Galilean principle of relativity, the velocity of motion of a body has different values for two observers in relative motion. This shows that the velocity of light cannot be constant in two real frames in relative motion. In the Lorentz-Poincare realistic version of the theory of relativity there is one real reference frame S and a second frame S′, which is a mutually exclusive substitute or replacement for the former, when the former has a hypothetical motion relative to some other frame. Thus, one of two frames S, S′ can be avoided once we have obtained the proper time interval

$$c^2 d\tau^2 = c^2 ct^2 - dx^2 - dx^2 - dy^2 - dz^2 = c^2 dt'^2 - dx'^2 - dy'^2 - dz'^2$$

i.e. one need only to retain either (i) O(x, y, z, ct) and O(x, y, z, $c\tau$) or (ii) O′(x', y', z', ct') and O′(x', y', z', $c\tau$) but not both. Simultaneous use of both sets is irrelevant.

Thus, there were only two methods available for the explanation of the null result of Michelson-Morley Experiment in 1905

(i) By using the contraction hypothesis of Fitzgerald Larmor, Lorentz and others explained by means of Galilean principles and a preferred frame of reference.

(ii) By using STR postulate of 'constancy of speed of light, independent of source emitting the light'.

The second method is based on the negation of ether, and this method is likely to fall flat, when the existence of ether is established finally. Even then the Lorentz-Poincare version will survive. We have already shown that the constancy of speed of light does not imply LT or any other linear transformation, but to a non-linear transformation. Still special relativists claim that they have proved LT from the postulates, without admitting the fact that they are using contraction hypothesis in disguise.

Review of the Literature on Special Relativity

We shall review two of the books dealing with special relativity. Whitrow treats with such problems as universal time, individual time, mathematical time, and from these arrive at relativistic time [16,17]. The author presents seven axioms, and after most detailed and subtle discussions, arrives at Einstein's results: $t = \frac{1}{2}(t_1 + t_2)$ and $r = \frac{1}{2}c(t_2 - t_1)$. This is actually the weak form of the concept of retarded/advanced time, since the above equations can be re-written as $t = t_2 - \frac{r}{c}$ and $t_1 = t - \frac{r}{c}$. From earlier discussions, we know that these weaker forms, not containing the relative velocity $\overline{v}_0$, can explain only the clock-synchronization and simultaneity, but not the truth of the LT. Knowing this fact, Einstein attempted to use the retarded time/advanced time by means of the expressions like $t - \frac{r}{c - v_0}, t + \frac{r}{c + v_0}$. This is wrong and contrary to the constancy postulate of STR as well as the postulate of retarded/advanced time. Thus, the book does not contain anything different from other books on STR.

Now we shall examine Bergson who made a serious study of STR, pin pointing the weak logical basis [16,18]. In the book, the author explains the unexpected result of Michelson-Morley Experiment, by using the Lorentz-Fitzgerald theory of contraction of length. of a moving body in the direction of its motion, in relation to ether and as compared with its length at rest in the ether. He supposes that the rest length ℓ_0 in ether will have the apparent length $\ell_0\sqrt{1 - \frac{v_0^2}{c^2}}$ when moving with velocity v_0 relative to ether and as judged from the ether. He further declares that the time of the system dilates in the ratio $1 : \sqrt{1 - \frac{v_0^2}{c^2}}$. This is equivalent to the statement $d\tau = \sqrt{1 - \frac{v_0^2}{c^2}}\, dt$ or $dt \approx \sqrt{1 + \frac{v_0'^2}{c^2}}\, d\tau$. From these bases, he deduces the LT and various other results found in STR. Since these concepts have no discordance with the postulate of retarded/advanced time, the conclusions obtained by Bergson are valid. He gives a very elaborate critical survey of some of the consequences drawn by STR. He raises the question as to, what extent the Einstein 'times' are real times. He proclaims that we cannot speak about a reality reigning without introducing consciousness. He declares: when we want to know if we have to do with a real time or a fictitious time, we only have to ask if the object presented could or could not be observed, become conscious. He elaborately discusses the relation between observations of events and processes by observers as well in the moving system S′ as in the system S at rest, and comes to the conclusion that, by comparison of the 'times' of observers in different systems, there is only one 'time' that is 'real', the time that is experienced by the real observer. The other times are fictions. Bergson expresses it thus: 'we thus always come back to the same point. There is one real time and the others are fictitious. What is a real time if not a time experienced, or which could be? What is an unreal, auxiliary, fictitious time, if not one which could not be effectively experienced by anything or anybody? 'The two observers in S and S′ live exactly the same length of time and the two systems thus have the same real time. This is more closely discussed in connection with the train problem, which is the basis of Einstein's definition of simultaneity. He compares the observations of the observer on the embankment in the midpoint M between the points A and B where the hypothetical lightning strokes occur and the observer in the midpoint M′ on the moving train between the points A′ and B′, where the lightning strokes occur with regard to the train. He comes to the result that one has to do with only one time. What is simultaneous with regard to the embankment is also simultaneous with regard to the train. Bergson comes here in flagrant opposition to Einstein's results. He explains it by pointing out that, we must suppose that the observations are really made by an observer – 'un-physician' – in the system. Only what this observer measures are real. But the observer can only be in one place. He is in M, and consequently cannot also be in M′. Bergson concludes that nothing has been really observed in M′ because that would presuppose another observer in M′, which is not the situation.

In a later discussion of the observations made by the observers in the two systems, one of which is resting on the earth, the other moving, he declares that the observer in the former system alone

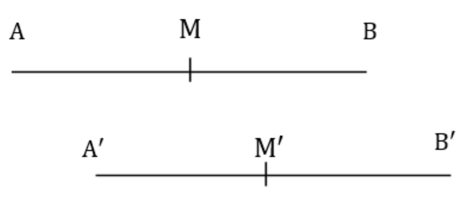

Figure 5

is real and the other observer a phantom. The exclusion of the privileged system of reference is the essence of STR. From the Lorentzian concept of time, we know that among the two local times t, t', only one is real, and the other is the correction or estimate to accommodate the relative motion of the single observer and the finite signal velocity of gravitational/electromagnetic signals. It is clear that Bergson's arguments are in agreement with the realistic version of relativity, but not in agreement with STR.

Bergson, in his criticism of Einstein's interpretation of the 'simultaneity' met with the rejoinder from Charles Nordmann who argued that if Einstein's theory was really based on the demonstration of simultaneity, his theory would collapse and remarked that the real foundation of STR is to be found in Einstein's 1905 paper 'Elektrodynamik' [16]. Failing to defend Bergson's criticisms, he virtually admitted the truth that the clock-synchronization, simultaneity etc. have no roles in the foundation of the theory of relativity. On the other hand, the realistic version of relativity based on the postulate of retarded/advanced time and the concept of proper time, has the correct logical foundations. The 'proper-time' can take the role of the classical time.

Conclusions

In STR there are two simultaneously real coordinate systems S and S′ in constant relative motion. In the realistic version of the principle of relativity, one real observer uses either of two coordinate systems (i) (x, y, z, ct) and $(x, y, z, c\tau)$ or (ii) (x', y', z', ct') and $(x', y', z', c\tau)$ but not both. In this approach, there is no need for simultaneous use of primed and the un-primed system, as they are relevant in mutually exclusive occasions. However, in Einstein's SRT, there are two simultaneously real coordinate systems (x, y, z, ct), (x', y', z', ct') and another coordinate system with proper time τ. Thus, there are two real space coordinate systems with three-time coordinates. The relativistic postulates do not lead to LT or any linear transformation, but to a non-linear transformation. The double use of t and t' as real times, led A. Einstein and H. Dingle to have contradictory views on time dilation. Einstein proved time dilation in 1905 by using LT and Dingle proved that moving clocks run fast, by using the inverse LT. The postulate of retarded time/advance time is superior to the 'postulate of constancy of speed of light'. The proper time $d\tau$ can be used as a substitute for the classical absolute time of Newtonian dynamics in infinitesimal region of a world-point. If Prof. Eugene I Shtyrkov's experimental evidence of ether-drift velocity of 29.45 km/sec is finally accepted as a universal truth, then the postulates of STR remain invalid but the concepts of retarded/advanced time will prevail [4]. Since the LT is not related to two separate real observers in relative motion, it will be valid according to the realistic interpretations of Lorentz, Fitzgerald, Larmor, Poincare, Minkowski et al. Since electron theory of H.A. Lorentz is in agreement with STR, the latter cannot produce results which are not already contained in the pre-relativistic Lorentz' Theory [15]. Further M.W. Evans completely refutes Einstien's GTR [7].

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