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Neutrino Charge with its Gauge Field as a New Physical Base for New Models of Solar Activity and the All Totality of Phenomena Associated with Supernovae Explosions, Forming of Pulsars and their Following Evolution

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The neutrino charge with its gauge field introduced in [Kopysov Yu. S., Stozhkov Yu. I., Korolkov D. N. (2001)] for the purpose of decreasing counting rates in solar neutrino detectors generates a lot of new phenomena in astrophysical objects. The physics of the new phenomena is determined by the value of the neutrino charge e_ν which carriers are neutrinos, quarks and neutrons, and also by almost degenerate neutrino condensate in substance of macroscopic objects. It is shown that the strongest restriction on the value of e_ν can be obtained by a method of thermal balance of the Sun developed in [Domogatsky G. V. (1968)]. The new interaction generated by a new gauge ("neutromagnetic") field, gives rise to the neutrino Dirac's magnetic moment of new type. Restriction on its value at the obtained restrictions on e_ν is only $2 \div 3$ orders of magnitude lower than the electronic Bohr magneton and on many orders of magnitude exceeds all possible estimates of the traditional anomalous neutrino magnetic moment! The new scenario of formation of solar activity at which new interaction can play a key role is offered. The new model assumes two-story structure of a convective zone: external with the developed thermal convection and internal — the solar troposphere, — in which under the influence of tidal forces of planets whirls like a tornado of the terrestrial troposphere are formed. In these whirlwinds magnetic fields of the new (neutromagnetic) type are generated which interaction with substance generates also usual magnetic fields.

The new class of the phenomena arises due to inclusion of the neutrino charge into the theory of collapsing and neutronizing stars. New opportunities for solving old problems are being opened on this pathway. In this regard it is desirable to have theoretical justification of need of introduction of the neutrino charge. In this work the problem of extension of the standard unified model of electroweak interaction by means of inclusion of the second charge in the right sector of extended model is put forward. The possible solution of this problem is planned.

Key words and phrases: neutrino charge, neutrino magnetism of "neutromagnetic" type, solar troposphere, solar activity.

1. Introduction

This report is a summary of the new direction of research in the astroparticle physics generated by the introduction of the second charge into the unified theory of electroweak interaction, which is analogous to the electric charge, formed in the left sector of the theory.

The second charge is formed in the right sector of the extended unified theory, and is actually the double of the electric charge, since it is introduced into the theory in order to restore the left-right symmetry of nature at an early stage of its dynamic evolution, when there was not yet a spontaneous breaking of local $\mathrm{SU}(2) \times \mathrm{U}(1)$-gauge symmetry.

New charge carriers are the neutrino and the neutron, so the second charge is natural to call the "neutrino charge", as well as a new interaction that occurs due to

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the existence of a new gauge vector field, is natural to call “neutromagnetic”. Neutrino charge, which is a coupling constant of the new “neutromagnetic” interaction, at the initial stage of dynamic evolution in magnitude is equal the electric charge. However, after the spontaneous breaking of gauge symmetry there is a splitting between two charges in its magnitude so that the magnitude of the neutrino charge $e_\nu = e_2$ becomes much smaller than that of electric charge $e_e = e_1$. By virtue of

$$e_2 \ll e_1 \tag{1}$$

neutrino charge is practically not observed in the laboratory. However, in astrophysical conditions, a new interaction by the same ratio (1) might radically change the whole picture of the processes occurring in astrophysical objects.

The introduction of the neutrino charge to the theory gives rise to many new phenomena in nuclear and neutrino astrophysics and cosmic ray physics. Study these phenomena requires a broad front of theoretical and experimental works. A worthy excuse to deploy the necessary research could be the experimental discovery of the neutrino charge and measuring its magnitude.

Among the new phenomena, which are in question, it should be noted such as the possibility of a new mechanism for the acceleration of cosmic ray particles in collapsing stars and pulsars, including the acceleration of neutrons. Resetting the negative neutrino charge during neutronization of the core of the collapsing star leads to efficient conversion of energy released in gravitational collapse of stars into energy of “neutrostatic” field, which, in turn, should lead to the expulsion of neutrons and neutron-rich nuclei to the surface of the star and, as a consequence, discharge of the shell. For this reason, at certain stages of the collapse neutronization may occur in the pulse mode (“neutrino pulsar”).

A very tempting prospect of research on the role of the neutrino charge and magnetic field of the new type is the formation of solar activity and the effects of modulation of the counting rate of solar neutrinos in neutrino detectors due to the presence of a neutrino magnetic moment of neutromagnetic type.

From the above it follows that experiments to detect neutrino charge and to measure its magnitude are of critical importance.

In this report it will be considered the closest to us astrophysical object — the Sun. It is shown that the conversion of electromagnetic quanta in the solar interior into quanta of neutromagnetic field and their subsequent inverse transformation on the atomic nuclei of a registering device into a bulk X-ray emission provides a new way of solar interior spectroscopy — the X-ray spectroscopy. We also show that most closely to this possibility and to the discovery of the neutrino charge approached the Italian DAMA / LIBRA experiment on dark matter search.

2. Theoretical Reasons for Introducing Neutrino Charge into Astroparticle Physics

2.1. Extended Electroweak Model with Including Neutrino Charge

Neutrino charge was put forward in [2]. There was a goal to check, whether it is possible to explain low counting rate in detectors of solar neutrinos by their interaction with substance at their passing through the solar interior. For this purpose the theoretical instrument was necessary for calculation of energy dissipation at neutrino interaction with solar matter. The theoretical instrument associated with a neutrino charge and its gauge field proved to be very convenient for this purpose.

We proceeded from simple symmetry considerations (see fig. 1). We took the neutrino charge of a neutrino Q_ν to be negative, and the neutrino charge of a neutron to be positive. By analogy with the Gell–Mann–Nishijima formula for the electric charge of a nucleon $Q_e = Q_1 = I_3 + Y_1/2$, we have taken for the neutrino nucleon charge a similar formula $Q_\nu = Q_2 = -I_3 + Y_2/2$. In accordance with a figure 1 we accepted $Y_2 = Y_1$ (another possibility, which has not been used here is $Y_2 = -Y_1$).

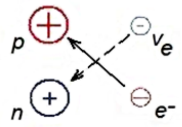

Figure 1. If the negative electric charge of an electron neutralizes the positive charge of a proton, then the neutrino charge of a neutrino, if any, should neutralize the opposite in sign neutrino charge of a neutron

The table 1 summarizes the supposed values of the neutrino charge for the particles of interest to us.

Table 1

Baryon number, hadron isospin, electric and hypothetical neutrino charges of different particles

Particles	Quantum number			
	B	I_3	Q_e	Q_ν
u	1/3	1/2	2/3	−1/3
d	1/3	−1/2	−1/3	2/3
s	1/3	0	−1/3	2/3
c	1/3	0	2/3	−1/3
$p(uud)$	1	1/2	+1	0
$n(udd)$	1	−1/2	0	+1
$\alpha(ppnn)$	4	0	2	2
e^-, μ^-, τ^-	0	—	−1	0
ν_e, ν_μ, ν_τ	0	—	0	−1
$\bar{\nu}_e, \bar{\nu}_\mu, \bar{\nu}_\tau$	0	—	0	+1

Calculations of the neutrino energy losses in the solar interior have shown that the solar neutrino deficit problem can be solved, if we take for the value of the neutrino charge as follows:

$$e_\nu = e_2 = 2 \cdot 10^{-4} e_1, \text{ where } e_1 \text{ — electron charge.}$$

The restriction having been received below by the analysis of the Sudbury neutrino (SNO) experiment data results in $e_2 \lesssim 10^{-6} e_1$.

The extended model of electroweak interaction proposed in this work explains the appearance of the second (neutrino) charge as well as its small magnitude. One proceeds from the chiral-symmetric

$$\mathrm{SU}(3) \times \mathrm{SU}(3) \tag{2}$$

(by analogy with the model of S. Weinberg, [3]) gauge-invariant lagrangian: $L = -\sum_{k=1}^{3} \bar{U}_k \gamma^\mu D_\mu U_k + \ldots$, where $D_\mu = \partial_\mu - ifA_\mu^\alpha \lambda_\alpha$, λ_μ — SU(3) generators, f — coupling constant, for massless Fermionic (U_k) and gauge (A_μ^α) fields, is invariant under gauge transformations

$$\begin{pmatrix} U_1 \\ U_2 \\ U_3 \end{pmatrix} \longrightarrow \exp\left(i \sum_{k=1}^{3} [\theta_{Lk}\lambda_{Lk} + \theta_{Rk}\lambda_{Rk}] \right) \begin{pmatrix} U_1 \\ U_2 \\ U_3 \end{pmatrix},$$

where $\lambda_{Lk} = \frac{1}{2}(1+\gamma_5)\lambda_k$, $\lambda_{Rk} = \frac{1}{2}(1-\gamma_5)\lambda_k$.

There is a subgroup SU(2) × U(1) in SU(3). Therefore, in the group (2) there are two invariant subgroups, left and right $[\mathrm{SU}(2)\times\mathrm{U}(1)]_{L,R}$, which are isomorphic to the SU(2) × U(1). In (2) one can also identify a subgroup of SU(3) with generators

$$\lambda_k = \lambda_{Lk} + \lambda_{Rk}.$$

The gauge invariance of (2) requires 16 gauge fields: 8 for the two chiral invariant subgroups and 8 for the subgroup of SU(3). Fields U_k include techniquarks carrying three technicolor charges.

As a working hypothesis, one suggests that the release of technicolor leads, at a certain stage of spontaneous symmetry breaking, to formation of the leptons with conversion of the initially captured colors to the free lepton flavors.

Spontaneous violation of gauge symmetry of SU(2)×U(1) (left and right) is accompanied by formation of electric and neutrino charges, as well as two pairs of semi-weak and semi-superweak charges, responsible for conservation of corresponding currents. In this case there are two Weinberg angles θ_{W1} and θ_{W2}, two constants g'_1 and g'_2, and one constant $g = g_1 = g_2$. Assuming $g'_2 \ll g'_1$, we have the following relations for the right sector:

$$\tan^2\theta_{W2} = \left(\frac{m_{Z2}}{m_{W2}}\right)^2 - 1 = \frac{4\Delta}{g\eta_2}\left(1+\frac{\Delta}{\eta_2}\right),$$

where $\Delta = m_{Z2} - m_{W2}$, η_2 — vacuum expectation value of the second Higgs field in the right sector (it is a free parameter which determines the values of the neutrino charge e_2 and θ_{W2}),

$$e_2^2 = g_2'^2 = 4g\frac{\Delta}{\eta_2}\left(1+\frac{\Delta}{\eta_2}\right),$$

$$G_{F2} = G_{SW} = \frac{1}{\sqrt{2}\eta_2},$$

where $G_{F2} = G_{SW}$ is the new Fermi constant of the new (super)weak interaction, accompanying neutromagnetic one.

2.2. Solar Neutrinos and Constraints on the Magnitude of the Neutrino Charge

As has been shown by subsequent experiments, the problem of solar neutrino deficit should be addressed in the framework of the theory of neutrino oscillations and the MSW-effect. A decisive role was played by measurements in the Sudbury Neutrino Observatory (SNO). As the neutrino detector, heavy water with dissolved NaCl salt has been used. NaCl was used for detection of neutrons from the neutrino neutral current splitting of deuterium.

The introduced above isotopic symmetry of interaction of gauge quanta $\gamma_1 = \gamma_e$ and $\gamma_2 = \gamma_\nu$ with nucleons generates the corresponding symmetry of interaction of these quanta with nuclei. We are interested in the pp-chain reaction (see Figure 2)

$$^2\mathrm{H} + p \to {}^3\mathrm{He} + \begin{pmatrix}\gamma_1\\ \gamma_2\end{pmatrix} + (Q = 5.494\,\mathrm{MeV}). \quad (3)$$

The ratio of the number of neutrino type quanta γ_2 emitted by this reaction to the number of emitted electromagnetic quanta γ_1 is proportional approximately to the ratio α_2/α_1. Neutromagnetic γ_2 quanta were producing disintegration of the deuterium in the detector SNO by the reaction $d + \gamma_2 \to p + n + (Q = 3.27\,\mathrm{MeV})$. The number of disintegrations of deuteron is also $\propto \alpha_2/\alpha_1$. It has been measured by counting the number of neutrons captured by NaCl. The neutron counting rate proved to be in accordance with the predictions of the SSM (Standard Solar Model)

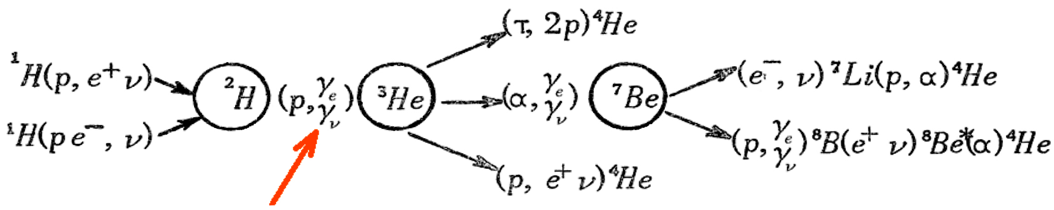

Figure 2. The scheme of the *pp*-chain. The orange arrow indicates the neutromagnetic quantum which is generated by the reaction (3)

for neutrino weak neutral current depletion of deuterium. So, there was no room for the reaction $d(\gamma_2, n)p$. From these results we can obtain an upper limit on the values of $\alpha_2 = e_2^2/\hbar c$ and e_2:

$$\alpha_2 \lesssim 10^{-12}\alpha_1, \qquad e_2 \lesssim 10^{-6}e_1. \tag{4}$$

Obviously, the conversion of γ_2 to γ_1 on the nuclei of type $^{56}\mathrm{Fe}+\gamma_2 \to {}^{56}\mathrm{Fe}^* \to {}^{56}\mathrm{Fe}+\gamma_1$ is possible as well as all sorts of giant conversion resonances. Another important consequences of the existence of the neutrino charge is a Fermi-Dirac neutrino condensate appearance in the matter and the absence of neutrinoless double β-decay.

2.3. Neutrino Magnetism of the New Type

By means of (4) one can obtain restrictions on the Dirac neutrino magnetic moment of the neutromagnetic type $\mu_\nu(nm)$ due to neutrino charge:

$$\begin{aligned} &\mu_\nu(nm) = \frac{\hbar}{2c}\left(\frac{e_2}{m_\nu}\right) = \frac{\hbar e_1}{2m_e c}\left(\frac{m_e}{m_\nu}\right)\left(\frac{e_2}{e_1}\right), \\ &\mu_\nu(nm) \lesssim \mu_B \quad \text{at} \quad \begin{cases} lm_e/m_\nu = 10^6, \\ e_2/e_1 \lesssim 10^{-6}. \end{cases} \end{aligned} \tag{5}$$

Here, μ_B stands for the Bohr magneton. The neutrino Fermi–Dirac condensate of macroscopic bodies can have a huge magnetic moment of the neutromagnetic type (neutrino diamagnetism and paramagnetism).

3. An Estimate of the Neutrino Charge Based on the Energy Balance of the Sun

The method we use here for estimating constants of hypothetical interactions of particles inside the Sun was invented in [4]. Believing that the conversion $\gamma_e \to \gamma_\nu$ on the nucleus $^Z A_N$ is described by diagram shown in Figure 3, one can calculate the cross section of the process, which is given by the formula

$$\sigma_A = \frac{8\pi}{3} r_e^2 \left(\frac{m_e}{m_A}\right)^2 Z^2 N^2 \left(\frac{e_\nu}{e}\right)^2, \tag{6}$$

where $r_e = \left(\frac{e^2}{\hbar c}\right)\frac{\hbar}{m_e c} = \alpha_e \lambda\!\!\!^{-}_{ec}$ is the classical electron radius, Z and N are the proton and neutron numbers in nucleus correspondingly, m_A — the nucleus mass, m_e — the electron mass.

The luminosity of the Sun in “neutromagnetic” quanta can be represented as:

$$L(\gamma_\nu) = \sum_{i,A} \sigma_A c n_{i,A} \langle n_{\gamma i} \varepsilon_{\gamma i}\rangle V_i.$$

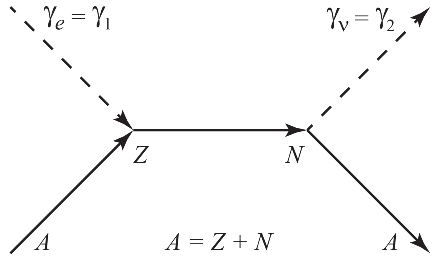

Figure 3. The process of conversion of γ-ray quanta of the electromagnetic type into the neutromagnetic type (similar to Thomson scattering of electromagnetic rays on protons and nuclei): ${}^{Z}A_N + \gamma_e \rightleftarrows {}^{Z}A'_N + \gamma_\nu$

Here the summation is over different types of nuclei (A) and radial layers of the Sun (i) with different density, temperature and chemical composition. The calculation was based on the SSM [5].

The astrophysical limit on the neutrino charge e_ν can be derived from the requirement that the solar luminosity in the neutrino quanta $L(\gamma_\nu)$ has virtually no effect on the structure of SSM. This requirement can be performed under the condition

$$L(\gamma_\nu) \lesssim 0.01 L(\gamma_e).$$

According to Table 2 one can take the limit $(e_\nu/e) < 10^{-9}$. The increase in $L(\gamma_\nu)$ to a value $L(\gamma_e)$ leads to a higher limit on the order of $(e_\nu/e) < 10^{-8}$. Under these constraints the neutrino magnetic moment of "neutromagnetic" type $\mu_\nu \lesssim \left(10^{-2} \div 10^{-3}\right) \mu_B$. Surprisingly, a large value of μ_ν of a new type is of crucial importance for astrophysical applications.

Table 2

The values of the ratio e_ν/e upper limit for two cases: (i) conversion on nuclei ^{4}He (first column), (ii) conversion on ^{4}He with the addition of heavy elements (second column)

	^{4}He	^{4}He + heavy elements
e_ν/e	$9.27 \cdot 10^{-10}$	$8.40 \cdot 10^{-10}$

4. The Detector DAMA (Dark Matter) as the First Astronomical Instrument for X-Ray Spectroscopy of the Solar Interior

Sensor element of Italian device to find dark matter (DAMA) is a NaI crystal. The device worked for about 13 years. It is found that the observed counting rate is displaying seasonal variations. Results are shown in Figure 4. A similar signal is expected from the X-rays generated by solar "neutromagnetic" quanta, but the maximum of this signal should lie at perihelion of the Earth's orbit.

One can calculate the DAMA detector response to the flux of solar "neutromagnetic" quanta. The full flux of solar γ_2 quanta equals to $\Phi(e_\nu/e) = 1.27 \cdot 10^{58} \cdot (e_\nu/e)^2$ quanta/s. In the window of sensitivity $(2-6)$ keV the "DAMA" detector responds only effective part of the flow $\Phi_{\text{eff}} = 0.504\,\Phi_0\,(e_\nu/e)$ (see Figures 4 and 5).

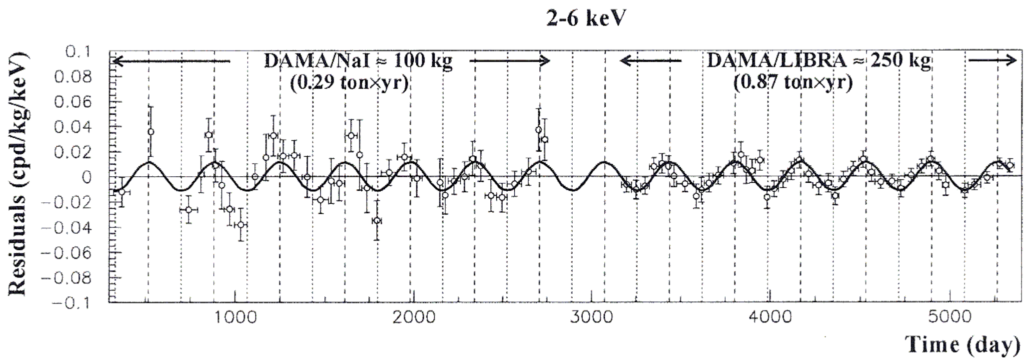

Figure 4. The observed DAMA annual modulation of the counting rate of particles attributed to dark matter (DAMA collaboration, 2010). The minimum of observed signal lies at perihelion of the Earth's orbit

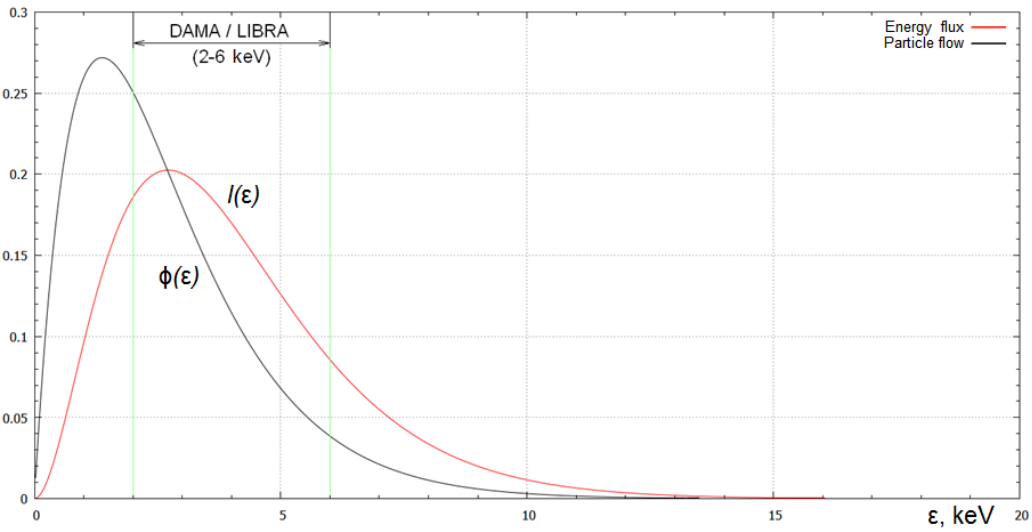

Figure 5. Normalized to unit energy flux distributions of "neutromagnetic" quanta from the Sun $\phi(\varepsilon)$ (black curve) and the corresponding luminosity $l(\varepsilon)$ (red curve) at $e_\nu/e = 1$

γ_2 flux density at the Earth:

$$\varphi_{\text{eff}} = \frac{\Phi_{\text{eff}}}{4\pi(1\,\text{a.u.})^2} = 3.556\cdot 10^{-28}\cdot\Phi_{\text{eff}}\ \left(\text{cm}^{-2}\text{s}^{-1}\right).$$

The cross section for the process $\text{Na} + \gamma_\nu \to \text{Na} + \gamma_e \to \text{Na}^* + e^-$:

$$\sigma_{\text{Na}} = \frac{8\pi}{3} r_e^2 \left(\frac{m_e}{m_{\text{Na}}}\right)^2 N^2 Z_{\text{eff}}^2 \left(\frac{e_\nu}{e}\right)^2. \tag{7}$$

We assume that $Z_{\text{eff}} = Z_{\text{Na}}$, i.e., the electron shell does not affect the cross section of (7). Then we have $\sigma_{\text{Na}} = 6.59\cdot 10^{-30}\left(\frac{e_\nu}{e}\right)^2 \text{cm}^2$, and the rate of formation of X-ray photons

$$\varphi_{\text{eff}}\sigma_{\text{Na}}(\gamma_\nu \to \gamma_e) = 15(e_\nu/e)^4\ \text{quanta/s/Na atom}.$$

One can represent the rate of production of X-rays and counting rate in units used by DAMA collaboration:

$$r(\text{cpd/kg/keV}) = 0.013\left(\frac{10^8 e_\nu}{e}\right)^4 (\text{cpd/kg/keV}).$$

These very simplified calculations demonstrate the possibility of using the DAMA detector to observe new phenomena related to neutrino charge and receive the experimental constraints on its value.

The effect of the annual modulation of the counting rate in the DAMA experiment could be attributed to the registration of "neutromagnetic" quanta, if the phase modulation was opposite to that observed in the experiment. However, these data can be used to obtain preliminary restraints of the neutrino charge value:

$$e_\nu \lesssim 10^{-8} e.$$

This result agrees with astrophysical estimates obtained above.

This analysis provides important indications in which direction should be improved detectors such as detector DAMA, to move towards implementation of the program X-ray spectroscopy of the solar core.

Measurements of the spectrum of the produced X-rays would give important experimental information on the radial profiles of temperature, density and chemical composition in the central regions of the Sun.

5. The Problem of a Solar Neutrino Counting Rate Variations and their Correlation with Solar Activity

The problem referred to in the title of this section, in its various aspects had been discussed in the works [6]. Experimental results on these issues are shown in Figures 6, 7. The motion of matter in the solar convection zone, generating the usual magnetic field can also generate powerful magnetic field of neutrino types. These variations in the solar cycle can lead to a change in direction of the neutrino magnetic moment of neutromagnetic type and to conversion of left neutrino into the right one that do not interact with the matter of neutrino detector. This may explain the variation of the counting rate of solar neutrinos in the chlorine-argon detector for that period of time in which it was at work.

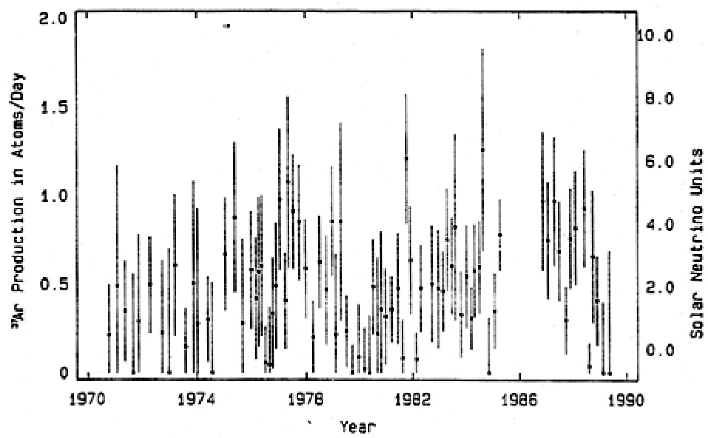

Figure 6. The ^{37}Ar production rates in the Homestake C_2Cl_4 solar neutrino detector [7]

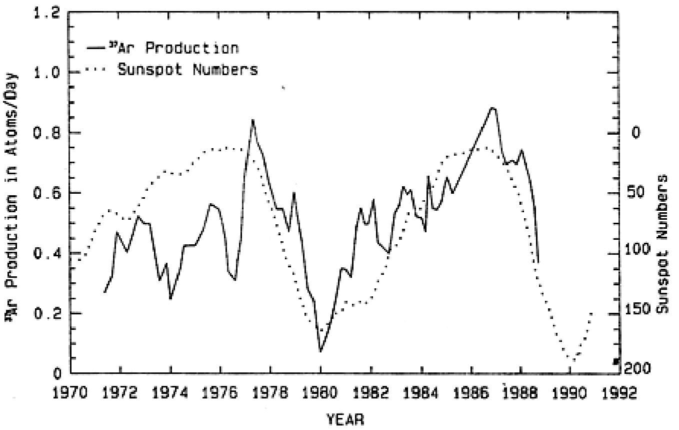

Figure 7. Comparison of the time variation of five extraction running averages of measured solar neutrino flux with the number of sunspots [7]

It is found a natural way to modify the thermodynamic structure of the lower part of the solar convective envelope, where thermal and hydrodynamic processes similar to processes in the Earth's troposphere are developing. It turns out that the tidal forces of the planets can play a key role in shaping both the solar troposphere, and periodic processes developing in this area of the solar convective envelope. In this model of solar activity, there is a natural explanation for the emergence of Maunder minimum and the other similar to it solar activity minima, correlated with conjunctions of planets. So, it is postulated that tidal forces of planets control the process of solar activity.

Results of numerous observations of the generation and behavior of vortices in hydrodynamic laboratory experiments, as well as observation of atmospheric vortices such as tornadoes points out the important role of microstructure of media in which the formation of tornadogenesis and other vortex structures occurs. A natural way to modify the thermodynamic structure of the lower part of the convective envelope of the Sun is proposed, in which, on the face of weak subadiabatic temperature gradient, the thermal and hydrodynamic processes are developing similar to processes in the troposphere of the Earth. These forces form the centers of action at the solar troposphere and the corresponding heliostrophic winds.

An important role in the formation of vortex motion in substance of the Sun plays a degenerate condensate of electron neutrinos, with the Fermi energy $E_F \lesssim 10kT$, where T is the local substance temperature. During the formation of vortex motion, lag of the entrainment of the neutrino condensate is expected. This is the reason for generation of neutrino type magnetic fields. These fields could produce a polarization of protons and nuclei and, consequently, magnetic fields of ordinary electromagnetic type. Such causation phenomena could result in the birth and formation of processes of solar activity.

6. Neutrino Charge and the Jet Particles Acceleration

There is a phenomenon of great promise. Associated with a neutrino charge, this phenomenon can produce a powerful mechanism of acceleration of particles up to relativistic and super relativistic energies. Let us consider in detail the scenario of this phenomenon.

If non-rotating spherically symmetric star collapses and neutronizes, the neutrino flux being emitted by the star carries a negative neutrino charge, leaving behind a positively charged neutron star skeleton. There appears a strong neutrostatic field, slowing down the neutrino flux and accelerating neutrons and neutron-rich nuclei, which evaporate from the surface. In this scenario, we should expect the appearance of a pulsating process of neutronization and collapse (neutrino pulsar [8]).

A completely different scenario of neutronization occurs when the rotating star collapses. We expect that the dragging of the neutrino condensate into the rotation late in time, so there is a strong magnetic field of neutromagnetic type generated by a rotating neutron skeleton. When rotating, collapsing star may precess, and the axis of rotation does not coincide with the magnetic axis. Such a star must radiate a powerful neutromagnetic wave. In this wave, the charged neutrino not slow down, but accelerate. Neutrons and nuclei also accelerate up to relativistic velocities. The accelerating nuclei leave behind the electrostatic field that accelerates the electrons also. There appears a process of jet outflow of relativistic particles — similar to point effect.

7. Conclusion

An attempt has been made to formulate the principles of elaborating an extended model of the unified electroweak interaction which includes, along with electric charge, also the neutrino charge e_ν. The neutrino charge in this model is a constant of a new interaction which is transferred by a new gauge (“neutromagnetic”) field. The value of interaction constant can be very small, but the condition $e_\nu = 0$, i.e. the case of absence of the new interaction, is only a special case that should not be considered as absolute truth. More sophisticated version of the neutrino charge theory will be discussed in a separate paper.

The main purpose of this study was to generate a phenomenology of the neutrino charge and get reliable estimates on the amount of e_ν. In implementing this program, we are at the beginning of the path. However, very interesting and important results in terms of their application to neutrino astrophysics are already obtained. So, on the basis of the Sun heat balance, it is shown that the upper bound value of the neutrino charge e_ν in units of the elementary electric charge e is between $e_\nu \lesssim (10^{-8} \div 10^{-9})$, but Dirac neutrino magnetic moment of a new, “neutromagnetic”, type $\mu_\nu(nm)$, measured in units of Bohr magneton μ_B is

$$\mu_\nu(nm) \lesssim (10^{-2} \div 10^{-3}) \left(\frac{0.5\,\mathrm{eV}}{m_\nu}\right) \mu_B,$$

that is, many orders of magnitude above all experimental and theoretical estimations of the neutrino anomalous magnetic moment of normal electromagnetic type. This result is perhaps the most important result of this work. In the subsequent works the program of laboratory experiments on search and observation of the phenomena connected with the existence of so high neutrino (and antineutrino) magnetic moment of new (“neutromagnetic”) type will be presented. Detection of such events will provide a reliable basis for the development of new areas of research in neutrino physics and neutrino astrophysics.

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Нейтринный заряд со своим калибровочным полем как новая физическая база для новых моделей солнечной активности и всей совокупности явлений, связанных с взрывами сверхновых, формированием пульсаров и их эволюцией

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Введённый в работе [Kopysov Yu. S., Stozhkov Yu. I., Korolkov D. N. (2001)] нейтринный заряд со своим калибровочным полем с целью снижения скоростей счёта в детекторах солнечных нейтрино порождает массу новых явлений в астрофизических объектах. Физика новых явлений определяется величиной нейтринного заряда e_ν, носителем которого являются нейтрино, кварки и нейтроны, а также почти вырожденным нейтринным конденсатом в веществе макроскопических тел. Показано, что наиболее сильное ограничение на значение e_ν можно получить методом теплового баланса Солнца, развитого в работе [Domogatsky G. V. (1968)]. Новое взаимодействие, порождённое новым калибровочным («нейтромагнитным») полем, порождает у нейтрино дираковский магнитный момент нового (нейтромагнитного) типа. Ограничение на его величину при полученных ограничениях на e_ν лишь на $2 \div 3$ порядка ниже электронного магнетона Бора и на много порядков превосходит все возможные оценки традиционного аномального магнитного момента нейтрино! Предложен новый сценарий формирования солнечной активности, при котором новое взаимодействие может играть ключевую роль. Новая модель предполагает двухъярусную структуру конвективной зоны: внешнюю с развитой тепловой конвекцией и внутреннюю — солнечную тропосферу, — в которой под воздействием приливных сил планет формируются вихревые движения типа торнадо земной тропосферы. В этих вихрях генерируются магнитные поля нового (нейтромагнитного) типа, взаимодействие которых с веществом порождает и обычные магнитные поля.

Новый класс явлений возникает при включении нейтринного заряда в физику коллапсирующих и нейтронизующихся звёзд. На этом пути открываются новые возможности для разрешения старых проблем. В связи с этим желательно иметь теоретическое обоснование необходимости введения нейтринного заряда. В данной работе поставлена проблема расширения стандартной объединённой модели электрослабого взаимодействия посредством включения второго заряда в правый сектор расширенной модели. Намечен возможный путь решения этой проблемы.

Ключевые слова: нейтринный заряд, нейтринный магнетизм «нейтромагнитного» типа, солнечная тропосфера, солнечная активность.