The quantum theory of the gravitation and "black holes" as cosmic rays sources of ultrahigh energies

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1. Introduction

As is known the background neutrinos play the slight role in the Universe standard model in the consequence of their assumed low density. The given assumption is unable be verified in the direct experiments by the inelastic scattering having the enough high energy thresholds of reactions. This allows to consider alternative models and in the first place with the use of "sterile" neutrinos and "sterile" antineutrinos (neutrinos and antineutrinos having the opposite polarization to observable neutrinos and antineutrinos by an inelastic scattering). As a result the assumed high density of "sterile" neutrinos by the enough low density of "normal" neutrinos (that causes to the observable spatial parity breakdown of weak interactions) may be explained by the spontaneous breaking of symmetry. The given state of physical systems is characteristic one by the low temperature the estimation of which is the temperature of the cosmic microwave background temperature. In this consideration it might be worthwhile to go to the Chernikov gravitational potential, the form of which assumes the quantum character of the zero oscillations in the neutrinos medium. Let's remark, that the asymptotical behavior of the Chernikov potential will be reduced to the behavior of the Yukawa potential which will be introduced for the description of short-range nuclear forces (the similar potential will be used and for the description of short-range electromagnetic fields in a plasma). As a result the constants in the Chernikov gravitational potential should be determined by the polarized properties of the medium from the weakly-interacting particles existing in the degenerate state.

2. The quantum theory of the standard gravitation

If we remember difficulties which's arisen by the quantum theory construction of strong interactions (and which's eliminated by the construction of quantum chromodynamics), it is not difficult to notice, that scientists faced with a similar situation and by the making of the gravitation quantum theory. In this connection it can make the supposition, that the gravitational interactions are not the fundamental ones as Yukawa nuclear forces and they have other a character on rather small distances in principle, which furnishes to use the gauge fields of a vector type. The more so, that the gravitational constant $G_N \approx 6.7\ 10^{-39}\ GeV^{-2}$ (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) is a suspiciously small value and a dimensional one furthermore (as is known the latter prevented the construction of the renormalizable quantum theory).

Bashkin's works appearing in 80th on a propagation of the spin waves in the polarized gases allowed to make the supposition [1], that the analogous collective oscillations are possible under certain conditions as well as in the neutrinos medium. Since the collective oscillations can induce an interaction between particles, Bashkin's works make us to pay attention to the background neutrinos of various flavors (under which we shall imply antineutrinos, too) filling our Universe. As the effective temperature of the background neutrinos is the fairly low one (the estimation of which may be the temperature of the cosmic microwave background detected by Penzias and Wilson in 1964), then it is fulfilled one of conditions [2] ($\lambda \gg r_w$, where λ is the de Broglie's wave-length of a neutrino and r_w is the weak interaction radius of an one) of the propagation of the spin waves in the polarized gases. As a result the quantum effects become the determinative ones in such medium and the interference of the neutrinos fields (being the consequence of the known identity of elementary particles) must induce the quantum beats.

In the experiments on the propagation of spin waves in the gases [2] the main role were allotted for their polarizations. For it were used both magnetic fields and the laser pumping. This role performs transverse virtual photons in the Coulomb interaction in my opinion at the same time as longitudinal virtual photons afford the "right" dependence on space coordinates [3]. By making of the gravitational interaction the neutrino pumping can stand duty as an analog of the laser pumping and the main role for the "right" space dependence can be play quanta of longitudinal oscillations. Taking into account the above we shall assume that the energy of the gravitational interaction must depend on numbers of particles and quasi-particles participating in this interaction. By this the energy dependence on space coordinates is defined the average number of quasi-particles – bosons, which's two the interacting real particles are exchanged.

As a result we shall have (n is the bosons number, x > 0) [4]:

$$\begin{aligned} V &= -A \sum_{n=0}^{\infty} n e^{-nx} \Big/ \sum_{n=0}^{\infty} e^{-nx} = A\frac{d}{dx}\ln\left(\sum_{n=0}^{\infty} e^{-nx}\right) \\ &= A\frac{d}{dx}\ln\left(\frac{1}{1-e^{-x}}\right) = -A\frac{e^{-x}}{1-e^{-x}} = -\frac{A}{e^{x}-1} \end{aligned} \tag{1}$$

(naturally that here we have only the analog of the Gibbs distribution for the ideal gas of quasiparticles and, what is more, the dependence of A on x is not excluded), where in the general case

$$A = \int \rho_1 \sigma_\nu \rho_\nu \sigma_\nu \rho_2 dV_1 dV_2 \tag{2}$$

(ρ_1 is the particles density of the first macroscopic body, ρ_2 is the particles density of the second macroscopic body, ρ_ν is the density of the Universe background neutrinos, σ_ν is the cross-section for scattering of background neutrinos on macroscopic body particles). Considering ρ_ν and σ_ν constant ones and using the standard gauge [3], we receive:

$$A = 2m_1\sigma_\nu\rho_\nu\sigma_\nu 2m_2 = 4m_1m_2\rho_\nu\sigma_\nu^2 \quad . \tag{3}$$

By this approach it might be worthwhile to go over to the Chernikov potential [5] for the gravitational interaction of macroscopic bodies lied at rather great distances between them. In this case the energy form

$$V(r) = \frac{G_N m_1 m_2}{L}\left(1 - cth\frac{r}{L}\right) = -\frac{2G_N m_1 m_2}{L}\frac{e^{-2r/L}}{1-e^{-2r/L}} = -\frac{2G_N m_1 m_2}{L}\frac{1}{e^{2r/L}-1} \tag{4}$$

(m_1, m_2 are masses of macroscopic bodies; r is the distance between them; L is the Lobachevskij constant) will assume the quantum character of zero (vacuum) oscillations and of course which depends on both numbers of particles and quasiparticles. Let us note that the asymptotic behavior of the Chernikov potential will be reduced to the behavior of the Yukawa potential

$$U(r) = -Ae^{-Br}/r \tag{5}$$

($B = 2 / L$). The Lobachevskij constant L must be defined by polarization properties of vacuum (a medium from weakly-interacting particles in a degenerate state).

We regard, that the standard gravitation interaction is not the fundamental one, but it is generated by collective oscillations in the Universe neutrino sea [1]. In consequence of this the weak interaction acquires the global value, because it causes the bond of neutrinos both one with the other and with charged leptons and quarks. Let us to consider the gravitational interaction at large distances. We shall consider the scattering of the neutrino upon the charge lepton, induced by the exchange of the neutral Z° boson (taking account of the low temperature of the Universe background neutrinos) only. As a result the cross-section of the scattering for the neutrino proves to be equals to the cross-section of the scattering for the antineutrino in the low-energy approximation (the energy of the neutrino $E \ll m$) and they are written down as

$$\sigma_\nu = 4kG_F^2E^2\left[(\xi - 1/2)^2 + \xi^2 - (\xi - 1/2)\xi\right]/\pi \tag{6}$$

($G_F \approx 1.166\ 10^{-5}$ GeV^{-2} is the Fermi constant, $\xi = \sin^2\Theta_W \approx 0{,}23$, and Θ_W is the weak angle), where for the charge leptons the factor $k = k_e$ depends on the fine structure constant $\alpha \approx 1/137$ ($k_e \sim 2\alpha/3$) only, while for the quarks the factor $k = k_q$ must depends on the running coupling constant α_s too, which define the collision radiation by gluons. Note that σ_ν proves to be minimal for $\xi = 1/4$. For the estimate of the constant σ_ν let us consider the scattering the background neutrino upon the electron only. Substituting the mean $\langle E \rangle$ instead of E it can receive ($T \approx 10^{-13}$ GeV, $\langle E \rangle \approx 3.15\ T$) the crude value of the constant $\sigma_\nu \sim \alpha\ G_F^2\ T^2 \sim 10^{-38}$

GeV^{-2} , which is near to the known value of the gravitational constant $G_N \approx 6.7\ 10^{-39}\ GeV^{-2}$ [6].

Let in the formula (1) for macroscopic distances

$$x = 2\rho_\nu \sigma_\nu r \ , \qquad (7)$$

then in the formula (4) it is possible the Lobachevskij constant to give the following physical interpretation, namely as the mean free path

$$L = 1/(\sigma_\nu \rho_\nu) \ . \qquad (8)$$

What is more, taking into account astronomical data it is possible to limit its magnitude by sizes of galaxies superclusters. So, as a minimum two parameters (G_N, L) must characterize the gravitational interaction in the Cosmology. These parameters must characterize also the state of the Universe neutrinos background as they are defined by σ_ν and by ρ_ν. The relaxation time is the enough large one in such medium that makes the matter density fluctuations the enough large one and it can causes to observable effects.

If we consider the fact that galaxies are distributed homogeneously in the Universe for distances being in excess of 100 megaparsec ($> 10^{40}\,GeV^{-1}$), we should suppose that the greater part of neutrinos is present in the form of the polycomponent Fermi liquid by a temperature is below 10 K ($< 10^{-12}\,GeV$). As a result only those neutrinos take part in the interaction with the normal matter, which's are at a short distance of the Fermi surface (the energy E of which's is different little from the Fermi energy E_F). In this case it is comfortable to work with quasiparticles and holes which's are fermions and the energy E of which's equal to $|E - E_F|$. Hence the average of E can be calculated by the formula

$$\langle E \rangle = \int_0^\infty \frac{E^3 dE}{\exp(E/T)+1} \Bigg/ \int_0^\infty \frac{E^2 dE}{\exp(E/T)+1} \approx 3.15T \ . \qquad (9)$$

Namely this causes the cross-sections for scattering of background neutrinos on macroscopic body particles to the quadratic dependence of the background neutrinos temperature ($\sigma_\nu \propto T^2$) [6].

3. The interaction between baryons

The assumption on the “sea” of Universe background fermions in the ground state allows using the Landau theory of the Fermi liquid considering charged particles as quasi-particles on the background of “sterile” neutrinos and “sterile” antineutrinos. The properties of the latter's must define the geometrical and topological properties of the space-time M_4, which must not be a singly connected one. The last property of the space-time M_4 justifies a quantization of any charges (specifically, electric charges and baryonic charges), because the wave function of the charged particle are bound to be a multivalued one (of course if $E < E_F$, where E

is the particle energy and E_F is the Fermi energy of Fermi liquid). The transition to the description of the slow subsystem with the help of the space-time manifold is carried when the Fermi energy of "sterile" neutrinos tends to infinity. The Universe all matter must be characterized (as it is adopted in the statistical physics) by the statistical sum. As a result, taking empirical data by the observation of type *Ia* supernovas into account, it understands the hypothesis necessity in General Relativity for the availability in the Universe of "dark energy", connecting it with the cosmological term. We regard, that the presence of the Universe neutrino background with the finite Fermi energy E_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 Universe neutrino background with the stability (or if only with the metastability) of elementary particles and also with conservation laws of electric charges and baryonic charges. Therefore cosmic rays of ultrahigh energies are not bound to interact with the cosmic radio background, so that their motion in the Universe can not be limited by the value of spatial distances.

We assume that the energy of fundamental interactions must depend on a number of particles and quasi-particles participating in this interactions, defining its dependence to space coordinates by means of a mean number of bosons, which's are exchanged two particles. As a result in the general case (n is a number of bosons) [7]:

$$E = -2\int \left\{ \sum_{(\sigma_1,\sigma_2)} \left[\left(\rho_1\sigma_1\rho\sigma_2\rho_2 \sum_{n=0}^{N} n e^{-2n\rho\sigma_1 r/T} \right) \Big/ T \sum_{n=0}^{N} e^{-2n\rho\sigma_1 r/T} \right] \right\} dV_1 dV_2 \ , \quad (10)$$

where ρ_1 is the energy density of first body particles; ρ_2 is the energy density of second body particles; ρ is the energy density of quasi-particles, T is theirs temperature; σ_1 and σ_2 are cross-sections with the emission or the absorption of particles or quasi-particles. Hence (considering, that $N \to \infty$) it can obtain the potential as

$$U(r) = -\sum_{\sigma} \left[C_\sigma \Big/ \left(e^{B_\sigma r} - 1 \right) \right] \quad (11)$$

($B_\sigma \propto \sigma_1$, $C_\sigma \propto \sigma_1\sigma_2$) for the description of fundamental interactions. As a result we obtain the dependence of fundamental constants on parameters characterizing the Universe dark matter.

The process of the symmetry recovery (the reverse to the spontaneous breaking of symmetry) from the group $SU(2)$ (characterizing the weak interaction) to the group $SU(3)$ must take place at nucleus distances, as a result of this the gluons will bear the main responsibility for a interaction between baryons [8]. Further we shell rely on the cold plasma theory developed for the first-kind superconductor and for the second-kind superconductor. By this a nuclear matter is an analog of second-kind superconductors with respect to gluons, which's as vortices penetrate in a Bose condensate of Cooper pairs compounded from neutrinos , at the same time the vacuum with respect to gluons is an analog of first-kind superconductors.

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 fiber bundle E_{n+N}, ∇_i is the covariant 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 conserving the possible linear dependence between vectors. We demand that the action was the invariant one with respect to the infinitesimal substitutions of the local Lie loop $G_r(x)$ [9] conserving the type of geometrical objects. By this the components $C_{ab}{}^{c}(x)$, alternating on down indices of the structural tensor, must satisfy to the generalized Jacobi identities [9]

$$C^{d}_{[ab}C^{e}_{c]d} - \xi^{i}_{[a}\nabla_{|i|}C^{e}_{bc]} + \xi^{i}_{[a}\xi^{j}_{b}R_{|ij|c}{}^{e} = 0 \qquad (12)$$

($R_{ijc}{}^{e}(x)$ are the curvature tensor components of the connection $\Gamma^{b}_{ia}(x)$; here and further x^i are the co-ordinates of the point x; $x^i + \delta x^i$ are the co-ordinates of the point $x + \delta x$; Latin indices *a, b, c, d, e* will run the values of integers from 1 to r; Latin indices *i, j, k, ...* will run the values of integers from 1 to *n*).

Of course, taking into account the absence of a bijection between the real world and the mathematical one, we can construction the maximum plausible physical theory only. It allows using an elemental description, if only for a local domain. 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. 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 (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 (12) 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. 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 are present in the space domain where intermediate vector bosons are absent and on the contrary intermediate vector bosons are present in the space domain where gluons are absent.

Because the gravitation theory is constructed for $r \to 0$ and $r \to \infty$, then naturally we must state the collision integral (10), retaining only two summands, as

$$E = -2\int\left[\left(\rho_1\sigma_{s1}\rho\sigma_{s2}\rho_2 \sum_{n=0}^{N} n e^{-2n\rho\sigma_{s1}r/T}\right)\Big/ T\sum_{n=0}^{N} e^{-2n\rho\sigma_{s1}r/T}\right]dV_1 dV_2 - 2\int\left[\left(\rho_1\sigma_{w1}\rho\sigma_{w2}\rho_2 \sum_{n=0}^{N} n e^{-2n\rho\sigma_{w1}r/T}\right)\Big/ T\sum_{n=0}^{N} e^{-2n\rho\sigma_{w1}r/T}\right]dV_1 dV_2, \quad (13)$$

where σ_{s1}, σ_{s2} are the cross-sections with the gluon emission or with the gluon absorption (the strong gravitation), σ_{w1}, σ_{w2} are the cross-sections with the quasi-particle emission or with the quasi-particle absorption in the neutrino collinear beam (spin waves), cementing together two hadrons and produced of the weak interaction (the standard weak gravitation) [1]. Thereby, we can consider the interaction between baryons using a potential consisting of two summands (considering, that $N \to \infty$)

$$U(r) = -C_s\Big/\left(e^{B_s r} - 1\right) - C_w\Big/\left(e^{B_w r} - 1\right), \quad (14)$$

where the first summand answers for the strong gravitation (induced by the interchange of gluons) and the second summand answers for the weak (standard) gravitation. Hence it can obtain the potential as

$$U(r) = -C_s\Big/\left(e^{B_s r} - 1\right) \quad (15)$$

($B_s \propto \sigma_s$, $C_s \propto \sigma_s^2$) for the description of the strong interaction. Naturally, that at very small distances processes must be described the quantum chromodynamics, but not the strong gravitation theory.

5. Conclusion

We suggested considering “black holes” as hadrons with very large baryonic charges [10]. It allows simulating similar objects in laboratory conditions (at high energy accelerators). Naturally, that we connect the use necessity of the quantum chromodynamics in the cosmology with the chance of the processes explanation which’s go in quasars and nuclei of Seyfert galaxies with the very large energy release. The Einstein theory cannot apply for this as in it the substantial object – the space-time torsion is absent by the gravitation geometrization (the space-time torsion is the locally diffeomorphic one to the corresponding structural tensor field of the Lie local loop characterizing the symmetry of the quantum system). What is more, in the Hawking process of the “black holes” quantum evaporation is violated the conservation low of the baryonic charge, accumulated the massive collapsing star. If we shall apply this process for the description to two-photon decay of pseudoscalar neutral mesons (this low takes place), then we receive a discrepancy with experimental data (instead the increase of the particles lifetime it is reducing with the growth of their masses).

At very small distances processes must be described by the quantum chromodynamics, in which the observed property of the asymptotic freedom takes place for particles of high energies. It assumes that "black holes" emit cosmic rays of ultrahigh energies. As a result the coordinate's definition task of such rays sources acquires the global value.

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