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Stochastic processes, quasi-group symmetries and the hadron stability

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We offer to do not increase the count of gauge fields beyond 8 as in the grand unified theory. For the realization of this purpose it is necessary to use quasi-group symmetries which are the maximum likelihood ones for the stochastic processes description, characterizing any open systems personally hadrons. Of course structure tensor components must be solutions of corresponding differential equations, which generalize Jacobi identities.

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1 Speaker

1. Two subsystems of the Universe matter. Neutrinos

The last astronomical data [1] do not let to doubt what the Universe is classified among the physical systems, the information's on which's it is impossible to consider the full one. As is known, for the description of the similar systems it is used the formalism in which the functions have the probable interpretation. As a result it might be out of place worthwhile to remember the Boltzmann fluctuation hypothesis of the Universe birth supplementing it the assumption about the existence of the great background from weakly interacting particles. That's precisely this supposition does the task of the construction of the Universe stationary model the practicable one. What is more, we shall suppose that the greater part of these particles exist in the degenerate (basic) state inserting the minor contribution in the vacuum polarization for the estimation of which the space curvature is used, what allows to solve the problem of the Universe planeness.

Neutrinos and antineutrinos of various flavors are classified among such kind of particles, their participation only in weak interactions is the peculiarity of which's. The total density of neutrinos and antineutrinos in the Universe is not known, because the estimations can be obtained when considering the inelastic scatterings, having the enough high energy thresholds. Having the neutrino Universe and considering the Fermi-Dirac statistics, we can remember on the Sakharov's hypothesis [2], in which the vacuum elasticity and the gravitational interaction of macroscopic bodies were interconnected. As a result it might be worthwhile to use the elasticity of the neutrino Fermi liquid for that object with the sufficiently high Fermi energy ε_F (characterizing of the Fermi particles density in the Universe).

Bashkin's papers [3] appearing in 80th on a propagation of the spin waves in the polarized gases initiated the supposition, that the analogous collective oscillations are possible under certain conditions as well as in the neutrinos medium [4]. Precisely it with the attraction of the Casimir effect allowed to connect the gravitational constant $G_N \sim 10^{-38}$ GeV^{-2} with parameters of the electroweak interaction ($G_N \propto \sigma_{\nu e}$, $\sigma_{\nu e}$ is the cross-section for scattering of a neutrino on an electron) [5]. Taking account of the obtained result and also the empirical formula [6] $H_\circ / G_N \approx m_\pi^3$, ($m_\pi \sim 10^{-1} GeV$ is the pion mass, $G_N \sim 10^{-38} GeV^{-2}$ is the gravitational constant, $H_\circ \sim 10^{-42} GeV$ is the Hubble constant) it can offer the interpretation of the Hubble constant as a quantity characterizing kinetic process of a relaxation in the Universe (we shall use the system of units $h/(2\pi) = c = 1$, where h is the Planck constant and c is the velocity of light).

We consider that the partition of the Universe matter on two subsystems is a description method allowing the construction of the Universe evolution theory not resorting to fantastic forms of a matter. In the first place it is necessary to give a definition of fast subsystem particles as particles participating in strong and electroweak interactions, at the time as slow subsystem particles do not have such opportunity. Causes of this can be the very different. According to

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our supposition for the most part of slow subsystem particles is what they being fermions (particles with a half-integer spin) formulate quantum liquids (the Fermi liquid, the Bose liquid from fermionic pairs). When particles go from the ground state to the excited one they acquire all properties of fast subsystem fermion – the color charge and (or) the electric charge.

In the degenerate state background fermions of Universe, generating Fermi and Bose liquids, are weakly-interacting particles, but it is not excluded by the interaction with hadrons their exhibition as color fermions – ghosts. We do not exclude also the possibility, that in the state of the Fermi liquid they must be considered as right neutrinos and left antineutrinos with the sufficiently high Fermi energy ε_F ("sterile" neutrinos and "sterile" antineutrinos) [7]. It must be exhibited in the absence of these particles by decays attributed to weak interactions of low energies (a mirror asymmetry). Thus for example, it can be interpreted a lepton production upon a charged pion decay as a freezing-out of color degrees of freedom what is expressed in the form of the spontaneous breaking of the $SU(3)$ symmetry characterizing the interaction of color quarks to the $SU(2)\times U(1)$ symmetry characterizing the electroweak interactions of leptons.

Using the Ginzburg-Landau theory it can consider, that hadrons are the analog of second-kind superconductors with the large London penetration depth, defined by sizes of strongly interacting elementary particles ($\lambda < 10\, GeV^{-1}$). At the freezing-out of color degrees of freedom and at the increase of the order parameter bound to the density of neutrino Cooper pairs, we obtain the vacuum as the first-kind superconductor with the small London penetration depth (the value $1/m_Z \sim 10^{-2}\, GeV^{-1}$ can play its role, m_Z is the rest mass of the Z° boson).

We note that the transition to the description of the slow subsystem by the adaptation of the space-time manifold is carried when the Fermi energy ε_F of "sterile" neutrinos tends to infinity. In this case the quotation--marks in the words "sterile" neutrinos can be discarded, because these neutrinos will not interact with the other particles even at very high energies.

2.The maximum plausible realizations

The principle of the theoretical notion adequacy to experimental data must be put in the base of the serious physical theory. It is precisely therefore we attach the fundamental importance to symmetries which in the condensed (pithy) form. For this in the elementary particle physics is used the scattering matrix which allows to guess a form of transition operators if only for linear approximation. Because we must forecast results of future experiments, the description of physical systems states will proceeds by use of smooth functions, which it is desirable to obtain as solutions of differential equations. It is precisely therefore we shall approximate the transition operators by differential operators using the variation formalism. We note that the presence of the neutrino background with the finite Fermi energy ε_F is the catalytic agent of stochastic processes, but the large value of this energy causes to the determinancy of physical processes. Specifically we connect the large value of the Fermi energy and the low temperature of the neutrino background with the stability (or if only with the metastability) of elementary particles.

Let us to consider the packet $\{\Psi(\omega)\}$ of functions given in some domain of a parametrical space M_r and let the substitutions

$$\Psi \to \Psi + \delta\Psi = \Psi + \delta T(\Psi)$$

are the most general infinitesimal ones, where δT are infinitesimal operators of a transition (we do not concretize at first which type of symmetries by them are given). We note that just the operators δT, defined by a scattering matrix, will generate the symmetries characterizing the studied interactions.

We draw smooth curves through the common point $\omega \in M_r$ with the assistance of which we define the corresponding set of vector fields $\{\delta\xi(\omega)\}$. Further we define the deviations of fields $\Psi(\omega)$ in the point $\omega \in M_r$ as $\delta_\circ \Psi = \delta X(\Psi) = \delta T(\Psi) - \delta\xi(\Psi)$ and we shall require that these deviations were minimal ones even if in "the mean". If we state the task – to find the smooth fields $\Psi(\omega)$ in the studied domain Ω_r of the parameters space M_r then it can turn out to be unrealistic one (possibly $r >> 1$ and possibly $r \to \infty$). That's precisely therefore the task of the finding of the restrictions $\Psi(x)$ on the manifold M_n ($x \in M_n \subset M_r$, $n \leq r$) will present an interest.

Let the square of the semi-norm $|X(\Upsilon)|$ has the form as the following integral

$$\mathrm{A} = \int\limits_{\Omega_n} \Lambda \, d_n V = \int\limits_{\Omega_n} \kappa \overline{X}(\Psi)\rho X(\Psi) d_n V \quad . \qquad (2.1)$$

(we shall name A as an action and Λ as a Lagrangian also as in the field theory). Here and further κ is a constant; $\rho = \rho(x)$ is the density matrix (tr $\rho = 1$, $\rho^+ = \rho$, the top index "+" is the symbol of the Hermitian conjugation) and the bar means the generalized Dirac conjugation which must coincide with the standard one in particular case that is to be the superposition of Hermitian conjugation and the spatial inversion of the space-time M_4. We shall name solutions $\Psi(x)$ of differential equations, which are being produced by the requirement of the minimality of the integral (2.1), as the maximum plausible realizations of Lie local loops [8] and shall use for the construction of the all set of functions $\{\Psi(x)\}$ (generated by the transition operators).

Of course for this purpose we can use the analog of the maximum likelihood method employing for the probability amplitude, but not for the probability as in the mathematical statistics. As is known, according to the Feynman's hypothesis the probability amplitude of the system transition from the state $\Psi(x)$ in the state $\Psi'(x')$ equal to the following integral

$$K(\Psi,\Psi') = \int\limits_{\Omega(\Psi,\Psi')} \exp(i\mathrm{A}) D\Psi =$$

$$\lim_{N\to\infty} I_N \int d\Psi_1 ... \int d\Psi_k ... \int d\Psi_{N-1} \exp\left(i \sum_{k=1}^{N-1} \Lambda(\Psi(x_k)) \Delta V_k \right) \qquad (2.2)$$

($i^2 = -1$; the constant I_N is chosen so that the limit is existing). So, the formula (2.2) allows describe the most adequately the physical process in the quantum theory. At the same time the functions Ψ(*x*), being the solutions of differential equations, received from the requirement of the minimum of the action A, may be the maximum likelihood ones only, but then they allow describing in condensed (short) form the same physical system. In this approach the Lagrangian Λ plays the more fundamental role than differential equations which are generated by it. As the transition operators are constructed on the base of experimental data, then the differential equations, obtained in a result of the Lagrangian special choice in the action (2.1), can name as the differential equations of the root-mean-square regression Ψ on *x*.

3. The Lie local loop of realizations

Let E_{n+N} is the vector fiber space with the base M_n and the projection π_N, $\Psi(x)$ is the arbitrary section of fibre bundle E_{n+N}, ∂_i is the partial derivative symbol. Let us to consider the infinitesimal substitutions defining the vector space mapping of the neighbour points x and $x+\delta x$ ($x \in U,\ \ x+\delta x \in U,\ \ U \subset M_n$) and holding the possible linear dependence between vectors. We write given substitutions as:

$$\Psi'(x+\delta x) = \Psi(x) + \delta\Psi(x) = \Psi(x) + \delta T(x)\Psi(x) \qquad (3.1)$$

where $\delta T(x)$ is the infinitesimal affinor fields. By this the vector field change in consequence of the transition in the neighbour point has the form: $\Psi(x+\delta x) - \Psi(x) \approx \delta x^i \partial_i \Psi(x)$ (here and further Latin indices *i, j, k, …* will run the values of integers from 1 to *n*) and the change of the field Ψ in the point $x+\delta x$ will equal

$$\Psi'(x+\delta x) - \Psi(x+\delta x) = \Psi'(x+\delta x) - \Psi(x)$$

$$-[\Psi(x+\delta x) - \Psi(x)] \approx \delta T(x)\Psi(x) - \delta x^i \partial_i \Psi(x).$$

Further we shall denote

$$\delta_\circ \Psi(x) = \delta T(x)\Psi(x) - \delta x^i \partial_i \Psi(x). \qquad (3.2)$$

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Let the formula (3.1) defines the infinitesimal substitution of the Lie local loop $G_r(x)$ moreover the unit e of the Lie local loop, the co-ordinates of which equal to zero, corresponds to the identity substitution. Then the infinitesimal substitutions of the Lie loop in co-ordinates are written as

$$x^i \to x^i + \delta x^i = x^i + \delta\omega^a(x)\xi_a^i(x), \tag{3.3}$$

$$\Psi^A(x) \to \Psi^A(x) + \delta\omega^a(x)T_{aB}^A(x)\Psi^B(x), \tag{3.4}$$

where x^i are the co-ordinates of the point x, $x^i + \delta x^i$ are the co-ordinates of the point $x + \delta x$, $\Psi^A(x)$ are the components of the vector field $\Psi(x)$ and $\delta\omega^a(x)$ are the components of the infinitesimal vector field $\delta\omega^a(x)$ being the section of the vector fibre bundle E_{n+r} with the base M_n and with the projection π_r (here and further Latin indices *a, b, c, d, e* will run the values of integers from 1 to r and Latin capital indices *A, B, C, D, E* will run the values of integers from 1 to N).

As a result the formula (3.2) is rewritten in the following form:

$$\delta_\circ\Psi = \delta\omega^a X_a(\Psi), \tag{3.5}$$

where

$$X_a(\Psi) = T_a\Psi - \xi_a^i\partial_i\Psi \tag{3.6}$$

or in the co-ordinates

$$X_a^A(\Psi) = T_{aB}^A\Psi^B - \xi_a^i\partial_i\Psi^A.$$

In the general case a type of geometrical objects can do not conserving with the similar substitutions. Therefore below we shall consider only such substitutions which conserve a type of geometrical objects.

In first in the formula (3.5) it ought to become to the covariant derivative. Let

$$\delta_\circ\Psi^A = \delta\omega^a X_a^A(\Psi) = \delta\omega^a(L_{aB}^A\Psi^B - \xi_a^i\nabla_i\Psi^A), \tag{3.7}$$

where

$$L_{aB}^A = T_{aB}^A + \xi_a^i\Gamma_{iB}^A, \qquad \nabla_i\Psi^A = \partial_i\Psi^A + \Gamma_{iB}^A\Psi^B,$$

and we demand that $L_{aB}^A(x)$ and $\xi_a^i(x)$ should be the components of intermediate [9] tensor fields. Hence if $\Psi(x)$ are the components of the vector field then $\Psi(x) + \delta_\circ\Psi(x)$ also are the components of the vector field.

We shall name the fields $X_a(\Psi)$ as the generators of the Lie local loop $G_r(x)$, if the multiplication $[X_a X_b]$ satisfies the following two axioms:

1) $$[X_a X_b] + [X_b X_a] = 0,$$

2) $$[[X_a X_b]X_c] + [[X_b X_c]X_a] + [[X_c X_a]X_b] = 0. \tag{3.8}$$

So, let

$$[X_a X_b] = X_a X_b - X_b X_a = C^c_{ab} X_c. \tag{3.9}$$

As a result the intermediate tensor fields $L_{aB}^{\ \ A}(x)$ and $\xi^i_a(x)$ must satisfy to the following correlations:

$$L_{aC}^{\ \ B} L_{bB}^{\ \ A} - L_{bC}^{\ \ B} L_{aB}^{\ \ A} + \xi^i_a \nabla_i L_{bC}^{\ \ A} - \xi^i_b \nabla_i L_{aC}^{\ \ A} - \xi^i_a \xi^j_b R_{ijC}{}^A = -C^c_{ab} L_{cC}^{\ \ A},$$

$$\xi^i_a \nabla_i \xi^k_b - \xi^i_b \nabla_i \xi^k_a - 2\xi^i_a \xi^j_b S^k_{ij} = -C^c_{ab} \xi^k_c,$$

where $S_{ij}^{\ \ k}(x)$ are the components of the torsion tensor and $R_{ijC}{}^A(x)$ are the curvature tensor components of the connection $\Gamma^A_{iC}(x)$. The components $C_{ab}^{\ \ c}(x)$, alternating on down indices owing to (4.9) of the structural tensor, must satisfy in consequence of (4.8) to the generalized Jacobi identities [10]

$$C^d_{[ab} C^e_{c]d} - \xi^i_{[a} \nabla_{|i|} C^e_{bc]} + \xi^i_{[a} \xi^j_b R_{|ij|c]}{}^e = 0 \tag{3.10}$$

($R_{ijc}{}^e(x)$ are the curvature tensor components of the connection $\Gamma^b_{ia}(x)$).

4. The mathematical formalism application

We shall use that smooth manifolds are locally diffeomorphic ones to the Euclidean space or to the pseudo-Euclidean space in a certain neighborhood of any point. Therefore we shall choose the connection components $\Gamma^b_{ia}(x)$ equal to zero in the region under consideration. As a result the structure equations (3.10) are rewritten in the form:

$$C^d_{[ab} C^e_{c]d} - \xi^i_{[a} \partial_{|i|} C^e_{bc]} = 0 \tag{4.1}$$

So, suffice it to assume

$$\partial_i C^e_{bc} = 0, \tag{4.2}$$

that in the points of space M_n, in which the correlations (4.2) are satisfied, the Lie local loop Q_r can be named the Lie local group G_r (the Jacobi identities are satisfied: $C^d_{[ab}C^e_{c]d} = 0$).

Since stable states or metastable states are characterized the specific symmetries, then giving the parameter dependence of structural tensor components C^c_{ab}, we can describe decay processes of elementary particles if only approximately. Specifically, we shall consider that the process of the spontaneous symmetry breaking is characterized the quasi-group structure. (Of course we take account of the presence of the Universe neutrino background which is the catalytic agent of stochastic processes, including decays of elementary particles). In consequence of this it is logically connect the stability of differential equations (4.1) solutions with the stability of elementary particles. As a result functions $C^c_{ab}(x)$ must describe the process of spontaneous breaking of symmetry at hadrons decay, including with the violation of baryonic charge conservation.

If the Lie local loop $Q_r(x)$ operates in the space of the affine connection as transitively so and effectively ($n = r$), then it can choose the components ξ^k_a of the intermediate tensor field equaled to the Kronecker symbols δ^k_a in a neighborhood of a point ω. As a result we must test the solution stability of differential equations

$$C^d_{[ab}C^e_{c]d} - \partial_{[a}C^e_{bc]} = 0 \qquad (4.3)$$

Specifically, when $n = r = 8$, it allows to do not increase the count of gauge fields beyond 8 as in the grand unified theory. Thereby we consider that gluons attend in the space domain where intermediate vector bosons are absent and on the contrary intermediate vector bosons attend in the space domain where gluons are absent. Here we can use the theory of second-kind superconductor. In the given case the order parameter must be connect with the density of Cooper neutrino pairs considering that it is reducing to the hadron center. That's precisely what causes to the dependence of properties both fermions and vector bosons in different space domains.

Note that in more general cases, when the connection components $\Gamma^b_{ia}(x)$ are not equal to zero and the Lie local loop $G_r(x)$ operates in the space of the affine connection as transitively so and effectively, then the correlations (3.10) become in the Ricci identity ($C^c_{ab} = 2S^c_{ab}$). Because the symmetry, characterizing the physical system, is selected in terms of experimental data, the geometrical structure tied to the symmetry is only the maximum plausible one. Hence

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it follows that it is desirable to use the spaces of the affine connection with the torsion for the description of particles. What is more precisely the torsion must depend on a rest mass of a particle. The assumption on the "sea" of quarks in the ground state allows using the Landau theory of the Fermi liquid considering observable particles as quasi-particles on the background of "sterile" neutrinos and "sterile" antineutrinos. (We evolve the Dirac hypothesis on the presence of the electrons sea with negative energies in the Universe for the explanation of the electrons stability with positive energies.) The properties of the latter's must define the geometrical and topological properties of the space-time M_n. Personally it must not be the simply connected space if physical systems are considered at sufficiently low energies that allow explaining the charge quantization of observable particles. As a result we forecast the appearance the new physics just at sufficiently high energies.

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