Neutrino On The Possible New Time Structure.

D.S. Baranov* and G.G. Volkov**

* Joint Institute of High Temperatures Moscow, Russia
** St. Petersburg Nuclear Physics Institute Gatchina, Russia
Neutrino Light Collaboration
E-mail:baranovd@rambler.ru; ge.volkov@yandex.ru

Abstract

We continue to study the problems of discovering new temporal and spatial properties of neutrinos from the point of the possible multi-dimensional extension the $D=(3+1)$ special theory of relativity. It is neutrino that can connect our Universe with new types of the matter, the new Universe. The possible discovery with neutrino new structure of the Time can confirm these ideas. However, the neutrino experiments aimed at new phenomena search can lead us to paradoxes related with the limits of applicability of the theory of relativity which demands special studies. This new phenomenon one can call by "Neutrino Paradoxes in Theories of Relativity". As examples of such paradoxes one can illustrate on the neutrino experiments MINOS, OPERA et al devoted to the measurements of neutrino velocity. As the interpretation of their results are model-dependent, by our opinion, the main goal of the observation a possible new time structure in these experiments is not reached. As the solutions to this problem it seems to us the way of holding cycle of long base neutrino experiments at high(super-high) energies which requires further debate in the literature. In addition to our discussions one can remark that the questions of neutrino physics ($M_S \rightarrow O(1 - 20 TeV - range)$) could be directly related to the collider physics at the LHC.
1 Introduction.

The neutrino speed measurement experiments are the continuations of the classic light speed measurement experiments have been done in range of the solar planet system (Ole Roemer-1676), in star system (James Bradely, 1728) and, at last, on the Earth (Lois Fizeau, 1849),.... The finite light speed measurement has led to the revolution in the humanity consciousness and eventually led to a new understanding of the visible universe. In 1998-2005, there were a lot of excited discussions at CERN [6],[7],[8] about the possibilities to perform the neutrino experiments to test the super-luminal neutrino hypothesis and to find new phenomena beyond the Standard Model. From one hand the idea of such experiments was associated with the hope to understand the role of the $V - A$- weak interactions, the quark-lepton family symmetry, the neutrino space-time properties and to observe some indications on a new vacuum structure existence outside of the Weak Scale, i.e.
in the region $1/R \sim (0.1 - 20) TeV$. From another hand the general trends of this idea has been related to the possible existence some extra space-time non-compact dimensions of the universe. In this context it would be first serious encounter with the dual conception between the physical phenomena of micro-cosmos and of universe. One of the main goals is to find with neutrino some new spatial and temporal structures that might explain the formation of our visible $D = (3 + 1)$-universe with all its space-time and internal symmetries which could be only a part of a vast Universe filled with other kinds of matter. The main difficulties of such experiments related to the possible relativity principle paradoxes have been discussed.

2 Light in the Evolution of the Time Structure.

Up to date there are several reasons for considering the possible extension of the observed $D = (3+1)$-space-time and its symmetries. In the first instance a number of fundamental problems in the field of high energy physics encountered in the Standard Model as well as in modern approaches $D = 10$ superstring theories / D-branes, 11-dimensional M-theory and 12-dimensional F-theory have to be taken into account.

The further great advance in Physics could be related to the progress of a modern mathematics: multidimensional Riemannian geometry, new theories of numbers, algebras and symmetries. Especially, we expect the powerful influence of this progress in the understanding of the basic Standard Model symmetries and beyond, in mysterious neutrino physics and its possible relation to the dark matter and dark energy, in high dimensional Gravity and Cosmology. It could lead to the further development in the understanding of our ambient space-time, the origin of the Poincaré-Lorentz symmetry with the matter-antimatter asymmetry, the geometrical basis of the fundamental physical characteristics: $EM$-charge, color, spin, mass.

To date it seems naturally expect that there is necessity to expand our
knowledge about new geometrical Riemann and tensor structures in the multi-dimensional spaces to achieve the better understanding of the Standard Model dynamic approaches. These new geometric objects could be associated with some new types of external symmetries (symmetry vacuum), which could allow to create a “reasonable” (renormalized) quantum field theories in multidimensional spaces with $D > 4$ and to construct the multidimensional generalization of the D-dimensional pseudo-Lorentz groups, what is an essential feature of the progress in the understanding the principles of the general relativity theory. The differential equations for the propagation of waves in a hypothetical multi-dimensional space-time could have the third- or higher degree with some exotic properties as a result of observing new symmetries.

There have been presented enough experimental arguments that the Special Theory of Relativity is being related to the electromagnetic charged matter what can be applied only in $D = (3 + 1)$ Minkowski space-time. The special relativity theory was formulated on the basis of axioms comprise the relativity principle, absolutism and the finite speed of light. Galilean symmetry group has been extended to the group of Lorentz transformations, and Poincaré translation group, and the absolutism of time transformed into absolutism of light.

Due to light synchronization in stationary system one can determine time globally. The link time and spatial coordinates between two inertial systems moving relatively to each other at a constant speed is defined by Lorentz transformations. These transformations can be built on the principle of maximal and constant speed of light and, therefore, locally determine the geometric structure of the electromagnetic vacuum, which is reflected in the fact that these transformations leave the four-dimensional interval

$$ds^2 = g_{\mu\nu}x^\mu x^\nu = c^2 dt^2 - dx_1^2 - dx_2^2 - dx_3^2$$  \hspace{1cm} (1)

invariant.

The progress with understanding the light speed axiom was gone in the direct accordance with the progress in the study the Euclidean plane axioms where changing the axiom of parallel lines had led after very long period to
the discovery of Lobachevsky spaces and Riemann geometry, and eventually had led to the discovery of the special theory of relativity in Minkowsky $D = (3 + 1)$-space-time.

It worth to note that the light speed maximum axiom can be interpreted primarily in close connection with the properties of electro-magnetic vacuum of our visible Universe. In Maxwell theory the absolutism of light speed is confirmed by identification the velocity of e.m. waves with the basic fundamental constants characterizing the internal electromagnetic vacuum structure:

$$c = (\mu_0\epsilon_0)^{-1/2}$$

The concept of the light speed absolutism in the observable Universe was especially emphasized in the analysis of Einstein’s fundamental ideas of the special relativity theory. The question of the new forms of the matter existence other than electromagnetic did not arise at those days! The mysteries neutrino was embedded in physics later.

Attempts of solving the problem of the Standard Model incompleteness were converted into multi-dimensional geometry where there could be a hypothetical sterile Matter (Dark Matter) with his ”invisible” radiation in addition to the observed electromagnetic-charged matter and for the description of which there can appear the necessity to generalize some $D = (3+1)$ axioms of the relativity theory. The basic idea of the such new phenomena discovering could be associated with the neutrino (or dark matter) since their unique properties could also spread in the space-time with one or two extra dimensions, $D = (4 + 1)$ or $D = (4 + 2)$, respectively. The corresponding extension of the $D = (3 + 1)$- special theory of relativity can lead to the possibility that for neutrino the 4-interval $ds^2$ is not invariant, what could be happened if neutrino can expand in $D > 4$-space-time with the extra 'topological' cycle [6]. This cycle could be related with some new spatial as well as with some temporal neutrino properties.

To the contrast of the spatial and temporal properties of neutrinos with respect to the similar properties of charged quarks and charged leptons there is a room to consider the observed three neutrino states as a single quantum
field in the space of dimension 6, that is, with 2 additional non-compact dimensions, and, in accordance with ternary complexity, one can imagine three implementations of neutrinos as a "particle" - "anti-particle" and "anti-anti-particle" (ternary neutrino model) [6],[7], [8],[10] in analogy with the 4-dimensional Dirac electron-anti-electron(positron) theory (see [1],[2], [3] and for review [4],[5]).

3 The EM-Charge Matter in the $D = (3 + 1)$ Space-Time

Relativistic quantum electrodynamics was formulated on the basis on the internal $U(1_{EM})$- and external Lorentz $SO(3, 1) +$ Poincaré (translation) group symmetries of the gauge boson and fermion fields- photon and electron/positron, respectively. The internal symmetry is related to the local and global conservation of electric charge $Q_{EM}$. The external symmetries reflect the fact that our space is isotropic and homogeneous what we observe in the form of the law’s conservations of such fundamental parameters as the angular momentum, momentum, energy, mass and life time at rest etc in the $D = (3 + 1)$ universe.

In theory of electron+positron there can be some duality links between the space-time geometrical structure and fundamental properties of the particles [8],[10]. For example, if one knows the fundamental properties of the particles one can get the information such as the ambient space-time dimensions. So, the four-dimensional $D = (3 + 1)$ space-time with external Lorentz/Poincaré quantum electrodynamics symmetry correctly corresponds to the possible quantum states - electrons+positrons - having the following internal properties: two spin states plus two charge conjugated states, electron/positron.

The finite discrete group symmetries related to the $C-, P-, T$- transformations make this link more subtle putting it finally to the fundamental theorem
of CPT-invariance (see for example [4]).

The CPT-invariance proved in such spaces for local quantum theory gives the very important results such as the equality of the particle and antiparticle masses (and life time):

\[ m(\Psi) = m(\bar{\Psi}) \rightarrow \text{binary CPT-invariance}. \]  

Similar to the role of the axiom of constant speed of light in the definition of the global time the conservation laws of these symmetries allow us to determine such fundamental parameters globally in the whole space-time. CPT-invariance allows to correctly define globally the concept of a particle and its antiparticle in the whole \( D = (3 + 1) \)-space-time.

In this approach the CPT-invariance and \( Q_{em} \)-conservation law can be the prerogatives for Minkowski \( R^{3,1} \)-space-time where the \( SO(3, 1) \) Lorentz group (Poincaré) symmetry and \( U(1_{em}) \) gauge symmetry [6],[7],[8] are valid. So, we want to emphasize that the proposal about the duality between the electric charge conservation and CPT-invariance can be valid in our Minkowski space \( D = (3 + 1) \) only, but for the hypothetical interactions of the \( Q_{em} \)-charged matter with the new exotic matter, these arguments are not valid any more.

In this approximation the observation of effects with CPT-invariance violation and/or with \( Q_{em} \) charge non-conservation could indicate some new exotic geometrical vacuum structures at the smaller distances beyond the weak interaction region or/and the existence of some global extra dimensions in Universe.

This observation will help us to extend the concepts of particles and antiparticles in the ternary case with 3-neutrino specie, for which a new type of hypothetical conjugation \( C_{D=6} \) can extend the concept of anti-world to the high-dimensional analogue of \( D = (3 + 1) \)-CPT-theorem [8], [10]. The observable violation of the conservation laws in \( D = (3 + 1) \) must be associated with some additional geometry and tensor structures of vacuum and can be linked to the appearance some hypothetical phenomena like new interactions, new particles,... In Standard Model this was vividly illustrated
by physics of $K^0 - \bar{K}^0$, $D^0 - \bar{D}^0$, $B^0 - \bar{B}^0$, ....mixing.

The possible Majorano neutrino nature (see for review [31]) among the all other kinds Standard Model Dirac charged fermions prompts another dynamics of baryo-lepto genesis based on the composite fermion Dirac matter structure created from more simple pra-fermions like Majorano neutrino sterile matter filling the extra dimensional world- Meta-Universe.

The fundamental conception such as idea is related with attempts to figure out a common the $Q_{em}$ charge Dirac matter creation mechanism with enough reasonable assumption that mechanism is such as must give a duality between the $Q_{em}$ conservation and $CPT$ invariance:

$$ CPT - \text{invariance} \leftrightarrow (Q_{em}) \text{ charge conservation}, \quad (4) $$

i.e. the invariance of $CPT$ in $D = 4$ space-time means the $Q_{em}$ charge conservation and vice versa.

Thus, if this kind duality exists, the CPT-invariance violating processes should accompanied by the electromagnetic charge violation too. May be, it could be one of the reasons why we have not saw some rare decays such as the proton decay. In this case, the idea of grand unification symmetries without the electromagnetic charge origin explanation is not enough to solve the proton stability problem.

Also a similar problem could be related with searches for the rare flavour-changing decay channels such as $\mu \rightarrow e + \gamma$, $\mu \rightarrow 3e$ etc. First, one must solve the origin of the quark-lepton families problem.

In such approach one can propose a mechanism of the geometrical electromagnetic charge $Q_{em}$ origin and the Dirac complex matter from more fundamental pra-matter [8]. The Majorano neutrinos with $m_{\text{Dirac}}(D = 3 + 1) = 0$ could be some representatives of a new matter (sterile or dark matter?). The idea can be applied to the further attempts to solve the baryon asymmetry of universe problem linking such question with an origin $Q_{em}$ charge matter in $D = (3 + 1)$-space-time. There is one very remarkable fact

$$ |Q_p + Q_e| < 10^{-21} \quad (5) $$

8
which can indicate the unique origin of the proton (quarks) and electron.
It suggests an existence of a hypothetical interaction into high dimensional space connecting the Dirac-charged fermions to the pra-matter. This interaction could be based on a new symmetry beyond Lie groups and can provide the universal electron/proton non-stability mechanism [8]. We add two extra dimensions to illustrate a possible mechanism of this kind interaction with a mass scale near $M_S \sim 10^{-20} TeV$- region [8].

Note, that the 3-color ”up”- and ”down”- quarks states interacting via $SU(3^C)$-gauge color bosons at the corresponding distances embedded into $D = (3+1)$-space-time is connected to the problems of a new quantum charge ”color” and fractional magnitudes of electromagnetic charge $Q = \pm 1/3, \pm 2/3$ origin explanations. We suppose that these problems could be closely related to a possible extension of the electromagnetic vacuum substructure and its link to the origin of the 3-quark-lepton families. One could consider some extra compactified dimensions what could change the foam structure of electromagnetic vacuum to find a new quantum number geometrical sense due to its confinement property. Thus, one should to produce the integer values of the charged leptons and the fractional values of quarks by unify way to find electromagnetic charge creation mechanism in universe.

### 4 Neutrino About New Time Structures of Universe.

Exclusive properties of three neutrinos could point out the existence of a new vacuum, with properties different from the properties of the electromagnetic and color vacua. Moreover, it can give some information about the symmetry of this hypothetical vacuum that might be associated with the exceptional properties of the three neutrino states-ternary symmetry [8],[10] in addition to the spin. This new ternary symmetry could shed light on the SM dark symmetry:

$$N(Color) = N(Family) = N(dim.R^3) = 3.$$  \hspace{1cm} (6)
So the three types of neutrinos can be described by a single 6-dimensional wave function and it would imply the existence of two additional dimensions with appearance in $D = 6$ the fundamental discrete space-time symmetries. It must be emphasized that the assumed charged matter ternary symmetry must be broken in $D = (3 + 1)$-space-time with all the attendant circumstances.

Opposite to the 3-neutrino masses one can see the charged leptons and charged quarks grand mass hierarchies increasing with the number of the families from one to the third:

\[
\begin{align*}
m(e) &\approx 0.5\text{MeV} & m(\mu) &\approx 106\text{MeV} & m(\tau) &\approx 1.7\text{GeV} \\
m(\text{up}) &\approx 3.5\text{MeV} & m(c) &\approx 1250\text{MeV} & m(T) &\approx 175\text{Gev} \\
m(\text{down}) &\approx 5.5\text{MeV} & m(s) &\approx 150\text{MeV} & m(B) &\approx 4.5\text{GeV}
\end{align*}
\]

Also one can see the reverse hierarchy of life times of the electromagnetic charge particles according to increasing the number of the generations: $1 \rightarrow 2 \rightarrow 3 \rightarrow \ldots$. There are some peculiarities related to the mass limits what could be important for our interpretation of the weak interaction region as a boundary between two vacua: electromagnetic and new hypothetical in $D = 6$-space-time.

The first peculiarity requires to postulate the minimal possible mass in EM-vacuum: electron mass $?$. Then the ”up”- and ”down”- quark masses could be expressed through the electron mass and the number of colors:

\[
1/2(m(\text{up}) + m(\text{down})) \approx N_c^2 m(e)
\]

Then the next peculiarity is related to a trend of upper limits on the masses with increasing number of the generation.

Under this circumstance it will be important to clarify the following problem: does the fourth generation exist or doesn’t? Some superstring models possessing the hypothetical family symmetry expect the fourth quark generation having some exceptional properties[13],[14] In this case one could
consider the quaternary extension of ternary hidden symmetry:

\[ N(Q-3\text{Color}+L-1\text{Color}) = N(Fam.-3+Ex.Fam.-1) = N(Dim.R^{3,1}) = 4. \]  

(9)

The experimental observation of the fourth quark generation could support the idea about real role of weak interactions in the Standard Model and in universe: "screening" at the very small distances beyond the weak interaction region \( r \leq 10^{-17} \text{cm} \). Thus one can suggest that the electromagnetic vacuum could be defined by the light speed and by the minimal Dirac mass possible for the stable electromagnetic Universe.

One of the our space-time extension possibilities could be due to a new "topological cycle" \((\tau, \xi)\) existence and it could be described by independent component such as new "time" coordinate \((\tau)\)[6],[7]. In this scenario, the question what is the real time raises again. These ideas implementation should require the construction of the Universe new geometric representations and, in particular, to find the Riemann metric tensor and might be another geometrical and tensor structure invariants of extended space-time. In fact, the hypothesis of the second "time coordinate" might be considered as a convenient way to describe the possible extension of the neutrino spread laws different from those projected by special relativity, for example, the light speed maximality principle.

One of the main difficulty of the study the neutrino intrinsic and space-time properties connected with the considerable discrepancy between the huge experimental data for the processes with neutrinos as products of hadron’s decays and very small amount of the processes where the space-time properties of neutrinos clearly manifested. If the analysis of the myriad of the neutrino channel meson decays restore the energy and angular spectrum of the neutrino collapse the further motion evolution of this collapse can contain significant uncertainty (see for example series of the articles devoted to the study for the formation of neutrino beams in accelerators [22],[23],[24],[25],[27],[26], [28],[29]). Further only a tiny fraction of neutrinos in these collapses observed in neutrino channels can be identified via the interaction of neutrinos with detector. The ratio of the accelerator produced
neutrinos in the collapses to those could be observed in the neutrino detector can be, depending on the experimental conditions, the order of $\sim 10^{7-10}$.

This is especially important to review the samples of long base-line neutrino experiments in K2K-SuperKamiokande [43], FNAL NuMi-MINOS [17] and SPS CNGS-LNGS OPERA [28],[20], [30]. The CNGS beam is obtained by accelerating protons to 400 GeV/c and ejecting ones into neutrino channel as two spills, each lasting $10.5\mu s$ and separated by $50ms$. The SPS CNGS cycle is 6 s long. Each spill contains from 2100 bunches with the time sub-structure $3 + 2 = 5nsec$ and intensity $\sim 10^{10}POT$. The resulting neutrino collapse is formed at the neutrino channel along a distance of $\sim 1000m$ [28], [29]. The total statistics used for analysis reported in this paper [20] was $\sim 15000$ events (from $\sim 60000$ total events) detected in rock and in detector, corresponding to about $10^{20}$- protons on target collected during the 2009, 2010, 2011 CNGS runs and the estimation of the total work-time is about $5 \times 10^{7}$ sec. So the total number of spills could be about $<\sim 10^{6}$ and each spill produces $<\sim 0.01\nu$-event in detector or in rock (the exact numbers one can see in [30]). It gives very complex problem to restore the total information about the all parameters of neutrino collapse spectrum. Naturally the question Whether is there a chance to synchronize neutrino events in such experiments to within less than time of extraction i.e. $\leq 10.5\mu sec$? [6],[7]. Sufficiently, Do we know well the spatial and temporal properties of neutrinos to achieve such synchronization accuracy?

This occasion can bring the any kind paradoxes caused by incorrect experimentalist understanding of the space-time behaviour dynamics of the neutrino collapses based only on extremely small recorded statistics of the detected neutrino events. The main paradox of such experiments is that the results of long term studies become to be equivalent to the following inference: what had been assumed that it was received. The opportunity of a wrong interpretation of the ambiguous experimental results makes the modern experimental neutrino physics is very complex and raises such experiments at the level of art.

It is well known that neutrino experiments consist of three phases: the
neutrino collapse production process, its space-time spread through the matter and the possible interaction of the collapses with the detector material. The neutrino collapse dynamics moving in space-time is another major challenge because of the proposal that the neutrino is an another kind of matter representative significantly different from the electromagnetic matter. This suggests that neutrinos could spread in accordance with the new vacuum structure kinematics. Despite the existence of three quark-lepton generations the three states forming a single wave field of $D = 6$-space-time evolution might be assumed and would be described by the corresponding wave equation. In a ternary model the neutrino wave field could have the own charge - ”neutrino light” [8],[10]. In this approach the neutrino field could be distributed according to the motion equations different from the equations used in $D = (3 + 1)$-geometry defined by the Lorentz group symmetry. It can give some new additional interpretations of the processes related to the well known neutrino oscillations.

The possible extra dimensional geometry existence can lead to the circumstance that the neutrino waves could spread by geodesic lines different from the geodesic lines of the electromagnetic charged particles (see for example, [35]). Appears from the above the neutrino flow cannot conserve in the $D = (3 + 1)$-space-time. It could be a reason of disappearance of neutrino flows at a distance.

In the article [6] some neutrino experiments were proposed to observe the possible our space-time expansion comprising another cycle characterized by its fundamental speed which could be much faster than electromagnetic light. The last assumption was supported by some arguments to solve the horizon problem in cosmological models [9]. Neutrinos due to their outstanding properties available in both cycles and the electromagnetic light speed maximality principle does not work any more. In particular, the new multi-dimensional geometrical spaces have the projective symmetries the understanding of them could help us to visualize new universes. Another factor is that the space-time expansion can carry out the introduction of new topological cosmic cycles. It means that these topological cosmic cycles may have own fundamental
parameters such as "speed", "mass", "charge", ...

Therefore, to check the hypothesis that neutrinos spread different than the light the experiment based on the possibility of measuring the neutrino speed depends on the parameters that might be related to the fundamental another cycle properties has been suggested, and we expected that dependence on such parameter one could get the neutrino speed: \( v_\nu > c_{\text{light}} \) (see the interesting discussions in [33],[34],[36], [37], [38]).

Such experiments could prove the existence the new vacuum and extra dimensions directly but this way involves a very delicate element associated with synchronization "almost invisible" neutrino.

In the classical experiments to measure the new fundamental constant the validity limits of the special relativity theory need to be understood. For our approach it was necessary to examine on what setting might have changed the neutrino velocity value if it really has a link to the new vacuum. The latter implies that there should be in minds some method of the possible \( D = (3 + 1) \) space-time expansions with the corresponding metric tensor forms for such models. Otherwise such experiments can lead to the logical paradoxes. In fact, such experiments can meet the challenge of measuring the absolute velocity or absolute motion or something else.

5 Non-Compact Large Extra Dimensions and Emergence of EM-Charge.

The main experience we have got from Kaluza-Klein, superstring/D-branes, \( D = 11 M \), \( D = 12 F \)- theories and from the study of the Riemann and tensor structures of the high dimensional Cartan symmetric and Berger-non-symmetric spaces is the compact small and the non-compact large dimensions are closely connected to the origin of internal and external space-time symmetries, respectively, in corresponding theories (see discussion in [41], [42]). The compact small dimensions are connected with the origin of internal symmetries. The role of the compact Calabi-Yau spaces was perfectly il-
illustrated in the 5-superstring dual theories. Correspondingly, non compact large dimensions are related to the extra space-time symmetries of the our ambient world. For the Standard Model this circumstance could be very important since we suppose that the problem of three neutrino species could be solved by adding the some global non-compact dimensions to our $D = 3 + 1$ space-time\[6],[8]. So the family symmetry appearance can be related to the large non-compact extra dimensions like it was happened with two ”families”, particle-antiparticle, and was proved by Dirac relativistic equations for the $D = 3 + 1$- Minkowski space-time.

In the past a lot of publications has been devoted to the possibility to solve the three family problems through the internal gauge family symmetries introduction. Let note that in super-string approach the $N = 1SUSY SU(3)_H \times U(1)_H$ gauge family symmetry appears with $3 + 1$ quark-lepton family \[13],[14]. The possible fourth family must have the exceptional properties since this family is singlet under $SU(3)_H$-symmetry in this approach . This broken family gauge symmetry could be responsible for the mechanism of $CP$-violation in $K^-, D^-, B^-$ meson decays \[11], \[12]. Thus one can see the common grand problem of the flavour mass hierarchy of quarks and charged leptons, family mixing, $CP$-violation that cannot be solved without understanding the role of the $(V − A)$-weak interactions.

There is also the very important difference between the three charged quarks/leptons and three neutrino states: Dirac-Majorano space-time nature \[1],[2], [3], their masses and etc. We can expect that for Majorano neutrino species the global family symmetry is exact... To explain the ambient geometry of our world with some extra infinite dimensions one can consider the our visible world (Universe) as just a subspace of the Meta- Universe with the pra-matter having new quantum numbers different from already known in our world.

The visibility of a new world phenomena is determined by the our understanding of the SM structure and its consequences for the Cosmology processes. The Majorano neutrino can travel in this Universe!\[6] To make it available we should introduce a new space time-symmetry with the usual
D-Lorentz symmetry generalization. In this case the region \( \leq M_S \sim (10-20) \text{Tev} \) could be considered as a "boundary" of a new world [8].

This proposal suggests an existence in high dimensional space a class of prs-fermions connected with our fermions through a new interaction which is based on a new symmetry beyond Lie. Such interaction could predict a non-stability of the electrons or protons. We can illustrate a scale of such an interaction, taking for example, two extra dimensions. To make estimations we are in the situation in which occurred E. Fermi. So we can follow to his ideas which he used for construction the four-fermion weak theory with coupling constant \( G_F \), which dimension is \([G_F] = [M^{-2}]\). So we can start from multi-fermion \( D = 6 \) Fermi Lagrangian the corresponding Fermi constant \( G_{FS} \), which should have a the dimension[8]:

\[
[G_{FS}] = [M^{-4}] \quad (10)
\]

In our opinion this coupling constant dimension corresponds to a new interaction that propagator could have a form like \( 1/[P(q, M_S)] \), where \( P(q) \) could be a polynomial of 4-th degree. Such as propagator form corresponds to a new \( D = 6 \)-metric tensor. So, for the tree level calculations of the quark or charged lepton decays into prs-fermions \( \nu_S \)

\[
q \mapsto n \nu_S, \quad e^\pm \mapsto n \nu_S \quad (11)
\]

can get the following estimation for the partial width

\[
\Gamma(e/q \to n\nu_S) \sim O(g_S) \frac{m^9_{e/q}}{M^8_S}, \quad (12)
\]

where \( m_{e/q} \) is the electron mass, and \( M_S \) is a new mass scale related to the hypothetical interaction in extra dimensional world what could be associated to the some new symmetries. What is very interesting that we can construct the universal mechanism of the decays for the all known quarks \(-u, d, s, c, b, t-\) and charged leptons- electron, muon, \( \tau \)lepton- into the \( EM \)-invisible matter. To get the lower boundary for \( M_S \) let’s compare the partial width for electron decay with the life time of muon in frame of \( D_4 \)-Fermi interactions:
\[
\frac{\Gamma(e \to 3\nu_s)}{\Gamma(\mu \to e\nu\bar{\nu})} = O(g_S/g) \frac{m_e^9 M_W^4}{m_\mu^5 M_S^8}
\] (13)

From the lower boundary on the electron life time one can get the following upper boundary for \(M_S\):

\[
M_S \geq O(g_S/g) \cdot (10 - 20) \cdot M_W.
\] (14)

This boundary has the universal magnitude what one can check from searching the baryon violation processes of neutron

\[
N \leftrightarrow 3\nu \quad \text{or} \quad N \leftrightarrow n\nu_S.
\] (15)

Apart from charge violation decays we can expect also the the \(CPT\) -invariance violation processes. For example, the \(M_S\) magnitude estimation can be get from the \(K^0 - \bar{K}^0\)- mass difference:

\[
\delta_m = |m - \bar{m}| \sim \frac{m^5}{M^4_S} < 10^{-15}GeV.
\] (16)

This estimation show that the \(M_S\) can be also in \(1 - 10TeV\) region.

6 The Paradoxes of Theory of Relativity in Long Base Neutrino Experiments.

The measurements of neutrino speed on the accelerator experiments can be associated with Fizeau experiment to measure the speed of Light. Opposite to Fizeau ideology (\(\{2 \times 8.5 \times 720 \times 24.5\} km/sec\)) in the neutrino projects [6] there must be studied three main discrepancies what are related to the some experimental and theoretical ambiguities. In contrast to the Fizeau experiment to measure the speed of neutrinos was a very daunting task to
identify and synchronize the departure of neutrinos or neutrino wave collapse formed during the release of the accelerator proton bunch on the target. The second discrepancy was related to the understanding the structure of neutrino collapse formed in the neutrino channel and getting all its parameters. The third important discrepancy was linked to the driving dynamics of neutrino fronts propagating over long distances, i.e. to represent its evolution during the flight from accelerator till detector. To solve the third problem one should have the information about possible some new spatial - temporal properties of neutrinos, i.e. that is to construct or have some sorts of models explaining the physical reasons why the neutrinos properties could be beyond some principles of special theory of relativity, in particularly to overcome the speed of light. If you do not accept this ideology the experiments of measurements the neutrino velocity will involve with attempts to measure the "absolute motion" (Aristotle, Galileo Galilei).

The main conclusion from this discussion is how to measure correctly speed of the objects with the properties completely different from the electromagnetic media (new time structure, synchronization). To make such experiments one can coincide themselves to the paradoxes of measurement the absolute movement. In electromagnetic media- universe and vacuum - only light can have the property of absolutism, $c$ is invariant fundamental constant. Between energy and wave length there exists the quantum link: $E_{\gamma} \cdot \lambda_{\gamma} = c \cdot h$, where $h$ is Plank constant. If neutrino is not related to the supersymmetry [32] or some unknown yet now phenomena in the frames of the special theory of relativity there appear the ambiguous situation. Absolutism of neutrinos? In special theory we know how to synchronize the events in electromagnetic media.

Now there can appear grand question how to synchronize the events in a new vacuum media. In this regard, in our projects, [6] we were looking for those neutrino observable parameters that could link the neutrino with a new vacuum in which the laws of the $D = (3 + 1)$- electromagnetic universe could not be valid any more. Other vacuums different than electromagnetic can have new fundamental properties what we suggested to check in the ex-
periments related to the measurements the propagator properties of neutrino like its velocity.

The extra dimensional (non trivial) generalization of the Lorentz group could imply the existence of another boost and possible extensions the concept of the time, even its structure. To find the confirmation of existing of exotic vacuum structure beyond the electromagnetic one should look for the experimental measuring parameters of neutrinos what could connected to the other hypothetical world. Or we can meet to the Aristotle - Galilei absolute movement problem. We know enough well the ways to synchronize electromagnetic events on the long distances using the light. But the many neutrino phenomena we don’t know yet well to be sure that we can synchronize correctly the neutrino events. In neutrino experiments made during some last years there was realized only the first part of the projects [6] what was based on conclusions of the the first measurement the neutrino velocity in 1977 FNAL[15] and in 1987 [24] + [5] = [11KII + 8IMB + 5B] + [5M)]- neutrino events getting from SN87A and detected in KAMIOKANDAI, IMB, BAXAN, Mont-Blanc [16]. From that observations there has been done the main conclusion that the magnitude of the speed of neutrino should be very closed to the corresponding magnitude of the light speed.

Since neutrino could link both worlds for neutrino the principle of absolutism of light is not valid more and we can take the energy as possible such parameter. The other possible parameter could be related to the sources of neutrinos since it gives the information about the region of neutrino production on the smaller and smaller distances.

In this choice it will be important to study the possible spatial and temporal structures of neutrino fluxes having the wide energy spectrum, producing from certain sources and moving on the different distances. We can compare the ideology of neutrino measurement velocity experiments [15], [16],[17],[20], [21] to the our conceptions [6],[7], [8]. As examples we can consider the productions of neutrino fluxes in SPS CERN from regular extractions of proton bunches in which the energy of proton beams equal to $E_p = 400GeV$ with regular extractions during $3nsec$ with separation $500nsec$ and intensity about
and $10^{11} \text{POT}$. For each extraction one can estimate the corresponding neutrino energy spectrum of $10^{8.9}$ neutrinos with the primary period about $3\text{ns}$.

For us it will be important to make the analysis of time and spatial expanding of this bunch on some different distances: $83\text{km}$, $366\text{km}$, $732\text{km}$, $1464\text{km}$.

In line with the hypothesis about the existence of $(1 + 1)$- extra dimensions we suggested that the expanding of neutrino fluxes depends on some parameters, \{\(t, L, E_{\nu}, k_i(r), c_i(y)\}\}, where \(t, L, E_{\nu}\) are ordinary parameters what we can measure in the experiments, parameters \(k_i\) are related to the type of sources of neutrino (muon, \(\pi\)- and \(K\)- mesons, charm, beauty, - quarks ...), parameters \(c_i\) should be directly linked to the fundamental characteristics of a new vacuum, depending on the type of a new hypothetical metric tensor.

As a result of this approach the spread of the neutrino collapses will be completely different from the flow of electromagnetically charged particles, i.e. the expansions of neutrinos must be beyond the laws determined by standard Lorentz \(D = (3 + 1)\)-metrics\[6\].

As we approached the speed of the neutrino is not absolute characteristic for the electro-magnetic vacuum there was made the assumption that the neutrino energy could one of the parameters binding our vacuum with a new vacuum. We can propose that the speed of neutrino could effectively depend on the neutrino energy what we were searching through ternary or quaternary extensions of \(D = (3 + 1)\)-metrics what can be constructed in \(R^n\)-spaces, \((n \geq 5)\) \[10\], \[39\]:

\[
ds^2 = f_1(y_a)ds^2_{3,1} + f_2(x_{\mu})ds^2_y, \tag{17}\]

As a possible variant, one can consider that the speed of neutrino is the product of electromagnetic charged particles could have some deviations from the speed of light: \((v_{\nu}/c - 1)_i \approx k_i \cdot (E_{nu}/M_S)^2\), where parameter \(k_i\) is determining by the region on neutrino production, for example, in our examples we consider two cases, neutrino from \(\pi\)- and \(K\)-meson decay for which \(r \sim 1/m_\pi\) and \(r \sim 1/m_K\), correspondingly. In our scenario, the behaviour of the neutrino velocity at super-high energies could be in accordance with the formula \(v_{\nu} \rightarrow c_{\text{new}}[E^2/(E^2 + M_S^2)]\), where new hypothetical velocity constant could be much more than light speed, \(c_{\text{new}} >> c\) \((c_{\text{new}}/c \geq 10^{7-8})\). The
proposed dependence of neutrino speed from the energy leads to the substantial change of the spatial and temporal picture of the neutrino collapses. Thus according to articles [6] we consider two variants of taking parameters what could help to observe the effects of existing a new space-time vacuum structure:

- 1. energy of neutrinos,
- 2. parents of neutrino production.

For illustrations in the first case we consider the neutrinos formed only from $\pi$-meson decays in CNGS neutrino channel formed as a result of the discharge of protons on target with the energy of 400 $GeV$ in certain time intervals (see fig.(1), fig.2, fig.3, fig.4 and fig.(5). For this case the coefficients $k_\pi$ is related to the magnitude of the wave function distribution of up- and down- quarks inside the $\pi$-meson structure region. For the second case we considered the possible parents of neutrino- kaons (see fig.6., fig.7, fig.8, fig.9). In this case we take into account both variants-energy and origin of production. The distribution of the neutrino energy formed from lepton- and semi-lepton- decays K-meson decays for which we take the following coefficients for $k_K/k_\pi \sim (m_K/m_\pi)^2$. According to [6] the neutrino velocity effect should more significant for neutrinos produced from the heavy quark decays. This one can see also on the figures fig.(10) where the temporal spread of the $\nu_K$- neutrino collapses can be much more than it was in $\nu_\pi$- cases. Combining both cases one can consider for neutrino velocity the more strongest energy dependence like as $v_\nu/c \sim (E_\nu/M_S)^4$ (see the fig.11 and fig.12). For illustration we can give the distributions of $\nu$-fluxes from SN87A at $M_S = 0.1-, 0.2-, 0.5-, 1TeV$ (see fig(9)). This cosmic experiment may be the first time gives us a hint about what the neutrinos cross the huge spatial and time intervals according to other laws. To draw concrete conclusions from this experiment is difficult to do. Any predictions depend on the theory of stellar evolution, and the
Figure 1: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies $E = 400 GeV$ [28]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from $\pi$-meson decays. Four distributions $\nu_\pi$- fluxes at the different scales: $M_s = 1−, 2−, 5−, 10 − TeV$ on the distance $183 km$.

structure of the tremendous medium through which the neutrino waves swept generated in the depths of supernova [16].
Figure 2: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies $E = 400 GeV$ [28]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from $\pi$-meson decays. Four distributions for $\nu_\pi$- fluxes at the different scales: $M_S = 1 - , 2 - , 5 - , 10 - TeV$ on the distance 366 km.

7 Conclusions. Towards the Super-High Energy Neutrino Experiments

Comparing with our ideas in [6] the conclusions obtained from the data analysis of experiments [17], [20], [21] demand a comprehensive reconsideration. From these experiments it is not clear what they measured - neutrino or light velocity? The conclusions depend on some proposals of neutrino spatial and temporal properties. In such kind of experiments the main accent should been done on the attempts of the synchronization problem solution
Figure 3: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies $E = 400 GeV$ [28]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from $\pi$-meson decays. Four distributions for $\nu_\pi$-fluxes at the different scales: $M_S = 1-2-5-10 - TeV$ on the distance $732 km$.

for two "neutrino" events: production and detection. However, to solve this problem in these experiments it was assumed that the spatial-temporal behaviour of neutrinos is determined by the Lorentz-Poincaré group symmetry $\psi_\nu \sim (\exp i k \cdot x)$. It wasn’t taken into account that neutrinos can have extraordinary spatial and temporal properties different from the charged matter properties. For example, in ternary or in quaternary description the following plane wave generalization can be taken in the following form [10],[39],[40]:

Figure 4: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies $E = 400 GeV$ [28].

The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from $\pi$-meson decays. Four distributions for $\nu_\pi$-fluxes at the different scales: $M_S = 1-, 2-, 5-, 10-TeV$ on the distance $1464 km$.

\[
\psi_\nu \sim \exp\{I_1(\hat{k} \cdot \hat{x}) + I_2(\hat{\rho} \cdot \hat{y}) + I_3(\hat{m}(p, k) \cdot \hat{s}(x, y))\}. \tag{18}
\]

Therefore, the reached conclusions on the neutrino velocity measurement can’t be interpreted unambiguously and it was illustrated in the previous section. It can be taken into account that these experiments collide with the absolute movement paradoxes. The results of such kind experiments correspond to common supposition that the neutrino collapses propagate through the space similar to the light fluxes.
Figure 5: The temporal distributions of the intensity of the neutrino fluxes for 5-bunches from the output proton beam with energy $E = 400\text{GeV}$ at a distances of 366 km and 732 km. $M_s = 1 \text{ TeV}, 2 \text{ TeV}$. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation neutrino fluxes from $\pi$-meson decays.

The good time resolution was achieved in these experiments to measure the speed of neutrinos but the energy resolution was not sufficiently precise for the proposed synchronization problem solution ideas. The energy has been measured with poor accuracy at least 20 percent. This is due to the several reasons:

- 1. The bad identification of the charged and neutral currents. In the neutral current neutrino takes a lot of energy
Figure 6: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies $E = 400GeV$ [28]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from $K$-meson decays. Four distributions for $\nu_K$- fluxes at the different scales: $M_S = 2^{\text{--}}, 5^{\text{--}}, 10^{\text{--}}, 20^{\text{--}} - TeV$ on the distance $183km$.

- 2. The carried away energy of neutrinos is poorly defined.

- 3. The $\pi$-meson and the proton are often not distinguished.

- 4. The observation of several events, secondary events are mixed up.
Figure 7: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies $E = 400 GeV$ [28]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from $K$-meson decays. Four distributions for $\nu_K$-fluxes at the different scales: $M_S = 2-, 5-, 10-, 20- \text{ TeV}$ on the distance $366 km$.

The detector containing passive elements can increase the number of problems with the neutrino energy definition. There is also the separation problem of the rock neutrino events. It would be important to study the dependence of registered neutrino fluxes on the energy and distance for the correct neutrino spectra normalization.

In fact, the experimental limits on the speed of neutrinos obtained in these experiments cannot be proven as the maintained synchronization depends on the specific assumptions. In our opinion, the problem that was posed in the
Figure 8: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies $E = 400 \text{GeV}$ [28]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from $K$-meson decays. Four distributions for $\nu_K$-fluxes at the different scales: $M_S = 2 - 5 - 10 - 20 - \text{TeV}$ on the distance 732 km.

works [6] requires a whole series of serious studies under different conditions: the wide energy range of the proton spills till some TeV, the short and the long distances, different time length of proton spills, different neutrino specie, etc.

There might be very important the questions connected to the decrease of the flux intensity dependent on the distance what can be occur due existence of extra dimensions and it is naturally expected in the ternary model neutrino. So the neutrino flux evolution with the distance and the energy can also test the hypothesis of non-compact extra dimensions.
Figure 9: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies $E = 400GeV$ [28]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from $K$-meson decays. Four distributions for $\nu_K$- fluxes at the different scales: $M_S = 2-, 5-, 10-, 20-TeV$ on the distance 1464km.

The considered scenarios showed that the solution of the neutrino phenomena mysteries still needs new and the more detail experiments. The our examples show that it is better to carry out the neutrino measurements at the more higher energies. The proton/electron stability provides the upper bound of $M_S \sim 20TeV$ [8]. Since the other models can be developed the investigation of this class of neutrino experiments needs to be continued.

In our projects [6], the suggestions on measurement of some global neutrino flux motion characteristics in spatial-temporal picture have been done.
We knew that in the case of neutrinos the successful implementation of these projects is determined by the our knowledge of or the correct ideas on the actual neutrino properties as a particle and a wave or some its generalization.

Since it was suggested that the effects of advancing the speed depends on the neutrino energy is natural to consider the neutrino programs at the high or the extremely high energies. The experiments at $\sim O(100 - 1000)GeV$ [6] could be already done in the nearest future at the accelerator modern complexes of FNAL and of CERN. One can say that such kind of experiments are
Figure 11: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies $E = 400 GeV$ [28]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from $\pi$-meson decays. Four distributions for $\nu_{\pi}$ fluxes at the different scales: $M_S = 0.1-, 0.2-, 0.5-, 1 – TeV$ on the distance 732 km.

linked to the another class of neutrino experiments at high energies opposite to the ideology of the experiments going to measure the neutrino oscillations. We should note that this class of neutrino experiments at super-high energy and on different bases including very long distances can be very important for the future of the SM-physics and beyond. For example, the experiments on the total cross section measurement of neutrino interactions in dependence on the distance between the source of neutrino beams and detectors might
Figure 12: The temporal distributions of the intensity of the neutrino fluxes for the only one bunch of the output proton beam at energies $E = 400\text{GeV}$ [28]. The duration of one bunch is equal to 3 nanoseconds, the gap between the neighboring bunches equals 500 nanoseconds. Consider the case of formation of the neutrino fluxes from $\pi$-meson decays. Four distributions for $\nu_\pi$- fluxes at the different scales: $M_s = 0.1\ldots 0.2 - 0.5\ldots 1\text{ TeV}$ on the distance $1464\text{ km}$.

The neutrino experiments at the high or the super-high energies will be able to expand the progress possibilities in discovering the secrets of neutrinos significantly if they will n’t not play a decisive role. In our opinion, the two programs of the low-energy neutrino physics associated with the study of the oscillations,[43],[44],[45],[46], etc and the neutrino physics at the ultra-high energies [23],[6] will only complement each other.
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