On the Nature and Values of the Gravitational and Cosmological Constants

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Stable particles of the Universe - protons and electrons - are in constant motion (there is a background component of their velocity), which is the source of the vacuum energy, explains the non-Newtonian vacuum potential and the curvature of space and determines the values of the gravitational and cosmological constants. This follows from the balance of interactions between a free electron and a proton, provided that there are no electrical forces and external influences.

1 Introduction

The origin and nature of the gravitational constant γ and, in particular, the cosmological constant Λ, introduced by Einstein into the equations of the general theory of relativity, are still the subject of discussion [1 - 3]. The cosmological constant determines the non-Newtonian gravitational forces and characterizes the curvature of empty space, as if additional mass or energy was introduced into it, and has dimension of m^{-2}.

One of the points of view is that the vacuum itself is material, and the space containing it rotates. That is, for the Universe being in the stationary state, it is necessary that the inertial forces field generated by rotation compensate for the vacuum gravitational attraction [3]. However, the question arises, is it really necessary to endow vacuum with a mass and space with rotation to maintain such a balance?

Indeed, there is a geometrodynamic concept (J. Wheeler et al. [4, 5]), in which, in fact, the materiality of space itself is postulated, and in this space the initial one-dimensional spatial elements can be organized into the three-dimensional objects that one can observe. Then the original primary elements, if they are real entities, not mathematical abstractions, should in its physical incarnation be vortex structures being based on the phase boundary (surface).

So, according to Wheeler, charged microparticles are singular points on the three-dimensional surface of our world, connected by a "wormhole", i.e. a vortex tube or a power current line (of the input-output kind) located in an additional dimension. As a result, a *closed* contour is formed which a physical vacuum or some medium circulates along. Wheeler's idea, even in a simple mechanistic interpretation, allows to use macroanalogies successfully for objects of any matter organization levels: see [6, 7] etc. In particular, in determining the speed of light, it was sufficient to apply Wheeler's scheme for a single closed proton-electron contour [8].

2 The gravitational constant in geometrodynamics

Let us consider, as in the case of determining of the light speed, a single spatial-material cell, where there is a balance of forces acting between a proton and an electron. Assume that in this case the particles are in a free state, not bound to an atom, and there are no electrical forces and external influences. That is, it is assumed that a hydrogen atom is formed only when the particles approach the distance of the Bohr radius, and as for the atom larger size (the excited state), it arises only when the atom receives additional energy.

Indeed, if the contour *is not closed*, then the "photon exchange" does not occur, and there are no electric forces between the proton and the electron, and the electron can not "rotate" around the proton if the distance between them exceeds the Bohr radius. Then, in the state of equilibrium particles must move rectilinearly, changing only their mutual position. The particles themselves, according to Wheeler, if the contour is open, can be considered as single-pole vortex formations. They interact with each other through gravity and also retain the magnetic interactions between their vortex tubes (force lines) extending into "extra" dimension. These forces between the particles must be compensated by the inertial quasi-centrifugal forces,

determined in the case of rectilinear motion of particles with respect to the instantaneous radius equal to the distance between the particles.

We recall that in [6, 7] the formula for electric and magnetic forces are written in the "Coulombless" form, where the charge is replaced by the electron ultimate momentum. It is assumed that the unit element of such a tube is an element having the size of the classical electron radius r_e and its mass m_e. In this case, the electric and magnetic constants have the form:

$$\varepsilon_0 = m_e / r_e = 3.23\times10^{-16} \text{ kg/m}, \quad (1)$$

$$\mu_0 = 1/(\varepsilon_0 c^2) = 0.0344 \text{ N}^{-1}, \quad (2)$$

where m_e, r_e, c are the electron mass, the electron radius, and the light speed. The balance between magnetic, inertial and gravitational forces has the form:

$$z_{e1}z_{e2}\,\mu_0^{-1}(l / 2\pi r)(r_e/(c\times[\text{sec}]))^2 + z_{g1}z_{g2}\,\mu_0^{-1}(\varepsilon_0\gamma/c^2)/ r^2 = z_g\,\mu_0^{-1}(v_0/c)^2/ r, \quad (3)$$

where l, r, v_0, z_e, z_g are the relative length of the vortex tube in units of r_e, the relative distance between the particles in units of r_e, the relative to each other velocity of the particles, the relative charge and mass in electron charges and masses. Making transformations and neglecting the electron mass, we represent (3) in the form:

$$r\,(l/m_p)(r_e^2/(2\pi\times[\text{sec}^2])) - r\,v_0^2 = \varepsilon_0\gamma, \quad (4)$$

where m_p is the relative proton mass in units of m_e. Thus, an equation has been obtained having the velocity squares dimension, and these terms of the equation are proportional to the energies of the corresponding interactions.

As for the vortex tube length, then $a < l < m_p$ (a is the fine structure inverse constant), since the electron spin $(ar_em_ec / 2)$ means the presence of either a "hidden" mass or a linear parameter in its structure which is increased not less than 137 times with respect to the electron standard parameters, even if the spin speed of rotation is equal to the light speed. On the other hand, l can not exceed of the proton vortex tube length (with correction for the projection angle) [7].

To maintain the equilibrium state, the velocity v_0 must be constant for any distance between particles, including for limiting cases. Neglecting the gravitational component at $r \to \infty$ and $l = m_p$, we obtain from (4):

$$v_0 = r_e /((2\pi)^{1/2}\times[\text{sec}]) = 1.12\times10^{-15} \text{ m/sec}. \quad (5)$$

Neglecting the magnetic component, when the distance between the particles is equal to the Bohr radius R_B, i.e. for $r = a^2$, we obtain:

$$v_0 = (\varepsilon_0\gamma)^{1/2}/a = 1.07\times10^{-15} \text{ m/sec}, \quad (6)$$

which actually coincides with the previous value. It can be reasonably assumed that this velocity is constant throughout the entire range of distances between particles - from the Bohr radius size to infinity - and it is a fundamental value, so that one can derive a formula for the gravitational constant. Bearing in mind (4) and (5), we obtain:

$$\gamma = r\,(1 - l/m_p)\,v_0^2/\varepsilon_0. \quad (7)$$

At the Bohr radius distance, substituting $r = a^2$, $l = 137$ and the v_0 value, we find $\gamma = 6.79\times10^{-11}$ $\text{m}^3\text{kg}^{-1}\text{sec}^{-2}$, which is close to the actual value. Since $\gamma = const$, an increase in the distance

between particles must be accompanied by in the vortex tubes length increase (the "hidden" mass) up to the value m_p.

We note that homogeneous particles behave otherwise. From the balance of interactions it follows that the free electrons must come together, and the free protons, on the contrary, move away from each other, starting from some distance between them. This difference, perhaps, contributes to the separation of particles in outer space.

The correct value of the gravitational constant for a single proton-electron unit cell has been obtained, and its value does not change when passing to cosmological scales. This gives grounds to believe that this scheme can be extended to the Universe level as a whole.

3 The cosmological constant

The equation (4) can be interpreted in the sense that the gravitational energy proportional to $\varepsilon_0\gamma$ is, as it were, a background or additional constant that ensures the equilibrium state of an elementary space-material cell regardless of its size, and the motion of free particles with velocity v_0 is something similar to cosmic "Brownian motion". Within the framework of this model, it is this motion of free particles that, when passing to cosmological scales, creates its own vacuum potential (which is perceived by an external observer as a manifestation of non-Newtonian forces) and determines the cosmological constant magnitude.

The inverse quantity Λ^{-1} can be regarded as the surface area on which the inertial forces, arising during rotation of the Universe as a whole with a background velocity v_0 over some radius L, act.

These forces counteract gravitational forces. In this case, the magnetic forces can be neglected, since in space macrobodies are in general electrically neutral. For the Universe being in equilibrium state, taking into account only the forces associated with masses, bearing in mind (4), one can write down the balance of pressures produced by these forces:

$$M\,\varepsilon_0\gamma / L^3 = M\,r v_0^2/(L\,\Lambda^{-1}), \tag{8}$$

where M is an arbitrary mass, L is a linear parameter (radius).

The balance does not depend on the mass of the Universe, but depends on its parameter L. Both the shape of the Universe and the position of its center are undefined, and any of its points can be taken as the center of rotation, so its volume can be taken equal to L^3, and the radius of rotation is equal to the parameter L. In [9] the basic parameter of the Universe L_v is uniquely defined as the length of a vacuum structural unit (vortex tube):

$$L_v = R_c^{\,2} / R_B, \tag{9}$$

where R_c is a mean geometric, the linear parameter obtained from the balance of electric and magnetic forces and equal to $(2\pi)^{1/2}c \times[\text{sec}] = 7.51\times10^8$ m. The parameter L_v is the *greatest* length to which the *lowest* peripheral speed v_0 corresponds.

The formal increase in the kinetic energy component in formula (8) a multiple of r, while maintaining the balance of pressures, requires that in this case there should be $L = L_v\, r^{-1/2}$, so the parameter r in (8) is reduced. As a result, referring to (5), (9) and revealing R_c and R_B, from (8) we obtain:

$$\Lambda = \varepsilon_0\gamma /(L_v v_0)^2 = (2\pi)^{-1}(a/c)^4\varepsilon_0\gamma \times[\text{sec}^{-2}] = 1.49\times10^{-52}\ \text{m}^{-2}, \tag{10}$$

and such a value must correspond to the equilibrium state of the Universe. At present, based on the assumed age of the Universe, the value of Λ is estimated at 10^{-52} m^{-2} [10].

Perhaps there are regions of space filled with free elementary particles that are not bound to atoms (voids). Then it is necessary to consider the sum of set of unit elementary cells, taking into

account the magnetic forces, and then the sum in brackets in an analogous formula is close to one:

$$\Lambda = (l/m_p + \varepsilon_0\gamma/(r\, v_0^2))/L^2 \approx L^{-2}. \quad (11)$$

In this case, there is a trivial uncertain result, depending only on the region size $\Lambda^{-1/2}$.

As for the hypothetical form of the Universe, the ratio $L_v / \Lambda^{-1/2} = 130.6$ is a very characteristic value close to a. Let us assume that the properties of vorticity and helicity are inherent in the structure of the Universe as a whole, as well as of its constituent units. Then the size $\Lambda^{-1/2} = 8.2\times10^{25}$ m can be associated with the diameter of its vortex tube, and the size $L_v = 1.06\times10^{28}$ m - with the size of a spiral turn, the number of turns is indeterminate and they are directed along the time axis to infinity. Note that this size has the same order of magnitude as the ultimate radius of the event horizon (0.59×10^{28} m), calculated by di Bartini [11]. Some hints on the unusual form of the Universe are found in [12], where cosmological effects are given, which the authors explain by the shape of the Universe resembling a horn or a saddle.

4 Conclusions

The stable particles of matter - protons and electrons are in continuous motion (the background component of its velocity). This follows from the balance of magnetic, gravitational and inertial interactions under the condition that there are no electrical forces and external influences. At cosmological scales, the field of inertial forces generated by their motion compensates for the gravitational attraction of the Universe matter as a whole. It is this balance applied to a unit cell containing a proton and an electron that determines the gravitational constant value, and, as applied to the Universe as a whole, determines the cosmological constant value. From the observer's point of view, Λ-field manifests itself as a result of the action of non-Newtonian gravitational forces, and therefore there is no need to involve dark energy and dark matter to substantiate this field.

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