If the Speed of Light is Not an Universal Constant According to the Theory of Reference Frames: on the Physical Nature of Neutrino

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Abstract

The Theory of Reference Frames considers two speeds of light: the physical speed which is an universal constant and the relativistic speed which instead is variable and depends on the relative speed between the considered reference frames. We analyse physical consequences of the not constant speed of light as per principles of the Theory of Reference Frames which makes use of different relativistic transformations of space-time. Specifically we consider variation of mass, relativity of space-time and the revealing physical effect concerning the muon average life. At last we make a few considerations about the recent experiment on the speed of muon neutrino from CERN to LNGS.

1. Introduction

Special Relativity (SR) is based on two principles: the Principle of Relativity and the Principle of Constancy of the Speed of Light. The most important results of the theory derive just from the second principle on which the Lorentz transformations are based. The first relevant result of SR is certainly the time relativity which affirms the existence of its own time for every moving reference frame. We need to underline that in SR time relativity is a kinematic property and therefore it is independent of the considered physical event: every moving reference frame has its own time which is different from that of other reference frames. The second important result is the space relativity that affirms the length of a body depends on its speed; mass variation with the speed is then an other relevant result. In SR all the reference frames are equivalent and therefore there isn' t a preferred reference frame: it generates many paradoxes and contradictions. The Theory of Reference Frames[1] (TR) is a critical theory of SR and at the same time it furnishes also a different viewpoint on some fundamentals of relativity. TR is founded on both the novel Principle of the Reference and the Principle of Relativity but rejects with strong arguments the Principle of Constancy of the Speed of Light and Lorentz's transformations which are the heart of SR. The Principle of the Reference claims the existence of a preferred reference frame which however isn' t absolute and coincides each time with the physical system where event happens. Let us consider for instance the physical phenomenon of fall of bodies: if it happens on the earth then in TR the preferred reference frame coincides with the earth' s reference frame but if the fall of bodies happens for example on the moon then the preferred reference frame is the moon' s reference frame. Moreover in TR two speeds of light are considered[2] : the physical speed, that is always the same for all reference frames, and the relativistic speed which depends instead on the relative velocity among reference frames. We will consider some important results of SR and will analyze what happens if the Principle of Constancy of the Speed of Light isn' t valid in tune with the TR.

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2. On variation of mass with the speed

In SR mass of any physical entity (body or particle) varies with the speed. Bodies are complex systems made up of molecules and atoms, particles are elementary systems. Specifically Einstein considered[3] the variation with the speed of longitudinal mass (towards motion)

$$m_l = \beta^3 m_o \qquad (1)$$

and of transversal mass (in transversal way to motion)

$$m_t = \beta m_o \qquad (2)$$

where m_o is the mass at rest and

$$\beta = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} > 1 \qquad (3)$$

is the Lorentz factor.
Already this consideration represents a strong contradiction because in SR the moving same object has two different values of mass according to the direction (longitudinal or transversal), and so infinite values of mass according to infinite directions (Contradiction of infinite masses).
We see then that for v=c $\beta, m_l, m_t \rightarrow \infty$, for v>c β, m_l and m_t are imaginary and on this account in SR the c speed of light is the possible maximum speed.
In TR situation is different: for bodies the m_o static mass is the mass at rest and the m dynamic mass varies with the v speed being given by

$$m = m_o\left(1 + \frac{v^2}{2c^2}\right) \qquad (4)$$

For v=c $m=3m_o/2$ and for v>c dynamic mass is real and positive $m(m>3m_o/2)$.
Nevertheless I have proved[4] that this variation of mass is only a virtual and not real effect, therefore for bodies the inertial mass is really constant with the speed.
For particles on the contrary TR considers the m electrodynamic mass and it varies with the speed like this[4]

$$m = m_o\left(1 - \frac{v^2}{2c^2}\right) \qquad (5)$$

This effect of variation of electrodynamic mass with the speed is real and concerns only elementary particles. Specifically we observe that for v=c the electrodynamic mass becomes half and it is null at the critical speed $v_c = \sqrt{2}\,c$. For $v>v_c$ it is real and negative.
If the speed of light isn' t an universal constant the first important consequence is that the speed of light can be exceed.

3. On the relativity of time and space

With respect to two inertial reference frames with v relative velocity in SR time doesn' t go similarly but in the reference frame supposed at rest time goes more quickly showing a dilation[3]

$$t = \beta\,\tau \qquad (6)$$

where t is time of the reference frame supposed at rest, τ is time of the moving reference frame with v speed with respect to the reference frame at rest. It is manifest that time of the moving reference frame goes more slowly presenting a contraction

$$\tau = \frac{t}{\beta} \qquad (7)$$

TR denies the existence of this relativistic kinematic effect on time and proves the cogency of a mathematical relationship between time and mass which represents an equation of time transformation for reference frames with any relative velocity[4][5]

$$d\tau = \frac{m_\tau}{m}\,dt \qquad (8)$$

and similarly

$$dt = \frac{m}{m_\tau}\,d\tau \qquad (9)$$

The (8) and (9) equations establish a general connection between time and mass and prove that a time relativistic effect exists only if there is also a mass relativistic effect. In fact if the two masses, m and m_τ are equal the relativistic effect of time doesn' t exist.

Those two equations open new important scenarios in physics.

For bodies (mechanical systems) at any speed there isn' t a real effect of variation of mass with the speed and therefore also for time the relativistic effect is only virtual and not real. For mechanical systems therefore time goes similarly at any speed.

For elementary particles situation changes. In fact electrodynamic mass of particles varies with the speed according to the (5) equation and therefore if τ is its own time of particle with v speed and with m_τ electrodynamic mass, the t time of the same particle with respect to the reference frame at rest (laboratory time) is

$$dt = \left(1 - \frac{v^2}{2c^2}\right) d\tau \qquad (10)$$

If the v speed is constant (inertial reference frames) and supposing that the two clocks (at rest and in motion) are synchronized at the initial time $t=\tau=0$ we have

$$t = \left(1 - \frac{1}{2}\alpha^2\right) \tau \qquad (11)$$

in which $\alpha = v/c$.

In inertial reference frames we observe a real relativistic effect of time with regards to elementary particles and for $v<v_c=1{,}41c$ this effect is a time contraction of particle in the reference frame at rest with respect to the τ time of the moving particle.
If particle moves with constant acceleration $v=a_o t$, we have

$$dt = \left(1 - \frac{a_o^2 t^2}{2c^2}\right) d\tau \qquad (12)$$

and making calculations[4] we find

$$t = \frac{1}{k_t} \operatorname{tgh} k_t \tau \qquad (13)$$

where $k_t = a_o / c\sqrt{2}$. Also for moving particles with constant acceleration there is a real effect of time contraction in the reference frame at rest.
If particle moves with any v(t) velocity we have

$$dt = \left(1 - \frac{v(t)^2}{2c^2}\right) d\tau \qquad (14)$$

$$\frac{2c^2 dt}{2c^2 - v(t)^2} = d\tau \qquad (15)$$

$$\int_0^t \frac{dt}{2c^2 - v(t)^2} = \frac{\tau}{2c^2} \qquad (16)$$

Also in that case particle undergoes a real relativistic effect of time.
When $v(t)=v_c$ we have always t=0 for each τ and therefore at the critical speed time with respect to the reference frame at rest (laboratory time) stops. If $v(t)>v_c$ then t<0 and this negative value of time (with respect to the reference frame at rest) requires to be deepened, considering that τ its own time of particle goes always similarly. Moreover, as we have seen in the previous paragraph, when time is negative ($v>v_c$) also electrodynamic mass is negative.
In SR the time relativity generates the twin contradiction because it is the result of a kinematic transformation of time described by the Lorentz tranformations. In TR the relativistic effect of time doesn' t produce contradictions because it is the result of the not kinematic relationship between mass and time and that effect is real only for particles and not for bodies. If τ is its own time of a moving particle then the calculated time with respect to the reference frame at rest (laboratory reference frame) of the same particle in the considered mathematical model is given by (11), (13) and (16) relationships.
If the speed of light isn' t an universal constant the twin contradiction isn' t possible and like this the main contradiction of SR is erased.

With regard to the space relativity let us consider a sphere with radius R_o which is in the moving inertial reference frame with v velocity with respect to the reference frame supposed at rest. In SR that same sphere considered with respect to the reference frame at rest transforms into an ellipsoid with the shorter R radius towards the motion while the other two R_o axes (in transversal direction) are unmodified

$$R = \frac{R_o}{\beta} \qquad (17)$$

This consideration represents in SR the space relativity which consists in a length contraction in the considered situation. The space relativity in SR is a kinematic consequence of the Lorentz transformations. In TR the length relativity doesn' t exist and the motion of a body modifies really no its length.

4. The speed of light

In SR space relativity and time relativity are consequences of Lorentz' s transformations which are founded on the Principle of Costancy of the Speed of Light (PCSL). Einstein proved mathematically in SR those transformations after Lorentz and Poincaré had deduced them empirically on the basis of result of Michelson-Morley's experiment.
That experiment was performed firstly in order to show the existence of ether and secondly to measure the velocity of the earth with respect to ether. The negative result of that experiment caused much confusion and disorientation in scientists. Lorentz tried to surpass that situation of scientific crisis introducing the Lorentz factor as a consequence of intrinsic physical properties of ether, Einstein on the contrary denied the existence of ether and proved the Lorentz factor as a consequence of the PCSL. Like this even though Lorentz and Einstein started from different ideas they reached the same equations of space-time transformations which are the basis of Special Relativity: this is the cause of so many contradictions in SR.
The TR exceeds those contradictions denying whether the ether or the PCLS and claiming the existence of a Preferred Reference Frame (PRF) which doesn' t coincide with the ether but with the physical system where the considered event happens (Principle of Reference)[1]. On the basis of both the PRF and the Principle of Relativity TR reachs the theoretical result concerning the existence of two speeds of light: the physical speed and the relativistic speed.
The physical speed of light is an universal constant and represents the speed of light with respect to the physical system where the propagation of light happens (PRF). Besides the physical speed of light is the same in every direction and it is a $\vec{c}$ vector quantity characterized by a magnitude and a direction. The physical speed is also the measured speed generally in all experiments because in all measurements the speed is measured always with respect to the reference frame where propagation happens and this is tied to the measurement apparatus which represents the preferred reference frame.
The $\vec{c}_r$ relativistic speed of light on the contrary is the calculated speed with respect to a reference frame different from the reference frame where propagation happens. It is very hard to measure the relativistic speed because it requires a

very sophisticated measurement equipment. In any case if $\vec{c}$ is the physical speed of light with respect to the reference frame where the propagation of light happens (PRF), the relativistic speed of light with respect to a moving reference frame with $\vec{v}$ relative speed is given by the theorem of vector composition

$$\vec{c}_r = \vec{c} + \vec{v} \qquad (18)$$

The relativistic speed can be whether smaller or greater than the physical speed. The concept of relativistic speed is a direct consequence of the Principle of Reference that in general affirms[1][2]

" a physical event must be firstly analysed by an observer, placed in symmetric way, who is inside the reference frame tied to the physical system where the event happens (PRF)".

In the event of the speed of light the Principle of Reference claims the measured speed of light is the physical speed and the relativistic speed can be calculated by the (18) relationship. It isn' t easy to measure directly the relativistic speed of light but it can be measured easily indirectly.

5. Muon average life

Muon average life is considered an important evidence in support of the SR and in support specifically of time relativity[6]. Muon is an unstable negative leptonic particle which decaies with average life $\tau_o \approx 2{,}2\mu s$. Cosmic muons are generated by collisions of cosmic protons with high strates of the earth' s atmosphere (10-15 km). In SR the speed of light cannot be exceeded and also if we suppose for muons a maximum speed equal to c the covered distance in their average life is

$$d = c\,\tau_o = 3 \times 10^8 \times 2{,}2 \times 10^{-6} = 660 \text{ m} \qquad (19)$$

very different from the height of the troposphere (10-15 km). Consequently this interpretation isn' t able to explain the presence of muons on the earth' s surface. SR nevertheless theorizes, as written before, the time relativity and therefore if τ_o is its own average life of moving muon the average life with respect to the reference frame at rest is

$$t_o = \beta\,\tau_o \qquad (20)$$

where β is the Lorentz factor

$$\beta = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} > 1 \qquad (21)$$

Assuming a muon speed very near to the speed of light, for example v=0,998c, we have

$$\beta \approx 16$$
$$t_o \approx 35\ \mu s \qquad (22)$$

and

$$d = 0{,}998c\ t_o = 0{,}998 \times 3 \times 10^{8} \times 35 \times 10^{-6} \approx 10{,}5 \text{ km} \qquad (23)$$

This value is in good concordance with the height of the troposphere. In SR it is necessary to consider the time relativity and to suppose very near speeds to c in order to explain the presence of muons on the earth' s surface.
If the speed of light isn' t an universal constant an alternative explanation about the presence of muons on the earth' s surface is possible.
In fact in TR the speed of light can be exceed by elementary particles.
Assuming an average distance of the troposphere equal to 10,5 km, muons are able to reach the earth' s surface, before decaying, with a speed c'≈16c. In fact in that case

$$c' = \frac{10{,}5 \times 10^{3}}{2{,}2 \times 10^{-6}} \approx 16c \qquad (24)$$

The decay distance d=12 km is obtained instead at the speed

$$c' = \frac{12 \times 10^{3}}{2{,}2 \times 10^{-6}} \approx 18c \qquad (25)$$

For a decay distance d=13,5 km the speed of muons is c'≈20c.
Those velocities seem very high but the world of unstable elementary particles is still an unknown world in many respects and in TR there isn' t a law which prohibits the overshooting of the speed of light.
If the speed of light isn' t an universal constant new important scenarios are possible in physics, in particular for elementary particles.

6. CERN and LNGS' s experiment: hypothesis on the physical nature of neutrino

Authors of this experiment have communicated muon neutrinos have traveled between CERN (in Geneva, Switzerland) and LNGS (in Abruzzo, Italy) at the greater speed than light of about 6 km/s. This result isn' t compatible with Einstein's theory of relativity but it is fully compatible with the Theory of Reference Frames. Pending further confirmations we can deduce some important considerations.
In the first place the result of that experiment clarifies the speed of neutrinos is very near to the speed of light and it is very plausible that neutrinos travel just at the same speed of light.
If neutrinos travel at the same speed of light we can deduce neutrinos have the same physical nature of photons.

If neutrinos have the same physical nature of photons we can still deduce they have null mass.
In second place if neutrinos have the same nature of photons then they are energy quanta and on this account respect Planck's relation.
Neutrinos therefore have a λ wavelength and a f frequency and if c_n is the speed of neutrinos we have $c_n=\lambda f$ where in all probability $c_n=c$.
Considering the muon neutrino, because "muon mass=206,77 electron mass" we have

$$\lambda = \frac{h}{c\,\Delta m} \tag{26}$$

from which $\lambda=1,2 \times 10^{-4}$ Angstroms and $f=2,55 \times 10^{22}$ Hz.
In our hypothesis muon neutrinos are electromagnetic nanowaves that cross matter because they don't have electric charge, don't have mass and have a very small wavelength.
Muon neutrinos are characterized by wavelengths $\lambda \sim 1,2 \times 10^{-4}$ Angstroms and by frequencies $f \sim 2,55 \times 10^{22}$ Hz and therefore the spectrum of muon neutrinos (that I call "δ rays") is over the spectrum of γ rays.
In conclusion we have formulated some hypotheses on the physical nature of neutrino as per also results of CERN and LNGS's experiment:

a. neutrino is an energy quantum as photon and not a particle of matter
b. neutrino has null mass and null electric charge
c. the frequency and wavelength of muon neutrinos are over the spectrum of γ rays into the spectrum of δ rays.

Further experiments will clarify if these deductions are accurate or it will be necessary to reach new more reliable conclusions.

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