The MSRT, The Interpretation of the Lorentz transformation Equations, Faster than Light and The Cherenkov Radiation

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Abstract
In this paper, I'll give an interpretation for the Lorentz transformation equations depending on my Modified Special Relativity Theory MSRT [23]. My interpretation illustrates, the Lorentz factor is equivalent to the refractive index in optics. Also, according to my MSRT, it is possible measuring speeds of particles or electromagnetic waves to be greater than light speed in vacuum, but in this case, there is no violation for the Lorentz transformation or causality, and thus it is keeping on the laws of physics to be the same in all inertial frames of reference. From that I refute the proposed claim by Cohen and Glashow in their paper [33] refuting the OPERA experiment, depending on the analogy of Cherenkov radiation, where this proposed claim is based on a wrong concept to the superluminal speeds, and this wrong concept is based on a flaw that is existed in the special relativity theory of Einstein.

The Theory

In my Modified Special relativity (MSRT)[23], I found, when the train is moving with constant speed V, its vacuum energy is increased compared to the vacuum energy of the earth surface. And when the light beam is passing through the vacuum of the train, it is similar to passing through a medium of refractive index greater than 1. In this case I proposed in my MSRT, the time required for the light beam to pass the length of the moving train for the earth observer is independent of the direction of the velocity of the train compared to the direction of transmitting the light beam (Robertson [33]). Thus, if the light beam is sent inside the moving train from the end to the front –at the direction of the velocity- in this case for the earth observer according to his clock the required time separation for the light beam to pass the length of the moving train is Δt where

$$\Delta t = \frac{L}{\sqrt{c^2 - v^2}} \tag{1}$$

Also if the light beam is sent from the front of the moving train to the end at the opposite direction of the direction of the velocity of the train, then the measured time separation for the light beam to pass the length of the moving train for the earth observer according to his earth clock is also given according to eq. (1). From eq. (1), the measured speed of light inside the moving train for the stationary earth observer according to his earth clock is c' where

$$c' = \sqrt{c^2 - v^2} \tag{2}$$

Where c' does not depend on the direction of transmitting the light beam compared to the direction of the velocity of the train. It depends only on the absolute value of the velocity of the train. This proposed solution - the independency of the measured speed of light inside the moving frame with the direction of the velocity of the moving frame – explains the negative result of the Michelson-Morley experiment [34].

In my MSRT I proposed also, the length of moving train L is the same if the train was stationary for the stationary earth observer, where I refute the length contraction in the special relativity of Einstein that the length of the moving frame will be contracted in the direction of the velocity for the earth observer. From that we get, when the train is stationary, and a light beam is sent along its length, we get

$$L = c\Delta t_0 \tag{3}$$

Where c is the light speed in vacuum, and Δt_0 is the time required for the light beam to pass the length of the stationary train for the stationary earth observer according to his clock. Now, if we substitute the value of L in eq. (3) to eq. (1), we get

$$\Delta t = \frac{c\Delta t_0}{\sqrt{c^2 - v^2}} = \frac{\Delta t_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{4}$$

Equation (4) indicates us that, for the stationary earth observer according to his earth clock, the time separation required for the light beam to pass the length of the moving train is greater than if the train is stationary by the factor of $\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$. Thus, eq.(4) indicates us also if the stationary earth observer registered by his clock a time separation for an event occurred inside the stationary train to be $\Delta t = \Delta t_0$, then if this train is moving with constant speed v, then the earth observer will register by his clock a time separation Δt for the same event to be occurred inside the moving train, where $\Delta t = \frac{\Delta t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$. Thus events are occurring inside the moving train in a slower rate than if the train was stationary for the stationary earth observer according to eq. (4).

Now suppose both the earth observer and the rider of the moving train are agreed to perform this thought experiment. The rider of the moving train sent a ray of light along his moving train length, and both the earth observer and the rider will measure the time required for the light beam to pass the length of the moving train, each one uses his clock. According to the MSRT [23], both the earth observer and the rider of the moving train will be agreed at the moment of transmitting the ray of light from the end of the moving train and then will be agreed at the moment of reaching the ray of light at the front of the moving train. We have seen previously relative to the earth observer the direction of transmitting the light beam is independent to the direction of the velocity of the moving train. Also, both of them will be agreed at the measured length of the moving train to be L. Thus for the earth observer the time separation of this event according to his clock is given according to eq. (4). Where, the earth observer will measure a time separation for light beam to pass the length of the moving train to be greater than if the train is stationary. Now for the rider of the moving train, since the motion of his clock inside the moving train is considered as events occurring inside the train, thus its motion will be slower when the train is moving than when it is at rest. And, since both the rider of the moving train and the stationary earth observer are agreed at the measured length of the moving train to be L, and also are agreed at starting of transmitting the light beam from the end of the train and then agreed at the moment of reaching the light beam to the front of the moving train. Thus, by these conditions, when the stationary earth observer computed the time Δt for the light beam to pass the length of the moving train L, at this moment the rider of the moving train will measure the time separation $\Delta t'$ according to his clock, where

$$\Delta t' = \sqrt{1 - \frac{v^2}{c^2}}\Delta t$$

And from eq. (4) we get

$$\Delta t' = \Delta t_0 \tag{5}$$

Thus, eq. (5) indicates us, the rider of the moving train will measure a time separation for the light beam to pass his moving train length to be the same time separation if the train at rest. From that the measured speed of light inside the moving train for the rider according to his clock is equal to the speed of light in vacuum, same as the stationary earth observer when he measures the speed of light on the earth surface; he will get it equals to the speed of light in vacuum. From that we get the main principle of the modified special relativity which is illustrating the consistency of the speed of light in the special relativity theory of Einstein;

(i) The speed of light is locally constant and equals to the speed of light in vacuum c for any inertial frame of reference.

From eq. (5), we can write eq. (4) as

$$\Delta t = \frac{\Delta t'}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{6}$$

Equation (6) represents the equation of time dilation in Einstein's SR.

The Lorentz transformation equations and the MSRT

How can we understand the Lorentz transformation equations according to the MSRT in order to keep the laws of physics are the same for all inertial frames of reference.

We have seen in the previous section, when the light beam passing through the moving train, then

i. The time separation for passing the light beam the length of the moving train is independent of the direction of transmitting the light beam compared to the direction of the velocity of the moving train (Robertson [33]).
ii. Both the stationary earth observer and the rider of the moving train are agreed at the length of the moving train to be L, same as if the train is stationary.
iii. Both the stationary earth observer and the rider of the moving train are agreed at the moment of transmitting the light beam from the end of the moving train

and also will be agreed at reaching the light beam at the front of the train, and vice versa if the light beam sent from the front to the end of the moving train.

From these postulates we derived eq. (6) which represents the equation of Einstein of the time dilation in special relativity.

Now suppose we have a tube full of water of length L. we have seen in optics, when a light beam is incident inside this tube, then the time separation for the light beam to pass the length of the tube is greater than if the tube is empty according to our lab clock. If the tube is empty and we measured the time separation Δt_0 by our clock for the light beam to pass the length of the tube, then when the tube is full of water we shall measure the time separation Δt where

$$\Delta t = n\Delta t_0 \tag{7}$$

Where n is the refractive index of water. According to postulate (i) and eq. (4), we get an equivalence between when the light beam is passing through the moving train or passing through a medium of refractive index n. Suppose we have a meter stick of length Δx_0 in free space. If we put this meter stick inside the tube of water, we shall see the length of this meter stick is longer than in the free space, by the factor of n, the refractive index of water, where

$$\Delta x = n\Delta x_0 \tag{8}$$

Where Δx is length of the meter stick inside the water for an observer in free space.
Thus from our equivalence principle, and from eq. (8), if we determined two points of length separation Δx_0 inside the train when it is stationary, then, when the train is moving with constant velocity v, the measured length of Δx_0 for the stationary earth observer will be Δx given according to eq. (8) as

$$\Delta x = \frac{\Delta x_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{9}$$

For the rider of the moving train the measured space time lengths inside his moving train will be equal as it is stationary, where from eq. (5) we have $\Delta t' = \Delta t_0$, and thus we get also

$$\Delta x' = \Delta x_0 \tag{10}$$

Thus from eq. (10), we can write eq. (9) as

$$\Delta x = \frac{\Delta x'}{\sqrt{1-\frac{v^2}{c^2}}} \tag{11}$$

Equations (6) and (11) represent the measured space-time inside the moving train comparing to the measured space-time locally on the earth surface for the earth observer. For a free particle moving on the earth surface, the particle is defined by the space-time length of Δx and Δt for the earth observer. But when this particle is incident inside the moving train, it will be defined locally by the space-time length of $\Delta x'$ and $\Delta t'$ of the stationary rider of the moving train. In this case Δx is related to $\Delta x'$ by eq. (11), and Δt is related to $\Delta t'$ by eq. (6). Now suppose a light beam is incident inside the moving train. According to the two points separated by a distance $\Delta x'$ inside the moving train, for rider of the moving train, the measured speed of light will be given as

$$c' = \frac{\Delta x'}{\Delta t'} = \frac{\Delta x_0}{\Delta t_0} = c \tag{12}$$

$\Delta t'$ is the time separation for rider according to his clock. Thus the rider will measure the light speed inside his moving train to be the light speed in vacuum.

For the stationary earth observer, within the same two points inside the moving train separated by a distance $\Delta x'$ for the rider of the moving train, the measured speed of light will be given as

$$c'' = \frac{\Delta x}{\Delta t} = \frac{\sqrt{1-\frac{v^2}{c^2}}\Delta x'}{\sqrt{1-\frac{v^2}{c^2}}\Delta t'} = \frac{\Delta x_0}{\Delta t_0} = c \tag{13}$$

Equation (13) indicates us; the measured speed of light inside the moving train for the earth observer will be equal to the speed of light in vacuum also. At the first time the reader will think eq. (13) is contradicted with eq. (2), but there is no contradiction. Since eq. (2) is predicting the light speed by measuring the time separation for the light beam to pass the length of the moving train according to the clock of the stationary earth observer. And since the length of the train is determined locally by the space on the earth surface and this length of the train is not changed if the train is moving or stationary. This is equivalent to the tube of length L full of water. Suppose the length of the tube is 1 meter. Now if we have two meter sticks of length 1 meter. Now if we put one meter stick inside, along the water tube length, and we put the other outside along the length of the tube. What will we see? We shall see the meter stick inside the water will be appeared longer than the meter stick outside. And since the meter stick outside will give us the length of the tube locally. The meter stick inside will give us the length of the tube according to the space inside the tube. Thus, by using eqs. (7)&(8) to determine the speed of light according to the space-time inside the water tube, we get

$$c'' = \frac{\Delta x}{\Delta t} = \frac{n\Delta x_0}{n\Delta t_0} = c \tag{14}$$

Equation (14) represents the measured speed of light inside the water tube according to the space-time coordinates inside the tube which is related to our coordinates according to eqs. (7)&(8). Where, according to eq. (14), the measured speed of light is equal to the speed of light in vacuum. Equation (14) represents another interpretation why the light beam is taking longer time separation when it is passing though a medium of refractive index greater than 1. According to the meter stick located outside along the length of the tube, the light speed will be decreased, and because of that it takes longer time separation according to our clocks. But according to the meter stick inside the medium, the light speed is the same light speed in vacuum, because the distance is longer inside the medium of refractive index greater than 1 according to eq. (8), so it takes longer time separation. Einstein in his special relativity adopted the second interpretation, the consistency of the speed of light and then the difference of measuring the time and space by the two observers who are moving in a relative velocity. But, what we have discovered in our MSRT that the two interpretations are equivalent to each others. Figure (1) illustrates what we discussed geometrically.

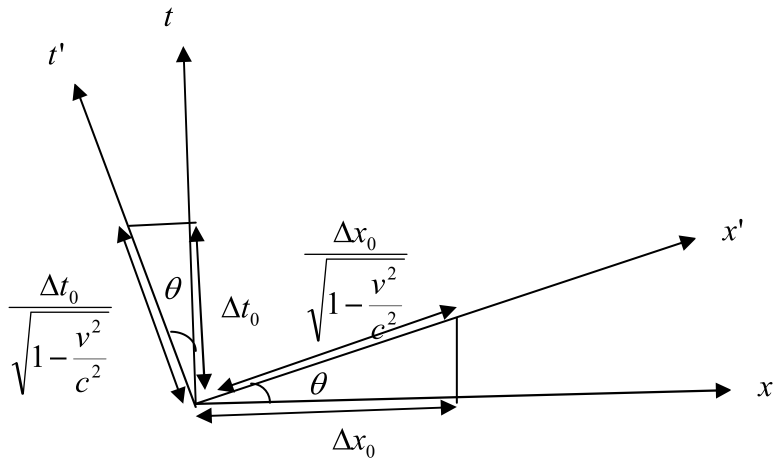

Fig. (1): illustrates the geometrical interpretation of the two coordinates systems S(x,t), and S'(x',t'). S(x,t) is stationary, and S'(x',t') is moving with constant velocity v.

We have got from the figure the coordinate system of the stationary earth observer is define by S(x,t), and Δx_0 represents the length of the meter stick outside the moving train along its length, and $\frac{\Delta x_0}{\sqrt{1-\frac{v^2}{c^2}}}$ is the measured length of the same meter stick but inside the moving train along its length for the earth observer. Δt_0 is measured time separation of the light beam to pass the length Δx_0 inside the train when the train is stationary according to the stationary earth observer via his clock, and $\frac{\Delta t_0}{\sqrt{1-\frac{v^2}{c^2}}}$ is the measured time separation of the same event inside the train according to the stationary earth observer via his clock when the train is moving with constant velocity v. According to eqs. (5)&(10) we have seen $\Delta t' = \Delta t_0$ and $\Delta x' = \Delta x_0$. The two coordinates S(x,t) and S'(x',t') are related to each other by the angle θ where $\cos\theta = \sqrt{1-\frac{v^2}{c^2}}$. When v <<c, at low velocities, $\cos\theta \approx 1$, and thus $\theta \approx 0$, that means the two coordinate systems will be coincided. Also, S(x,t) and S(x',t') are agreed to the measured speed of light to be c the speed of light in vacuum according to this transformation.

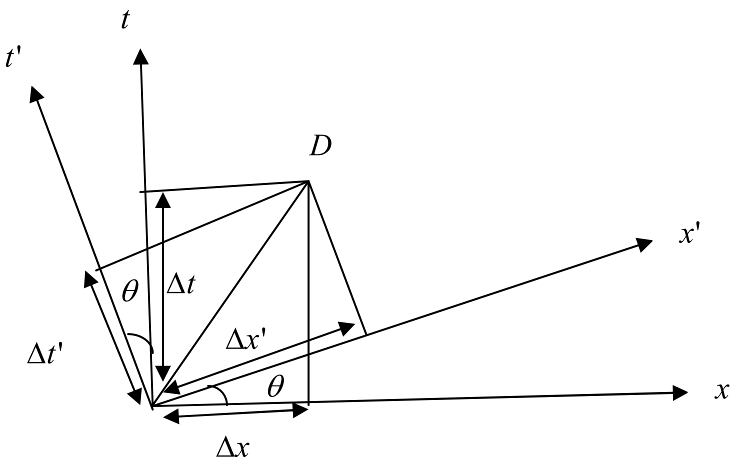

Fig. (2): illustrates the geometrical interpretation of the Lorentz transformation.

We have from the figure, both S(x,t) and S'(x',t') will be agreed at the measured line element D^2, where by considering the consistency of the speed of light for the two frames, and c=1, so, according to that we have

$$\Delta t'^2 - \Delta x'^2 = \Delta t^2 - \Delta x^2$$

And after the mathematical treatment we can reach to the Lorentz transformation equations

$$\Delta x = \frac{\Delta x'}{\sqrt{1-\frac{v^2}{c^2}}} + \frac{v\Delta t'}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$\Delta t = \frac{\Delta t'}{\sqrt{1-\frac{v^2}{c^2}}} + \frac{vx/c^2}{\sqrt{1-\frac{v^2}{c^2}}}$$

But the new modified thing in the Lorentz transformation equations which is predicted by our MSRT is existed in the case of the space axis y and z, where the transformation will be according to our MSRT as

$$\Delta y = \frac{\Delta y'}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$\Delta z = \frac{\Delta z'}{\sqrt{1-\frac{v^2}{c^2}}}$$

According to the Lorentz transformation equations we keep the laws of physics are same for all inertial frames of reference. And we see here according our MSRT we could derive the same equations and then keeping the laws of physics are the same in all inertial frames of reference. Lorentz by his transformation equations proposed that the length of the moving frame will be contracted in direction of the velocity. Where he proposed the length contraction in order to interpret the negative result of the Micheson-Moreley experiment

[34]. In our MSRT we could interpret the negative result by the first postulate of our new theory which is taken from Robertson[33]. Thus, in the case of the length contraction in SR, it is occurring in the direction of the velocity- for example in the x-direction- thus, in the other two directions in space y and z, we get $\Delta y = \Delta y'$ and $\Delta z = \Delta z'$. But that is different in our MSRT as seen previously.

The Length Contraction according to MSRT

To understand the concept of the length contraction according to the MSRT [23], let's assume Sally is driving a train with constant velocity 0.87c between the two pylons A&B, and the distance between the two pylons is 100 m. let's assume also at the moment of reaching the train at pylon B, Sara who was stationary on the earth could stop the train instantaneously by a remote control. In this case we neglect the deceleration because this case is equivalent to some cases in quantum as we shall see in following sections. Thus, in this case we consider the velocity of the train is changed from 0.87c to zero in a zero time separation at the moment of reaching to Pylon B. Thus, by this condition we have

$$v = 0 \text{ at } L = 0$$
$$v = 0.87c \text{ at } 0<L\leq 100 \text{ m}$$
$$v = 0 \text{ at } L = 100 \text{ m}$$

The concept of the length contraction which is adopted by the MSRT [23] is agreed with the concepts, principles and laws of quantum theory (Copenhagen School).

Subsequently, according to MSRT [23], when Sara sees the train reached to pylon B, at this moment Sally will not see the train reached at the second pylon B, it is still in the middle of his trip at 50 m to pylon B, and thus it is still approaching to the second pylon B. Subsequently, according to this interpretation, when Sara sees the moving train at a distance x, at this moment Sally will see her moving train at the distance $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}\Delta x$. This interpretation is agreed with the concept of Heisenberg to the wave function, where the observer has the main formation of the phenomenon. And by this interpretation Sally and Sara creates their own pictures about the location of the moving train. Now, for Sara, the measured velocity of the moving train is given as $v = \frac{\Delta x}{\Delta t} = 0.87c$ which is equal to the equivalent velocity of the kinetic energy owned by the moving train. For Sally (who is the driver of the train) there are two states that the train existed in instantaneously, the first one is the state of motion, and the measured velocity of the train at this state for Sally is given as

$$v' = \frac{\Delta x'}{\Delta t'} = \frac{\sqrt{1-\frac{v^2}{c^2}}\Delta x}{\sqrt{1-\frac{v^2}{c^2}}\Delta t} = v = 0.87c$$

And this measured velocity is equal to the measured velocity equivalent to the kinetic energy owned by the moving train. The other state is the state of stationary, and the predicted velocity of the train for Sally at this state is given as

$$v' = \frac{\Delta L'}{\Delta t'} = \frac{\Delta L}{\sqrt{1-\frac{v^2}{c^2}}\Delta t} = \frac{v}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{0.87c}{\sqrt{1-(0.87)^2}} = 1.74c$$

Those two states of the train are separated by a distance equals to 50m, where Sally will think her train passed this distance in a zero time separation as seen in fig. (3), and then Sally will think the distance of 100m was passed by her train with velocity equals to 1.74c which is greater than the speed of light in vacuum. This measured velocity is not real, as we have seen the train hasn't moved with speed greater than the speed of light in vacuum locally for Sara, but because of the time dilation, and as we have seen in eqs. (4)&(6), events are occurring in the frame of the moving train in a slower rate than on the earth surface, and then the clock of the moving train will compute a time separation of the event less than the earth clock. The difference of time between what is computed by the train clock of Sally at the state of stationary, and what is computed by the earth clock of Sara for the train to pass the distance 100m, we find this difference is negative, and this difference led Sally to think her train passed the distance 100m between the two pylons with speed greater than the speed of light in vacuum. From fig. (3), Sally would confirm that the distance between the interval 50<x'<100m was not passed by her train. Her train was transformed from 50m to 100m in a zero time separation.

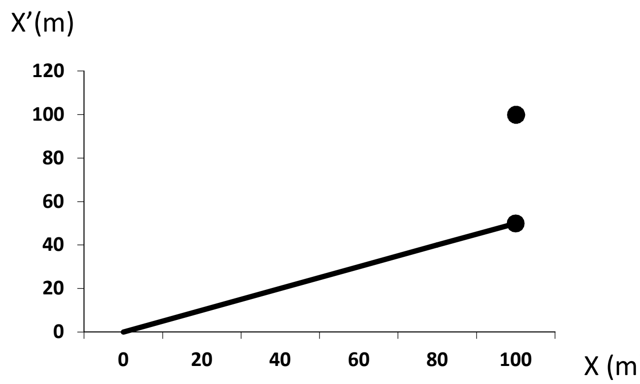

Fig. (3): illustrates the relationship between x and x' .

There is another consequence that produced by adopting this interpretation of the length contraction by MSRT. It is; how does Sally see the motion of Sara's earth clock comparing to her clock during the motion. According to MSRT [23], Sally will see the motion of the earth clock of Sara is moving similar to her moving train clock, and by adopting this principle let's study the following thought experiment.

Suppose Sally during the motion of her train is looking at the stationary earth clock of Sara by applying this condition

$$v = 0 \text{ at } \Delta t_{Sara} = 0$$

$$v = 0.87c \text{ at } 0 < \Delta t_{Sara} \leq 4 \text{ years.}$$

$$v = 0 \text{ at } \Delta t_{Sara} > 4 \text{ years}$$

Where Δt_{Sara} is the reading of Sara from her clock. We can draw Δt_{Sara} versus Δt_{Sally} as in figure (4), where Δt_{Sally} is the reading of Sally from the clock of Sara. From fig. (4), we find two straight lines; the first one is for $0<\Delta t_{Sara}\leq 4 years$ and its slope is equal to 0.5. The second line is for $\Delta t_{Sara}>4$ years, and its slope is equal to 1. We find from the figure, the years between $2<\Delta t_{Sara}\leq 4 years$ would not be determined by Sally, where her train was stopped at $\Delta t_{Sara}>4$ years, and thus she would find that Sara was living the years at $\Delta t_{Sara}>4$ years, while her last reading was equal to 2 years. That means the events were lived by Sara between $2<\Delta t_{Sara}\leq 4 years$ were not be received by Sally during her motion.

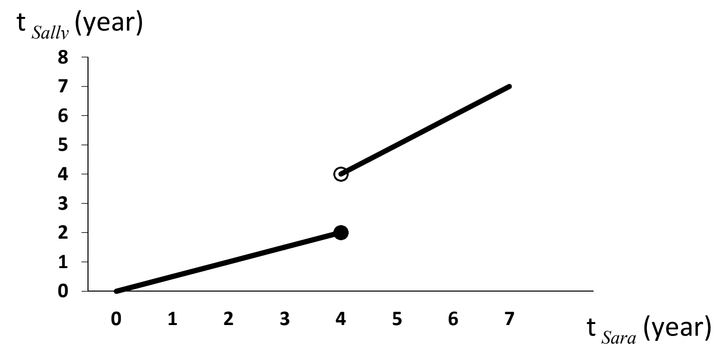

Fig. (4): t (Sara) versus t (Sally).

From the figure we get, the observer is the main participant in formulation of the phenomenon, where each one creates his own clock picture during the motion although they used the same clock. That is in contrast with the objective existence of the phenomenon.

The Vacuum Energy and The Equivalence Principle of MSRT

Suppose Sally is living on a planet of mass M. and Sara is stationary very far from the planet in space. Now according to the general relativity theory of Einstein, if Sara is looking at the clock of Sally, she will find the clock of Sally is moving in a slower rate than her clock according to the equation

$$\Delta t'=\sqrt{1-\frac{2GM}{c^2 R}}\Delta t$$

Where, $\Delta t'$ is the time separation measured by Sara from the clock of Sally, Δt is the time separation measured by the clock of Sara for Sara, G is the gravitational constant, and R is the radius of the planet. Thus from the equation above $\frac{2GM}{R}$ is equivalent to v^2, that means it is equivalent that Sally is riding a train moving with constant speed v. Thus according to the previous discussion, if Sally is looking at the clock of Sara, then Sally will see the clock of Sara is moving at the same rate that her clock is moving, and what is Sally seeing now about Sara is done for Sara in the past. Now suppose both Sally and Sara are in the Lab. They cooled an empty tube to -237^oC. In this case the vacuum energy of the tube is less than the vacuum energy of the lab. That is equivalent; both of Sara and Sally are moving with velocity v relative to the tube, and then the events in the lab are occurring in a slower rate than if the same event are occurring inside the tube. What is the consequence of that according to what we discussed previously is what we shall discuss in the next section.

Quantum Tunneling and Quantum Entanglement

Quantum tunneling experiments have shown that 1) the tunneling process is non-local, 2) the signal velocity is faster than light, i.e. superluminal, 3) the tunneling signal is not observable, since photonic tunneling is described by virtual photons, and 4) according to the experimental results, the signal velocity is infinite inside the barriers, implying that tunneling instantaneously acts at a distance. We think these properties are not compatible with the claims of many textbooks on Special Relativity [1-9, 16]. The results produced by our modified special relativity theory [23] are in agreement with the results produced by quantum tunneling experiments as noted above, and thus it explains theoretically what occurs in quantum tunneling. It proves the events inside the tunneling barrier should occur at a faster rate than the usual situation in the laboratory. It provides a new concept of time contraction which is not existed in special relativity theory. The concept of time contraction in our theory is proven by many experiments where some enzymes operate kinetically, much faster than predicted by the classical $\Delta G^{\ddagger}$. In "through the barrier" models, a proton or an electron can tunnel through activation barriers [11, 12]. Quantum tunneling for protons has been observed in tryptamine oxidation by aromatic amine dehydrogenase [13]. Also British scientists have found that enzymes cheat time and space by quantum tunneling - a much faster way of traveling than the classical way - but whether or not perplexing quantum theories can be applied to the biological world is still hotly debated. Until now, no one knew just how the enzymes speed up the reactions, which in some cases are up to a staggering million times faster [14]. Seed Magazine published a fascinating article about a group of researchers who discovered a bit more about how enzymes use quantum tunneling to speed up chemical reactions [15].

In order to understand what is causing by quantum tunneling, let's study this thought experiment depending on the concepts and principles what we proposed previously.

Suppose Sara and Sally in the lab, they made a tube of glass of length L. the vacuum energy inside the tube is negative compared to the vacuum energy of the lab. That means the vacuum energy of the tube is less than the vacuum energy of the lab. Now suppose the amount of the negativity comparing to the vacuum energy of the lab is equivalent that the observer in the lab moving with speed equals to v. In quantum, the negativity of the vacuum energy inside the tube is depending on the difference of temperature, pressure and the effective density.

Now, suppose Sara entered inside the tube, and Sally remained in the lab. After that, Sally sent a ray of light through the length of the tube. Now, since the vacuum energy is less inside the tube than outside in lab, which means the events inside the tube will occur in a faster rate for Sara than Sally. That means the rate of occurring the information which define the location and time for the light beam inside the tube is faster for Sara inside the tube than Sally in lab. Thus, if Sara determined the light is passed the distance Δx inside the tube, at this moment Sally will determine the location of the light beam at $\Delta x'$ inside the tube, where $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}\Delta x$, also for Sara the distance Δx was passed by the light beam in a time separation Δt according to her clock.

Also, for Sally the distance $\Delta x'$ was passed by the light beam inside the tube in a time separation $\Delta t'$ according to her lab clock. From that the measured speed of the light beam for Sara is $v = \frac{\Delta x}{\Delta t} = c$, which is the speed of light in vacuum, and for Sally is $v' = \frac{\Delta x'}{\Delta t'} = \frac{\sqrt{1-\frac{v^2}{c^2}}\Delta x}{\sqrt{1-\frac{v^2}{c^2}}\Delta t} = c$.

Thus, both Sally and Sara will agree at the measured speed of the light beam inside the tube. But, when Sara sees the light beam reached to the end of the tube and passed the distance L the length of the tube, at this moment for Sally, the light beam have not reached to the end of the tube, it is still at $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}L$. After that the light will exit the tube, and will be seen for Sally at the distance $\Delta x'$ >L. In this case, for Sally, the light beam is transformed from the point $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}L$ to the point $\Delta x'$ >L in a zero time separation. Thus Sally will see the light beam is existed in two places or states at the same time. Now, when Sally sees the light beam at $\Delta x'$ >L and tries to compute the speed that light beam passed the distance L of the tube, she will find the light beam passed this distance by a speed $c' = \frac{L}{\Delta t'} = \frac{L}{\sqrt{1-\frac{v^2}{c^2}}\Delta t} = \frac{c}{\sqrt{1-\frac{v^2}{c^2}}}$, where for Sara inside the tube, the light beam passed the length of the tube with speed $c = \frac{L}{\Delta t}$ which equals to the speed of light in vacuum. Thus for Sally in the lab, she will think the light beam passed the length of the tube in a speed greater than the light speed in vacuum, but this measured speed is not real. *In this case, although, Sally measured the light beam passing the length of tube faster-than-light speed in vacuum, But according to that there is no violation for Lorentz transformation or causality*. Where, according to Sara inside the tube, the light beam passing all the length of the tube with speed equals to the speed of light in vacuum.

Suppose now, Sally sent instead of a light beam, she sent a particle of kinetic energy E inside the tube, which is equivalent the particle to move with speed v(E), as seen in figure (5).

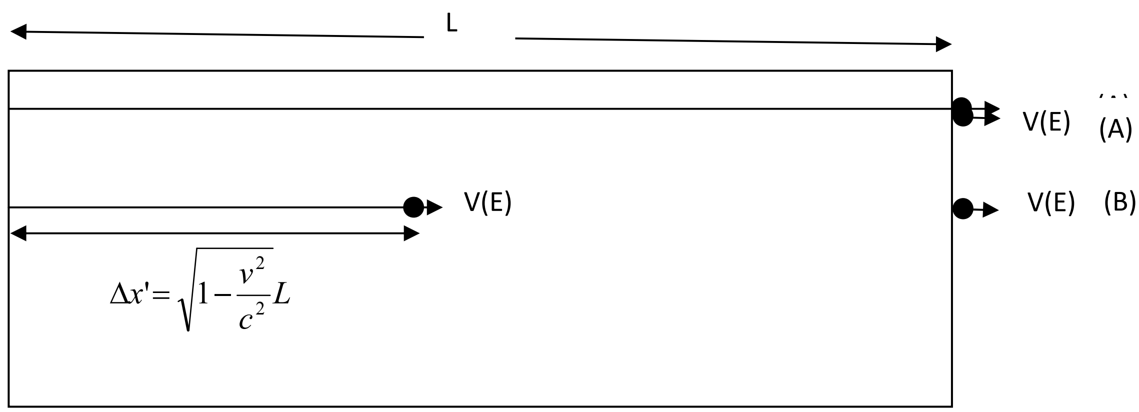

Fig. (5): (A) Sara who is living inside the tube will see the particle is passing all the length of the tube, and exit it with kinetic energy v(E). (B) Sally who is in the lab will see the particle existed in two places at the same time, one place is at $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}L$*, and the other place is at* $\Delta x' > L$*. Sally will think the particle is transformed from* $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}L$ *to* $\Delta x' > L$ *at a zero time separation. When Sally measures the kinetic energy of the particle at* $\Delta x' > L$*, she will find it is equal to the kinetic energy at the moment of sending the particle inside the tube.*

According to fig. (5), when Sara who is living inside the tube seeing the particle reached at the end of the tube and passed the distance L of the tube in a time separation Δt according to her clock, at this moment for Sally who is in the lab, will see the particle location at $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}L$, and this distance was passed at a time separation $\Delta t' = \sqrt{1-\frac{v^2}{c^2}}\Delta t$ according to Sally's lab clock. At this moment, the predicted velocity of the particle for Sara is $v = \frac{L}{\Delta t} = v_p(E)$ and for Sally is $v' = \frac{\Delta x'}{\Delta t'} = \frac{\sqrt{1-\frac{v^2}{c^2}}L}{\sqrt{1-\frac{v^2}{c^2}}\Delta t} = v_p(E)$. At this moment the particle will exit the tube and will be seen for Sally out of the tube. Sally will think the particle is transformed from the point $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}L$ to the point $\Delta x' >$L at a zero time separation, and then the particle will be seen at two places or states at the same time for Sally. Sally will think the particle passed the length of the tube with velocity equals to $v' = \frac{L}{\sqrt{1-\frac{v^2}{c^2}}\Delta t} = \frac{v_p(E)}{\sqrt{1-\frac{v^2}{c^2}}}$, and if $v_p(E)$ is very close to c, in this case it is possible the predicted speed will be greater than the speed of light in vacuum for Sally depending on the negativity of the tube, same as what happened in the OPERA experiment, where the OPERA team measured the speed of the neutrino greater than the speed of light in vacuum. The OPERA team found the error in their experiment was in the measured time separation of the trip of neutrino. And as we have seen this error is not instrumental, it is produced -as we have seen previously- similar as; Sally's clock in lab measured a time separation for the event to be less than Sara's clock inside the tube. The neutrino locally not exceeding the light speed in vacuum.

The result produced by the ICARUS team is agreed with what predicted previously. The actual measured speed of the neutrino is measured according to a clock inside the tube. We have seen Sara inside the tube will measure the speed of the neutrino to be equal or less than the speed of light in vacuum, and this speed is equal to the equivalent speed of the kinetic energy owned by the neutrino.

If the OPERA team instead of sending neutrinos, they sent a ray of light in their equipment, we have predicted previously that both the light ray and the neutrinos will reach at the end of the tube at the same time separation (if the actual speed of the neutrinos is equal to c), and thus according to the OPERA team clock, they will predict that the ray of light is moving with speed greater than the light speed in vacuum, same as the neutrinos. Both the neutrinos and the light ray will reach the detector at the same time approximately). This interpretation illustrates why the neutrinos of the SN 1987A arrived at the Earth- hours not years- before the detected photons from the supernova.

And in order to understand what a quantum entanglement is, let's study this thought experiment. Suppose Sally sent a beam of electrons inside the tube. The negativity of the vacuum energy of the tube is equivalent that Sally who is staying in the lab, moving with speed equals to v. Also, suppose Sally applied a magnetic field on the tube at a distance equals to $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}L$ as seen in fig. (5). Now for Sara inside the tube, she will see the electron passes through the magnetic field before Sally, and then it will be affected on the magnetic field. Now when the electron reaches to the end of the tube and passes the distance L the length of the tube. At this moment Sally will see the electron is at $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}L$, and at this moment she will see the electron is affected on the magnetic field. Also at this moment, Sally will see other picture for the electron at $\Delta x'$>L, and this picture of the electron at $\Delta x'$>L was affected by magnetic field as seen by Sara. And since the two pictures of the electron are seen by Sally in the lab at the same time. Sally will think at the moment of applying the magnetic field on the electron at $\Delta x' = \sqrt{1-\frac{v^2}{c^2}}L$, this effect was transformed instantaneously to the electron at $\Delta x'$>L.

The Cherenkov radiation

While electrodynamics holds that the speed of light in a vacuum is a universal constant (c), the speed at which light propagates in a material may be significantly less than c. For example, the speed of the propagation of light in water is only 0.75c. Matter can be accelerated beyond this speed (although still to less than c) during nuclear reactions and in particle accelerators. Cherenkov radiation results when a charged particle, most commonly an electron, travels through a dielectric (electrically polarizable) medium with a speed greater than that at which light would otherwise propagate in the same medium. Cohen and Glashow [32] pointed out that these analogs to Cherenkov radiation must appear at superluminal speeds. And from that they refuted the OPERA collaboration claim that muon neutrinos with mean energy of 17.5 GeV travel 730 km from CERN to the Gran Sasso at a speed exceeding that of light by about 7.5 km/s or 25 ppm. According to the special relativity theory of Einstein, in order the neutrinos to move with speed equals to the speed of light c in vacuum, it is required the neutrinos to be owned kinetic energy equals to infinity. So, what about if these neutrinos moved with speed greater than the speed of light in vacuum? From that the proposed solution by Cohen and Glashow in their paper is based on a wrong concept to the superluminal speeds, and this wrong concept is based on a flaw existed in the special relativity. So, what is the flaw that is existed in SRT in order not accepted or interpreting superluminal speeds? According to my MSRT I found the concept of the relative velocity in SR is wrong, and instead it is required to consider the vacuum energy of the medium in which the light moving. For example, suppose the tube that is existed in fig. (5) of length L. The negativity of the vacuum energy of the tube compared the vacuum energy of the lab is equivalent that the observer stationary on the lab are moving with speed 0.87c relative to the tube. Now, if a neutrino is sent inside the tube of kinetic energy E_k. As we have seen previously, when the neutrino reached to the end of the tube and passed the distance L for an observer stationary inside the tube, then at this moment, for the observer of the lab, the neutrino is located at the distance $L'=\sqrt{1-\frac{v^2}{c^2}}L=\frac{L}{2}$. Now, if there is a detector at the end of the tube, that means, the neutrino is not passing through the space of the lab, in this case, for the observer on the lab, according to his clock, the neutrino passed the distance of the tube in a less time separation than it is required according to his kinetic energy. Now if the kinetic energy inside the tube of the neutrino is equivalent to move in a velocity $\sqrt{1-\frac{v^2}{c^2}}c < v_{neutrino}$ <c, which is according to our examples, 0.5c< $v_{neutrino}$ <c, in this case when the neutrino is detected by the detector for the observer of the lab, he will think, the neutrino was moving

with speed equals to $v'_{neutrino} = \frac{v_{neutrino}}{\sqrt{1-\frac{v^2}{c^2}}}$, and in the case 0.5c< $v_{neutrino}$ <c, then the measured speed of the neutrino for the lab observer according to his clock is greater than c, the speed of light in vacuum, where, $v'_{neutrino}$ >c. But, when the neutrino is detected by the detector without passing through the space of the lab, Then, neutrino will register an energy spectrum fully corresponding with what it should be for particles traveling at the speed of light and no more as predicted by ICARUS experiment result.The neutrino inside the tube will not exceed the light speed in vacuum locally. But if the lab observer removed the detector, and then the neutrino passing through the space of the lab, in this case the neutrino will radiate an energy equivalent to the Cherenkov radiation. The Cherenkov radiation is emitted when a particle travels in medium with speed v_p such that c/n< v_p <c, where n is the refractive index of the medium.

The Modified General Relativity and the Exact Solution of the Pioneer Anomaly

Is light bending by gravity or refracted? According to special relativity, light speed is constant and equals to light speed in vacuum for all inertial frames of reference. General relativity was formulated according to the concepts and principles of SR. Thus, according to GR, light speed must be constant, and thus to keep the constancy of the speed of light, Einstein proposed in his GR that, for an observer located far away from the gravitation field, this observer will see the light beam will be bended toward the big mass when passing through gravitational field of the big mass. Einstein explained this bending of the light beam through the gravitational field because when the light beam is passing through the gravitational field, then for an observer located far away from the gravitational will see this light beam is moving in a geodesic path, and that means the light beam will passing a longer distance through the gravitational field than if there is no gravitational field, and thus registering longer time separation for the event according to the clock of the observer far away from the gravitational field. Thus, according to that, the geodesic path is referring to the strength of gravitational field depending on the distance from the center of mass. According to our MSRT, we have seen how we keep on the consistency of the speed of light according our derivation to the Lorentz transformation equations and the equivalence of the Lorentz factor to the refractive index in optics. From that, at the same time of keeping the consistency of the speed of light, in our MSRT, we keep the changing the speed of light as existed in the concept of the refractive index in optics. Thus by applying this concept on GR, taking into account the dependency of the strength of the gravitational field on the distance from the center of mass, and thus the dependency of the equivalent refractive index of the gravitation field on the distance from the center of mass. Thus, according to the modified general theory MGRT according to MSRT, I could reach to the exact solution to the Pioneer anomaly [35]. According to MGRT, if a particle or light beam passing through the gravitational field, then the measured speed of the particle or the light beam will be decreased for an observer far away from this gravitation field. Hubble’s law can be interpreted according to this principle [35]. My solution to the Pioneer anomaly is more accurate than the proposed solution of the thermal origin of the Pioneer anomaly [36].

The Wormholes and the Faster-than-light travel

The impossibility of faster-than-light relative speed only applies locally. Wormholes allow superluminal (faster-than-light) travel by ensuring that the speed of light is not exceeded locally at any time. While traveling through a wormhole, subluminal (slower-than-light) speeds are used. According to GR, if two points are connected by a wormhole, the time taken to traverse it would be less than the time it would take a light beam to make the journey if it took a path through the space outside the wormhole. However, a light beam traveling through the wormhole would always beat the traveler. As an analogy, running around to the opposite side of a mountain at maximum speed may take longer than walking through a tunnel crossing it. In GR, the interpretation of faster-than-light is different from our interpretation although we accept that the impossibility of faster-than-light locally. According to our MGRT depending on our MSRT, both the local observer on the mountain and the observer located far away from the mountain will agree at the length of the distance passed, and the particle will move through the same path on the mountain for both observers. The particle will not walking through a tunnel crossing it. According to our MGRT depending on MSRT, the particle will reach the opposite side of the mountain for the local observer before the observer far away seeing it on the opposite side. And if the observer sees the particle on the opposite side of the mountain in a less time separation than the local observer, in this case there must be a distance was not seen by the observer far away that the particle passed it on the mountain. For that observer the particle transformed from point A to point B separated by a distance D on the mountain in a zero time separation.

As we have seen in the case of faster-than-light in MGRT and MSRT there is no violation for the Lorentz transformation or causality, and our interpretation is solving the contradiction between quantum theory and relativity (general and special).

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