Neutrino Masses and Their Oscillation Periods Calculated Using Wheeler's Geometrodynamics Agree with the Results of the Neutrino-4 Experiment

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The mass values of the Majorana and sterile neutrinos and the period of their oscillations, calculated on the basis of a physical model based on J. Wheeler's geometrodynamics, coincide with the results obtained in the Neutrino-4 Experiment.

The results of the recent Neutrino-4 experiment to search for sterile neutrinos, which was carried out by teams from the Kurchatov Institute and the B.P. Konstantinov Petersburg Institute of Nuclear Physics, allow us to estimate the sterile neutrinos mass at (2.70 ± 0.22) eV, which does not contradict the other experiments results within the 3σ experimental error contours [1].

The oscillation period for a neutrino energy of 4 MeV is 1.4 m, Fig. 1. (taken from [1]). It was also found the Majorana neutrino mass value, obtained with the Neutrino-4 oscillation parameters, to be (0.25 ± 0.09) eV.

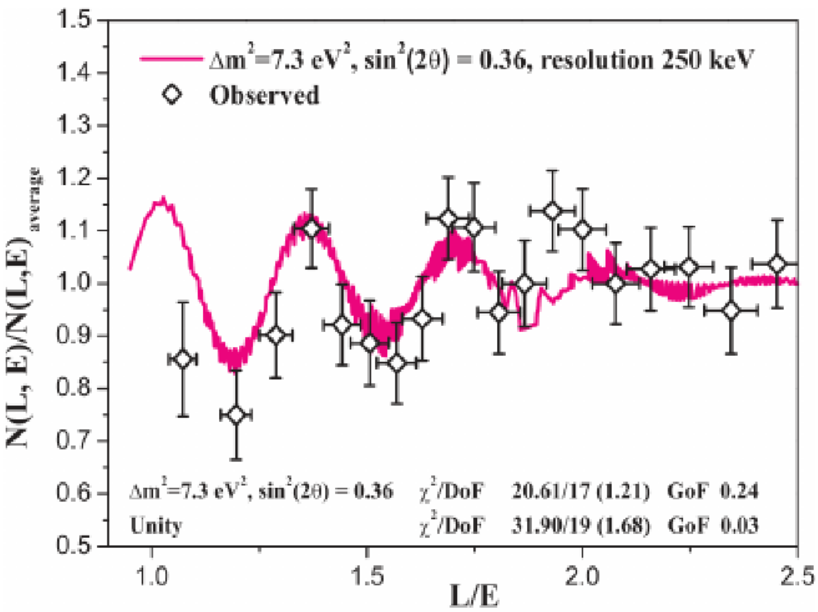

Fig. 1. Full curve of the oscillation process from the center of the reactor active zone

But it should be emphasized that it is these parameters that follow from the accepted neutrino model [2] and, in general, from the physical model of microphenomena outside the SM framework and based on the mechanistic interpretation of J. Wheeler's geometrodynamics, previously described in works [3 – 6] and others. This model makes it possible to directly calculate the parameters of neutrinos and other microparticles.

The mass of the neutrino is determined by introducing gravity, whose role in the microworld is erroneously denied in the SM. Let us recall that in the accepted model, the electron does not rotate around the proton and is not "smeared" in orbits, but the proton and electron are connected by a vortex current tube of the drain-source type in an additional dimension (conditionally, the Y -axis). As a result, a closed contour is formed along which the material medium circulates. The contour exists due to the equality of gravitational and magnetic forces. In the Coulomb-free form, i.e. when replacing the Coulomb with the value $m_e c$, the geometric mean follows from this equality in units of r_e:

$$L = l\,r = (z_{g1} z_{g2} / z_{e1} z_{e2})(2\pi\,\gamma\rho_e) \times[\mathrm{sec}]^2 \;, \tag{1}$$

where z_{g1}, z_{g2}, z_{e1}, z_{e2}, r, l, γ, ρ_e are the gravitational masses and charges in the masses and charges of the electron, the distance between the current tubes and their length, the gravitational constant and the electron specific density, equal to m_e / r_e^3. In formula (1), the value of z_{g1} is the active part of the proton mass (i.e. the quark) entering the circulation contour, z_{g2} is the electron mass.

According to the accepted model, a vortex tube of radius r_e, *boson mass* M, length l is spirally filled with a vortex thread of radius r. In units of r_e and m_e

$$M = l = (an)^2 \,, \tag{2}$$

$$r = c_0^{2/3} / (an)^4 \,, \tag{3}$$

where c_0 is the dimensionless speed of light c / [m/sec], a is the inverse fine structure constant, n is the quantum parameter. With complete compression of the spiral vortex thread, the mass-energy of the vortex tube becomes equal to (in units of $m_e c^2$)

$$L = l\,r = c_0^{2/3} / (an)^2 \,. \tag{4}$$

In works [2, 4] it is shown when particles to approach each other at a certain distance, the contour connecting them transfers energy-momentum to the internal structure of the proton, losing charge, and then is released in the form of a one-dimensional vortex tube of neutrinos, which carries away the electron spin. Neutrino release occurs under the condition that the Y -vortex tube mass-energy in its compressed state reaches the quark mass-energy, which makes it possible to determine the Y -vortex tube quantum parameter n_ν . In work [2] it was obtained :

$$n_\nu = c_0^{1/9} (2\pi\,\gamma\rho_e \times[\mathrm{sec}]^2)^{1/3} / a = 1.643, \tag{5}$$

and then the neutrino fermion mass was defined as the Y -vortex tube *fermion mass* m_ν = 4.39×10^{-7} (0.225 eV) and the quark mass m_k = 8.84 (4.51 MeV) was defined. The neutrino exists in this form at the moment of escaping, but since it has no detectable charge, therefore, then there is a neutrinos' transforming into some closed structure.

In [3] it is shown the electron vortex tube to contain three vortex zones. But since one of the zones must necessarily be double, then there should be four single vortex threads in general, containing on average ¼ of the electron total momentum (charge). Therefore, the neutrino should be considered as a pair of closed vortex threads of two possible types: a pair with left-right rotation and, conversely, a pair with right-left rotation (relative to the axis of motion direction).

In [2] the neutrino closed form mass value m_ν was obtained as *the gravitational mass*, i.e. as the value $z_{g1} = z_{g2} = m_\nu$ with $z_{e1} = z_{e2} = ¼\, e_0$ and under the assumption that the vortex thread has the Planck size $r = r_h = (\hbar\gamma / c^3)^{1/2} = 5.74\times10^{-21}\, r_e$, and then

$$m_\nu = z_g = c_0^{1/6}\, r_h^{1/4} (32\pi\gamma\rho_e \times [\mathrm{sec}^2])^{-1/2} = 4.31\times10^{-7} \;\; (0.220\text{ eV}), \tag{6}$$

which coincides with the fermionic mass of the neutrino vortex tube. Thus, two different neutrino states with identical masses are obtained - at the moment of neutrino birth in the form of the fermionic part of the vortex Y-tube and in its final state in the form of a closed structure having gravitational mass.

In addition to the work [2], it should be noted that if we consider a contour consisting of a pair of closed vortex threads, each having 1/3 of the electron charge, under the condition that the ***gravitational energy-mass of the particle means to be equal to the energy-mass of the compressed contour***, i.e., when $m_v = L = l\,r$, then it will have the following parameters:

$$m_v = (18\pi\gamma\rho_e \times [\mathrm{sec}^2])^{-1} = 6.52\times10^{-6}\ \ (3.33\ \mathrm{eV})\ , \qquad (7)$$

$$r = m_v^2 / c_0^{2/3} = 9.51\times10^{-17}\ \text{или}\ \ (130^2 r_h)\ , \qquad (8)$$

$$l = c_0^{\,2/3} / m_v = 6.86\times10^{10}\ \ \text{или}\ (1910\ a)^2. \qquad (9)$$

Here the particle mass depends only on the electron density and the gravitational constant, and the particle contour will have very characteristic parameters with axial dimensions close to $a^2 r_h$ and to the limiting atom size in space [7]. Obviously, such a particle is more fundamental one and in this form cannot participate in the weak interaction according to the above mechanism. The limiting energy of such a neutrino at $r \to r_e$ would be $6.86\times10^{10}\times 0.511 = 3.5\times10^{10}$ MeV (to date, the highest recorded neutrino energy is 2×10^{9} MeV).

Thus, the calculated neutrino masses according to the accepted model are as follows:

a) the neutrino masses at the moment of formation and in closed form coincide with the Majorana mass of the electron neutrino obtained in the Neutrino-4 experiments;

b) the more fundamental neutrino mass actually coincides with the estimate of the sterile neutrino mass obtained in the Neutrino-4 experiments. The discrepancy in the latter case is not significant, since, as the authors of the work [1] noted, at L/E>1 the best fit shifts to the region of larger values.

Moreover, the period (length) of the oscillations is also easily determined. Indeed, the speed of the sterile neutrino is proportional to the square root of the reactor neutrino energies value to the neutrino energy limiting value ratio:

$$v = c\ \ (4\ \mathrm{MeV} / 3.5\times10^{10}\ \mathrm{MeV})^{\,1/2} = 3210\ \mathrm{m/sec}\ . \qquad (10)$$

The time constant or duration of oscillations τ (like the proton lifetime [4]) is the ratio of the characteristic size of the contour r at n_v (according to (3) $r = 1.72\times10^{-4}\ r_e = 4.90\times10^{-19}$ m) to the fundamental rotation speed of the vortex threads, determined from the balance of magnetic and dynamic forces [4]:

$$v_0 = r_e/((2\pi)^{1/2} \times [\mathrm{sec}]) = 1.12\times10^{-15}\ \mathrm{m/sec}\ , \qquad (11)$$

and, accordingly, $\tau = r / v_0 = 4.37\times10^{-4}$ sec. Consequently, the period (distance) of oscillations for a sterile neutrino is $v\tau = 3210\times4.37\times10^{-4} = 1.4$ m, which exactly coincides with the experimental value.

As for the oscillations of electron neutrinos, in the initial period of its existence at an energy close to the quark mass-energy (about 4 eV), having the speed of light, they move away from the source in time τ to a distance of 1.31×10^{5} m, and if there is a neutrinos' transforming into another form, then a decrease in their number will be registered, provided the detector to be removed from the source at a distance no less than the calculated one.

It was at this distance and at these energies that the large neutrino detector KamLAND (Kamioka Liquid scintillator Anti-Neutrino Detector), located on the island of Honshu in Japan, recorded a decrease in the neutrino flux in experiments on detecting antineutrinos from nuclear reactors [8].

Thus, the theoretical results that were obtained based on the physical model outside the SM framework are confirmed by extensive and carefully performed experiments within the Neutrino-4 project.

References

1. Serebrov A.P., Samoilov R.M., Chaikovskii M.E. Analysis of the result of the Neutrino-4 Experiment together with other experiments on the search for sterile neutrinos within the 3 + 1 neutrino model. *Journal of Experimental and Theoretical Physics* (*JETP*), 22 August 2023, v.137, 55-70.

2. Belyakov A.V. Determination of the neutrino mass. *Progress in Physics*, 2016, v. 12, issue 1, 34–38.

3. Belyakov A.V. Charge of the electron, and the constants of radia tion according to J. A. Wheeler’s geometrodynamic model. *Progress in Physics*, 2010, v. 6, issue 4, 90–94.

4. Belyakov A.V. Macro-analogies and gravitation in the micro-world: further elaboration of Wheeler’s model of geometrodynamics. *Progress in Physics*, 2012, v. 8, issue 2, 47–57.

5. Belyakov A.V. Nuclear power and the structure of a nucleus according to J.Wheeler’s geometrodynamic concept. *Progress in Physics*, 2015, v. 11, issue 1, 89–98.

6. Belyakov A.V. Does the Macroworld Need Quantum Mechanics? *Progress in Physics,* 2025, v. 21, issue 1, 29–37.

7. Belyakov A.V. On the Nature of Some Cosmic Radiations. *Progress in Physics*, 2022, v. 18, issue 2, 164–168.

8. Orekhov D.I. Toolkit for neutrino physics. Dept. of Physics, Moscow State University, August 27, 2006.