FEEDING THE UNIVERSE AND NEUTRINO

Evgeny A. Novikov
University of California - San Diego, BioCircuits Institute, La Jolla, CA 92093 -0328; E-mail: enovikov@ucsd.edu

Abstract
Based on the quantum modification of the general relativity (Qmoger), it is shown, that the Vacuum is continuously feeding the universe with ultralight particles (vacumo). Vacumos are transforming into more heavy (but still ultralight) gravitons, which form quantum condensate even for high temperature. The condensate, under gravitational pressure in galaxies, produces the first generation of "ordinary" massive particles, with are identified with neutrinos. The estimated in this theory mass of neutrino satisfies the experimental bound. The oscillations of neutrino are explained in terms of interaction with the background condensate of gravitons. The electric dipole moment of neutrino is estimated.

In the quantum modification of the general relativity (Qmoger), in contrast with the conventional Big Bang theory (BB) [1], the matter (energy) is continuously produced by the Vacuum. The Qmoger equations differs from the Einstein equations of the general relativity by two additional terms, responsible for production (absorption) of matter [2-4]. These works were presided by invention of a new type of fluid, namely the dynamics of distributed sources-sinks [5, 6], which, in turn was presided by exact analytical solution of the (1+1)-dimensional Newtonian gravitation [7]. Qmoger theory was motivated by many deficiencies of BB [1-4, 8]. The additional terms in Qmoger equations take into account the space-time divergency (stretching), the effect of which is comparable with the effect of the space-time curvature in the Einstein theory.

The simples situation with continuous production of matter from the Vacuum is when the averaged density of matter is constant: $\rho = \rho_0$. In more general situation [9] the averaged density of enthalpy is constant: $w = \varepsilon + p = w_0$, where $\varepsilon = \rho c^2$ is the energy density, p is the pressure and c is the speed of light. The pressure can be high in stars. But the averaged pressure in the universe is small and the dust approximation ($p = 0$) is useful in many situations. In this case, the main parameters in the Qmoger theory are: the gravitational constant G, c and ρ_0. From these parameters we have unique length scale:

$$L_* = c\,(G\rho_0)^{-1/2} \qquad (1)$$

We use value $\rho_0 \approx 2.6 \cdot 10^{-30} gcm^{-3}$, which, according to WMAP, includes ordinary and dark matter. We do not include the dark energy, which does not exist in Qmoger (see below). (1) gives $L_* \approx 76$ billion light years (bly) [3, 4], which is comparable with the current size of the visible universe $a_0 \approx 46.5$ bly. Qmoger equations have corresponding exact analytical solution [10, 3, 4] for the scale factor a in homogeneous and isotropic universe:

$$a(\tau) = a_0 \exp[H_0\tau - 2\pi(\tau/L_*)^2],\ \tau = ct, \qquad (2)$$

where H_0 is the Hubble constant, divided by c, which is the current value of function $H(\tau) = d(\ln a)/d\tau$. Remarkably, $L_* H_0 \approx 2.6$. The temporal scale H_0^{-1} and the eternal scale L_* are of the same order because currently $a(\tau)$ is relatively close to its maximum (see below). In the isenthalpic case ($w = w_0$), which takes into account radiation [9], Qmoger equations have the same solution (2) with $L_w = c^2 (G w_0)^{-1/2}$instead of L_*. These two scales are very close because averaged pressure in small.

Solution (2) does not have any fitting parameters and is in good quantitative agreement with cosmic data [10, 3]. This solution eliminates major controversies - critical density of the universe, dark energy (cosmological constant) and inflation.

In nonrelativistic regime, Qmoger reproduces Newtonian dynamics, but the speed of the gravitational waves can be different from c [10]. This give us a hint, that gravitons have mass (unlike photon). With scale (1) we associate gravitons with mass $m_0 = \hbar/(cL_*) \sim 0.5 \cdot 10^{-66} gram$ and electric dipole moment (EDM) $d_0 \sim m_0^{1/2} l_P^{3/2} c \sim 2 \cdot 10^{-72} gram^{1/2} cm^{1/2} s^{-1}$[3, 4], where $l_P = \left(\hbar G/c^3\right)^{1/2} \approx 1.6 \cdot 10^{-37} cm$ is the Planck scale. EDM of background gravitons can explain the baryon asymmetry of the universe (prevalence of particles over antiparticles) in terms of breaking the reflection symmetry. It is shown [3, 4]], that such particles form quantum condensate even for high temperature. The concentration of particles n and characteristic scale are:

$$n = \frac{\rho_0}{m_0} \approx 5 \cdot 10^{36},\, l = n^{-1/3} \approx 2.7 \cdot 10^{-13} cm. \tag{3}$$

According to (2), the universe was born in the infinite past ($a(-\infty) = 0$) from small fluctuation. But, formula (2) is solution of Qmoger differential equations for the space-time metric, which is assumed to be smooth. The smooth metric we can expect only starting with condition $a = l_P$. It is natural to associate this condition with the beginning of the universe in frame of the Qmoger theory. From that condition, using (2), we get time [3, 4]: $t_1 \approx -327$ billion years. The mass of the embryonic universe can be estimated by $M_1 = \rho_0 l_P^3 \approx 10^{-128} gram$. This result suggest existence of particles (or quasiparticles) with much smaller mass than m_0 (see also below). Any such particle we will call vacumo. It seems reasonable to suggest, that Vacuum is feeding universe with vacumos.

The next important step in the evolution of the universe is the production of gravitons with indicated above mass m_0. The corresponding condition is: $a = l$. In this case, (2) gives [4] : $t_2 \approx -284$ billion years. So, it took about 43 billion years of nurturing the universe to accommodate it for production of gravitons. It seems natural, that the feeding comes from an external part of the Vacuum, which do not have to be equipped with a metric. The mature universe transforms vacumos into gravitons, which form the background quantum condensate. Size of the universe (2) riches the maximum $a_{\max} \approx 1.32\, a_0$ at time $t_{\max} = (L_*^2 H_0)/(4\pi c) \approx 12.6$ billion years. It was shown [9], that universe is globally stable during expansion ($-\infty < t < t_{\max}$). But, after that it becomes unstable and additional investigation is needed for evolution of the universe at $t > t_{\max}$.

During formation of galaxies (in a manner described in Ref. 7), in stars and in hot planets (Jupiter, Saturn), the local density of matter becomes large and new "ordinary"particles (including photons) are synthesized. In these processes, instead of G, the Planck constant ħ becomes important. From c, ħ and ρ_0, we now have unique scale:

$$l_n = \hbar^{1/4} \left(c\rho_0\right)^{-1/4} \approx 10^{-2} cm. \tag{4}$$

We can rewrite (3) in the form:

$$l_n = \frac{\hbar}{cm_*},\ m_n = \rho_0 l_n^3 = \rho_0^{1/4} \left(\hbar/c\right)^{3/4} \approx 3.132\,6\times10^{-36} gram \approx 1.76\cdot10^{-3} eV/c^2. \tag{5}$$

So, scale l_n corresponds to the Compton wavelength of a particle with mass of background matter occupying volume of size l_*. This indicates a mechanism of formation new particles from background gravitons. Mass m_n is determined uniquely by the new scaling. Apparently, it is a typical mass of the first generation of "ordinary" massive particles, produced by indicated mechanism from the background condensate. Among the experimentally observed particles, neutrino is the best candidate for being produced in this way. Indeed, mass m_n corresponds to experimental bound for the mass of neutrino [11]. The time scale:

$$t_n = \left(\hbar/\rho_0\right)^{1/4} c^{-5/4} \approx 3.3 \cdot 10^{-13} s \tag{6}$$

could be associated with formation and acceleration ($c/t_n \sim 8.46 \cdot 10^{22} cms^{-2}$) of neutrino, as well to the neutrino oscillations [11]. The physics of these oscillations can be related to interaction of neutrino with the background condensate of described above ultralight dipolar gravitons. The averaged number of gravitons interacting with such neutrino can be estimated by $N_n = m_n/m_0 \sim 10^{30}$. During a flight, neutrino can create waves in the background and temporary carry along coherent groups of gravitons. This will influence the effective mass and the flavor of neutrino [11]. This is an example of interface between dark and ordinary matter (Idom), which was introduced in Ref. 12 in connection with the phenomena of qualia (subjective experiences).

The new scaling also predict EDM for neutrino or similar particles:

$$d_n = \hbar^{3/2} c^{1/2} \rho_0^{-1/2} \approx 5.8 \cdot 10^{-11} gram^{1/2} cm^{5/2} s^{-1}, \tag{7}$$

which is much bigger than indicated above EDM of graviton.

References

[1] https://en.wikipedia.org/wiki/Big_Bang

[2] E. A. Novikov, Vacuum response to cosmic stretching: accelerated universe and prevention of singularity arXiv:nlin/06080050.

[3] E. A. Novikov, Ultralight gravitons with tiny electric dipole moment are seeping from the vacuum, Modern Physics Letters A, **31**, No. 15, 1650092 (5 pages) (2016).

[4] E. A. Novikov, Quantum modification of general relativity, Electr. J. Theoretical Physics, **13**, No. 35, 79-90, (2016).

[5] E. A. Novikov, Dynamics of distributed sources, Physics of Fluids **15**, L65 (2003).

[6] E. A. Novikov, Distributed sources, accelerated universe and quantum entanglement, arXiv:nonlin.PS/0511040.

[7] E. A. Novikov, Nonlinear evolution of disturbances in (1+1)-dimensional universe, Zh. Exper. Teor. Fiz. **57**, 938 (1969) [Sov. Phys. JETP. **30** (3), 512 (1970)]; arXiv:1001,3709 [physics.gen-ph].

[8] Steinhardt, Paul J. The inflation debate: Is the theory at heart of modern cosmology deeply flawed?, Scientific American, April; pp. 18-25 (2011).

[9] E. A. Novikov, Isenthalpic universe (submitted for publication)

[10] S. G. Chefranov & E. A. Novikov, Hydrodynamical vacuum sources of dark matter self-generation without Bing Bang, J. Exper. Theor. Phys., 111(5),731-743 (2010) [Zhur. Eksper. Theor. Fiz.,138(5), 830-843 (2010)]; arXiv:1012.0241v1 [gr-qc].

[11] https://en.wikipedia.org/wiki/Neutrino

[12] E. A. Novikov, Gravicommunication, subjectivity and quantum entanglement, NeuroQuantology, v. 14, issue 4, 677-682 (2016).