

Theory of Faster Than Light Neutrinos

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Abstract

With an overall significance of 6.0σ , the velocity of muon neutrinos from CERN through the crust of the earth to the underground Gran Sasso Laboratory has been determined to be in excess of that of light. The Reciprocal System explains this "anomalous" finding by mathematically extending the Special Theory of Relativity, in an inverse fashion, to the cosmic (inverse) sector. The calculated velocity is shown to be equal to the observed velocity within the experimental error.

keywords: neutrinos, Special Theory of Relativity, Reciprocal System, CERN, faster-than-light speeds

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Nomenclature

c_c = speed of light as measured in cosmic sector, sec/m

c_m = speed of light as measured in material sector, m/sec

l_R = interregional ratio for atoms (dimensionless)

l_{R_1} = interregional ratio for subatoms (dimensionless)

n_c = index of refraction of cosmic neutrinos through material solid, stated in cosmic terms

n_m = index of refraction of cosmic neutrinos through material solid, stated in material terms

s = total space involved in event, m

s_{clock} = clock space involved in event, m

s_{coord} = coordinate space involved in event, m

t = total time involved in event, sec

t_{clock} = clock time involved in event, sec

t_{coord} = coordinate time involved in event, sec

v_c = velocity as measured in cosmic sector, sec/m (subscript "max" for maximum velocity)

v_m = velocity as measured in material sector, m/sec (subscript "max" for maximum velocity)

v_{v_calc} = calculated velocity of muon neutrino, m/sec

v_{v_obs} = observed velocity of muon neutrino, m/sec

δt = difference in arrival time between photon and neutrino at detector, sec

Note: A black square in the upper right of an equation means that the equation is disabled from running in *Mathcad*. This is done because not all variables in the equation have, as yet, been given numerical values at that point in the program.

1. The Experiment

Ref. [1] describes the experiment. The muon neutrinos appear to arrive at the detector earlier than photons in a vacuum by this amount (Ref. [1], p. 19):

$$\delta t := 60.7 \cdot 10^{-9} \text{ sec} \quad \pm 6.9 \times 10^{-9} \text{ (statistical error)} \pm 7.4 \times 10^{-9} \text{ (systematic error)} \text{ sec} \quad (1)$$

The travel distance in the experiment (measured by GPS devices) is

$$s_{\text{coord}} := 730085.0 \text{ m} \quad (\text{Ref. [1], p. 19}) \quad (2)$$

The assumed velocity of light in a vacuum is

$$c_m := 299792458 \text{ m/sec} \quad (3)$$

The observed velocity of the muon neutrinos is then computed from

$$\frac{v_{\nu_obs} - c_m}{c_m} = \frac{\delta t}{\frac{s_{\text{coord}}}{c_m} - \delta t} = 2.48 \times 10^{-5} \quad (4)$$

$\pm 0.28 \times 10^{-5} \text{ (statistical error)} \pm 0.30 \times 10^{-5} \text{ (systematic error)}$

$$v_{\nu_obs} := \frac{s_{\text{coord}}}{s_{\text{coord}} - \delta t \cdot c_m} \cdot c_m \quad v_{\nu_obs} = 299799930.52705574 \text{ m/sec} \quad (5)$$

(disregarding the error estimates). The observed "index of refraction" (in material terms) is then

$$n_{m_obs} := \frac{c_m}{v_{\nu_obs}} \quad n_{m_obs} = 0.999975075 \quad (6)$$

This is "anomalous," of course: according to the Special Theory of Relativity, *nothing* can travel faster than the speed of light.

2. The Reciprocal System Explanation

The Reciprocal System of theory is described in Dewey B. Larson's books, such as Ref. [2], [5], [8], [9]. It is a unified, general theory of the universe, based on the concept that space-time is the fundamental component. In this theory, space-time is perfectly symmetrical, and there are two major sectors of the universe, our material sector, and the cosmic (or inverse) sector. The cosmic sector is identical to the material sector except that space and time are interchanged. The basic velocity equations are as follows.

material sector "normal low speed" conditions: coordinate space, clock time

$$v_m := \frac{s_{\text{coord}}}{t_{\text{clock}}} \text{ m/sec} \quad |s_{\text{coord}}| \ll |t_{\text{clock}}| \quad (7)$$

cosmic sector "normal low (inverse) speed" conditions: coordinate time, clock space

$$v_c := \frac{t_{\text{coord}}}{s_{\text{clock}}} \text{ sec/m} \quad |t_{\text{coord}}| \ll |s_{\text{clock}}| \quad (8)$$

But for high speeds (uniform linear motion) in the material sector, Eq. (7) must be modified to include the Lorentz transform from Special Relativity (see Ref. [3], [4] if you need a review).

material sector "high speed": coordinate space, clock time, coordinate time

$$v_m := \left(t^2 - t_{\text{clock}}^2 \right)^{\frac{1}{2}} \cdot \frac{c_m}{t} \quad t = \text{total time, } t > t_{\text{clock}} \quad (9)$$

$$t_{\text{coord}} := t - t_{\text{clock}} \quad \text{time dilation} \quad (10)$$

Note: There is no *space contraction* in the material sector, so the Reciprocal System agrees, mathematically, with the Special Theory of Relativity, but *not* conceptually.

Similarly, for high (inverse) speeds (uniform linear motion) in the cosmic sector, Eq. (8) must be modified to include the (inverse) Lorentz transform from Special Relativity; this is an *extension* of Special Relativity to the cosmic sector.

cosmic sector "high speed": coordinate time, clock space, coordinate space

$$c_c := \frac{1}{c_m} \quad c_c = 3.335640952 \times 10^{-9} \quad \text{sec/m} \quad (11)$$

$$v_c := \left(s^2 - s_{\text{clock}}^2 \right)^{\frac{1}{2}} \cdot \frac{c_c}{s} \quad s = \text{total space, } s > s_{\text{clock}} \quad (12)$$

$$s_{\text{coord}} := s - s_{\text{clock}} \quad \text{space dilation} \quad (13)$$

Note: There is no *time contraction* in the cosmic sector, so the Reciprocal System agrees, mathematically, with the *extension* of the Special Theory of Relativity to the cosmic sector, but *not* conceptually.

Note: The *maximum one-dimensional* speed of a material object in the material sector is

$$v_{m_max} := c_m \quad \text{m/sec} \quad (14)$$

And the *maximum one-dimensional* speed of a cosmic object in the cosmic sector is

$$v_{c_max} := c_c \quad \text{sec/m} \quad (15)$$

The question now is: how do we compute the space dilation for *cosmic subatoms traveling through material atoms*? We can derive the answer by reviewing p. 72 of Ref. [5]. This will come as a shock to conventional scientists, but in the Reciprocal System, cosmic atoms are plentiful in the material environment—they are the *controlling* units in the nuclei of biological cells!

"The biological cell is considerably larger than the [crystal] unit cell of the material aggregate because of the cosmic nature of the life unit force, the effective reach of which determines the cell size. The diameter of the cell in both cases is basically related to the natural unit of distance, which has been evaluated from fundamental relationships as 5×10^{-6} cm [4.558816 $\times 10^{-6}$ cm, more precisely], but the nature of the interatomic forces has an effect, explained in detail in previous publications, which reduces the radius of the unit cell of solid matter to roughly 150th [1/156.4444 more precisely] of this natural unit of distance, or about 3×10^{-8} cm [2.914 $\times 10^{-8}$ cm]. Because of the reversal of directions in the cosmic sector, the range of effectiveness of the cosmic forces is approximately 150 times [156.4444 times] the natural unit of distance, or about 8×10^{-4} cm [.000713 cm]; that is, the maximum diameter of a biological cell is about .015 millimeter [.01426 mm]."

The interregional ratio for material atoms is computed (Ref. [2], pp. 29-30), as

$$I_R := \left[128 \cdot \left(1 + \frac{2}{9} \right) \right] \quad I_R = 156.444444444 \quad (\text{atoms}) \quad (16)$$

The 2/9 factor is for the two photons present. But subatoms have only one rotating photon, so Eq. (16) must be modified to:

$$I_{R_1} := \left[128 \cdot \left(1 + \frac{1}{9} \right) \right] \quad I_{R_1} = 142.222222222 \quad (\text{subatoms}) \quad (17)$$

For cosmic atoms and subatoms, we must use the *inverse* of these two equations. Therefore, the space dilation for cosmic subatoms is

$$\frac{s}{s_{\text{clock}}} = I_{R_1} \quad (\text{space dilation for cosmic subatoms}) \quad (18)$$

Eq. (12) can be rearranged into an expansion ratio:

$$I_{R_1} = \frac{1}{\sqrt{1^2 - \frac{\left(\frac{1}{v_{\nu_calc}}\right)^2}{c_c^2}}} \quad v_{\nu_calc} := \frac{1}{1 - \left(\frac{1}{I_{R_1}}\right)^2} \cdot \frac{\left[1 - \left(\frac{1}{I_{R_1}}\right)^2\right]^{\frac{1}{2}}}{c_c} \quad (19)$$

$$v_{\nu_calc} = 299799868.91599363 \text{ m/sec} \quad (\text{expressed in material terms}) \quad (20)$$

Therefore

$$\frac{v_{\nu_calc}}{v_{\nu_obs}} = 0.999999794 \quad (21)$$

$$\frac{v_{\nu_calc} - c_m}{c_m} = 0.00002472 \quad (22)$$

which compares with the experimental value:

$$0.0000248 \pm .0000028 \text{ (statistical error)} \pm .0000030 \text{ (systematic error)}$$

(Ref. [1], p. 19)

And

$$n_{c_calc} := \frac{c_c}{\frac{1}{v_{\nu_calc}}} \quad n_{c_calc} = 1.00002472 \quad (23)$$

$$n_{m_calc} := \frac{1}{n_{c_calc}} \quad n_{m_calc} = 0.99997528 \quad (24)$$

$$\frac{n_{m_calc}}{n_{m_obs}} = 1.000000206 \quad (25)$$

$$s_{clock} := 730085.0 \quad m \quad (26)$$

$$s := s_{clock} \cdot |R_1| \quad s = 103834311.11111112 \quad m \quad (27)$$

$$s_{coord} := s - s_{clock} \quad s_{coord} = 103104226.11111112 \quad m \quad (28)$$

quite a space dilation!

In cosmic terms:

$$v_c := \left(s^2 - s_{clock}^2 \right)^{\frac{1}{2}} \cdot \frac{c_c}{s} \quad \text{sec/m} \quad v_c = 3.335558496 \times 10^{-9} \quad \text{sec/m} \quad (29)$$

$$\frac{1}{v_c} = 299799868.91599369 \quad \text{m/sec} \quad \text{in agreement with Eq. (20)} \quad (30)$$

The Reciprocal System calculations agree with the observations to within the experimental error given in Ref. [1].

Up to this point it has not really been necessary to determine exactly *which kind* of subatom, in Reciprocal System terms, has been used in this experiment (muon neutrinos to conventional scientists). Table I, from Ref. [6], lists the massless, chargeless subatoms in the Reciprocal System. (Of course, the electrons and positrons tabulated can take an electric charge, but we are here concerned with the "bare" particles.) These particles *all* move with the space-time progression at speed c unless, of course, they're moving *within* atoms or c-atoms, in which case there can be "refraction."

Subatom	Photon Freq.	Rot. Displ.	Eff. Rot. Displ.	Rot. Speed	Rot. Freq.
m-positron	2 R	1-0-1	0-0-1	1/2-1-1/2	$R/\pi-2R/\pi-R/\pi$
c-positron	1/2 R	(1)-0-(1)	0-0-(1)	2-1-2	$4R/\pi-2R/\pi-4R/\pi$
m-electron	2 R	1-0-(1)	0-0-(1)	1/2-1-2	$R/\pi-2R/\pi-4R/\pi$
c-electron	1/2 R	(1)-0-1	0-0-1	2-1-1/2	$4R/\pi-2R/\pi-R/\pi$
m-massless neutron	2 R	1-1-0	1/2-1/2-0	1/2-1/2-1	$R/\pi-R/\pi-2R/\pi$
c-massless neutron	1/2 R	(1)-(1)-0	(1/2)-(1/2)-0	2-2-1	$4R/\pi-4R/\pi-2R/\pi$
m-neutrino	2 R	1-1-(1)	1/2-1/2-(1)	1/2-1/2-2	$R/\pi-R/\pi-4R/\pi$
c-neutrino	1/2 R	(1)-(1)-1	(1/2)-(1/2)-1	2-2-1/2	$4R/\pi-4R/\pi-R/\pi$

Table I. Massless, Chargeless Subatoms

Cosmic subatoms moving through material atoms appear to *speed up* (to us)—just as the experiment found. This is *space dilation*, completely analogous to time dilation. Incidentally, material electrons are essentially just rotating space units and so they, too, can move faster than light in matter—when the current is greater than 1.05353×10^{-3} A (Ref. [9], p. 110).

A muon neutrino can be either a c-neutrino or a c-massless neutron or an m-neutrino or an m-massless neutron. The reactions in the experiment involve pions, which are c-Si, and kaons, which are gravitationally-charged c-Kr (Ref. [2], 2nd ed., p. 201). According to Larson, Ref. [8], pp. 385-386:

"The phenomena of the cosmic sector with which we are now concerned are the observable events which involve contacts of material objects with objects that are either partially or totally cosmic in character. Interaction of a *purely material* unit with a cosmic unit, or a *purely cosmic* unit with a material unit follows a special pattern. Where the structures are identical, aside from the inversion of the space-time relations, as in the case of the electron and the positron, they destroy each other on contact. Otherwise, the contact is a relation between a space magnitude and a time magnitude, which is motion. Viewed from a geometrical standpoint, these entities move *through* each other.....Material and cosmic atoms, and most sub-atomic particles, are composite structures that include both material (spatial [time displacement]) and cosmic (temporal [space displacement]) components. Inter-sector contacts between such objects therefore have results similar to those of contacts between material objects." This is *refraction*.

Presumably, a cosmic neutrino would suffer less equivalent refraction than a cosmic massless neutron, because of the additional electric displacement, so our tentative conclusion is that the muon neutrino--in this particular experiment--is a cosmic neutrino . In other experiments and observations, it might be one of the other possible subatoms, like an m-massless neutron (Ref. [2], 2nd ed., p. 214). Incidentally, (most, if not all of) the observed neutrinos coming from material supernovae are m-neutrinos or m-massless neutrons--their speed is very slightly *less* than c_m because of interstellar gas and dust particles.

It's also important to note that cosmic atoms and subatoms do not "see" material solids the way we (as observers in the material sector) do. Rather, they "see" material solids as very diffuse cosmic gases. This is because of the reciprocal postulate: material atoms (or, more properly, their force fields) are contiguous in *coordinate space*, and far apart in *coordinate time*. Incidentally, that's why we don't see aggregates of cosmic atoms (like cosmic stars) in coordinate space--they are not localized in space, they are localized in time.

The material gas with the lowest index of refraction is that of helium: 1.000036 (at 273.15 K), (Ref. [7], p. 58). This is in the range given by Eq. (23), as we would expect. The SiO_2 of the earth's crust appears to the cosmic subatoms as something like *very diffuse c-He*.

Important Note: If, in fact, material neutrinos rather than cosmic neutrinos are used in the experiment, then the above results would *not* be found--*there would be no speeds higher than c_m* .

Conclusion

The Reciprocal System explains the conundrum of the CERN experiment involving faster than light muon neutrinos. The Special Theory of Relativity is mathematically extended, inversely, to the cosmic (inverse) sector, and the velocity of the muon neutrinos is calculated. The result is within the experimental error of the observation.

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References

- [1] T. Adam, et. al., "Measurement of the Neutrino Velocity with the OPERA Detector in the CNGS Beam," Cornell University Library, <http://arxiv.org/abs/1109.4897>, 09/22/2011.
- [2] D. Larson, *The Structure of the Physical Universe* (Portland, OR: North Pacific Publishers, 1959); *Nothing But Motion* (Portland, OR: North Pacific Publishers, 1979). The latter is Volume I of the 2nd ed. of *The Structure of the Physical Universe*.
- [3] R. Resnick, *Introduction to Special Relativity* (New York, NY: John Wiley & Sons, 1968).
- [4] H. Young, R. Freedman, *Sears and Zemansky's University Physics*, Vol. 3, 11th ed. (San Francisco, CA: Pearson, Addison-Wesley, 2004).
- [5] D. Larson, *Beyond Space and Time* (Portland, OR: North Pacific Publishers, 1995).
- [6] R. Satz, "Further Mathematics of the Reciprocal System," *Reciprocity*, Vol. X, No. 3, Autumn 1980.
- [7] W. Martienssen, H. Warlimont, ed., *Springer Handbook of Condensed Matter and Materials Data* (Berlin, Germany: Springer, 2005).
- [8] D. Larson, *The Universe of Motion* (Portland, OR: North Pacific Publishers, 1984). This is Volume III of the revised and enlarged *The Structure of the Physical Universe*.
- [9] D. Larson, *Basic Properties of Matter* (Salt Lake City, UT: International Society of Unified Science, 1988). This is Volume II of the revised and enlarged *The Structure of the Physical Universe*.

Last updated 12-03-2012 to utilize same form of I_R as in other papers