Superluminal Neutrinos from Gran Sasso:
Cosmic Membrane Theory conform to Special Relativity

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Abstract

The publication of the OPERA collaboration concerning superluminal neutrinos raised hope to find a further proof of the existence of a rest frame in the sense of Newton’s absolute space. The CMB rest frame was the first serious indication. Now, the first time in the history of physics a team measured very exactly a velocity with a different starting and ending point of the course. All former measurements used mirrors or round courses with coinciding starting and ending point.

However, a more precise analysis showed that this hope was illusive. If a reference frame moves relative to the rest frame, and a photon or a neutrino starts with speed of light then the particle needs more time from sight of the moving observer because the particle moves in the rest frame in reality, and the ending point of the course is also moving together with the moving reference frame, but otherwise the clock at the ending point is late by exactly the above mentioned additionally needed time. The experimenter finds always the number c=299792458 m/s for the measured speed if he divides the length of the course by the run time, and this result is independent of the orientation of the course relative to the motion of our reference frame.

In this sense, the Cosmic Membrane Theory of the author conform the Special Relativity of Albert Einstein. The effect found by the OPERA collaboration must have another explanation.

Zusammenfassung

Die Veröffentlichung der OPERA Collaboration zu einer möglichen Überlichtgeschwindigkeit von Neutrinos schien nach der Entdeckung der Kosmischen Hintergrundstrahlung einen weiteren Beweis für die Existenz eines festen, ruhenden Bezugssystems (Ruhesystem) im Sinne von Newtons absolutem Raum liefern zu können, denn hier wurde zum ersten Mal in der Geschichte der Physik eine Geschwindigkeit sehr genau gemessen, bei der Start und Ziel der Laufstrecke weit voneinander entfernt liegen. Alle früheren Messungen arbeiteten mit Spiegeln oder ringförmigen Laufstrecken, so dass Start und Ziel zusammenfielen.

Bei einer genaueren Untersuchung erwies sich diese Hoffnung jedoch als falsch. Bewegt sich ein Bezugssystem relativ zum Ruhesystem und startet in ihm ein Photon oder ein Neutrino mit Lichtgeschwindigkeit, dann benötigt das Teilchen für den bewegten Beobachter zwar länger, weil sich das Teilchen in Wirklichkeit im Ruhesystem bewegt und der Zielpunkt sich

während der Laufzeit etwas entfernt, dafür ist die Uhr am Zielpunkt aber exakt um diese verlängerte Laufzeit zu spät. Der Experimentator findet immer, wenn er Laufstrecke durch Laufzeit dividiert, die Zahl c=299792458 m/s für die gemessene Geschwindigkeit, und das völlig unabhängig von der Ausrichtung der Laufstrecke gegenüber der Bewegung unseres Bezugssystems relativ zum ruhenden Bezugssystem.

In diesem Sinne gehen die Spezielle Relativitätstheorie von Albert Einstein und die vom Autor aufgestellte Kosmische Membrantheorie konform. Der von der OPERA Collaboration gefundene Effekt muss eine andere Ursache haben.

Résumé

La publication de la collaboration OPERA en matière de une vitesse des neutrinos plus vite que la lumière a rendu l’espoir à une preuve supplémentaire pour l’existence du référentiel absolu (« L’espace absolu » de Newton). Le fond de rayonnement cosmologique (CMB) était une première preuve. Pour la première fois en histoire de la physique on avait mesuré une vitesse sur une route avec un point de départ et un point de destination différente l’un de l’autre. Toutes les mesures antérieures travaillent avec des miroirs ou avec des routes cycliques de façon que le point de départ et le point de destination soient identiquement.

Mais une analyse plus précise montre que cet espoir fût vain. Si un référentiel se déplace relativement par rapport au référentiel absolu et on démarre un photon ou un neutrino à la vitesse de la lumière dans cet référentiel, puis il est vrai que cette particule ait besoin de plus temps pour l’observateur en mouvement puisque la particule se déplace dans le référentiel absolu en réalité et le point de destination s’éloigne pendant la durée de vol , mais pour la compensation l’horloge au point de destination est en retard exactement cette durée de vol supplémentaire. Le expérimentateur trouve toujours le nombre c=299792458 m/s pour la vitesse mesurée, si il divise la distance de la route par la durée de vol. Ce résultat ne dépend pas de la direction de la route par rapport au mouvement de notre référentiel dans le référentiel absolu.

En ce sens, la Relativité restreinte d’Albert Einstein et la Théorie de la Membrane Cosmique de l’auteur vont en accord. L’effet trouvé par la collaboration OPERA faut une autre cause.

1. Introduction

On 22 Sep 2011 the OPERA collaboration has posted a paper describing their result concerning measurements of the speed of neutrinos [1]. The author has copied the abstract of the paper: Measurement of the neutrino velocity with the OPERA detector in the CNGS beam.

(Submitted on 22 Sep 2011)

The OPERA neutrino experiment at the underground Gran Sasso Laboratory has measured the velocity of neutrinos from the CERN CNGS beam over a baseline of about 730 km with much higher accuracy than previous studies conducted with accelerator neutrinos. The measurement is based on high-statistics data taken by OPERA in the years 2009, 2010 and 2011. Dedicated upgrades of the CNGS timing system and of the OPERA detector, as well as a high precision geodesy campaign for the measurement of the neutrino baseline, allowed reaching comparable systematic and statistical accuracies. An early arrival time of CNGS muon neutrinos with respect to the one computed assuming the speed of light in vacuum of (60.7 \pm 6.9 (stat.) \pm 7.4 (sys.)) ns was measured. This anomaly corresponds to a relative difference of the muon neutrino velocity with respect to the speed of light (v-c)/c = (2.48 \pm 0.28 (stat.) \pm 0.30 (sys.)) \times 10-5.

Briefly summarised, this experiment delivers a speed of the neutrinos which is about 7.2 km/s greater than the speed of light. This fact is in contradiction to Special Relativity, which postulates the velocity of light, **c** , to be the upper limit of each motion.

2. Cosmic Membrane Theory

The Cosmic Membrane Theory (CMT) [7, 8, 9, 10, 11] postulates a rest frame: the cosmic membrane. The frame in which the Cosmic Microwave Background Radiation (CMB or CMBR) [6] has no dipole character is the best candidate for this rest frame (CMB rest frame).

The photons propagate in the CMB rest frame in all directions with speed c. Neutrinos are assumed to have the same (or nearly the same) speed. This follows from the observation of a supernova [2, 3, 5]. Photons and neutrinos arrived on Earth nearly at the same time, not temporally deferred. The author cites G. Feldman of Harvard [4]:

“In 1987, a supernova exploded millions of miles away, collapsing in on itself, sending particles hurtling through space. Neutrinos arrived on Earth three hours before the light given off by the supernova. The difference in the speed of the neutrinos observed by Grand Sasso’s OPERA detector was greater than the speed of the supernova’s neutrinos. “If OPERA was correct, these neutrinos should have preceded the light by four years,” said Feldman.

Feldman explained that these neutrinos essentially had a head start. Because of their negligible mass, neutrinos can pass through matter more easily than protons carrying light. In the case of the supernova, he said, the neutrinos escaped from the centre of the explosion faster and began their journey through space first.”

By the dipole character of the Cosmic Microwave Background Radiation we know that the Sun moves with a speed of about 369 km/s relative to the CMB rest frame in direction of the Virgin cluster [6].

The Galactic coordinates of this direction are:

galactic longitude	l=264.31°
galactic latitude	b=48.05°

In Equatorial coordinates this direction is given by

Right ascension	α = 11 h 11 m 57 s or 167.988°
Declination	δ = - 7.22°

Fig. 1 shows the relations:

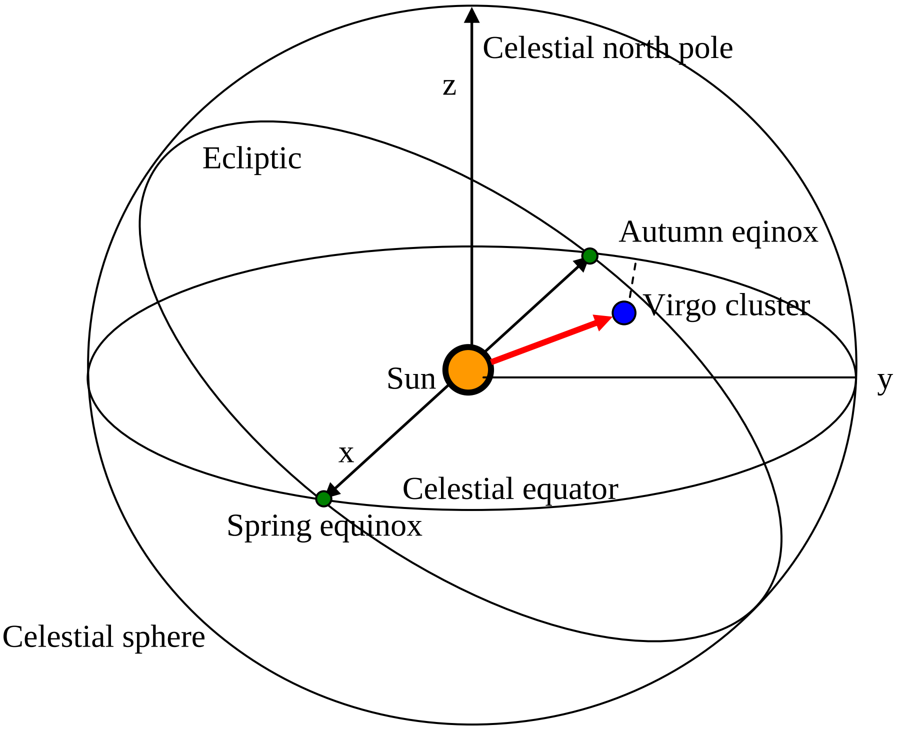

Fig. 1: Movement of the Sun in direction of the Virgo cluster

The Earth moves together with the Sun. The orbit of the Earth is nearly a circle. The orbital speed if the Earth is about 30 km/s. Thus, the movement of the Earth in the CMB rest frame is the movement of the Sun superposed by the movement of the Earth on its orbit.

3. Addition of velocities and change of time

Physics with a rest frame is slightly different from Special Relativity (SR). But only in some few points [10]. We denote our comoving reference frame by $\boldsymbol{\sigma}'$**,** and we assume speed v of this frame in the rest frame. In a first estimation of the apparent change of the speed of the neutrinos, Δc, measured in our comoving reference frame $\boldsymbol{\sigma}'$ we look at fig. 2.

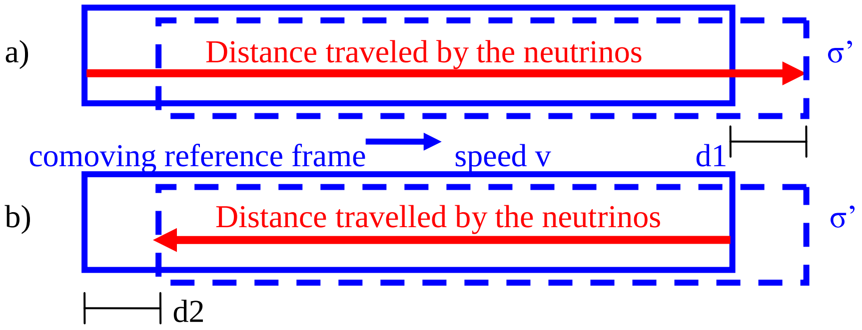

Fig. 2: Different distances in a moving frame depending on direction

In case a) the neutrinos travel in the same direction as the comoving reference frame is moving. During the runtime **t** the reference frame runs the small distance **d1**. The travel time of the neutrinos is longer, and we compute therefore a smaller speed, that is a negative change of the speed of the neutrinos Δ**c**. The measured apparent speed is **c-v**. That means: If the neutrinos move exactly parallel to the movement of the Sun in the CMB rest frame, then their speed should be found to be 369 km/s to low in relation to speed **c** in our reference system, with accentuation on "should".

In case b) the neutrinos travel in the opposite direction as the comoving reference frame is moving. During the runtime **t** the reference frame runs the small distance **d2**. The travel time of the neutrinos is shorter, and we compute therefore a higher speed, that is a positive change of the speed of the neutrinos Δ**c**. The measured apparent speed is **c+v**. That means: If the neutrinos move exactly in the opposite direction to the movement of the Sun in the CMB rest frame, then their speed should be found to be 369 km/s to high in relation to speed **c** in our reference system.

Neither the OPERA experiment nor the astronomical observations yield such a result. What is wrong? Time transformation is the magic word. Clocks change their speed if they are in movement.

The relativistic time dilation is in the Cosmic Membrane Theory [10] the same as in the Special Relativity. Only the interpretation differs somewhat.

$$t = \frac{t'}{\sqrt{1 - v^2/c^2}}. \qquad (1)$$

Eq. (1) has the meaning that a time t will be measured with a greater amount in the rest frame than time t' in the comoving reference frame. Here **v** is the speed of the comoving reference frame. Now we assume that a clock moves with speed **u** inside the comoving reference frame. Speed **v** and **u** must not have the same direction. Therefore we write them as vectors. We denominate with **dt'** the time step of a clock in the comoving reference frame (laboratory), and with **dt"** the time step of a clock with speed **u**. We get

$$dt = \frac{dt''}{\sqrt{1 - \frac{(\vec{v} + \vec{u})^2}{c^2}}}. \qquad (2)$$

Now we replace **dt** by **dt'**.

$$\frac{dt'}{\sqrt{1-v^2/c^2}} = \frac{dt''}{\sqrt{1-\frac{(\vec{v}+\vec{u})^2}{c^2}}}, \qquad (3)$$

or

$$dt'' = \frac{\sqrt{1-\frac{(\vec{v}+\vec{u})^2}{c^2}}}{\sqrt{1-v^2/c^2}} \cdot dt'. \qquad (4)$$

If the speed v of the comoving reference frame inside the rest frame is much smaller than the speed of light (v<<c) and **u** is smaller than **v** (u<v), then we can simplify eq. (4). We get

$$dt'' = \left(1-\frac{(\vec{v}+\vec{u})^2}{2c^2}\right) \cdot \left(1+\frac{v^2}{2c^2}\right) \cdot dt'. \qquad (5)$$

If **v** and **u** have the same direction then $(\vec{v}+\vec{u})^2 = v^2 + 2vu + u^2$. If **u** is much smaller than **v** then we can neglect u^2. In this case we get $(\vec{v}+\vec{u})^2 = v^2 + 2vu$. In this case eq. (5) can be further simplified to

$$dt'' = -\frac{vu}{c^2} \cdot dt'. \qquad (6)$$

If **v** and **u** have the opposite direction then $(\vec{v}+\vec{u})^2 = v^2 - 2vu + u^2$. If **u** is much smaller than v then we can neglect u^2. In this case we get $(\vec{v}+\vec{u})^2 = v^2 - 2vu$, or dt"= $+vu/c^2$.

Now we consider a clock which is transported in our comoving reference frame from one laboratory (coordinate x'_1) to another laboratory (coordinate x'_2) at a constant small speed **u** (u<<v). Further we assume **v** and **u** to be parallel. If speed **u** is constant, we can replace u·dt' by a path step **dx'** in the comoving reference frame. Now we had to integrate.

$$\Delta t'' = \int_{t'_1}^{t'_2} -\frac{vu}{c^2} dt' = \int_{x'_1}^{x'_2} -\frac{v}{c^2} dx' = -\frac{v \cdot s'}{c^2}. \qquad (7)$$

Here **s'** is the path length the clock has been moved. The clock at line x'_2 shows a time which is by $\Delta t'' = vs'/c^2$ less than that of the clock at line x'_1 (reference time). If **u** and **v** have opposite direction (movement from line x'_1 back to line x'_0) we get $\Delta t'' = +vs'/c^2$. The clock at line x'_0 shows a time which is by $\Delta t'' = vs'/c^2$ greater than that of the clock at line x'_1.

It is not shown here, but this result does not depend on the path of movement itself. Only the starting line x'_1 and the ending line x'_2 of the movement are of interest (or line x'_0, respectively). If **u** is not parallel or antiparallel to **v** then we had to replace in eq. (7) the product vs' by the scalar vector product $\vec{v} \cdot \vec{s}\,'$. That means that only that component of the path **s'** is of interest which is parallel or antiparallel to the speed **v** of the comoving reference frame. The rest frame is the only frame in which we can synchronise clocks by a very slow movement from one place to another. Fig. 3 illustrates this fact.

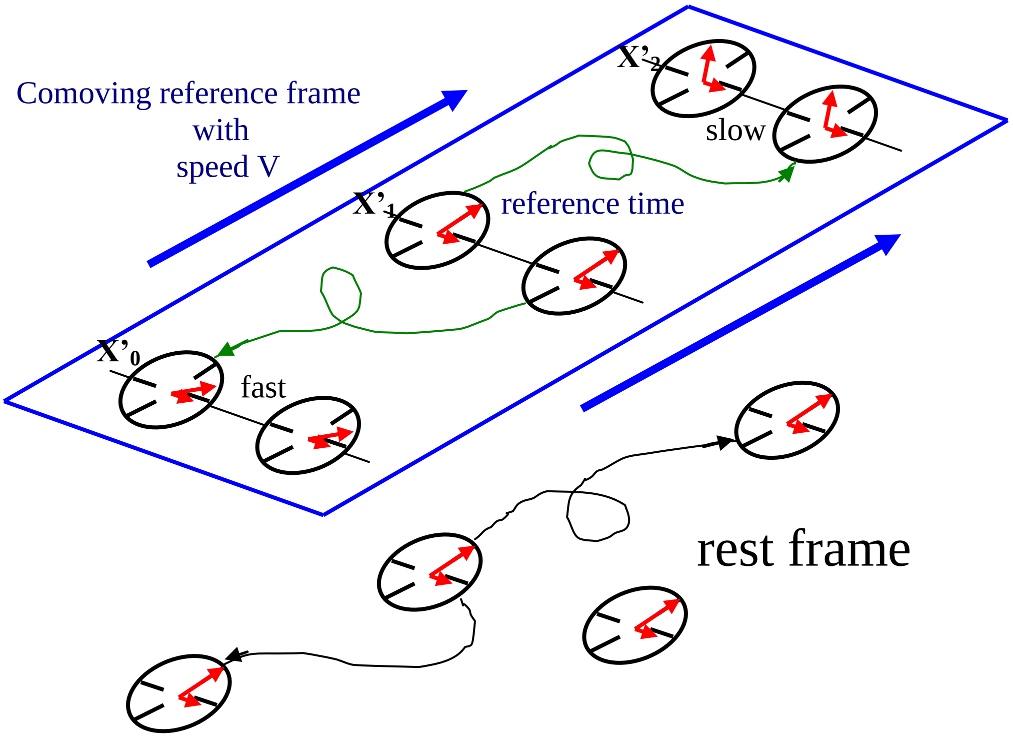

Fig. 3: Clocks show different time depending on its position in a moving frame.

Now we can constate that the apparent speed **c-v** from above we had gotten by the consideration that the photons or neutrons need more time if they move parallel to speed **v** of the comoving reference frame. But because the clock in the ending point is too late we will register exact the time t'=s'/c.

More mathematically, the additionally needed time for the parallel movement is Δt=s'/(c-v) – s'/c, and if v<<c, Δt=s'c (1+v/c)-s'/c, or Δt=s'v/c. But the clock at line x'_2 is exact this time to late. Both time intervals cancel one another, and we find c = s'/t'. It does not matter that our reference frame moves. We will find always that the speed of light is c.

In the antiparallel case the apparent speed was c+v. The less needed time for the antiparallel movement is Δt=s'/(c+v) –s'/c, and if v<<c, Δt=s'c (1-v/c)-s'/c, or Δt= -s'v/c. But the clock at line x'_0 is exact this time ahead. Again both time intervals cancel one another. Again we will find that the speed of light is c.

4. Discussion

The OPERA collaboration can not measure the runtime of a single neutrino because the time of creation is not known. The procedure is more complicated.

The LHC near Geneve produces proton packets during a time interval of 10 µs. The protons hit a target and produce neutrinos. The Gran Sasso laboratory measures only a tiny percentage of these neutrinos (N=16111 events over 3 years).

The registered neutrinos are counted in a histogram with class width 150 ns. Over the 3 years the physicists of the Gran Sasso got a time distribution of the registered neutrinos. This distribution has the same form as a single proton wave registered in the LHC.

The histogram and the original proton wave have a time lag relative to the expected runtime of the neutrinos. But this time lag is by -1050 ns to small. From this missing time the Gran Sasso physicists can declare 990 ns by systematic errors. The remaining rest of -60 ns are the time the neutrinos arrive to fast the Gran Sasso Laboratory. The 60 ns are equivalent to a surplus of speed with amount Δc=7.2 km/s.

First, the author wants to congratulate the OPERA collaboration for this work. Three years of data collecting, then the statistical analysis. Hats off to the team.

Reading the paper [1] one could miss a remark concerning the Doppler effect of the moving GPS satellites. The speed of a satellite is about 3.8 km/s. The above mentioned surplus of speed of 7.2 km/s is about twice the speed of a satellite.

What remains to say?

Special Relativity, and also the Cosmic Membrane Theory, measures the vacuum speed of light as a constant in all reference frames (not accelerated, not rotating, far away from heavy masses).

Astronomy denies that the speed of the neutrinos differs from the speed of the photons, or if it differs than much less.

But there is a little chance that the speed of neutrinos can exceed the speed of light. Sound waves propagate with 333 m/s through air. But the single molecule has an averaged speed which is higher (about 500 m/s). In the same way one could imagine that special particles can exceed the speed of light.

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