THE CONFINEMENT AND THE DARK MATTER OF THE UNIVERSE

Valery Koryukin

Department of Physics and Mathematics, Mari State University

Lenin sq. - 1, Yoshkar-Ola, 424001, Russia.

E-mail: kvm@marsu.ru

It is known that at present not a fundamental scalar particle (for example: the Higgs boson, the axion [1]) is detected although there is the set of the composite scalar (pseudoscalar) mesons (hadrons with spin 0). What is more we do not know anything about the graviton (the fundamental tensor boson with spin 2) which must be responsible for the gravitational interaction in the quantum theory by definition. At the same time there are a major number of the observed fundamental fermions with spin 1/2, if we shall relate the color quarks together with leptons to this class. Thereby experimental data hint at the existence of the fundamental Universe property concerned with the spin nature of elementary particles which must be laid in the foundations of physical theory.

Quite possibly that by the construction of theory it is necessary to reverse the concept of vacuum regarding hadrons as holes in the quark sea of particles being in the ground (degenerate) state by the temperature $T_\circ \sim 10^{-13}\, GeV$ (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), the estimation of which may be the temperature of the cosmic microwave background detected by Penzias and Wilson in 1964 [2]. As it is known the fact, what the vacuum energy density of electromagnetic field was the negative one, awaken the hope at Casimir to construct the model of the extended elementary particles in the form of spheres in which the Coulomb repulsion is placed in equilibrium with the attraction, connected with zero-point oscillations of vacuum [3]. The Casimir energy, calculated by the computer, proved the positive one and was equal to $E = +0{,}09235/(2r)$ (r is the sphere radius) [4]. Thus it had to seek the other causes explaining a stability of elementary particles what causes us to remember the Dirac hypothesis 1930 about the existence of the electron sea with the negative energy. In our opinion the degenerate fermions pressure of the ground (vacuum) state can be the main cause, not allowing a fermion, having the charge, "is inflated".

The offered hypothesis by us explains both the confinement (within hadrons the confinement of color quarks which's we shall consider as exited states of ground fermions) and the asymptotic freedom (within hadrons at small distances (where the effective temperature is high enough) the conduct of color quarks as freedom particles). In the degenerate state ground 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 [5]. We do not exclude also the possibility, that in the form of the Fermi liquid they must be considered as right neutrinos and left antineutrinos with the sufficiently high Fermi energy. It must be exhibited in the absence of these particles by 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.

Naturally, that the color plasma frequency, defined by the energy of the compound scalar boson having the minimal mass, allows to give the crude estimation of the density $n_{\circ} \sim m_{\pi}^{2} m_{q} \sim 10^{-3}\ GeV^{3}$ ($m_{\pi} \sim 10^{-1}\ GeV$ is a mass of pion, m_q is a mass of light quark ($m_q \sim 10^{-2} \div 10^{-1} GeV$)) ground fermions of Universe.

As stated above in spite of all attempts fundamental scalar particles was unable to detect (supporters of an existence of scalar Higgs bosons await the work results of the large hadron collider at CERN due at 2009, but it is necessary to note that they have the justification for the negative outcome even if in the subsequent increase of this particles rest masses) and all familiar scalar particles are compound ones (scalar mesons). This problem attracts an attention more and the more so, that the Lagrangian of scalar fields in the standard electro-weak model has obviously the macroscopic nature which is necessary for the actuation of the mechanism of the spontaneous breaking of symmetry. The similar mechanism [6] of the spontaneous breaking of symmetry was considered in the theory of superconductivity for Cooper pairs and it would be logically to use pairs from ground fermions of Universe instead of scalar particles in standard electro-weak model. It can be remove questions on the infinitesimal of the interaction constant of the charged fermions with the scalar field and its dependence from their flavors [7].

In the elementary particles physics the spontaneous breaking of symmetry, realized by compound fields and having the name of the dynamic breaking of symmetry, was considered with 1961 in works of many authors (the literature on this subject can be taken in papers [8,9]). In connection with this it must be noted the work [9], in which in our opinion are made the important commentaries on the role of the quark condensate in order to make hadrons massive ones. Let us note that the mass problem in the gauge theory of arbitrary interactions was the urgent one only for three fundamental particles: W^+, W^-, Z^o. The photon and gluons are massless particles. The other bosons are compound ones and the entire problem with masses transfers to fermions for which's it do not exist simply. In consequence of this it was necessary to decide the question on the mass nature only for W^+, W^-, Z^o bosons what we are doing, advancing the hypothesis on the major background of Universe particles which's exist in the ground state and which's manifest itself in the weak interaction [10].

The large density of particles in the Universe interacting only weakly is confirmed also by the considerable value (~ 10^2 *GeV*) of rest masses m_W and m_Z accordingly of $W^{\pm}$-bosons and Z^o-boson generating the weak interaction. Here for a vacuum we have the analog of the first-kind superconductor with the large coherence length (its role can be played the value $1/H_\circ$, giving the estimation to the length of a free run of particle in "vacuum" (the Hubble constant $H_\circ \sim 10^{-42} GeV$)) and with the small

London penetration depth of the weak field (the value $1/m_Z$ can play its role) [11]. Using the analog of the known formula [12] for the London penetration depth of the magnetic field ($\lambda_L^2 = m_p c^2 / \left(4\pi n_p g^2\right)$, where λ_L is the London penetration depth, $m_p \sim 10^{-10} \div 10^{-9} GeV$ is the mass of the Cooper pair (we consider that $m_p \sim m_\nu$, where m_ν is the supposed rest mass of the electron neutrino), $g \sim 10^{-2} \div 10^{-1}$ is the charge of the Cooper pair), we can do the crude estimation of the density of the Cooper pairs: $n_p \sim n_\circ \sim 10^{-3}\ GeV^3$.

Moreover it can obtain this estimation of density $n_\circ$ using the kinetic relation connecting the mean free path of charged particles in a vacuum with the density of Universe ground neutrinos, if we shall take into account only the weak interaction. We shall use the known empirical relation [13] $H_\circ / G_N \approx m_\pi^3$ considering that the Hubble constant (also as before) gives the estimation $1/H_\circ$ the mean free path $l \sim 1/\left(n_\circ \sigma_\nu\right)$ of a particle in a vacuum (σ_ν is the scattering cross-section of a neutrino on a charged particle) and taking into account the interpretation given before for the gravitation constant $G_N \sim 10^{-38}\ GeV^{-2}$ ($G_N \sim \sigma_\nu \propto \alpha G_F^2 T_\nu^2$ [14], $\alpha \sim 10^{-2}$ is the fine structure constant, $G_F \sim 10^{-5}\ GeV^{-2}$ is the Fermi constant, $T_\nu \sim 10^{-13}\ GeV$ is the temperature of Universe ground neutrinos). Let us note what in this case it can not assume giant fluxes of high energy neutrinos from astrophysical sources for the explanation of the observable flux of events of cosmic rays of ultrahigh energies within the scope of the *Z-burst* mechanism (the *Z-burst* mechanism is the mechanism of the generation of cosmic rays of ultrahigh energies in a result of an annihilation of a high energy neutrino (under which we shall imply antineutrinos, too) on an neutrino background of the Universe) [15].

The Hubble constant may be connect also with the shielding length of the electromagnetic field in a vacuum because of the photon scattering by virtual charged particles the high density of which's is supported by the presence of Universe ground particles. As is known [16] the last astronomical data caused to introduce such notion as the dark energy endowing some of matter properties (energy, pressure) on the bare vacuum in addition to the available dark matter which was introduced before for the explanation of the non-standard behavior of galaxies [1]. This notion (and instead of it the more careful notion – the quintessence) was called to conserve the standard Friedman model of the expanding Universe, but many its problems remain not solved up to now. Specifically it is the planeness problem (the space curvature close to zero) and the horizon problem (the high degree of isotropism of cosmic microwave background from causal free regions of the Universe) [1]. In the Einstein theory because of the gravitational instability of a matter with a low density this facts are difficult to explain.

In our opinion it necessary to make the more radical decision, namely to support Hubble doubts [17] in regard to the explanation of the red frequency shift of an electromagnetic radiation of distant galaxies at the expense of its recession (Hubble assumed the photon ageing) and to return to the construction of the stationary model of the Universe. As was said before for this it is necessary to revise cardinally the matter quantity, considering that the greater its part exist in the degenerate state, characterized by the low temperature. If it will adopt for its estimation the temperature of the cosmic microwave background in the Universe, then for this we receive sufficient basis. Moreover namely the role of irreversible processes in the Universe become principal one by the construction its stationary model. It allows looking at new on Hoyle and Narlikar hypothesis [18] on the dependence of elementary particle masses on space-time coordinates.

It is obvious that a fundamental problem solution of an arbitrary physical system description is run into information incompleteness about a Universe matter. It causes us to make use of a probability interpretation of field functions for a production of a model-independent solution of its problem. Naturally that for this aim the Feynman formulation [19] of the quantum theory is more attractive one. As a result the classical description must satisfy the requirement of the maximum probability.

We note that in the twentieth century it was made largely attempts to break down the determinism which firmly established in the science to the nineteenth century close. Certainly the quantum mechanics inserted the principal contribution in this, the formation of which was initiated by results of experiments in atomic and nuclear physics. But and in the base of bases in which the determinism was founded - in the classical mechanics - it was marked “disadvantages” causing to the loss of illusions [20]. Despite the fact that with illusions were finished it is difficult to give up the determinism idea, as the planning of the physical experiments was based on the accounts relying on the methods which appeared in the science during the determinism domination.

In the first place to these methods it is necessary to attribute the infinitesimal calculus. It is difficult to overestimate the successes in the field. We can indicate only at a field of mathematics - the Lie group theory - which exercised the huge influence on all theoretical physics. Of course, here the useful results can be received owing to the “good” properties of the used spaces (it is used the Hausdorff spaces in spite of the quantum nature of laws acting in the microcosm). What is more the availability of the smooth congruence's which are the solutions of differential equations plays the important role in the Lie group theory. At the same time in the quantum mechanics the existence of the elementary particles paths are negated. In consequence of this instead of the Lie derivatives it is becoming necessary to use the more general operators which can induce the more general algebraic structures in comparison with the Lie groups. Specifically it can be the Lie local loops [21] which's allow to take into account the absence of the determinism in the real physical processes.

Let us to consider the packet $\{\Psi(\omega)\}$ of functions and let the substitutions

$$\Psi \to \Psi + \delta\Psi = \Psi + \delta T(\Psi) \tag{1}$$

are the most general infinitesimal ones where δT are infinitesimal operators of a transition. 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

$$\delta_\circ \Psi = \delta X(\Psi) = \delta T(\Psi) - \delta\xi(\Psi) \tag{2}$$

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 ($x \in M_n \subset M_r$, $n \leq r$).

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

$$\mathrm{A} = \int\limits_{\Omega_n} \Lambda\, d_n V = \int\limits_{\Omega_n} \kappa \overline{X}(\Psi) \rho X(\Psi) d_n V \,. \tag{3}$$

(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 ($\mathrm{tr}\ \rho = 1$, $\rho^+ = \rho$, 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. Solutions $\Psi(x)$ (and even one solution) of equations, which are being produced by the requirement of the minimality of the integral (20) can be used for the construction of the all set of functions $\{\Psi(x)\}$ (generated by the transition operator).

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 [19], 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

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

$$\lim_{N\to\infty} I_N \int d\Psi_1 ... \int d\Psi_k ... \int d\Psi_{N-1} \exp\left(i \sum_{k=1}^{N-1} \Lambda(\Psi(x_k))\Delta V_k \right) \quad (4)$$

($i^2 = -1$; the constant I_N is chosen so that the limit was existing). Therefore the functions $\Psi(x)$, received from the requirement of the minimality of the action A, are also the maximum likelihood ones only. In this approach the Lagrangian Λ plays the more fundamental role than differential equations which are received from it.

We suppose that the greater part of weakly interacting particles constituting the great background of Universe exist in the degenerate (basic) state inserting the minor contribution in the vacuum polarization for the estimation of which the space curvature is used. In consequence of the low temperature $T_\circ$ of the Universe matter ground state (the density of the Universe matter ground state $n_\circ \sim 10^{-3} GeV^3$) the excited states of color fermions – the quarks in the form of baryons are distributed inhomogeneously and with a marginal density $\rho_b \sim 10^{-48}\ GeV^4$ (ρ_b is the energy density of the Universe baryon matter). Therefore the geometrical structure of the space is distinguished from the structure of the flat space no too distinct. What is more it can assume that the symmetry of the

Minkowski space-time is induced by physical properties of Universe fermions in a degenerate state when $T_{\circ} = 0$. It allows to solve not only the problem of the Universe planeness [1] but also to solve the problem of the observer horizon (the isotropy problem of the cosmic microwave background from the observer horizon of the Universe [1]).

References

[1] H.V. Klapdor-Kleingrothaus, K. Zuber. *Teilchenastrophysik.* (B.G. Teubner GmbH, Stuttgart, 1997).

[2] A.A. Penzias and R.W. Wilson, *Astrophys. J.,* **142**, 419 (1965).

[3] H.B.C. Casimir, *Proc. Kon. Nederl. Akad. Wet.,* **51**, 793 (1948).

[4] A.A. Grib, S.G. Mamaev, V.M. Mostepanenko, *Kvantovye effekty v intensivnykh vneshnikh polyakh* (Atomizdat, Moskva, 1980).

[5] F.J. Yndurain, *Quantum Chromodynamics: An Introduction to the theory of Quarks and Gluons* (New York, Berlin, Heidelberg, Tokyo: Springer-Verlag, 1983).

[6] V.L. Ginzburg, L.D. Landau, *Journal of Experimental and Theoretical Physics,* **20**, 1064 (1950).

[7] J.C. Taylor. *Gauge Theories of Weak Interactions,* (Cambridge, London, New York, Melbourne: Cambridge University Press, 1976).

[8] V.A. Miranskij, P.I. Fomin, *Physics of Elementary Particles and Atomic Nuclei,* **16**, Part 3, 469 (1985).

[9] B.L. Ioffe, *Uspekhi Fizicheskikh Nauk,* **176**, 1103 (2006).

[10] V. Koryukin. *In Proceedings of the XXV international workshop on the fundamental problems of high energy physics and field theory*

"Geometrical and Topological Ideas in Modern Physics" (Ed. V A Petrov) (Protvino: IHEP, 2002). p. 56.

[11] V. Koryukin. *In Proceedings of the International Conference BGL-4 (Bolyai-Gauss-Lobachevsky) "Non-Euclidean Geometry in Modern Physics and Mathematics"* (Nizhny Novgorod, September 7-11, 2004) (Edited by L. Jenkovszky and G. Polotovskiy) (Nizhny Novgorod - Kiev: Bogolyubov Institute for Theoretical Physics National Academy of Sciences of Ukraine, 2004). p. 134.

[12] V.V. Shmidt. *Vvedenie v fiziku sverkhprovodnikov* (Moskva: MTsNMO, 2000).

[13] S. Veinberg. *Gravitation and Cosmology* (Massachusetts: Massachusetts Institute of Technology, 1972).

[14] V.M. Koryukin, *Izvestiya vuzov. Fizika,* № 10, 119 (1996).

[15] V.A. Ryabov, *Uspekhi Fizicheskikh Nauk,* **176**, 931 (2006).

[16] B. Leibundgut and J. Sollerman, *Europhysics News,* **32,** № 4, 121-125 (2001).

[17] A.M. Cherepashchuk, A.D. Chernin. *Vselennaya, zhizn', chernye dyry* (Fryazino: Vek 2, 2003).

[18] J. Narlikar, *Violent Phenomena in the Universe*, (Oxford, New York: Oxford University Press, 1984).

[19] R.P. Feynman, A.R. Hibbs, *Quantum Mechanics and Path Integrals*, (New York, 1965).

[20] D.I. Blokhintsev, *Printsipinal'nye voprosy kvantovoj mekhaniki* ("Nauka", Moskva, 1987).

[21] A.I. Mal'tsev, *Matematicheskij sbornik*, 36, № 3, 569 (1955).