A Modified Special Relativity Theory in the Light of Breaking the Speed of Light

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Abstract

In the OPERA experiment the neutrino broke the speed of light. It moved with speed greater than the highest speed in the universe (the speed of light in vacuum) according to the special relativity [32]. This experiment if it is confirmed will contradict the main basis that the special relativity built on which is the constancy of speed of light, and no particle or electromagnetic wave can exceed this speed [37]. In 2000, NEC Research Institute in Princeton claims to have achieved propagation speeds of 310 *c* (*c*= speed of light) by Quantum tunneling [34] . 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 [1-9]. In March 2010 researchers at UC Santa Barbara have provided the first clear demonstration that the theory of quantum mechanics applies to the mechanical motion of an object large enough to be seen by the naked eye. In a related experiment, they placed the mechanical resonator in a quantum superposition, a state in which it simultaneously had zero and one quantum of excitation. This is the energetic equivalent of an object being in two places at the same time [33]. The researchers showed that the resonator again behaved as expected by quantum theory. From this experiment we can conclude that the theory that governs the micro and macro world must be same. According to the previous experiments, all of these phenomena can be explained by quantum laws, while special relativity theory of Einstein incapacitate to comprise the interpretation of these experiments. If the OPERA experiment [32] is confirmed, is that meaning scientists must give up the relativity theory of Einstein? specially, the relativity theory introduced to us interpretations for many confirmed phenomena like the time dilation, the increasing of mass while increasing velocity, and the equivalence of mass and energy. None of the scientists can deny the Einstein's favor by his relativity in developing several branches of physics. I agree with the scientists, if the OPERA experiment is confirmed by other scientists, physics will be in a big puzzle. But this puzzle is easy to be solved if we thinking to modify the relativity theory of Einstein according to the concepts, principles and laws of quantum theory. Or in other words trying to understand the relativity through the sight of quantum theory. And from that, I think the modification in relativity will be more conceptual than mathematical. Modifying the special relativity theory according to the concepts, principles and laws of quantum theory, will not only solve the puzzle regarded to measuring speeds greater than speed of light in vacuum, but will open new doors toward developing new physics, and will change the undescriptive concepts of quantum regarded to the previous experiments to be descriptive and imaginative as we will see in this paper, which is considered the first step toward unifying between quantum and relativity in

concepts, principles and laws. In this work (the modified special relativity theory), we will unify the special relativity theory and quantum theory (Copenhagen school) in concepts, principles and laws. While this new theory is in agreement with the concepts, principles and laws of the quantum theory (Copenhagen school), and it introduces some changes in the concepts, principles and laws of quantum to be descriptive, and imaginative. As previously stated, quantum theory was applied to the micro world, while the macro world was controlled by the laws of classical physics. In my paper I believe that the theory that controls the micro and macro worlds are the same. When Einstein formulated his special relativity theory, he was believing in the objective existence of phenomena, also, in the principles of continuity, determinism, and causality in the nature laws [17,18, 25]. But Quantum theory (Copenhagen school) discovered that the observer participates in determining the formulation of phenomena. That is clear from Heisenberg's definition of the wave function, (1958) “it is a mixture of two things, the first is the reality and the second is our knowledge of this reality [19].” Thus, we get from this definition that the phenomenon does not exist without the observer receiving it. Einstein was hardly refusing this concept for formation of the phenomenon, as Pais said in (1979) “ while I was walking with Einstein, he said, - look at the moon do you believe it is existed because we are looking at it? ” [20] . Furthermore, quantum theory adopts the principles of non-causality, indeterminism, and discontinuity in the nature laws [30]. The mathematical formula for Einstein's relativity depends on Rieman’s space of four dimensions , but in quantum Hilbert’s space with infinite dimensions. Stapp said in (1972) “the Copenhagen school refused understanding the world by the concepts of space-time, where it considers relativity theory is inconsistent for understanding the micro world, and quantum theory forms the basis for understanding this world” [21] . Also in formulating his relativity equations, Einstein depends on the possibility of simultaneously measuring the location of a particle and its momentum. Heisenberg discovered this is impossible to do (Heisenberg uncertainty principle) [23,24] . Oppenheimer said “Einstein in the last days of his life tried to prove the inconsistency of quantum laws but failed. After that he said - I dislike quantum theory, especially Heisenberg's uncertainty principle” [22] .

Theory

1- The Concepts and Principles of The Modified Special Relativity Theory

1.1 If we scrutinized the beginning of Einstein for formulating his special relativity in order to solve the puzzle produced by the Michelson-Morley experiment and to comprise the Lorentz transformation equations according to the sight of his relativity, and then keep the invariance of the Maxwell's equations. He started from the two postulates; 1) the laws of physics are the same in all inertial frames of reference, 2) the constancy of the speed of light in all inertial frames of reference. Then he started with an imaginative experiment; suppose a train moving with constant speed v, and the rider inside this train sent a ray of light inside the train from down to up, the distance from up to down of the train for the rider is $\Delta L'$. Now according to Einstein's derivation, the path that the ray of light will pass inside the moving train for a static observer on the earth surface is ΔL where

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

And since the speed of light is constant for both the train rider and the earth observer according to Einstein's special relativity, then the time required for ray of light to pass the distance ΔL for the earth observer is Δt according to his clock, where

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

Since $\frac{\Delta L'}{c}$ is the time measured for the rider of the moving train via his clock for the light ray to pass the distance $\Delta L'$ inside the train, thus from eq. (2) we get

$$\Delta t = \frac{\Delta t'}{\sqrt{1-\frac{v^2}{c^2}}} \tag{3}$$

Equation (3) represents the famous equation of Einstein of the time dilation, and it indicates that the earth observer will observe the clock of the moving train is moving slower than his earth clock. And as we see previously eq. (3) is reproduced from the light ray takes longer distance inside the moving train for the earth observer than for the train rider. And by the constancy of the speed of light we conclude that eq. (3) represents the time dilation in special relativity. The reciprocity principle of the special relativity of Einstein introduces that, for the rider of the moving train, he will observe that the earth clock motion will move slower than his moving train clock.

Now suppose that both the earth observer and rider of the moving train will make this imaginative experiment; the train will move between the two pylons in order to measure the distance between the two pylons. Suppose the distance between the two pylons for the static earth observer is Δx. Now suppose the train started at rest to move with constant velocity v from pylon A to pylon B. According to Einstein's Special relativity theory, Einstein proposed implicitly that both the earth static observer and the moving train rider will agree at the measured velocity of the moving train. And, since Einstein was believing in the objective existence of the phenomenon as it was existed in the classical physics laws at that time. That led Einstein to propose that both the earth observer and the moving train rider will agree on the location of the moving train when it was at point A, and then at point B. Thus, from that, the rider of the moving train will measure the distance $\Delta x'$ between the two pylon as

$$\Delta x' = v\Delta t' \tag{4}$$

$\Delta t'$ is the time that is measured for the moving train rider according to his clock for the train to pass the distance between the two pylons. And for the static earth observer

$$\Delta x = v\Delta t \tag{5}$$

Thus from eqs. (4) and (5), we have

$$\frac{\Delta x'}{\Delta x} = \frac{\Delta t'}{\Delta t} \tag{6}$$

Thus from eqs. (3) and (6) we get

$$\Delta x' = \sqrt{1 - \frac{v^2}{c^2}}\Delta x \tag{7}$$

Equation (7) represents the famous equation of the length contraction in special relativity. The rider of the moving train will measure the distance between the two pylons is less than its real distance as if the distance is contracted. And from the reciprocity principle and according to eq. (7), the static earth observer will measure the length of the moving train as if it is contracted in the direction of the velocity. Einstein could interpret the Lorentz length contraction according to eq. (7) but in a different concept. According to Einstein, Since the static earth observer will observe the clock motion of the moving train will be slower than his earth clock motion, then the rider of the moving train will observe the distances on the earth surface as it is contracted in the direction of the velocity. And since the rider of the moving train will observe the motion of the earth clock is slower than his clock motion, thus the earth observer will observe the length of the train is contracted in the direction of the velocity. Length contraction was postulated by George Francis FitzGerald (1889) and Hendrik Antoon Lorentz (1892) to explain the negative outcome of the Michelson-Morley experiment and to rescue the hypothesis of the stationary aether (Lorentz–FitzGerald contraction hypothesis). Although both FitzGerald and Lorentz alluded to the fact that electrostatic fields in motion were deformed ("Heaviside-Ellipsoid" after Oliver Heaviside, who derived this deformation from electromagnetic theory in 1888), it was considered an Ad hoc hypothesis, because at this time there was no sufficient reason to assume that intermolecular forces behave the same way as electromagnetic ones. In 1897 Joseph Larmor developed a model in which all forces are considered as of electromagnetic origin, and length contraction appeared to be a direct consequence of this model. Yet it was shown by Henri Poincaré (1905) that electromagnetic forces alone cannot explain the electron's stability, and he had to introduce non-electric binding forces to ensure stability and to give a dynamical explanation for length contraction. But this model was subject to the same problem as the original hypotheses: Length contraction (and the non-electromagnetic forces) were only invented to hide the motion of the preferred reference frame, *i.e.*, the stationary aether. Albert Einstein (1905) was the first who completely removed the ad-hoc character from this hypothesis, by demonstrating that length contraction was no dynamical effect in the aether, but rather a kinematic effect due to the change in the notions of space, time and simultaneity brought about by special relativity. Einstein's view was further elaborated by Hermann Minkowski and others, who demonstrated the geometrical meaning of all relativistic effects in spacetime. So length contraction is not of kinetic, but kinematic origin [35, 36, 37, 38]. Einstein by his special relativity theory succeeded to keep the relativity principle in the laws of physics and explained the negative outcome of the Michelson-Morley experiment and then could keep the invariance of Maxwell's equations.

After we introduced the main ideas, concepts and principles of the special relativity theory and the physical issues that led Einstein to build his theory, now, let's introduce the modified special relativity theory in order to keep special relativity agrees with the concepts, principles and laws of quantum theory (Copenhagen school) and then agrees with latest measurements of the experiments that introduce measuring speeds greater than the light speed in vacuum.

Equation (3) represents the time dilation reproduced by special relativity theory of Einstein which is confirmed by many experiments. It is interested me to think about the speed of light by the other way. As we studied from optics, when the light beam is entered inside a medium of refractive index n, then light speed c' inside this medium as measured by an observer in the lab. will be decreased according to the equation

$$c' = \frac{c}{n} \tag{8}$$

From (8) we get

$$n = \frac{c}{c'} \tag{9}$$

Now from eq. (3) if I proposed $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$ and by multiplying γ by $\frac{c}{c}$ we get

$$\gamma = \frac{c}{\sqrt{c^2 - v^2}} \tag{10}$$

Thus from eqs. (9) and (10) I get

$$c' = \sqrt{c^2 - v^2} \tag{11}$$

Equation (11) represents the measured speed of light inside the moving train for the static observer on the earth surface. And the negative outcome of the Michelson-Morley experiment indicates me that c' does not depend on the direction of the velocity of the moving train compared to the direction of the velocity of the ray of light inside the moving train, and this is supported also by Heisenberg uncertainty principle.

Suppose a train moving with constant velocity v, and the rider of the train sent a ray of light along the length Δx of his train (for example from the end of the train at x_1 to the beginning of the train at x_2). And if the ray of light is reflected from x_2 to x_1, then both the earth observer and rider train will be agreed at the moment of seeing the ray of light at x_2 and seeing it at reaching at x_1. According to this view the principle of relativity is fallen down. Where, according to the relativity principle, if the ray of light is sent from x_1 to x_2 in the same direction of the velocity, then the rider of the train will see the light ray reaches to x_2 before the earth observer, and if it is sent from x_2 to x_1, where it is moving in the opposite direction of the velocity of the train, then the earth observer will see the ray of light reaches to x_1 before the rider train. Now according to our new relativity principle, if the earth observer desired to measure the time required Δt via his earth clock to the ray of light to pass the distance from x_1 to x_2 inside the moving train, then he will get according to eq. (11) that

$$\Delta t = \frac{\Delta x}{c'} = \frac{\Delta x}{\sqrt{c^2 - v^2}} \qquad (12)$$

And same Δt he will measure if the ray of light is sent from x_2 to x_1 in the opposite direction of the velocity of the train. Since $\Delta x = c\Delta t_0$ where Δt_0 is the time required for the ray of to pass the distance Δx when the train is static, where we proposed here the length of the train Δx when it is static is equal to the same length in the direction of the velocity when it is moving, and from that the length contraction of Einstein is falling down. Thus from eq. (12) we get

$$\Delta t = \frac{c\Delta t_0}{\sqrt{c^2 - v^2}} = \frac{\Delta t_0}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (13)$$

Equation (13) indicates us that the time separation for any event that happens inside the moving train is bigger than the time separation of the same event if it happened inside the train when the train at rest for the earth observer according to his earth clock. Thus, from that, since the motion of a clock inside the moving train is an event occurring inside the train, then the earth observer will see that the clock inside the moving train will move in a slowing rate than when the train is at rest. Thus the earth observer will see the moving train clock is moving slower than his earth clock.

1.2 Now, suppose one of the riders of the moving train sets his clock inside the train to measure the time required for the light beam to pass the length of his train during the motion. According to eq. (13), the time separation for any event that is happening inside the train, is greater when it is moving than when it is at rest for the reference frame of the earth surface. Because the clock motion inside the train is considered as events occurring inside the train, thus, it will be slower than the clock of the static observer in the reference frame of the earth surface. Now, if we assumed that both the earth observer and the rider of the moving train will be agreed on the beginning of the event and ending it inside the moving train, then if the observer computed the time Δt, via his clock for the light beam to pass the length of the moving train, then the rider would compute the time $\Delta t'$ via his moving train clock, where

$$\Delta t' = \gamma^{-1} \Delta t \qquad (14)$$

Where $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$. And since from eq. (13)

$$\Delta t = \gamma \ \Delta t_0$$

Thus from eq. (14) we get

$$\Delta t' = \Delta t_0$$

From the above equation, we find that the time separation of the event inside the train that is measured by the rider via his clock during the motion is equal to the rest time separation of the same event (the measured time when the train is at rest). And thus the moving train rider will measure light speed inside his train equals to c (the speed of light in vacuum), same as the static earth observer will measure the light speed on the earth surface is equal to the light speed in vacuum. As a result of the slowing of the light speed inside the moving train comparing to the reference frame of the earth surface, it makes the time to slow (movement of clocks) inside the train. That makes the measurement of the light speed inside the train to be the same as the speed of light in vacuum for the rider according to his moving train clock. Subsequently, we can write eq. (13) as

$$\Delta t = \gamma \ \Delta t' \tag{15}$$

1.3 Now suppose the stationary observer on the earth surface desires to compare the motion of the clock of the moving rider with the motion of his clock. According to equation (14), and because the motion of the clock of the rider is an event inside the moving train, thus the clock will be slower when the train is moving than when it is at rest for the earth observer. Thus, if the earth observer computes the time Δt via his clock, at this moment, he will find that the clock of the rider will compute the time $\Delta t'$ where

$$\Delta t' = \gamma^{-1} \Delta t$$

1.4 Now suppose the rider of the moving train desires to use the clock of the stationary observer for computing the time required to the light beam to pass the length of his train. The time which will be measured by the stationary observer via his clock is Δt where

$$\Delta t = \gamma \ \Delta t_0$$

If we consider the rider is moving with constant velocity forward, then the clock of the earth observer should be moving with the same velocity in the opposite direction for the rider. In this case, the rider (for himself) is considered as static, and the earth observer clock as a frame moving with constant velocity v relative to the rider. Thus, according to the preceding discussion, the earth clock will be slower for the rider than the observer for the reference frame of the earth surface. Thus, if the observer computes the time Δt by his clock, at this instant, the rider will compute the time $\Delta t'$ by the same clock {or by his clock inside the train as we have seen in (1.2), where

$$\Delta t' = \gamma^{-1} \Delta t$$

For more clarification, suppose the length of the train is *21 m,* and its speed is *0.87c* . If the clock computes by *ns* where $1ns = 10^{-9}$ *second*. Thus, the time required to the light beam to pass the length of the moving train for the earth observer via his clock is Δt, where from equation (13) we get

$$\Delta t = \frac{\Delta t_0}{\sqrt{1-(0.87)^2}} = \frac{\Delta t_0}{0.5}$$

And

$$\Delta t_0 = \frac{21}{3.0 \times 10^8} = 70 \ ns$$

Thus we have

$$\Delta t = \frac{70}{0.5} = 140 \ ns$$

Thus, the static observer will compute *140ns* via his clock for the light beam to pass the length of the moving train. For the rider, the time is $\Delta t'$ where from eq. (14) we get

$$\Delta t' = \gamma^{-1} \Delta t = 70ns$$

So, the rider will compute *70ns* for the light beam to pass the length of his train via the earth clock. Both, the earth observer and the moving train rider will agree on the beginning and ending the event, and when both used the same clock to compute the time separation for this event, the clock was slower for the rider than the observer. So, when the observer has *140ns* for the time separation, at this moment, the rider received only the first *70ns* of the clock motion that were experienced by the earth observer in the past. Where, the present of the earth observer at this moment is at *140ns,* while the present of the rider is at *70ns*. Subsequently, we can consider the rider of the moving train lives –at his present- in the past of the observer on the earth surface during his motion. In this example we find that when both the rider and the observer used the same clock, each one creates his own clock to get his reading. That is in contrast with the objective existence of the phenomenon. In our example, we determine that the observer is the main participant in the formulation of the phenomenon as in the concepts of the Copenhagen School.

1.5 Now suppose train (a) is at rest and its length is ΔL. Also, there is another train (b) moving with constant velocity v and static observer on the earth surface. Both the static earth observer and the rider of the moving train (b) will measure the time required for the light beam to traverse the length of the static train (a). For the earth observer, the measured time separation for the event according to his clock is

$$\Delta t_0 = \frac{\Delta L}{c}$$

For the rider of the moving train (b), since train (a) is considered to be moving with constant velocity –v, thus the speed of light inside it compared to the reference frame of the earth observer should be $c' = \sqrt{c^2 - v^2}$, thus the rider should be computing the time separation Δt_r for the event, where

$$\Delta t_r = \frac{\Delta L}{\sqrt{c^2 - v^2}} = \gamma \ \Delta t_0$$

Where, Δt_0 is the time separation of the event when the train rider is static. Because the rider's clock is slowed during the motion compared to the reference frame of the earth surface, thus, the rider will compute the time $\Delta t'$ for the event, where

$$\Delta t' = \gamma^{-1} \Delta t_r = \Delta t_0 \qquad (16)$$

Equation (16) indicates that, both the rider of the moving train (b) and the static observer will measure the same time separation for the light beam to pass the length of the static train (a). That leads us to say that the measured speed of light is the same for both the static earth observer and the moving train (b) rider inside the static train (a) and is equal to c (the speed of light in a vacuum). Thus, we can write equation (16) in this case as

$$\Delta t' = \frac{\Delta L}{c} \qquad (17)$$

If both the static observer and the rider of the moving train (b) agree on the time required for the light beam to pass the length of the static train (a) , then, they will be different in the beginning and ending the event. We have seen previously that the rider of the moving train was living in the past of the static observer on the earth surface during the motion. For more clarification, let us assume that both the observer and the rider agree on the beginning of the event by applying the condition of

$$v = 0 \text{ at } \Delta t = 0$$
$$v = 0.87c \text{ at } \Delta t > 0$$

when the earth clock points to zero at $\Delta t = 0$, (before transmitting the light beam,) the velocity of train (b) of the rider was equal to zero, and at the first moment of transmitting the light beam at $\Delta t > 0$, the velocity of the train was equal to *0.87c* (in this case, for simplicity, we neglect the effect of acceleration). Subsequently, the static observer and the rider of the moving train (b) will agree on the beginning of transmitting the light beam inside the static train (a) , and will be different in reaching the end. If the length of the static train (a) is *21m* , then, the time required for the light beam to pass the length of the static train (a) for the static earth observer according to his clock is

$$\Delta t = \frac{21}{3.0 \times 10^8} = 70 \ ns$$

For the rider of the moving train (b) according to his clock and from equation (17), we get

$$\Delta t' = \frac{21}{3.0 \times 10^8} = 70 \ ns$$

From that, we see that both the rider and the observer will measure the same time separation for this event –each one according to his clock. But because the time (clock) of the moving train (b) is slower than the time (clock) of the static earth observer for the reference frame of the earth surface, thus the light beam will arrive at the end of the static train (a) faster for the observer than the rider. Thus, if the observer confirms that the light beam arrived at the end of the train (a), at this moment, the rider confirms that the light beam arrived at the middle of the train (a). Where, if the observer confirms that the light beam passed the distance Δx , at this moment the rider will confirm that the light beam passed the distance $\Delta x'$ where $\Delta x' = \gamma^{-1}\Delta x$. As well, we get, in this case, $\Delta y' = \gamma^{-1}\Delta y$ and $\Delta z' = \gamma^{-1}\Delta z$. Now, if the observer looks at the clock of the rider, he will confirm that the clock of the rider computes only 35*ns* at the moment that his clock computes 70*ns* , where we get $\Delta t' = \gamma^{-1}\Delta t$. But, if the train (b) rider looks at the clock of the earth observer, he will confirm that the clock of the observer computes only *35 ns* , same as in his clock, at this moment the earth observer confirms that his clock is reading 70*ns*, where the moving train (b) rider is seeing in his present the events that are happening on the earth which are considered as past for the earth observer.

1.6 Now, if the rider of the moving train observes the clock of the static observer at the condition of

$$v = 0 \text{ at } \Delta t_{observer} = 0$$
$$v = 0.87c \text{ at } 0 < \Delta t_{observer} \leq 4 \text{ sec.}$$
$$v = 0 \text{ at } \Delta t_{observer} > 4$$

Where $\Delta t_{observer}$ is the reading of static earth observer from his clock. We can draw $\Delta t_{observer}$ versus Δt_{rider} as in figure (1), where Δt_{rider} is the reading of the moving train rider from the clock of the static earth observer. From figure (1), we find two straight lines; the first for 0< $\Delta t_{observer} \leq 4\,\text{sec}$.and its slope is equal to 0.5. The second line is for $\Delta t_{observer}$ >4 sec. and its slope is equal to 1. We find from the figure, the seconds between $2 < \Delta t_{observer} \leq 4\,sec.$ would not be determined by the rider where the train of the rider stopped at $\Delta t_{observer}$ >4 sec. He would find that the observer was reading the seconds at $\Delta t_{observer}$ >4 sec., while his last reading was equal to 2 sec. That means the events measured by the fixed observer between 2< $\Delta t_{observer} \leq 4\,sec.$ were not received by the rider of the moving train.

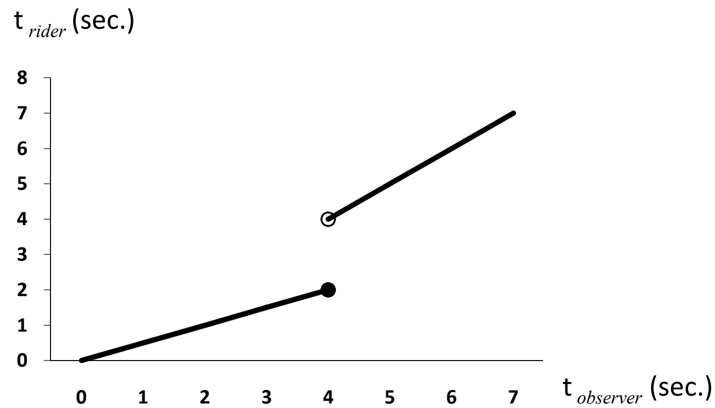

Fig. (1): t (observer) versus t (rider).

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 same clock. That is in contrast with the objective existence of the phenomenon.

2- Velocity in the Modified Special Relativity theory

2.1 Now let us go back to the moving train rider and the static observer on the earth surface, where both of them will do an experiment to measure the velocity of the moving train. This can be done with two pylons, the distance between them is Δx . Now, the measured time according to the earth observer for the train to pass the distance Δx is Δt according to his clock, so the measured velocity of the moving train for him is $v_{observer}$, where

$$v_{observer} = \frac{\Delta x}{\Delta t} = v$$

Now, when the earth observer determines that the train reached to the end of its journey at Δx , at this moment, according to the train rider (during his motion) the train did not reach the end of the journey, and did not pass the distance Δx , the train reached to the distance $\Delta x'$ where

$$\Delta x' = \gamma^{-1} \Delta x$$

And this distance was passed at a time separation equal to $\Delta t'$ according to his clock, where

$$\Delta t' = \gamma^{-1} \Delta t$$

Therefore the measured velocity with respect to the moving train rider will be v_{rider} , where

$$v_{rider} = \frac{\Delta x'}{\Delta t'} = \frac{\gamma^{-1} \Delta x}{\gamma^{-1} \Delta t} = v_{observer} = v \qquad (18)$$

From that we find that both the earth observer and the rider of the moving train will measure the same train velocity during the motion, where both will measure the actual velocity. In the special theory of relativity of Einstein, the measured distance for the moving train rider between the two pylons will be $\Delta x'$ where

$$\Delta x' = \gamma^{-1} \Delta x$$

Therefore the distance between the two pylons will decrease during the motion of the train according to the train rider. That is because Einstein was believing in the objective existence of the phenomenon. According to this concept, both the earth observer and the moving train rider will be in agreement for the start of moving the train from the first pylon and then will agree on the train reaching the end of its journey at the second pylon. Subsequently, according to the reciprocity principle, the earth observer will also see the length of the moving train will be decreased according to the factor γ^{-1} in the direction of the velocity. But in our modified special relativity theory both the earth observer and the moving train rider will measure the same train length in the velocity direction (say in x-direction) and also in any direction y and z, also both of them will be agreed on the measured distance between the two pylons, but the train motion makes the rider get his measurements at a slower rate than the earth observer. This is in agreement with the Copenhagen School concepts, where the observer plays the major role in determining phenomena. Both the earth observer and the rider make their own determination of the motion of the train and clocks.

2.2 Now suppose, there is a static train (a) on the earth surface which contains a clock. As we have seen previously, the rider of the moving train (b) will determine the clock motion of train (a) is identical with his clock motion, where the time that is measured via his clock is equal to the time that is measured via the clock of train (a) . Also the earth observer will determine that the motion of the clock of train (a) is identical with his clock motion. Now if train (a) is moving with constant velocity v_a between the two pylons, then as we have seen in the previous section both the earth observer and the moving train rider (b) will agree on the actual measured velocity of the train as v_a. Now if it is sent a light beam along the length of train (a) during its motion, then the required time for the light beam to pass the length of train (a) with respect to the earth observer is Δt according to his clock where

$$\Delta t = \frac{\Delta t_0}{\sqrt{1 - \frac{v_a^2}{c^2}}}$$

But according to the train (b) rider, the time separation of this event is $\Delta t'$ according to his clock, where

$$\Delta t' = \frac{\Delta t_0'}{\sqrt{1 - \frac{v_a^2}{c^2}}}$$

Where $\Delta t_0'$ is the time separation to the light beam to pass the length of train (a) with respect to the moving train (b) rider, when train (a) is at rest. And, since both the earth observer and the moving train (b) rider will agree on the time separation of this event when train (a) is at rest, thus we get

$$\Delta t_0' = \Delta t_0$$

Subsequently, we get

$$\Delta t' = \Delta t$$

From the last equation, we know that both the earth observer and the moving train (b) rider will be agreed on the time separation for the light beam to pass the length of moving train (a) , but both of them will be disagreed on the beginning of the event and ending it. Also, both will be agreed, that the clock motion of the moving train (a) will be slower than their clocks and they will be agreed on the slowing rate. We get from this example that the motion of train (b) did not affect on the rider measurements, where his measurement was identical with the earth observer measurements during his motion, but the motion of train (b) made the rider to get these measurements at a slower rate than the earth observer.

2.3 Suppose a ball is moving with constant velocity v_p on the earth surface. As we have seen previously, both the earth observer and the moving train rider will be agreed on the ball velocity on the earth surface, where both of them will measure the velocity to be equal to the actual velocity v_p. Now, if this ball entered inside the moving train and passed the length of the train, then the time separation for the ball to pass the length of the train for the rider is $\Delta t'$ via his clock and Δt for the earth observer via his clock where

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

Here, v is the velocity of the moving train. In this case, both the earth observer and the train rider should be agreed on the beginning of the event from the initial sphere motion inside the moving train and the final, when the sphere passed the train length ΔL, but they will be differed on the measured time separation. Subsequently the measured velocity for the sphere inside the moving train according to the train rider is v_{rider} where

$$v_{rider} = \frac{\Delta L}{\Delta t'} = v_p$$

The rider of the moving train will measure the actual velocity of the ball inside his train. For the static earth observer, the measured velocity of the ball inside the moving train will be $v_{observer}$ given as

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

Thus

$$v_{observer} = \sqrt{1 - \frac{v^2}{c^2}} v_p \tag{19}$$

From eq. (19) we get the ball velocity will be decreased by the factor $\sqrt{1 - \frac{v^2}{c^2}}$ for the earth observer when it entered inside the moving train comparing to its actual velocity on the earth surface for the earth observer.

2.4 Now suppose that both the earth observer and the train rider desire applying this condition

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

This condition illustrates the moving train velocity in terms of x , where x is the train passed distance according to the earth observer. Figure (2), illustrates the relationship between x and x', where x' is the distance passed by the moving train as seen by the rider of the train.

From figure (2), we find that the relationship between *x* and *x'* is a straight line. Its slope is $\sqrt{1-\frac{v^2}{c^2}}$ and we find that when the earth observer confirms that the train passed the distance 100*m*, at this moment the rider will confirm (during the motion) that his train passed only50*m*. When the train is at rest at $x = 100m$, and the rider leaves his train, he will be surprised that the passed distance is 100*m*, not 50*m*. Subsequently he will avow that his train transformed from 50*m* to *100m* at zero time separation, and the distance in the interval 50<x <100 was not passed by his train.

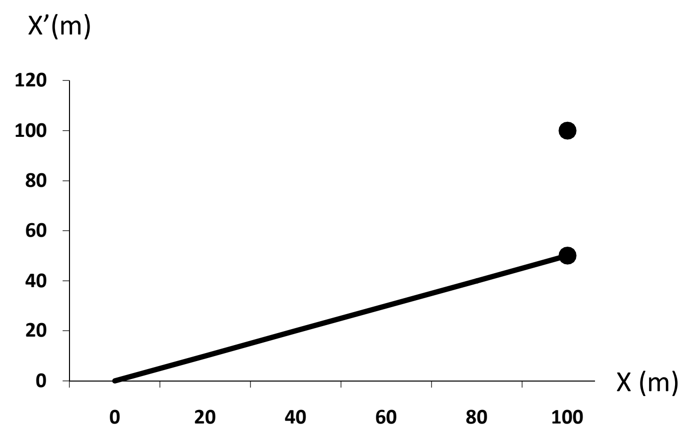

Fig. (2): illustrates the relationship between x and x' .

From that the rider will predict that his train was moving with speed v'

$$v' = \frac{\Delta x'}{\Delta t'} = \frac{\Delta x}{\sqrt{1-\frac{v^2}{c^2}}\Delta t} = \gamma\ v \tag{20}$$

Thus from eq. (20) we get $v' = \frac{0.87c}{0.5}$ =1.74c. Subsequently, the rider will predict that his train was moving with speed greater than the speed of light in vacuum. whereas, after the train stopped the measured distance passed by the train for the rider is $\Delta x' = \Delta x$ and this distance was passed at a time separation $\Delta t' = \gamma^{-1}\Delta t$ according to his clock. Where, Δx is the measured distance for the earth observer, and Δt is the measured time by the earth observer according to his earth clock.

3- Quantum Tunneling, Breaking the Speed of Light and Time Speedup

3.1 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 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 speedup which is not existed in special relativity theory. The concept of time speedup 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]. The modified special relativity theory answers all the preceding questions as we shall see now.

3.2 The Equivalence Principle of The Modified Special Relativity Theory

The $\gamma-$ *factor* which is equal to $\dfrac{1}{\sqrt{1-\dfrac{v^2}{c^2}}}$ is equivalent to something like refractive index as mentioned in section (1.1), eq.(10). The refractive index of a medium is a measure of how much the speed of light is reduced inside the medium. If a train was moving with constant speed v, then the measured speed of light inside this train is equal to $c'=\sqrt{c^2-v^2}$ for the static earth observer. The refractive index of the moving train is equivalent to γ where $\gamma=\dfrac{c}{\sqrt{c^2-v^2}}=\dfrac{1}{\sqrt{1-\dfrac{v^2}{c^2}}}$. From that we get the Helmholtz equation for phenomena periodic in time, with a frequency of $f=\omega/2\pi$ inside the moving train as

$$\nabla^2\phi_x{}^2(x)+\frac{\gamma^2\omega^2}{c^2}\phi_x(x)=0$$

Where γ is something equivalent to refractive index. The equivalence principle of the modified special relativity theory will allow us to understand quantum tunneling. For example, a typical soda-lime glass has a refractive index of 1.5, which means that in glass, light travels at 1 / 1.5 = 0.67 times the speed of light in a vacuum. This is equivalent to a train moving with a constant speed of 0.75c, where $\gamma^{-1} = 0.67$. Now if the speed of this train is equal to zero, then the speed of light inside it is equal to c for the static earth observer, where the events that occur inside this train will occur in a same rate as it occurs on the earth surface. That is because according to the modified special relativity theory, the internal speed of the medium inside the train is the same as on the earth surface. But now if the internal speed of the medium of the train is less than the internal speed of the earth surface, this is equivalent to the earth observer as moving with speed v relative to this train. In this case it is equivalent to the γ' inside the train (the refractive index) to be purely imaginary. Then the solution of Helmholtz's equation is called an *evanescent mode* [1-9]. Similar features can be found for the stationary Schrodinger equation, where if a particle transformed from a frame of less internal energy (tunneling barrier) to a frame of higher internal energy (in the laboratory), it is equivalent to penetration of the particle through a higher potential energy U where E<U and E is the kinetic energy. Thus the solution inside the potential barrier is the quantum analogue of an evanescent mode. Obviously for electromagnetic evanescent modes, the refractive index plays the role of the potential in wave mechanical tunneling. The modified special relativity theory will give you a descriptive analytics transformation from the purely imaginary refractive index γ' inside the tunneling barrier to how it is related to the refractive index γ in the laboratory.

The modified special relativity theory states that; in the case of a tunneling barrier, the internal speed inside the barrier should be less than the internal speed of the laboratory, thus the observer in the laboratory is equivalent to moving with speed v relative to the barrier and the observer inside the barrier is static. For more clarification, suppose a tunneling barrier of length ΔL where $\Delta L = 1\ m$. Now if a light beam is sent through this tunneling barrier and the observer of our laboratory measured the signal speed through this barrier to be 4.7c. That means $\gamma = 4.7$ as from equation (20). This is equivalent to the observer in the laboratory moving with speed 0.98c relative to the tunneling barrier.

Now according to figure (3), the events inside the barrier will occur at a faster rate than the same events outside the barrier (in the laboratory), that is, relative to the observer inside the barrier. Therefore, if we proposed that if both the observer inside the barrier, and the observer outside the barrier (in the laboratory) are agreed at the moment of transmitting the light beam inside the barrier, then, according to our modified relativity theory, if the observer inside registered that the light beam covered the distance ΔL through his barrier, then, at this moment, the observer in the laboratory will register that the light beam covered the distance $\Delta L'$ where

$$\Delta L' = \gamma^{-1} \Delta L$$

Subsequently, in this experiment there is formed a frame with time speedup inside the barrier relative to the frame of the laboratory, where the events inside the barrier will occur at a faster rate than the same events if happened in the laboratory. Therefore, if the observer inside the barrier registered that the light beam reached the end of his barrier at point A as in fig. (3), where it covered the distance $\Delta L = 1 meter$, then according to the observer in the laboratory, at this moment, the light beam had not reached to point A, but it was still at a distance $\Delta L'$ where

$$\Delta L' = \gamma^{-1}\Delta L = \frac{1}{4.7}\times 1 = 0.21\ m$$

After that, the observer inside will register that the time separation for the light beam to cover the distance of 1*meter* in his barrier, is Δt according to his clock where

$$\Delta t = \frac{\Delta L}{c} = \frac{1}{3.0\times 10^{8}} = 3.3\times 10^{-9}\ \text{sec}.$$

But relative to the observer in the laboratory the measured time separation of this event is $\Delta t'$ according to his clock, where

$$\Delta t' = \gamma^{-1}\Delta t = \frac{1}{4.7}\times 3.3\times 10^{-9} = 7.0\times 10^{-10}\ \text{sec}.$$

Subsequently, the light beam will exit the barrier, into the laboratory, and will be sensitive to laboratory detectors, where the observer will be puzzled as how the light beam got out of the barrier from point (A), while it was seen at point (B) at $\Delta L' = 0.21m$ inside. Thus, the laboratory observer will think that the distance between 0.21< $\Delta L' \leq 1m$ was not covered by the light beam relative to him, where the light beam is transformed from $\Delta L' = 0.21m$ to the distance $\Delta L' = \Delta L =$ $1m$ at a time separation equal to zero, where, laboratory observer will see light beam in two places at the same time one place at *0.21m* and the other place at *1m*, and this is explaining the UC Santa Barbara experiment which happened in 2010 [33]. Furthermore, since the light beam left the barrier without covering the distance 0.21< $\Delta L' \leq 1m$ for the laboratory observer, that leads us to think we broke the causality and determinism as what happened in the quantum tunneling experiments.

When we compute the speed at which light was moving inside the barrier, we would think that it was $4.7c$, where we divide the length of the barrier over the measured time separation according to our clock. Thus, we think that we are breaking the speed of light. But according to our theory that is wrong. The speed of light for the observer inside the barrier is $\frac{\Delta x}{\Delta t} = c$, and for the laboratory observer, it was $\frac{\Delta x'}{\Delta t'} = c$, where $\Delta x' = \gamma^{-1}\Delta t$ and $\Delta t' = \gamma^{-1}\Delta t$. But since the events inside the barrier occurred at a faster rate than outside for an observer inside, then the light beam will exit the barrier before the observer of the laboratory seeing it passes the total length of the barrier, since at the moment that the light exits the barrier at point A, the observer of the laboratory was seeing it at point $\Delta x' = 0.21m$, while for the observer inside, the light beam covered the total length of the barrier and exited it. That means according to our theory, when we look at the events inside the barrier -in our present-, we look at events happened in the past relative to the observer inside the barrier. From that we could answer the questions regarded to the quantum tunneling experiments. We could answer; 1) How the photon is transformed in a zero time-space through the tunneling barrier, 2) How we measure a light speed greater than the light speed in vacuum not only for photons which own rest mass equal to zero, but also for particles which own rest mass greater than zero, same as in the OPERA experiment, where scientist thought that the neutrinos broke the speed of light. 3) How the enzymes speed up the reactions through the tunneling barrier, which is in agreement with the concept of the time speedup in our theory.

To understand more about the concept of time speedup in our theory, suppose twins, John and Jack, are 20 years of age. Now if John stayed in the laboratory and Jack entered the previous barrier, and if Jack computed by his clock 4.7 years had passed and after that he exited the barrier to the laboratory, Jack would be 24.7 years, but the time that passed according to John is not 4.7 years, but $\Delta t' = \gamma^{-1}\Delta t = \frac{4.7}{4.7} = 1 year$, and then the John's age is 21 years. Subsequently the tunneling barrier of Jack is speeding up the time relative to the laboratory by a factor of 4.7. If a chemical reaction occurs in the laboratory in a time separation of 1 second, then if we put this reaction inside Jack's barrier, it would be performed in a time separation of 1/4.7 seconds. We heard in the news about the Swine flu/N1H1 virus, where it performs a transform each 40 years. If we would like to know what form this virus will take place after 40 years, we should make a tunneling barrier of γ=1262304000, where $c' = 1262304000\ c$, then we put it inside this barrier, we will get the form of this virus in 1 second according to our time. The time passed inside the barrier would be 40 years according to a clock inside, while the time passed according to our clock is 1 second. Einstein in his special relativity theory introduced the concept of time dilation, but according to our modified special relativity theory, we introduce the concept of time dilation, furthermore the time speedup.

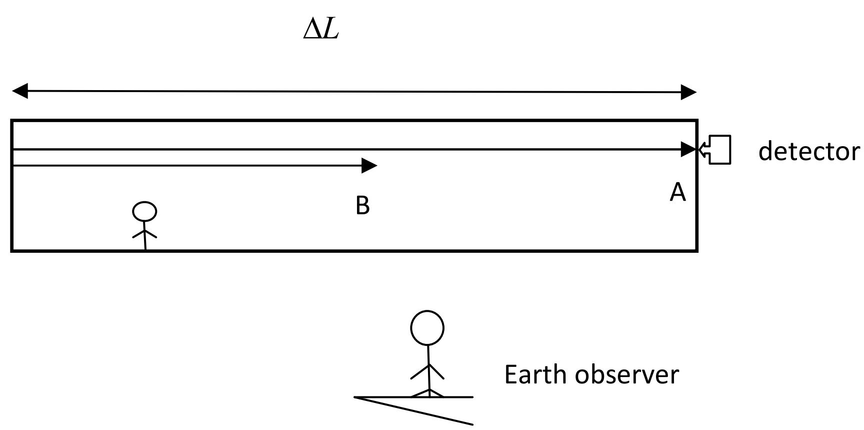

Fig. (3): Quantum tunneling barrier, ray (A) as seen by an observer inside the barrier, at this moment when this ray reached to the end of the barrier for an observer inside, the earth observer will see ray (B) at the middle of the barrier. After that, the beam will be detected by the detector and the earth observer will see the ray of light as it is transformed from point B to A at zero time separation, and the ray of light will be seen for the earth observer as it is in two places at the same time, the first place at point (B), and the second at point (A).

4. The relativistic Mass in the Modified Special Relativity Theory

4.1 In this section, we shall derive the measured mass for the moving train according to the earth observer. Suppose that both the earth observer and the train rider agreed at the time $\Delta t = 0$,where the train velocity was equal to zero. At Δt >0, the train moved with constant velocity *V*, and after the train passed the distance Δx according to the earth observer, the train stopped. In this case, the earth observer records according to his clock, the time Δt for the train to pass the distance Δx . Therefore he will predict that the train was moving with velocity $v_{observer}$, where

$$v_{observer} = \frac{\Delta x}{\Delta t} = v$$

Then the measured train momentum according to him was equal to $P_{observer}$ where

$$P_{observer} = mv_{observer} = m\frac{\Delta x}{\Delta t} = mv \qquad (21)$$

Where m is the measured mass of the train according to the earth observer during its motion. But according to the train rider, when the train stopped, the passed distance is $\Delta x'$, where $\Delta x' = \Delta x$ as in figure (2), and rider will confirm that this distance was passed in a time separation $\Delta t'$ according to his clock, where

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

Where Δt is the measured time according to the earth observer clock. Subsequently the rider will predict that the train velocity was v_{rider} where

$$v_{rider} = \frac{\Delta x'}{\Delta t'} = \frac{\Delta x}{\sqrt{1 - \frac{v^2}{c^2}}\Delta t} = \frac{v}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (22)$$

We find that, equation (22) disagrees with eq. (18), where we find from equation (18) that $v_{rider} = v_{observer} = v$. That is because eq. (18) is applied during the train motion where the passed distance according to the rider is $\Delta x' = \sqrt{1 - \frac{v^2}{c^2}}\Delta x$. Where Δx is the passed distance according to the earth observer. But when the train is stopped the passed distance is $\Delta x' = \Delta x$ as in fig. (2). Therefore the rider confirm that the train was moving with momentum P_{rider} , where

$$P_{rider} = m_0 v_{rider} = m_0 \frac{v}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (23)$$

m_0 is the train rest mass, where we have assumed that the mass of the moving train according to the train rider is the rest mass. Now if we assume that both the train rider and the earth observer are agreed on the momentum measurement of the moving train, subsequently after we equate between the two equations (21) and (23) we get

$$mv = m_0 \frac{v}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Thus from the last equation we get

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (24)$$

Thus from eq. (24) the relativistic mass of the moving train according to the earth observer will be increased by the factor $\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$.

4.2 Suppose the rider of the moving train (b) desires measuring the mass of the stationary train (a) on the earth surface. As we have seen, the rider will confirm that the clock motion of train (a) is symmetrical with his clock motion, where the time that will be measured via the train (a) clock equals to the time that will be measured via his clock, which means that $\Delta t' = \Delta t''$, where $\Delta t'$ is the time separation that the rider will measure via his clock, and $\Delta t''$ is the time separation that the rider will measure via the train (a) clock. Now if train (b) passed the distance $\Delta x'$ according to the rider of train (b) , then we can consider for the rider of train (b) , that train (a) is moving with constant velocity v , but in the opposite direction to the train (b) velocity . Subsequently it may be considered that train (a) passed distance $\Delta x'$ with respect to train (b) rider. Therefore the measured momentum of train (a) for the train (b) rider is P_{rider} where

$$P_{rider} = m\frac{\Delta x'}{\Delta t'} \tag{25}$$

Where m is the relativistic mass of train (a) with respect to the rider of the moving train (b) . But according to the measured momentum for train (a) with respect to itself according to the reference frame of the moving train (b) is P_{rider} (according to the clock of train (a) with respect to the rider of train (b)), where

$$P_{train} = m_0\frac{\Delta x'}{\Delta t''} = m_0\frac{\Delta x'}{\Delta t'} \tag{26}$$

When we equate the two eqs. (25), and (26) we get

$$m = m_0 \tag{27}$$

From the last equation we find that the rider of the moving train (b) will measure (during his motion) the mass of the stationary train (a) to be equal to the rest mass, same as the static earth observer on the earth surface. But the rider of the moving train (b) will receive this measurement in a slowing rate than the earth observer.

4.3 Suppose now train (a) was moving with constant velocity v_a between the two pylons, and after the train covered the distance $\Delta x'$ between the two pylons according to the rider of the moving train (b) , the train (a) stopped. In this case, the moving rider will confirm that the train passed this distance in time separation $\Delta t'$ according to his clock, and subsequently the rider will predict that train (a) was moving with momentum P_{rider}, where

$$P_{rider} = mv_{rider} = m\frac{\Delta x'}{\Delta t'} \tag{28}$$

Where *m* is the relativistic mass of the moving train (a) according to the rider of the moving train (b) . But according to the moving train (a) , the distance $\Delta x'$ was covered in time separation $\Delta t''$ according to his clock with respect to the reference frame of the moving train (b) , where

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

and subsequently the momentum of train (a) can be predicted according to itself with respect to the reference frame of the moving train (b) to be P_{train} , where

$$P_{train} = m_0 \frac{\Delta x'}{\Delta t''} = m_0 \frac{\Delta x'}{\sqrt{1 - \frac{v_a^2}{c^2}} \Delta t'} \tag{29}$$

And by equate eqs. (28) and (29) we get

$$m = \frac{m_0}{\sqrt{1 - \frac{v_a^2}{c^2}}} \tag{30}$$

Equation (30) represents the measured relativistic mass of the moving train (a) with respect to the rider of the moving train (b) , whereas we find according to equation (30) that the train (a) mass will increase during the motion by the factor $\frac{1}{\sqrt{1 - \frac{v_a^2}{c^2}}}$ according to the rider of the moving train (b) , and also according to the earth observer. Whereas we find that both the earth observer and the rider of the moving train (b) will agree on the measured relativistic mass of moving train (a) , but the motion of train (b) makes the rider to get his measurement at a slower rate than the earth observer.

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