The Superluminal Neutrinos Once More

Sylwester Kornowski

Abstract: Here, we motivate that the superluminal neutrinos can be produced only due to the weak interactions in the central condensates of baryons and only when the quantum entanglement between produced neutrinos in the beta decays and the neutrons/protons is destroyed. We assume that in the earlier experiments, the superluminal neutrinos were not eliminated whereas in the later ones such neutrinos were eliminated because of the additional elements of apparatus between the place of collision and the detector. It is the reason that we cite the earlier scientific works. The observed neutrino speed in the earlier MINOS experiment, in the earlier OPERA experiment, and the observed time-distance between the fronts of the neutrino and photon beams, observed on the Earth, for the supernova SN 1987A are consistent with the theoretical results obtained within the Scale-Symmetric Theory. All results are obtained within the same coherent model. How we can verify presented model? We should measure time distances between photon and neutrino fronts for supernovae - they should be directly proportional to distances between supernovae and Earth. We as well should repeat the MINOS experiment at lower energies applying proper apparatus - there should be observed the upper limit for the speed of neutrinos 1.000050(21)c.

1. Introduction

To see the problem we must adduce cosmology.

Due to the superluminal quantum entanglement, emitted photons are entangled with their source or with a last-interaction object (it can be a detector). The superluminal quantum entanglement fixes the speed of photons c in relation to source or a last-interaction object so it is not true that a photon has simultaneously the speed c in relation to all frames of reference but it is true that all detectors (they are the last-interaction objects) always measure the speed c – such is the correct interpretation of the Michelson-Morley experiment. We will call such phenomenon the duality of relativity.

Now consider the redshift of most distant galaxies. Doppler redshift leads to conclusion that observed redshift should not be greater than 1. But we know that there are galaxies with redshift higher than 1. Scientists suggest that we should transform the observed redshift into the Special-Relativity relativistic redshift that is always lower than 1. On the other hand, the mean radial speeds of big groups of galaxies and of the local radial speeds of the dark matter and dark energy are the same i.e. the groups are not the relativistic objects because they are in the rest in relation to the expanding dark matter and dark energy [1]. It leads to conclusion that we should not apply the Special or General Relativity to explain the observational redshift higher than 1.

So what phenomena are responsible for the observed redshift $z > 1$? The answer to this question follows from the cosmology described within the Scale-Symmetric Theory (SST) [1]. Due to the inflows of the dark matter and dark energy into the very early Universe built of neutrons grouped in larger structures (protogalaxies), there appeared as well the protuberances of the dark matter, dark energy and Einstein spacetime (they all consist of the same particles i.e. of the luminal neutrino-antineutrino pairs: dark matter is entangled with the leptonic and hadronic matter whereas dark energy consists of additional free neutrino-antineutrino pairs). Emphasize as well that the photons and gluons are the rotational energies of the neutrino-antineutrino pairs [2]. Due to the weak interactions, the protuberances interacted with the protogalaxies so there appeared the advection. Due to the cascades of protuberances, there appeared the relative radial velocities higher than the velocity of light in "vacuum" c. But we should not see such galaxies. Why we see them? And the answer follows from the duality of relativity. The emitted light by the "superluminal galaxies" had speed c in relation to them so we cannot see such light. But due to the very high dynamic pressure of the Einstein spacetime (about 10^{45} Pa [1]), the protuberances were very quickly dampened but due to the quantum entanglement the emitted light has always speed c in relation to decelerating galaxies. For an external observer to which these protogalaxies are moving away it looks like a photon acceleration so photons lose energy so there appears the redshift – it is the real cause of the observational redshift for distant galaxies higher than 1. Today we can see such galaxies because today their relative radial speed is lower than c.

The most important conclusion is as follows. Due to the quantum entanglement, speed of neutrinos and neutrino-antineutrino pairs in relation to their source or in relation to an apparatus that stops the muons or pions to produce neutrinos, is equal to c. So what we should do to produce superluminal neutrinos? And the answer is very simple. Due to some interactions we should accelerate neutrinos that appear in the beta decays – they can be accelerated due to their weak interactions with quadrupoles of, for example, muons or W bosons that are created in the central condensate of the baryons, and next we should destroy the quantum entanglement between such neutrinos and baryons. SST shows that it is possible only due to the nuclear weak interactions of the central condensate in the core of baryons [2]. The chaotic motions of the neutrino-antineutrino pairs inside the condensate (condensate is stable because of the volumetric confinement and because it is the modified black hole because of the nuclear weak interactions [2]) can destroy quantum entanglement between neutrino from beta decay and its source i.e. neutron/proton.

Emphasize as well that according to SST, the neutrinos acquire their gravitational masses because of their interactions with the superluminal Higgs field [2]. Moreover, due to the internal structure of neutrinos and spacetime, gravitational mass of neutrinos does not depend on their speed i.e. they are moving with speeds close to the c but they are the non-relativistic particles [2].

There is obligatory the four-particle/object symmetry [2]. Such quadrupole symmetry causes that the quadrupoles do not violate the laws of conservation of spin, charge and internal helicity of nucleons. Mass of the central condensate of baryons is $Y = 424.1245$ MeV so it can create quadrupoles of muons (mass of bound muon calculated within SST is $M_{Muon} = 105.82889$ MeV) [2]. Mass of the core of baryons is $H^+ = 727.44$ MeV or $H^o = 724.78$ MeV (it is the condensate plus the torus/charge), [2], so it can create quadrupoles of relativistic pions (mass of each component is about $M_{Rel\text{-}pion,mean}$ = 181.53 MeV). At higher energies of collision, for example, in explosions of supernovae, there are created quadrupoles of W bosons. Mass of W boson calculated within SST is $M_{W\text{-}boson}$ = 80.381 GeV [3].

2. Calculations

Assume that the above mentioned quadrupoles are created because of the nuclear weak interactions inside the central condensate in baryons (denote masses of the constituents by m). In the beta decay of a neutron there appears a neutrino. Assume that one pair of the quadrupole is exchanged between the neutrino and the second pair the quadrupole consists of. Then, the centrifugal force acting on the neutrino is directly proportional to the product

$$F_{neutrino} \sim 2m\,(2m + m_{neutrino}). \tag{1}$$

In approximation, the increase in the centrifugal force ΔF acting on the neutrino on surface of the condensate is

$$\Delta F_{neutrino} \sim 2m\,(2m + m_{neutrino}) - 4m\, m_{neutrino} \approx 4m^2. \tag{2}$$

The force $\Delta F_{neutrino}$ is responsible for the radial speed of the neutrino.

The neutrinos are the non-relativistic particles so we can apply to them the Newton's second law. The Newton's second law we can write for neutrinos as follows

$$m_{neutrino}\,\Delta v_{neutrino} = F_{neutrino} \cdot t_{exchange}. \tag{3}$$

From formulae (2) and (3) we obtain that the increase in the radial speed of beta-decay neutrinos is ($m_{neutron} - (m_{proton} + m_{electron})$ = 0.7813 MeV [2])

$$v_{neutrino} - c = \Delta v_{neutrino} \sim 4\,\{m_{neutron} - (m_{proton} + m_{electron})\}^2 = 4M^2. \tag{4}$$

The increase in the radial speed of the neutrinos appearing in the weak decays of other particles inside the central condensate of the baryons is (the initial spin speed is equal to c whereas initial radial speed is zero – it follows from the fact that the condensate is the modified black hole in respect of the nuclear weak interactions [2])

$$v_{neutrino} - 0 = \Delta v_{neutrino} \sim 4m^2. \tag{5}$$

From formulae (4) and (5) we obtain

$$(v_{neutrino} - c) / v_{neutrino} = (M / m)^2. \tag{6}$$

Since $v_{neutrino} \approx c$ then in approximation is

$$(v_{neutrino} - c) / c = (M / m)^2, \tag{7}$$

or

$$v_{neutrino} = \{1 + (M / m)^2\} c. \qquad (8)$$

To the constituents of the quadrupoles that initially appear as the condensates, we can apply the theory of stars. The theory of stars leads to conclusion that lifetime $T_{Lifetime}$ is inversely proportional to four powers of mass, i.e. $T_{Lifetime} \sim 1 / m^4$, so we can rewrite the formula (7) as follows

$$(T_{Lifetime\text{-}of\text{-}particle} / T_{Lifetime\text{-}of\text{-}neutron})^{1/2} = (v_{neutrino} - c) / c. \qquad (9)$$

We can see that we can calculate the superluminal speeds of neutrinos both from the masses of particles (formula (7)) or from their lifetimes (formula (9)).

From the Uncertainty Principle and the invariance of the neutrino mass follows that the squared change in neutrino speed is inversely proportional to the time of exchange $t_{exchange}$. On the other hand, from formula (4) and the relation $T \sim 1 / M^4$ follows that similar relation is for the lifetime $T_{Lifetime}$.

In baryons, there are three characteristic distances for the strong interactions: the radius of the core (about 0.7 fm), the radius of the Schwarzschild surface (about 1.4 fm) and radius of the boundary of the strong field (about 3 fm). If we assume that the central value is 1.4 fm then the upper and lower limit is defined in an approximation by the interval (1.4/2, 1.4·2) – we can assume that it defines the broadened central value. In an approximation the resultant speed of the neutrinos and neutrino-antineutrinos pairs is invariant so the interval defines as well the broadened lifetime or time of exchange of condensates. This means that the interval for the broadening of the time of exchange $t_{exchange}$, i.e. the $(t_{exchange}/2, 2t_{exchange})$, leads to following conclusions. To obtain the maximum neutrino speed, we must multiply the central value for an increase in neutrino speed in relation to the c (i.e. the $\Delta v / c = (v - c) / c$) by $sqrt(2)$ i.e. $v_{maximum} = (1 + \Delta v \cdot sqrt(2) / c)c$. For the minimum speed we obtain $v_{minimum} = (1 + \Delta v / (sqrt(2)\, c))c$. Such broadening should be characteristic for the modified black holes in respect of strong, weak, and gravitational interactions. The theoretical results are the central values whereas in the round brackets we will write the increases in speed for the maximum neutrino speed.

We assume that in the initial experiments, the superluminal neutrinos were not eliminated whereas in the later ones such neutrinos were eliminated because of the additional elements of apparatus between the place of collision and the detector. It is the reason that we cite the earlier scientific works.

For lower energies, such as in the MINOS experiment [4], there are mostly the neutrinos from the decays of neutrons and the condensates carrying energy equal to the mass of the bound muon. The ratio of the lifetime of neutron to lifetime of muon is smallest ($882/2.20\cdot10^{-6} \approx 4\cdot10^8$ [2]) so the obtained neutrino speed is the upper limit. From formula (9) follows that for the more precise MINOS experiment, for the neutrino speed we should obtain $1.000050(21)c$ i.e. the maximum neutrino speed should be $1.000071c$.

For higher energies, such as in the OPERA experiment [5], there are mostly the neutrinos from the weak decays of the neutrons and the condensates carrying energy equal to 181.5 MeV. Formula (7) leads to the neutrino speed equal to $1.0000185(77)c$ i.e. the maximum speed is $1.0000262c$ so the time-distance between the fronts of the neutrino and photon beams should be about 64 ns.

For highest energies, such as in the explosions of the neutron cores of supernovae, there dominate the neutrinos from the decays of the neutrons and the condensates carrying energy equal to the mass of the W boson. Better result we obtain applying formula (9). The quadrupole symmetry shows that creation of systems containing 4 elements is preferred. This means that the lifetime of the muon is characteristic also for the central condensate in the core of baryons (i.e. 424 MeV $\approx 4 \cdot 105.7$ MeV – each one of the four muons lives $2.2 \cdot 10^{-6}$ s [2]). This leads to conclusion that lifetime of the W bosons (mass = 80,400 MeV [2]) that decay due to the weak interactions is

$$T_{lifetime\text{-}W\text{-}boson} = 2.2 \cdot 10^{-6} \text{ s} / (80{,}400 / 424)^4 = 1.7 \cdot 10^{-15} \text{ s}. \qquad (10)$$

This leads to following neutrino speed $1.0000000014(6)c$ i.e. maximum speed is $1.000000002c$ (i.e. $(1 + 2 \cdot 10^{-9})c$).

The time-distance Δt between the fronts of the neutrino and photon beams, measured on the Earth for the SN 1987A, should be

$$\Delta t = 168{,}000 \text{ ly} \cdot 365 \text{ days} \cdot 24 \text{ hours} \cdot 2 \cdot 10^{-9} = 3 \text{ hours}. \qquad (11)$$

This result is consistent with the observational facts [6].

3. Summary

Here, we motivate that the superluminal neutrinos can be produced only due to the weak interactions in the central condensates of baryons and only when the quantum entanglement between produced neutrinos in the beta decays and the neutrons/protons is destroyed.

We assume that in the earlier experiments, the superluminal neutrinos were not eliminated whereas in the later ones such neutrinos were eliminated because of the additional elements of apparatus between the place of collision and the detector. It is the reason that we cite the earlier scientific works.

The observed neutrino speed in the earlier MINOS experiment, in the earlier OPERA experiment, and the observed time-distance between the fronts of the neutrino and photon beams, observed on the Earth, for the supernova SN 1987A are consistent with the theoretical results obtained within the Scale-Symmetric Theory.

All results are obtained within the same coherent model.

How we can verify presented model? We should measure time distances between photon and neutrino fronts for supernovae – they should be directly proportional to distances between supernovae and Earth. We as well should repeat the MINOS experiment at lower energies applying proper apparatus – there should be observed the upper limit for the speed of neutrinos $1.000050(21)c$.

References

[1] Sylwester Kornowski (23 November 2015). ”Foundations of the Scale Symmetric Physics (Main Article No 2: Cosmology)” http://vixra.org/abs/1511.0223

[2] Sylwester Kornowski (25 November 2015). ”Foundations of the Scale Symmetric Physics (Main Article No 1: Particle Physics)” http://vixra.org/abs/1511.0188

[3] Sylwester Kornowski (2 December 2015). ”Reformulated Quantum Chromodynamics” http://vixra.org/abs/1512.0020

[4] P. Adamson *et al.* (MINOS Collaboration) (2007). "Measurement of neutrino velocity with the MINOS detectors and NuMI neutrino beam". *Physical Review D* **76** (7). arXiv:0706.0437.

[5] OPERA Collaboration, T. Adam *et al.* (2011), “Measurement of the neutrino velocity with the OPERA detector in the CNGS beam”, arXiv:1109.4897 [hep-ex].

[6] K. Hirata *et al.*, Phys. Rev. Lett. 58 (1987) 1490;
R. M. Bionta *et al.*, Phys. Rev. Lett. 58 (1987) 1494;
M. J. Longo, Phys. Rev. D 36 (1987) 3276.