Quantum Gravity Inside of the Gravitational Well

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Abstract. Gravity is determined by the presence of a gravitational well around the gravitational mass. A gravitational well is a potential well that describes an inhomogeneous gravitational field of an energy gradient, a quantum density gradient of a medium, and a gravitational action potential gradient. The force of gravity is determined by the gradient of gravitational energy, the deformation vector of quantized space-time and the strength of the gravitational field. It should be noted that the force F of gravity is always directed to the bottom of the gravitational well in the direction of decreasing gravitational energy, quantum density of the medium and gravitational action potential [1-7].

Keywords: quantum gravity, gravitational well, gradient, gravitational energy, quantum density, gravitational action potential, deformation vector.

So that we can understand how gravity works, we write the Poisson gravitational equations for plus-mass (positive mass) for the quantum density ρ of the medium and gravitational potentials φ [1-7]:

$$\operatorname{div}(\operatorname{grad}\rho) = k_o \rho_m \qquad (1)$$

where ρ is the quantum density of the medium, q/m^3;

ρ_m is the density of matter, kg/m^3;

k_0 is the proportionality coefficient.

$$\operatorname{div}(\operatorname{grad}\varphi) = 4\pi G \rho_m \qquad (2)$$

where $G = 6.67 \cdot 10^{-11}$ Nm^2/kg^2 is gravitational constant;

φ is gravitational potentials, J/kg.

The Poisson equation (1) has a two-component solution in the form of a system of equations for the regions of gravitational extension ρ_1 and compression ρ_2 of quantized space-time as a result of its spherical deformation during the formation of the mass of a particle (body) [1-4]:

$$\begin{cases} \rho_1 = \rho_o \left(1 - \dfrac{R_g}{r}\right) \text{ at } r \geq R_S \\ \rho_2 = \rho_o \left(1 + \dfrac{R_g}{R_S}\right) \end{cases} \qquad (3)$$

where ρ_o is quantum density of undeformed quantized space-time, q/m^3;

R_S is radius of the gravitational boundery (the interface) between the regions of tension and compression (radius of the particle, body), m;

r is distance, m;

R_g is gravitational radius (without multiplier 2), m:

$$R_g = \frac{Gm}{C_o^2} \tag{4}$$

where $G = 6.67 \cdot 10^{-11}$ Nm^2/kg^2 is gravitational constant;
m is mass, kg;
$C_o^2 = 9 \cdot 10^{16}$ J/kg is gravitational potential of the undeformed quantized space-time.

None of the physicists before could find a two-component solution of the Poisson equation (4) for gravitational potentials by analogy with the solution for the quantum density of the medium (2). Now, by analogy with solution (2), we can write a two-component solution of the Poisson equation (4) for gravitational potentials:

$$\begin{cases} \varphi_1 = C^2 = C_o^2\left(1 - \dfrac{R_g}{r}\right) \text{ при } r \geq R_S \\ \varphi_2 = C_o^2\left(1 + \dfrac{R_g}{R_S}\right) \end{cases} \tag{5}$$

where φ_1 and φ_2 are the distribution functions of the gravitation potential for the spherically deformed space-time, J/kg.
C^2 is gravitational action potential, J/kg.

The quantum density of the medium is an analogue of the gravitational potentials. Each parameter of the quantum density (ρ_o, ρ_1, ρ_2) of the medium has its own gravitational potential ($\varphi_o = C_o^2$, φ_1, φ_2). Figure 1 shows in the section the region of quantized space-time with a spherical sign-alternating shell of the nucleon (the dotted sphere) formed inside the region. The shell is initially compressed to a sphere with radius R_S. As already mentioned, the non-perturbed quantized space-time is characterized by the quantum density of the medium ρ_0. (ρ_1, φ_1 is the region (blue) of expansion and ρ_2, φ_2 is the region (red) of compression) [1-5].

To describe the regions of spherically deformed space- time, the theory of Superunification uses four gravitational potentials: $\varphi_0 = C_o^2$, $\varphi_1 = C^2$, φ_n, φ_2 [1, 7, 8] in contrast to classic gravitation in which only one Newton gravitational potential φ_n is known [1]. The fact that the three additional gravitational potentials C_o^2, C^2 and φ_2 are unknown makes all the attempts of theoretical physics ineffective in development of the theory of gravitation. Taking into account that every value of the gravitational potential has its own quantum density of the medium, we can write the relationships between them through coefficient k_φ, denoting ρ_1' as ρ_n, i.e., corresponding to the Newton potential φ_n [1]:

$$k_\varphi = \frac{\rho_o}{C_o^2} = \frac{\rho_1}{C^2} = \frac{\rho_n}{\varphi_n} = \frac{\rho_2}{\varphi_2} = 4\cdot 10^{58}\,\frac{q}{J}\,\frac{kg}{m^3} = const \tag{6}$$

The conversion coefficient k_φ (1) of the quantum density of the medium and gravitational potentials is a constant:

$$k_\varphi = \frac{\rho_o}{C_o^2} = 4\cdot 10^{58}\,\frac{q}{J}\,\frac{kg}{m^3} = const \tag{7}$$

From (1) we find the gravitational potential we need by writing it through the quantum density of the medium and the coefficient k_φ (2):

$$\varphi_1 = C^2 = \frac{\rho_1}{k_\varphi} = C_o^2\frac{\rho_1}{\rho_o} \tag{8}$$

$$\varphi_2 = \frac{\rho_2}{k_\varphi} = C_o^2\frac{\rho_2}{\rho_o} \tag{9}$$

$$\varphi_n = \frac{\rho_n}{k_\varphi} = C_o^2\frac{\rho_n}{\rho_o} \tag{10}$$

$$C_o^2 = \frac{\rho_o}{k_\varphi} \tag{11}$$

And vice versa, from (3), (4), (5) we can write the quantum density of the medium through its gravitational potential:

$$\rho_1 = k_\varphi\varphi_1 = k_\varphi C^2 = \rho_o\frac{C^2}{C_o^2} \tag{12}$$

$$\rho_2 = k_\varphi\varphi_2 = \frac{\rho_o}{C_o^2}\varphi_2 \tag{13}$$

$$\rho_n = k_\varphi\varphi_n = \frac{\rho_o}{C_o^2}\varphi_n \tag{14}$$

$$\rho_o = k_\varphi C_o^2 \tag{15}$$

Figure 1 shows the gravitational diagram of the distribution of the quantum density of the medium (3) and gravitation potentials (5) as the two-dimensional representation of the spherically deformed Lobachevski space. A special feature of the gravitational diagram of the nucleon is the presence of gravitation well in the external region of the quantized medium outside the interface with radius R_S, and the interface is characterized by a jump of the quantum density of the medium and the gravitation potential. On the gravitational diagram we can clearly see the ‘curvature’ of the quantized space-time which cannot be seen on the spheres of the Lobachevski space in the three-dimensional representation. For spherical deformation, the curvature of space is inversely proportional to distance r to the centre of the nucleon and depends only size of the perturbing mass m, i.e., depends on the extent of deformation of the quantized space-time.

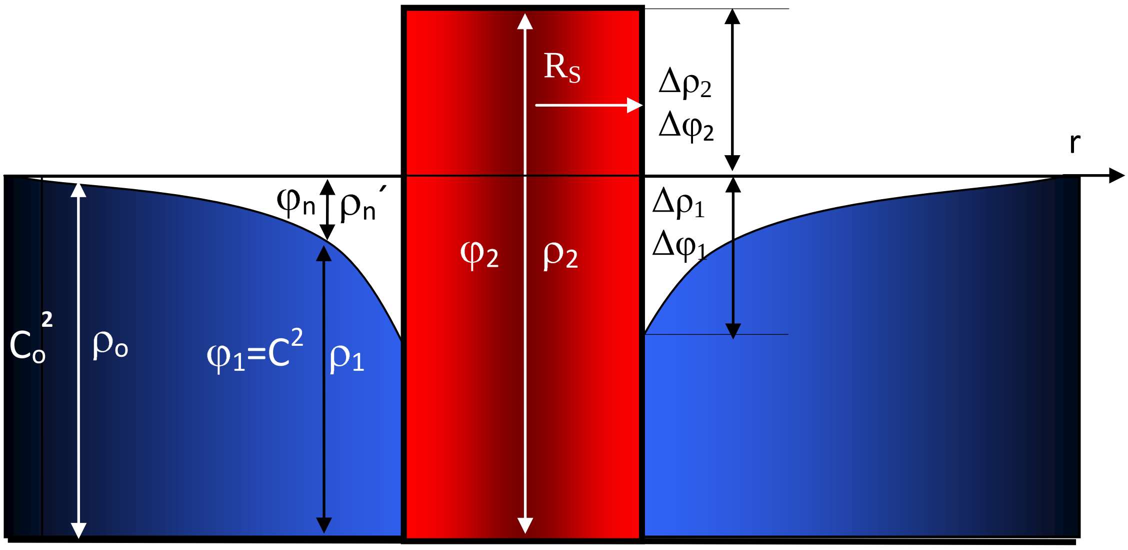

Fig. 1. Gravitational diagram of the distribution of the quantum density of the medium (ρ_1, ρ_2) and gravitational potentials (φ_1, φ_2) of the nucleon; ρ_2 is the region of compression of the medium, ρ_1 is the region of stretching of the medium.

The gravitational diagram (Fig. 1) was originally intended to describe the nucleon's gravitational field. To analyze the gravitational field of cosmological objects, we used the principle of field superposition when a large number of gravitational fields of nucleons and atoms are summed into the gravitational field of a cosmological object. So for the Earth, the radius R_S (2), (5) is the Earth's radius (Fig. 1).

From (3) and (5) we will write the balance of the quantum density ρ_1 of the medium and gravitational potentials $\varphi_1=C^2$ inside the gravitational well (Fig. 1):

$$\rho_1 = \rho_o - \rho_n \tag{16}$$

$$C^2 = C_o^2 - \varphi_n \tag{17}$$

The gravitational diagram in Fig. 1 shows clearly the Newton potential φ_n as the apparent potential (which does not exist in reality), included in the balance of the gravitational potentials (17):

$$\varphi_n = -\frac{Gm}{r} \tag{18}$$

Gravitation is characterized by the energy W gradient of quantized space-time [x]:

$$\mathbf{F} = \mathrm{grad}W \tag{19}$$

where **F** is force of the gravity inside the gravitational well (Fig. 1), N.

The change in the energy dw of a particle with mass m_1 inside a gravitational well is described by the equation:

$$dW = d(m_1\varphi_1) \qquad (20)$$

We integrate (20) for a point particle with allowance for (17) and obtain its energy W inside the gravitational well (Fig. 1):

$$W = m_1C^2 = m_1(C_o^2 - \varphi_n) \qquad (21)$$

We find from (21) the force **F** of gravity as the gradient of energy (19) in view of (18):

$$\mathbf{F} = \text{grad}(m_1C^2) = m_1\text{grad}(C_o^2 - \varphi_n) = G\frac{m_1m}{r^2}\mathbf{1_r} \qquad (22)$$

where $\mathbf{1_r}$ is the unit vector in the direction of the radius **r**. Gradient from constant C_o^2 (22) is zero.

As we see the application of the gravitational action potential C^2 (17) has not changed the Newton's universal law of gravitation (22).

In a similar way (22), we do calculations for the quantum density ρ_1 (12) of the medium:

$$\mathbf{F} = \text{grad}(m_1C_o^2\frac{\rho_1}{\rho_o}) = m_1\frac{C_o^2}{\rho_o}\text{grad}(\rho_1) \qquad (23)$$

The deformation vector **D** of quantized space-time is the gradient of the quantum density ρ_1 of the medium (23) [x]:

$$\mathbf{D} = \text{grad}(\rho_1) \qquad (24)$$

$$\mathbf{F} = m_1\frac{C_o^2}{\rho_o}\mathbf{D} \qquad (25)$$

So, the gravitational force **F** (25) is determined by the deformation vector **D** of quantized space-time. Einstein's concept of gravity of curved space-time eats right. We replaced the geometric curvature with a deformation vector and thereby significantly simplified the mathematical apparatus of calculations.

Next, we substitute quantum density ρ_1 (3) into (25) taking into (24):

$$\begin{aligned}\mathbf{F} &= m_1\frac{C_o^2}{\rho_o}\mathbf{D} = m_1\frac{C_o^2}{\rho_o}\text{grad}(\rho_1) = m_1\frac{C_o^2}{\rho_o}\text{grad}\rho_o\left(1 - \frac{R_g}{r}\right) = \\ &= m_1C_o^2\text{grad}\left(-\frac{R_g}{r}\right) = m_1C_o^2\text{grad}\left(-\frac{Gm}{C_o^2r}\right) = G\frac{m_1m}{r^2}\mathbf{1_r}\end{aligned} \qquad (26)$$

So we got the Newton's universal law of gravitation (26):

$$\mathbf{F} = m_1 \frac{C_o^2}{\rho_o} \mathbf{D} = G \frac{m_1 m}{r^2} \mathbf{1_r} \qquad (27)$$

Formula (27) is equivalent to formula (22):

$$\mathbf{F} = m_1 \mathrm{grad}(C_o^2 - \varphi_n) = G \frac{m_1 m}{r^2} \mathbf{1_r} \qquad (28)$$

The deformation vector **D** (24) determines the strength of the gravitational field and it is equivalent to the acceleration vector **a** taking into (25):

$$\mathbf{D} = \frac{\rho_o}{C_o^2} \mathbf{a} \qquad (29)$$

Or:

$$\mathbf{a} = \frac{C_o^2}{\rho_o} \mathbf{D} \qquad (30)$$

In cases where gravitational calculations are performed using the quantum density of the medium, we can do an equivalent transformation of formulas describing gravity by gravitational potentials.

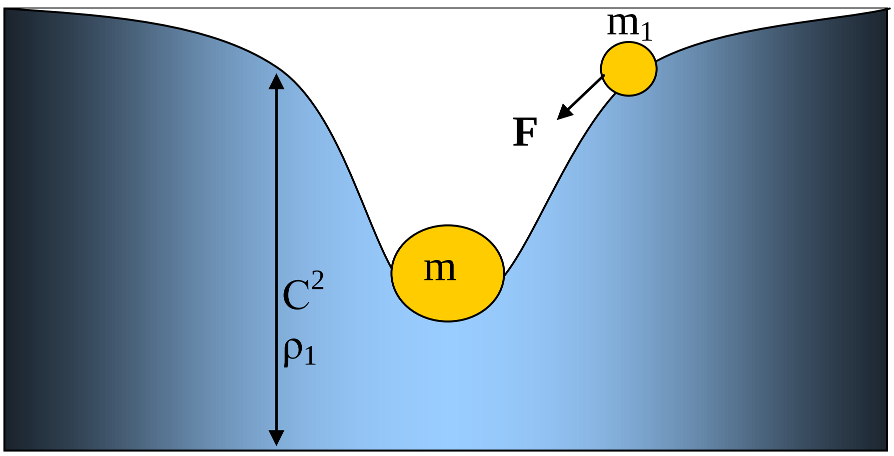

Fig. 2. Presence of the gravitation well in the quantized space-time around the perturbing mass **m** explains the effect of the gravity force **F** on trial mass $\mathbf{m_1}$.

Figure 2 showed the gravitation diagram of the elementary particle inside a gravitation well (Fig. 1). The gravitation well forms in exactly the same manner around any object, having a perturbing mass. Figure 2 shows that formally the trial mass rolls into the gravitational well towards the perturbing mass, ensuring their gravity. The theory of gravitation has never considered the presence of gravitation dwells inside the quantized space-time during its gravitational perturbation.

It should be noted that the force **F** of gravity is always directed to the bottom of the gravitational well in the direction of decreasing gravitational energy W (19), quantum density ρ_1 (26) of the medium and gravitational action potential C^2 (22).

Figure 3 shows that the trial mass m1 is situated in a heterogeneous gradient field of the Earth. Quantum density ρ_1 (or action potential C^2) weakens at the Earth surface. However, the function $\rho$and C^2 do not determine the gravitational force and determine its gradient (23) i.e., deformation **D** (24) of the quantized space-time. The theory of Superunification changes our views on gravity which cannot form outside the quantized space-time. Einstein connected gravity with the distortion of the space-time. It can now be said that the gravity is based on the real deformation of the quantized space-time.

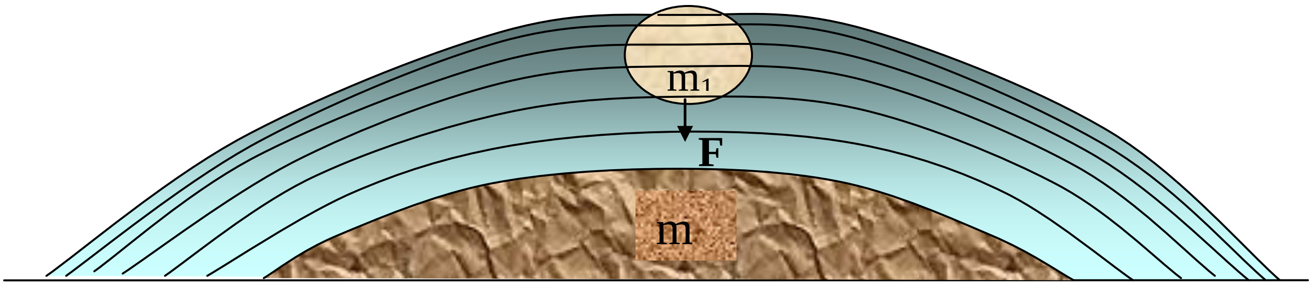

Fig. 3. Gravity force **F**, acting on the mass m in the field of the perturbing mass m_1 inside the gravitational well (Fig. 2).

As already mentioned, the quantized space-time, regardless of its electromagnetic nature, which is also gravitational in its basis, is characterized by the gravitational potential C_0^2 of the undeformed quantized space-time. In the absence of a gravitation perturbation, the potential C_0^2 is uniformly distributed in space and there are no gradients and forces. Only the presence of gradients leads to the formation of a non-balanced gravitational force **F** [1-7].

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