
On the Independent Determination of the Ultimate Density of Physical Vacuum

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In this paper, we attempt to present physical vacuum as a topologically non-unitary coherent surface. This representation follows with J. A. Wheeler's idea about fluctuating topology, and provides a possibility to express some parameters of the unit space element through the fundamental constants. As a result, we determined the ultimate density of physical vacuum without use of Hubble's constant.

The ultimate density of physical vacuum is regularly calculated through the experimentally obtained quantity — Hubble's constant. This constant follows from astronomical observations, and therefore its numerical value is under permanent update. On the other hand, the ultimate density of physical vacuum can also be determined in an independent way, through only the fundamental constants. Moreover, in the framework of this mechanistic model, it does not matter what we mean saying “physical vacuum”: a material substance, or space itself.

As an initial model of the space micro-element of matter, it is reasonable to use J. A. Wheeler's idea about fluctuating topology. In particular, electric charges are considered therein as singular points located in a three-dimensional surface, and connected to each other through “wormholes” or current tubes of the input-output (source-drain) kind in an additional dimension, thus forming a closed contour. Is this additional dimension really required? It is probably that the three-dimensional space, if considered at a microscopic scale, has really lesser number of dimensions, but is topologically non-unitary coherent and consists of linkages [1].

The most close analogy to this model, in the scale of our world, could be the surface of an ideal liquid, vortical structures in it and their interactions which form both relief of the surface and sub-surface structures (vortical grids, etc.).

From the purely mechanistic point of view, this model should not contain the *electric charge* as a special kind of matter: the electric charge only manifests the degree of the non-equilibrium state of physical vacuum; it is proportional to the momentum of physical vacuum in its motion along the contour of the vortical current tube. Respectively, the *spin* is proportional to the angular momentum of the physical vacuum with respect to the longitudinal axis of the contour, while the *magnetic interaction* of the conductors is analogous to the forces acting among the current tubes.

Of course, in the framework of this model, both point and line are means physical objects, which have specific sizes. We assume the classical radius of the electron r_e as the minimal size. This approach was already justified in determination of the numerical value of the electron's charge, and the constants of radiation [2].

Thus matter itself can finally be organized with step-by-

step complication of the initial contours, and be a “woven cloth”, which, in its turn, is deformed into the objects we observe. The objects therefore are very fractalized (upto the micro-world scales) *surfaces*, which have a fractional dimension of the number almost approaching three and presupposingly equal to the number e .

The latter conclusion verifies that fact that the function $n^{1/n}$, which can be interpreted as the length of a ridge of the unit cube (its volume is equivalent to the summary volume of n cubes of the n th dimension), reach its maximum at exact $n = e$. We can understand this result so that the world of this dimension $n = e$ is most convex to the other worlds.

As a result, the surface being non-deformed can logically be interpreted as empty space, while the deformed and fractalized surface, i.e. the surface bearing an information about local deformations — as substance, masses. What is about an absolutely continuous three-dimensional body, it has not any internal structure thus does not bear any information about its interior (except, as probably, its own mass): such bodies do not really exist, even in the real micro world. In other words, the surface is material. However, being non-deformed, it does not manifest its material properties.

It should be noted that it is impossible to discuss the real geometry of topology of the world in the framework of this concept. Moreover, it is quite complicate to differ the surface from space, and space from matter, because such a step means at least a conceivable leaving our surface, which consists ourselves and the Universe itself. On the other hand, our model does not require such a step.

To calculate the density of physical vacuum in the framework of our suggested model, it is sufficient to determine the square, thickness, and mass of the “smoothed” surface (non-perturbed physical vacuum), then reduce the mass to the ultimate volume. To do it, we need to determine parameters of the initial micro-element and elementary contour.

According to the assumed model, we write down the electric forces F_e and the magnetic forces F_m in the “coulombless” form, where we replace the electric charge with the ultimate momentum of the electron $m_e c$. We obtain, for the electric forces,

$$F_e = \frac{z_1 z_2 (m_e c)^2}{\epsilon_0 r^2}, \quad (1)$$

where z_1 and z_2 are the numbers of the electric charges, c is the velocity of light, m_e is the electron's mass, while $\varepsilon = \frac{m_e}{r_e}$ is a new electric constant, which is 3.23×10^{-16} kg/m and is the linear density of the vortical tube. Respectively, for the magnetic forces, we obtain

$$F_m = \frac{z_1 z_2 \mu_0 (m_e c)^2 L}{2\pi r \times [\text{sec}^2]}, \quad (2)$$

where $\mu_0 = \frac{1}{\varepsilon_0 c^2}$ is a new magnetic constant, whose numerical value is 0.034 H^{-1} , L is the length of the conductors of the current (vortical tubes), while r is the distance between them. Numerically, the electric forces (1) and the magnetic forces (2) coincide with those calculated according to the standard equations of electrodynamics.

Thus, the quantity inverse to the magnetic constant, is the centrifugal force which appears due to the rotation of the vortical tube's element whose mass is m_e , with the velocity of light c around the radius r_e . The centrifugal force is also equivalent to the force acting among two elementary electric charges at this radius. We note, that the latter conclusion is the same as that W. C. Daywitt arrived at in the paper [3].

In the non-perturbed physical vacuum the electric, magnetic, and other forces should be compensated. In particular, proceeding from the equality of the electric and magnetic forces, one can deduce the *geometric mean value*, which is a linear parameter independent from the direction of the vortical tubes and the number of the electric charges

$$R_c = \sqrt{Lr} = \sqrt{2\pi} c \times [\text{sec}] = 7.51 \times 10^8 \text{ [m]}. \quad (3)$$

This fundamental length is close to the radius of the Sun and also the sizes of many typical stars.

Thus equation (3) represents the ratio between the contour's length and the distance between the vortical tubes. Now, assuming that the figures of the contours satisfy the formula (3), we are going to calculate the total mass of physical vacuum, which fills the Universe, and also its density.

Let the "smoothed" surface of physical vacuum has a size of $L \times L$, and is densely woven on the basis of parallel vortical tubes (they have parameters L and r) which, in their turn, are filled with the unit threads (each of the threads has a radius equal to the radius of the electron r_e). Also, assume that, even if there exist structures whose size is lesser than r_e , they do not change the longitudinal density ε_0 . Thus, the total mass of the surface of the thickness r , which is the mass of physical vacuum M_v (including all hidden masses), is obviously determined by the formula

$$M_v = \frac{\pi}{4} \varepsilon_0 L \frac{L}{r} \left(\frac{r}{r_e} \right)^2. \quad (4)$$

The average density of the substance of physical vacuum ρ_v is expressed through the ratio of the mass M_v to the spherical volume $\frac{4}{3}\pi L^3$. As a result, extending the formula of ε_0

then expressing L from (3), we obtain

$$M_v = \frac{\pi}{4} \frac{\rho_e R_c^4}{r}, \quad (5)$$

$$\rho_v = \frac{3}{16} \rho_e \left(\frac{r}{R_c} \right)^2, \quad (6)$$

where ρ_e is the density of the electron derived from its classical parameters, and is $\rho_e = \frac{m_e}{r_e^3} = 4.07 \times 10^{13} \text{ kg/m}^3$.

The main substance of the Universe is hydrogen. Therefore, it is naturally to assume r equal to the size of the standard proton-electron contour, which is the Bohr 1st radius $0.53 \times 10^{-10} \text{ m}$.

Thus we obtain: the ultimate large length of the contour $L = 1.06 \times 10^{28} \text{ m}$, the total mass of substance in the Universe $M_v = 1.92 \times 10^{59} \text{ kg}$, and the ultimate density of physical vacuum $\rho_v = 3.77 \times 10^{-26} \text{ kg/m}^3$ (or $\rho_v = 3.77 \times 10^{-29} \text{ g/cm}^3$ in the CGS units).

The calculated numerical value of the average density of matter (physical vacuum) in the Universe is close to the modern esteems of the crucial density (the density of the *Einsteinian vacuum*).

With breaking the homogeneity of physical vacuum the anisotropy appears in the Universe. This is subjectively perceived in our world as manifestations of the pace of time, and the preferred directions in space. It is possible to suppose that the Universe as a whole evolutionary oscillates near its state of equilibrium, thus deforming the vacuum medium and creating the known forms of matter as a result. The stronger deformation, the larger contours (the heavier elements of substance) appear. Proceeding from the fact that elements with more than seven electron shells are unknown, we can conclude that the scale of the evolutionary oscillations of the Universe in the part of deformations of its own "tissue" is very limited. This is despite, as is probably, the Universe goes through the zero-state of equilibrium of physical vacuum during its evolution, where all real masses approach to zero, and the forces of gravitation — to their minimum. Here we see a relative connexion to *Mach's principle*, i.e. a dependency of the masses of objects on the mass of the entire Universe (of course, if meaning the mass of the entire Universe as the mass of physical vacuum, which is much greater than the summary mass of regular substance).

In conclusion, we suggest a supposition. Because masses or physical objects are merely forms of the relief of the surface of the vacuum medium, *which can only exist if the forming medium moves permanently along ordered trajectories*, in the framework of this interpretation *time* manifests evolution, change of objects and structures along the direction of motion of matter they consist of. Therefore, all paradoxes of time vanish here: the hypothetical displacement of an observer toward or backward with the current of matter leads only to his arrival at his alternative past or future; his actions

therein cannot change his own present — his own evolving section of the Universe.

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