OPERA, ICARUS and SN1987a Interpretations According To The Modified Special Relativity theory

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Abstract

The OPERA experiment [1] at the Gran Sasso laboratory south of Rome, said they recorded neutrinos beamed to them from the CERN research center in Switzerland as arriving 60 nanoseconds before light would have done. But ICARUS [2], another experiment at Gran Sasso - which is deep under mountains and run by Italy's National Institute of National Physics - now argues that their measurements of the neutrinos energy on arrival contradict that reading. In their paper, the ICARUS [2] team says their findings "refute a superluminal (faster than light) interpretation of the OPERA [1] result." They argue, on the basis of the published studies by two top U.S. physicists, that the neutrinos pumped down from CERN, near Geneva, should have lost most of their energy if they had travelled at even a tiny fraction faster than light. But in fact, the ICARUS scientists say, the neutrino beam as tested in their equipment registered an energy spectrum fully corresponding with what it should be for particles traveling at the speed of light and no more. Neutrinos scarcely interact with matter, which means they escape an exploding star more quickly than photons, something the SN 1987A measurements confirmed. But SN 1987A is 170,000 light years away. If neutrinos moved slightly faster than the speed of light, they would have arrived at the Earth years - not hours - before the detected photons from the supernova.

According to my modified special relativity theory (MSRT) [3], I'll give an interpretation for the OPERA experiment, ICARUS and the SN 1987A, and how they are related with the same theory. The previous experiments are considered as a confirmation for my proposed modified special relativity theory, which is formulated in 1996 in order to unify between quantum theory (Copenhagen school) and relativity theory in concepts, principles and laws.

Theory:

To understand how the previous experiments can be interpreted and how they are related according to MSRT, we must understand the following thought experiment according to the MSRT [3].

According to MSRT [3], Suppose a train moving with constant velocity v, and an observer stationary on the earth surface. Now, if the rider of the moving train observes the clock of the stationary observer according to this condition

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

Where $\Delta t_{observer}$ is the reading of stationary earth observer from his clock. We can draw $\Delta t_{observer}$ versus Δt_{rider} as in fig. (1), where Δt_{rider} is the reading of the moving train rider from the clock of the stationary earth observer. From fig. (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 that was lived by the fixed observer between $2< \Delta t_{observer} \leq 4\,sec.$ were not be received by the rider of the moving train. According to the MSRT - during the motion of the train rider with constant velocity v we have $\Delta t_{rider} = \sqrt{1-\frac{v^2}{c^2}}\Delta t_{observer}$.

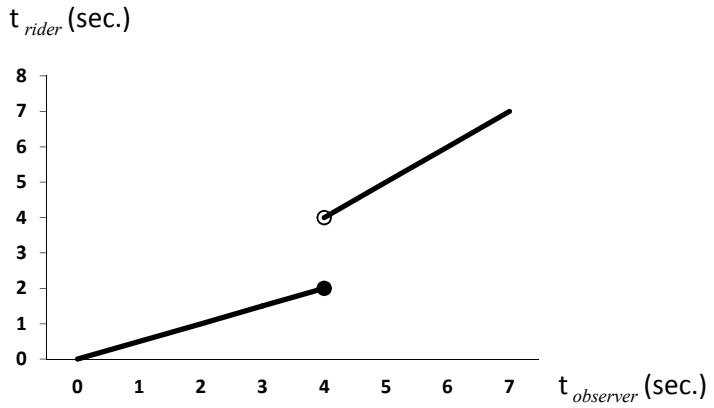

Fig. (1): t (observer) versus t (rider).

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

From this thought experiment we find that also, when the train stopped, the train rider would find the clock of the earth observer more preceded than his clock (on the train), where the clock of the earth observer is computing the seconds greater the 4, while at this moment his clock is computing the seconds greater than 2. This thought experiment which is interpreted by the MSRT is illustrating why the moving train rider will be younger than the earth observer (if they were at the same age when the rider left the earth observer) when he back to the earth observer and stopped his train, which this is solving the twin paradox in the special relativity theory of Einstein. According to the MSRT-during the motion- the rider of the moving train will see the clock motion of the earth observer is analogue to his clock motion on the moving train. But when the train stopped according to the previous condition, he would find the reading of his clock is greater than 2, while the earth observer clock reading is greater than 4.

Let's now study the other thought experiment according to the MSRT. 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. Fig. (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 $\gamma^{-1} = \sqrt{1-\frac{v^2}{c^2}} = 0.5$, and we find that when the earth observer confirms that the train passed the distance 100m, at this moment, the rider will confirm -during the motion- that his train passed only50m. When the train is at rest at x = 100m, and the rider left his train, he would be surprised that the passed distance was 100m, not 50m. Subsequently he would avow that his train transformed from 50m to *100m* at a zero time separation, and the distance in the interval 50<x <100 was not be passed by his train.

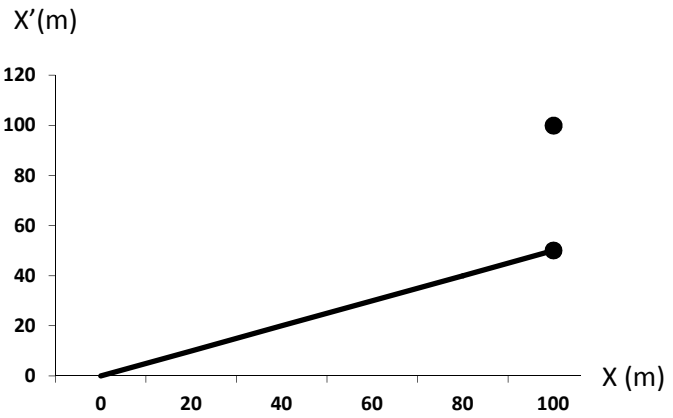

Fig. (2): illustrates the relationship between x and x'.

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

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

Thus from eq. (1) 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.

We have seen from eq. (1) that the train rider will predict that his train was moving with speed greater than the speed of light in vacuum according to his clock time, but this speed is not a real speed, where the real speed is given according to the clock time of the earth observer, where according to the earth observer clock,

$$v = \frac{\Delta x}{\Delta t} = 0.87c$$

The OPERA experiment interpretation according to the MSRT:

To understand the result produced by the OPERA experiment which introduces the neutrinos to moving with speed greater than the speed of light, we must understand the equivalence principle of the MSRT. From the preceding examples, we have seen how the train rider predicted that the speed of his train was greater than the speed of light in vacuum according his clock. Where, his clock was moving more slowly than the clock of the earth observer. And since any clock that is located in a greater potential is moving more slowly than a clock located in a lighter potential. Thus, in the case of the readings of the moving train rider that is taken from the earth observer, it is equivalent to an observer located at a higher potential desiring to take measurements from a system located in a lighter potential. Special Relativity theory is verified experimentally in the case of an observer located in a lighter potential desiring to take physical measurements (space and time) from a system located in a higher potential (moving frame with constant velocity). But in our recent case, it is not verified till the time of performing the OPERA experiment.
To study the case of the OPERA according to MSRT, let's characterize the experiment, according to fig. (3)

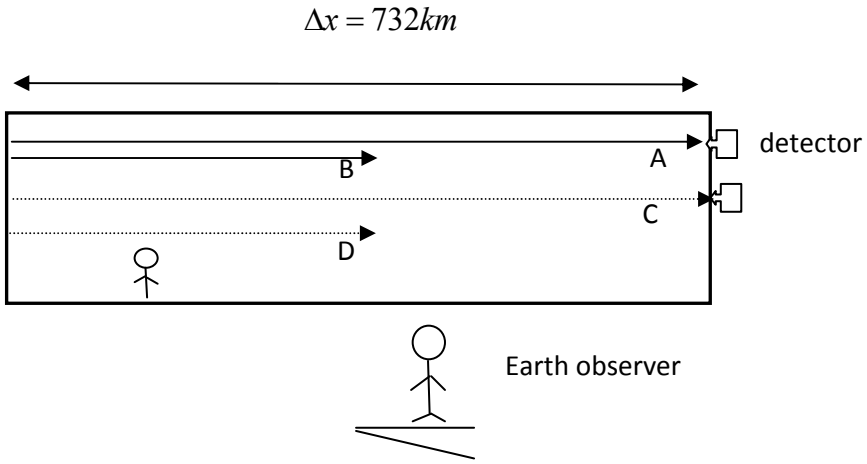

Fig. (3): ray (A) is the picture of the neutrinos location for an observer located inside the tunnel. Ray (B) is the picture of the location of the neutrinos seen by an observer located outside the tunnel (OPERA team). Ray (C) is the picture location of a ray of light seen by an observer located inside the tunnel. Ray (D) is the picture location of a ray of light seen by an observer located outside the tunnel (OPERA team). According to the MSRT, for the OPERA team, both the beam of the neutrinos and the ray of light will be reached to the detector at the same time. This illustrating why the neutrinos from the SN 1987A arrived the earth – hours not years- before the detected photons from the supernova. Both the ray of light and the neutrinos will pass the

distance 732 km in a time separation less than the usual time for the OPERA team according to their clocks, and then the OPERA team will think, both the neutrinos and the ray of light are moving with speed greater than the speed of light in vacuum.

In the case of the OPERA experiment according to the MSRT, the OPERA team are located in a higher potential than the tunnel that the neutrinos are moving in (according to the MSRT, it is equivalent that the OPERA team are moving with constant velocity v_o inside the tunnel). Thus from that, the events that occur inside the tunnel, will occur in a faster rate than outside for an observer stationary inside, and then the clocks inside will moving in a faster rate than outside for an observer inside. From that if a beam of neutrinos are sent inside, then the neutrinos will reach to the end of the tunnel for an observer inside before an observer outside (OPERA team) seeing it reaching the end. Whereas according to the MSRT the distance that is seen passed by the neutrinos according to the OPERA team is $\Delta x'$ comparing to the distance that is seen passed according to an observer inside the tunnel is Δx, where according to the MSRT we have

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

Where $\gamma^{-1} = \sqrt{1 - \frac{v_o^{\,2}}{c^2}}$, or equivalent to the potential difference, and this potential difference is depending on the difference of mass, pressure and temperature.
And this event is done according to the clock of the OPERA team in a time separation $\Delta t'$ comparing to a time separation of the clock of an observer inside the tunnel Δt, where

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

And now when the neutrinos reached to the end of the tunnel for an observer inside the tunnel, and they passed the distance Δx, then they are actually reached to the end of the trip and passed the distance 732 km, and after that it will be reached to the detector and will be sensitive for the detector of the OPERA team. Thus according to the MSRT, for the OPERA team, the neutrinos are transformed from $\Delta x' = \gamma^{-1} \Delta x$ to $\Delta x' = \Delta x$ in a zero time separation, and they will think that the distance that is passed is $\Delta x' = \Delta x$ at a time separation $\Delta t' = \gamma^{-1} \Delta t$ according to their clocks. Thus from that, the predicted speed of the neutrinos by their clocks is v where

$$v' = \frac{\Delta x'}{\Delta t'} = \frac{\Delta x}{\gamma^{-1} \Delta t} = \gamma \; v \qquad (1)$$

Where v is the actual speed of the neutrinos which is given as

$$v = \frac{\Delta x}{\Delta t} \qquad (2)$$

Δx is the passed distance for the neutrinos for an observer inside the tunnel, and Δt is the time separation of the event according to the observer inside the tunnel according to his clock. Now if the actual speed of the neutrinos is equal the speed of light, then the measured speed of the neutrinos relative to the OPERA team is given according to eq. (1) which is greater than the speed of light in vacuum according to their clocks, and this is verified by the OPERA experiment.

The ICARUS experiment interpretation according to the MSRT:
In their paper, the ICARUS team says their findings "refute a superluminal (faster than light) interpretation of the OPERA result." They argue, on the basis of the published studies by two top U.S. physicists, that the neutrinos pumped down from CERN, near Geneva, should have lost

most of their energy if they had travelled at even a tiny fraction faster than light. But in fact, the ICARUS scientists say, the neutrinos beam as tested in their equipment registered an energy spectrum fully corresponding with what it should be for particles traveling at the speed of light and no more. The result produced by the ICARUS team is agreed by the predicted by the MSRT. The actual measured speed of the neutrinos is measured according to eq. (2) which is equal or less than the speed of light in vacuum, which is the measured speed for the observer located inside the tunnel.

The SN 1987A interpretation according to the MSRT:

Neutrinos scarcely interact with matter, which means they escape an exploding star more quickly than photons, something the SN 1987A measurements confirmed. But SN 1987A is 170,000 light years away. If neutrinos moved slightly faster than the speed of light, they would have arrived at the Earth years - not hours - before the detected photons from the supernova.

If the OPERA team instead of sending neutrinos, they sent a ray of light in their equipment, the MSRT predicts that both the light ray and the neutrinos will reach at the end of the tunnel at the same time separation (if the actual speed of the neutrinos is equal to c) according to the OPERA team clock, and then they will predict that the ray of light is moving with speed greater than the light speed in vacuum, same as the neutrinos (as in figure (3), both the neutrinos and the light ray will reach the detector at the same time approximately). This interpretation according to the MSRT illustrates why the neutrinos of the SN 1987A arrived at the Earth- hours not years- before the detected photons from the supernova. The good confirmation also for my MSRT is that the OPERA team is performing their experiment by sending photons instead of neutrinos and they measure the time separation for these photons to pass the distance 732 km. they will see that these photons are passed this distance with a time separation less than the required time separation, and then they will think these photons are moving with speed greater than the light speed in vacuum same as the neutrinos.

Conclusion:

My MSRT is not only confirmed by OPERA experiment, ICARUS, and SN 1987A, but also by the quantum tunneling experiments. 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 [4-9]. The results produced by my 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 speeding up which is not existed in special relativity theory. The concept of time speeding up 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 [10, 11]. Quantum tunneling for protons has been observed in tryptamine

oxidation by aromatic amine dehydrogenase [12]. 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 [13]. 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 [14]. There is another experiment which have done, and considered good support for my MSRT. 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 [15], and this illustrated in fig. (2) in this paper. My MSRT is considered as the first step in order to unify between quantum theory (Copenhagen school) and relativity theory.

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