LETTERS TO PROGRESS IN PHYSICS

Does the Macroworld Need Quantum Mechanics?

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In a series of articles, the author explained some phenomena and calculated a number of parameters related to the microworld using the non-quantum methods of the geometrodynamics (introduced by J. A. Wheeler). Thus, the nature of the electric charge has been revealed, its value and the proton/electron mass ratio have been calculated, the light quarks mass have been determined, etc. This publication gives a short survey of the obtained results.

Initial provisions

Developing an adequate physical model of the microworld is a primary task. The Standard Model of fundamental interactions (SM) is replete with abstractions that are understandable only to a few theorists. Over the last century, many researchers attempted to construct physical models of the microroworld based on non-quantum methods. Currently, despite some positive results obtained in this field, these results are not yet recognized by the scientific community.

However, contrary to the generally accepted views on the impossibility of adequately representing the microworld phenomena with visual images and analogies from the reality surrounding us, such analogies undoubtedly exist, since the basic physical laws are reproduced at various large-scale levels of the organization of matter. And if non-quantum methods can explain at least some of the microworld phenomena, then this will remove the mystery layer from it, allow us to look at microphenomena from a different angle and accelerate progress in their study and understanding.

The author has solved this problem to some extent, and this is proven by the definition of many properties and parameters of the microworld, and, unlike the works of other researchers, the author's model made it possible to determine many more of the mentioned parameters, moreover, using simpler methods. To solve this problem, the author's physical model was based on:

a) A mechanistic interpretation of John Wheeler's geometrodynamic, where the materiality of space itself is postulated, and the initial one-dimensional spatial elements are vortex structures that can form a continuous two-dimensional network [1] and then, when deforming, three-dimensional objects are formed [2–4]. Charged microparticles according to Wheeler are special points on the three-dimensional surface of our world, where, for example, a proton and an electron are connected by a "wormhole" or a vortex current tube of the drain-source type in an additional dimension. As a result, a *closed contour* is formed which the material environment circulates along;

b) The concept of elementary particles as unipolar vortices with a funnel on the surface (*analogous to a fermion*, conventionally along the X-axis in our world) and a vortex thread under the surface in depth (*analogous to a boson*, conventionally along the Y-axis in an additional dimension), which, according to a well-known physical analogy, spirally fills the current tube with an electron radius r_e. These forms, during oscillations, can transform into each other. Fermions retain part of the boson mass, bringing in a half spin. Boson masses cannot be stable in principle, as well as their physical analogues — vortex formations in a continuous medium, if they do not lean on the phase boundary. The boson mass is one-dimensional one and proportional to the vortex tube length. The bosons vortex elements rotate relative to the longitudinal axis with a circumferential velocity v_0, determined from the balance of dynamic and magnetic forces (see below). This velocity is constant, does not depend on the rotation radius, so many bosons can be located coaxially, that is, in one place;

c) The existence of a "hidden" mass, which in one way or another introduces *gravity into the microworld*, no matter whether it is an additional dimension, a "wormhole" or simply a topological feature, which for an external observer is some additional degree of freedom associated with electromagnetism; it is this that determines the electron charge and spin.

In this model, the electron volume with mass m_e and radius r_e is taken as an element of the mentioned material medium, and the quantity that replaces the charge in the well-known formulas of Coulomb and Ampere is $m_e c$; then the electric and magnetic constants ε_0 and μ_0 in the Coulomb-free form take the form:

$$\varepsilon_0 = \frac{m_e}{r_e} = 3.233 \times 10^{-16} \ \text{kg/m}, \tag{1}$$

$$\mu_0 = \frac{1}{c^2 \varepsilon_0} = 0.03441 \ \text{1/N}. \tag{2}$$

Thus, ε_0 becomes the linear density of the vortex tube, and μ_0 becomes the value of the inverse centrifugal force, and the formulas for electrical, magnetic, gravitational and dynamic (inertial) forces are written as:

$$F_e = \frac{1}{\mu_0}\left(\frac{r_e}{r_0}\right)^2 z_{e_1} z_{e_2}\,, \tag{3}$$

$$F_m = \frac{1}{\mu_0}\frac{l}{2\pi r_0}\left(\frac{r_e}{c\times[\text{sec}]}\right)^2 z_{e_1} z_{e_2}\,, \tag{4}$$

$$F_g = \frac{1}{\mu_0}\frac{1}{f}\left(\frac{r_e}{r_0}\right)^2 z_{g_1} z_{g_2}\,, \tag{5}$$

$$F_i = \frac{1}{\mu_0}\frac{r_e}{r_0}\left(\frac{\upsilon_0}{c}\right)^2 z_g\,, \tag{6}$$

where υ_0, r_0, l, z_e, z_g, f are, respectively, the circumferential velocity, circumferential radius or distance between vortex tubes, the length of a vortex tube (thread) or contour, the relative values of charge and mass in the charges and masses of an electron, and the electrical forces to gravitational forces ratio, equal to $c^2/\varepsilon_0\gamma$.

The balance of these forces leads to the emergence of structures that are necessary for the microworld and beyond. Based on the model, the microworld properties are unexpectedly easily and naturally clarified and important parameters are calculated, which proves the complete correspondence of the model to physical reality. The most important results have been the determination of the electron nature and its charge nature [5], as well as other parameters that *were not explained or calculated by quantum methods within the SM framework*, namely: the proton/electron mass ratio [6], the proton structure and the quarks mass [6, 7], the neutrino mass [8], etc.

The electron charge

The **electron charge** in a simple mechanistic interpretation of Wheeler's idea becomes proportional to the amount of medium motion along the vortex current tube contour, the spin, accordingly, to the angular momentum relative to its longitudinal axis, and the magnetic interaction between conductors is analogous to the forces acting between vortex current tubes.

Assuming a charge to be a momentum, we are convinced that many bizarre electrical and magnetic dimensions are simplified in a striking way and take on a meaningful and physically obvious form: the current strength becomes simply a force [kg $\times$ m/sec^2] or [N], the potential — a velocity [m/sec], the capacitance — the mass of electrons accumulated on the capacitor plates [kg], the conductivity — the mass velocity [kg/sec], the inductance — the value reciprocal of the mass acceleration [sec^2/kg], the magnetic field strength — the mass acceleration [kg/sec^2], the solenoid magnetic induction — the winding density of its turns [1/m], etc. [9].

Moreover, the established nature of the charge reveals the Boltzmann constant and temperature essence. It is known the exact value k_{B} to give by the ratio of Planck's constant to the speed of light and the electron charge, $k_{\text{B}} = h/ce_0$, but the reason for this is not clear, since the dimension of k_{B} is completely different. However, if we consider the electron charge as a momentum, then the dimension of k_{B} becomes [sec], which is equal in magnitude to the time it takes light to travel the distance close to the electron size. Then the temperature dimension turns out to be physically understandable and obvious, namely, the microparticles chaotic motion kinetic power [J/sec].

To determine the **charge magnitude** e_0, it is sufficient to introduce a unit of potential (velocity υ) in the Coulomb-free system

$$1\ [\text{m/sec}] = \frac{m_e \upsilon^2}{e_0}\,, \tag{7}$$

and for the contour with the maximum energy of a single charge write:

$$\upsilon\ [\text{m/sec}] = \frac{m_e c^2}{e_0}\,. \tag{8}$$

It is necessary to take into account that the charge magnitude and other microworld parameters are projected from the additional dimension onto our three-dimensional world surface with distortions at a certain angle q. In the work [5] this angle is determined, and it almost exactly coincides with the Weinberg mixing angle in weak interaction $q_{\text{W}} = 28.7°$. As a result, the observed electron charge magnitude, taking into account (7) and (8), is equal to:

$$e_0 = m_e c_0^{4/3} \cos q_{\text{W}} \times [\text{m/sec}] = 1.602\times10^{-19}\ \text{kg}\times\text{m/sec}, \tag{9}$$

where the dimensionless speed of light is $c_0 = c/[\text{m/sec}]$.

Since the charge (momentum) is by definition equal to $M\upsilon$, then in (9) the first factor is the contour mass $M = 4.48 \times 10^5\, m_e$, and the second is the vortex current tube longitudinal velocity $\upsilon = 4.48\times10^5$ m/sec. A contour having an energy $M\upsilon^2$, which is equal to the energy of a "point" electron $m_e c^2$ (i.e. at the point where the contour intersects our world surface) can be called "standard", for it $n = 4.884$; but here and below the parameter n does not have any special quantum properties, but simply determines the contour size.

The "hidden" mass of the standard contour approximately corresponds to the W, Z-bosons total mass. Therefore, it can be stated that the vortex tube of current is formed by three vortex threads rotating around a common longitudinal axis. These threads necessarily have right, left, and the last, obviously double, total zero rotation. They can be associated with the vector bosons W^+, W^-, Z^0.

In the work [5] the indicated thermodynamic constants of Boltzmann, Wien, Stefan-Boltzmann are determined, if we correlate the energy of a "point" electron per photon $m_e c\upsilon/z$ with the energy of thermal motion kT (the average energy of the radiation oscillator) for some characteristic conditions; and it is also established the unit oscillator energy $k_{\text{B}} b/\lambda_{\text{C}}$ at the Compton wavelength to be equal to the kinetic energy of the electron rotating along a circular trajectory, $2m_e(c/\pi)^2$.

Thus, the identification of the electron nature at the same time establishes its connection with both the weak interaction in the SM and the molecular-kinetic properties of atoms and molecules.

The proton/electron ratio

The **proton/electron ratio** is determined on the basis of the adopted model of microparticles and the proton-electron contour. As shown in [5], for any contour with an arbitrary quantum number n, with constant values of the electric and magnetic constants, charge and spin, the contour mass, its length, velocity and radius of the vortex thread, filling the contour tube, in units of m_e, r_e and c have the form:

$$M = m_y = l = (an)^2, \tag{10}$$

$$v = \frac{c_0^{1/3}}{(an)^2}, \tag{11}$$

$$r = \frac{c_0^{2/3}}{(an)^4}, \tag{12}$$

where a is the inverse fine structure constant.

Note that by analogy with natural vortex structures (in the case of the formation of subsequent spiral structures of radius r inside of a contour tube of radius r_e), the vortex thread can be extremely "compressed", i.e. shortened by a multiple of $1/r$. In this case, its mass-energy in units of $m_e c^2$ will be

$$L = lr = \frac{c_0^{2/3}}{(an)^2}, \tag{13}$$

or, conversely, extremely "stretched", i.e. extended by a multiple of $1/r$.

It is assumed that the contour to contain structural units (waves or photons), and their number z is the ratio of the "stretched" contour total length to the wavelength λ. In [5], the number of photons in the contour is determined, and in the standard contour $z \approx a = 137$, and for the case of contour decay (ionization) for the transition $n \to \infty$ the number of photons $z \approx n^4$.

In this model, the elementary particle has both point (intersection region) and wave properties, since the vortex funnel creates ring waves or second-order contours on the surface, which one can assign proper quantum numbers to that determine other parameters in accordance with formulas (10–13). In [6] it is defined:

$$\text{for a proton} \quad n_p = \left(\frac{2c_0}{a^5}\right)^{1/4} = 0.3338, \tag{14}$$

$$\text{for an electron} \quad n_e = \left(\frac{2c_0}{a^5}\right)^{1/8} = 0.5777. \tag{15}$$

It is accepted that a one-dimensional boson thread in the process of oscillations along the Y-axis is capable of packing extremely tightly into a fermion form along all four degrees of freedom, increasing the fermion relative linear size along the X-axis proportionally to $l_y^{1/4}$ and, as shown in [6], as a result, any i-th fermion mass in relation to the electron mass is determined by the ratio:

$$m_i = \left(\frac{n_e}{n_i}\right)^{14}. \tag{16}$$

For a proton, $m_p = (n_e/n_p)^{14} = 2160$, and the proton boson mass $(an_p)^2 = 2092$ is almost equal to its fermion mass, which is one of the conditions of its stability (the difference in values is due to simplifications in the formula for n) and, when corrected by the cosine of the Weinberg angle, it almost exactly coincides with the relative mass of the proton $2092 \cos q_{\mathrm{W}} = 1835$.

Zitterbewegung, i.e. electron oscillations with amplitude λ_{C} are revealed by a simple non-quantum method, without recourse to solving the Schrödinger equation, since the parameter n_e determines the electron contour length $l_y = (an_e)^2$, which envelops three inscribed circles with diameter d_y, which the vortex threads rotate inside; this also confirms the three-zone structure of the electron, noted in [10]. From geometric considerations it follows:

$$d_y = \frac{(an_e)^2 \sin 60^\circ}{2\pi} = 863.8\, r_e \quad \text{or} \quad 2.43 \times 10^{-12}\ \text{m}, \tag{17}$$

which exactly corresponds to the Compton wavelength.

Three generations of elementary particles naturally exist in this model, since a microparticle is considered as a contour itself, therefore any contour connecting charged particles can be likened to a particle included in a larger contour, assuming the mass of the smaller contour to be the mass of a hypothetical fermion (a proton analog) for the larger one. Thus, interconnected contours can exist. For the contour of the third generation and the last, extremely excited one, $v \to 1$, $r \to 1$ and $n = 0.189$.

The structure of the photon

The **structure of the photon**, as well as various virtual abstractions of quantum theory in the SM (such as quarks, partons, color, confinement, etc.) in this model naturally acquire physical content or become unnecessary [6].

A proton in a proton-electron contour as a special (singular) point is the place where the medium flow crosses the boundary between the regions X (fermions) and Y (bosons), where, by analogy with liquid or gas flows, phase inversion occurs and the medium parameters acquire critical values. It is clear that in the critical section their densities are compared.

Assuming the volume of fermions to be a sphere $w_x = (r_x)^3$, and the one-dimensional volume of the boson thread to be a cylinder $w_y = r^2 l_y$ and equating their densities, we obtain the quantum number belonging to the critical section, $n_q = 0.480$. This averaged parameter can be attributed to a certain particle — a quark, existing only in the region of the phase transition.

In accordance with (24) its mass $m_{qx} = 12.9$, which is the total mass, since the ratio of the boson mass of the electron to the boson mass of the proton, bearing in mind (10), $M_e/M_p = (n_e/n_p)^2 = 3.0$. That is, to satisfy the conditions of continuity of the flow and constancy of the charge in any critical section, the general contour flow must split in the proton region into *three parts* and *reverse circulation currents must arise*, i.e. there, in the proton, must be zones with different charge signs, as shown in Fig. 1:

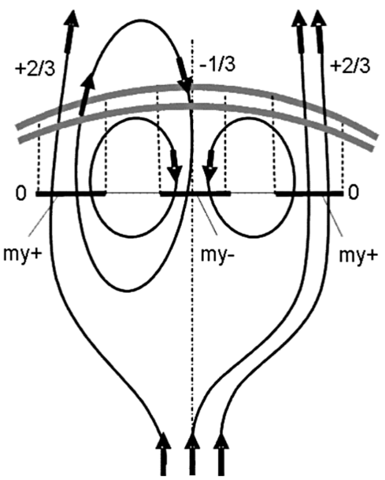

Fig. 1: A scheme of the proton: distribution of the current lines inside the proton.

In fact, quarks should be associated with stable ring currents containing, as follows from Fig. 1, one or two closed unit contours intersecting three critical sections. Therefore, the quark masses are 1/3 or 2/3 of the total mass, i.e. $4.3\,m_e$ and $8.6\,m_e$, which coincides with the masses of light quarks. The phenomenon of confinement or "non-escape" of quarks seems self-evident, since in this model the proton has no constituent parts, it only has the peculiarities of its structure.

Thus, the proton internal structure is characterized by a set of parameters that find their virtual analogues in the SM: vector bosons (three vortex threads connecting the proton and electron in an additional dimension), fractional charge (projection of current lines onto the outer surface of the proton), quarks (ring currents), "color" (three different critical sections), antiquarks and "anticolor" (opposite to the direction of currents and rotation of vortex tubes), partons (zones of increased velocity pressure), mesons (pairs of boson tubes with a total mass of $\sim 270\,m_e$). Here they all find their physical representation [6, 7]. The proposed proton structure in the form of a unique configuration of field lines does not require the existence of a "sea" of virtual quarks and gluons.

The **anomalous magnetic moment of the proton** is also explained in [6]. By definition, μ_p = (charge×velocity×path). This product agrees well with the known value of μ_p if we take the velocity to be υ, the path to be πr, and calculate these parameters using (11) and (12) with the proton parameter n_p.

The neutrino mass

The **neutrino mass** is determined by *introducing gravity into the microworld*, whose rôle is erroneously denied in the SM. Neutrinos are released in weak interaction processes, for example, in the case of *e*-capture; in this case, quarks and vector bosons participate in the process, but even in this complex case there is a macroanalogy — something similar to the charge and spin separation — a phenomenon recorded in ultra-thin conductors [11]. In the applied model [8], all virtual participants find a physical correspondence.

Let us recall that here the electron does not rotate around the proton and is not "smeared" over the orbits, while the proton-electron contour exists due to the *gravimagnetic balance*, when $F_m = F_g$, from which it follows in units of r_e:

$$L_x = l\,r = \frac{z_{g_1} z_{g_2}}{z_{e_1} z_{e_2}}\,(2\pi\gamma\rho_e) \times [\mathrm{sec}^2], \qquad (18)$$

where the value L, according to (13), is the mass-energy of the compressed contour, z_{g_1} is the mass of the proton active part (i.e. the quark) entering the circulation contour, z_{g_2} is the electron mass, ρ_e is the electron specific density, equal to m_e/r_e^3.

In the work [8] it is shown when particles to approach each other at a certain distance, the contour connecting them transfers energy-momentum to the proton internal structure, losing charge, deforms and reorients into the Y-region, releasing in the form of a one-dimensional neutrinos vortex tube, carrying away the electron spin. This occurs under the condition the quark mass-energy to reach the Y-vortex tube mass-energy in its compressed state, formula (13). At the same time $r_x = l_y$, see Fig. 2. This makes it possible to determine the neutrino quantum parameter n_υ.

As a result, in [8] it was obtained

$$n_\upsilon = \frac{c_0^{1/9}(2\pi\gamma\rho_e \times [\mathrm{sec}^2])^{1/3}}{a} = 1.643, \qquad (19)$$

and then, according to (16), the neutrino fermion mass is determined

$$m_\nu = \left(\frac{n_e}{n_\nu}\right)^{14} = \left(\frac{0.5777}{1.643}\right)^{14} = 4.39 \times 10^{-7}\ (0.225\ \mathrm{eV}). \quad (20)$$

Next, the quark mass $m_q = 8.84\,m_e$ (4.51 MeV) was calculated, which agrees well with the previously calculated quark mass when considering the proton structure, and in general it agrees with the **d-quark mass** (4.8 MeV); and the mass-energy of the X-contour $L_x = 1.51 \times 10^5$ (77 GeV) was calculated, which turns out to be close to the ***W*-bosons mass** (80 GeV), see Fig. 2. See [12] for more detail. Moreover,

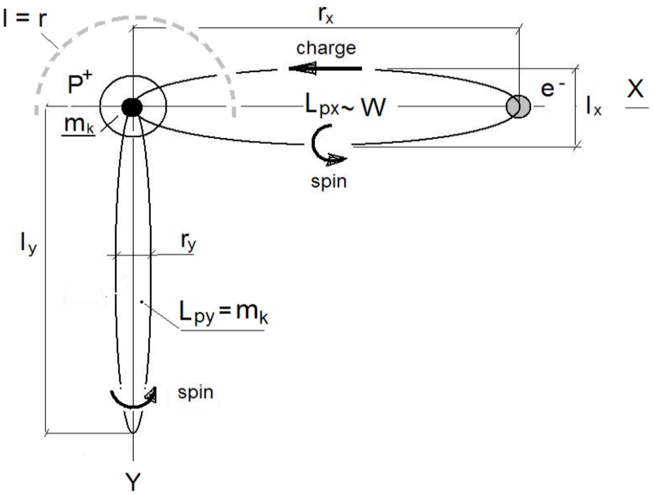

Fig. 2: Scheme of formation of the neutrino.

in [8] exactly the same neutrino mass value was obtained as the gravitational mass, i.e. as the value $z_{g_1} = z_{g_2} = z_g$, when considering the contour consisting of a pair of closed vortex threads having the Planck size $r_\hbar = (\hbar\gamma/c^3)^{1/2}$ and each having 1/4 of the electron charge

$$m_\nu = z_g = \frac{c_0^{1/6} r_\hbar^{1/4}}{(32\pi\gamma\rho_e \times [\mathrm{sec}^2])^{1/2}} = \\ = 4.31 \times 10^{-7}\ (0.220\ \mathrm{eV}). \quad (21)$$

Thus, two different neutrino states with identical masses were obtained — at the moment of birth in the form of a vortex Y-tube fermionic part and in its final state in the closed structure form having a gravitational mass. Such duality, as shown in [8], possibly explains **neutrino oscillations**.

The obtained values of the neutrino mass are consistent with the estimate of Adam Moss and Richard Battye, where the upper limits on the sum of neutrino masses are about 0.320 ± 0.081 eV [13].

The **difference in the proton and neutron masses, the neutron lifetime and energy of beta decay**, which are undetermined in the SM, are found due to the gravimagnetic balance, which allows the contour to have various configurations and, when the proton passes into the neutron, to become axisymmetric at the intersection of the regions X and Y, see Fig. 2. Then, with equal axes, its relative length and mass are equal to $c_0^{2/9}$. In [6] it is shown the symmetric contour, replacing the quark contour, to increase the nucleon mass by the desired value:

$$\Delta m = r\left(c_0^{2/7} - \frac{m_q^{9/7}}{2}\right)\cos q_{\mathrm{W}} = 2.53\, m_e\,, \quad (22)$$

here r is the electron vortex thread radius, determined by (16) at n_e.

The **lifetime of a neutron** is determined by the time of deformation and decay of the same symmetrical contour due to the proper rotation of the vortex threads relative to the longitudinal circular axis, which gives the time constant $\pi l/\upsilon_0$, where υ_0 is determined from the *magnetodynamic balance* at $F_m = F_i$ and is a fundamental constant. For unidirectional vortex threads, taking into account (4) and (6), at $z_{e_1} = z_{e_2}$ and at $z_g = l/r_e$:

$$\upsilon_0 = \frac{r_e}{(2\pi)^{1/2} \times [\mathrm{sec}]} = 1.12 \times 10^{-15}\ \mathrm{m/sec}, \quad (23)$$

then the time constant for $\pi l = \pi c_0^{2/9}$ has the form:

$$\tau = 2^{1/2}\pi^{3/2} c_0^{2/9} \times [\mathrm{sec}] = 603\ \mathrm{sec}. \quad (24)$$

The obtained value agrees with the half-life of the neutron $\tau_{1/2}$. By definition, $\tau_{1/2} = \ln 2 \times \tau_n$, where τ_n is the neutron lifetime; its value is 878.5 sec [14], then $\tau_{1/2} = 609$ sec. In [6], this time is also determined in another way.

In *beta decay*, the energy of the excited contour is transferred to the electron and antineutrino released in this process. The paper [6] provides examples of calculating the beta decay energy E_β, which by definition is the ratio of the acquired momentum (charge) square to the released particles mass. In particular, for the highest of beta decay (for isotopes) energy value, it was obtained

$$E_{\beta\,(\mathrm{lim})} = \frac{c_0^{1/3}\cos q_{\mathrm{W}}}{18} = 32.6\, m_e c^2\ (16.7\mathrm{MeV}). \quad (25)$$

Indeed, the highest value of E_β among various isotopes was recorded for the 12N → 12C transition (16.6 MeV), which coincides with the value (25) calculated within the framework of this model.

The model of the atomic nucleus

The **model of the atomic nucleus** is continuously updated, and various hypotheses about its structure are still being put forward. And here, at the level of the atomic nucleus, the non-quantum method demonstrates its applicability and effectiveness [15].

The **coupling constant** a, which in the SM determines the intensity of the exchange of specific quanta between microparticles, actually indicates the bonds strength between the elements of the proton structure (quarks) and is determined by the formula:

$$a_s = \frac{m_e c_0^{2/3} \upsilon_0^2/r_e}{\gamma m_e^2/r_e^2} = 26.25, \quad (26)$$

where the ratio of the inertial forces arising from the rotation of the boson mass of a standard contour vortex tube of radius r_e with the circumferential velocity υ_0 and acting toward the periphery to the gravitational forces acting between masses of size m_e at a distance r_e can serve as an equivalent of the coupling constant. In this case, coupling particles (π-mesons) are not needed.

The proton has a complex structure, therefore the interaction energy increasing, i.e. "deepening" along the proton Y-axis and, accordingly, decreasing the distance between quarks, it is perceived by an external observer as a nuclear forces changing.

At *low energies* of interacting particles (small "depth" along Y), the peripheral inertial forces exceed the attractive forces, so the quarks are weakly bound to each other, can move away from their original position and interact with the quarks of nearby nucleons.

At *high energies* (~100 GeV, a large "depth" along Y), the attractive forces hold the quarks within the nucleon, which reduces the microparticles interaction efficiency with each other. In [15], a_s were calculated, which coincide with the values accepted for these types of interactions [16].

The **radius of the proton** is calculated at $a_s = 1$, when there is a balance between the forces of attraction and the peripheral forces of inertia. From (26), assuming that the quarks are located at the corners of an equilateral triangle, at $m = m_e$ and $r = r_e$ we obtain

$$r_p = \frac{(8\pi\gamma\rho_e)^{1/2} \times [\text{sec}]}{3^{1/4} c_0^{1/3}} = 0.297, \quad \text{i.e. } 0.836 \times 10^{-15} \text{ m}, \qquad (27)$$

which exactly coincides with the proton charge radius value (0.833 femtometers, with an uncertainty of ±0.010 femtometers [17]). Thus, **nuclear forces** as a special interaction may not exist at all. At high energies and small distances, when the internal structures of nucleons overlap, the interaction between nucleons occurs *within their common quark bag* between quarks with charges +1 and −1 at a distance equal to the quark vortex tube size r_q. Outside the quark bag, the Coulomb interaction takes place between fractional charges of different signs located *on the nucleons outer surface*. The attractive potential decreases sharply in this case, for protons — proportionally to the product $\frac{1}{3} \times \frac{2}{3}$.

In [15, 18], the depth of the attractive potential for single charges, the binding energies for the deuteron, tritium, tetraneutron and alpha particle were calculated. At the same time, within the SM framework, these quantities are almost impossible to calculate. For example, the authors of the work studying the tetraneutron (see [18]) admit that "*More recent state-of-the-art theoretical calculations have concluded that without altering fundamental characteristics of the nuclear forces, the tetraneutron should not be bound. More theoretical calculations were performed, all of them agreeing that a bound tetraneutron is not supported by theory*".

Within the framework of the proposed model, these parameters are calculated because it takes into account the quarks mass-energy's changing in accordance with the contour size, the distance between quarks or charges, and the geometry of objects. Moreover, for example, the binding energy of an alpha particle (28.2 MeV) was determined in two ways — on the basis of the quark masses and on the basis of the quarks energy, see Fig. 3 [15]:

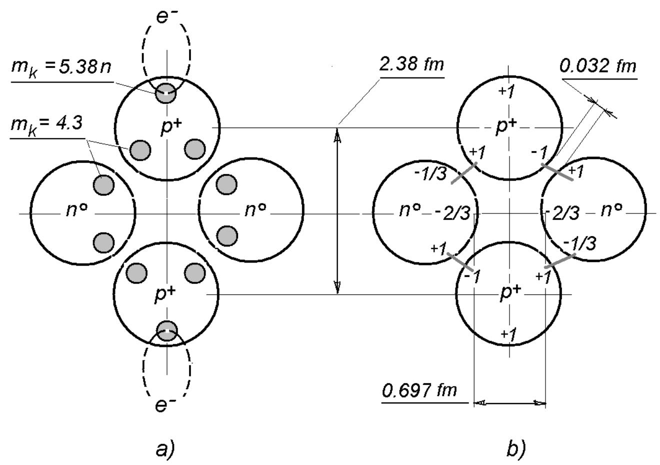

Fig. 3: Settlement scheme of the alpha particle: a — on the basis of the quark masses, b — on the basis of energy of the quarks.

Atomic nuclei are the system of nucleons and alpha clusters that are in dynamic equilibrium [19]. Their packing density in the nucleus increases toward the center, since electrons located in more distant orbits are associated with protons located at nucleus deeper levels, while the distance between the vortex tubes of the $p^+ - e^-$ contours decreases and their length increases, formula (18); thus, *layers or shells similar to electron ones are formed in the nucleus*.

Since r cannot be less than the alpha particle size $1.42\, r_e$ (4 fm), this limits the number of the shell whose electrons can bind to protons included in alpha clusters. In [15] it is shown that the *fourth layer or shell is the last one in the nucleus*; alpha clusters are not formed closer to the center of the nucleus. A similar condition for the nucleon size also determines the largest possible atom electron shell number and, if $r \leqslant 2r_p$, then $n_{\max} \geqslant 8$. As calculated in [15], the alpha particle maximum energy is achieved during the transfer of energy from protons located in the nucleus center, which are bound to the last seventh shell (27.5 MeV), which exactly coincides with the maximum energy value of alpha particles determined in the study of the fission of heavy nuclei [20].

Also, in the work [15] the stable isotope of lead detailed calculation was performed, which gave its exact mass $A = 207$. It turned out that for elements heavier than lead, protons associated with electrons of the fifth and subsequent electron shells no longer completely "fit" into the nucleus core, limited by the fourth filled shell. With an increase in the number of protons, the fourth nuclear shell expands, additional neutrons are included in it, and the nucleus radius increases. Neutrons that are not included in clusters (for $_{82}\text{Pb}^{207}$ there are 65 such neutrons) are located in the remaining free volume, being forced out into the outer shells.

In [15] a relation was obtained between the number of nucleons in the nucleus core and in the adjacent shell, which the nuclear density of nucleons in them is the same at. This *homogeneity condition* is observed very precisely for lead: 22 nucleons in the core correspond to 64 nucleons in the 4th shell (32 protons and 32 neutrons) and also approximately for xenon, neodymium, iron and for some other elements, and that for the nuclei of such elements the observed *electric quadrupole moments are close to zero* [21]. For lighter nuclei, the core can be considered the volume of the inner shell, including protons and neutrons.

So the reason for the deviation of the electric charge distribution in the atomic nucleus from spherically symmetrical is the non-uniformity in the "packing" of nucleons inside the atomic nuclei, so for most elements their nuclei can have a non-spherical shape. In addition, to fill the outer nuclear shells, neutrons are usually insufficient, and for some nuclei their outer shell must shrink, lose the spherical layer shape and take the polyhedron shape, in the corners of which alpha clusters are located [22].

It is interesting that the obtained homogeneity condition makes it possible to calculate the number of protons Z and neutrons N for superheavy elements of the hypothetical "island of stability". Thus, if we accept that the fourth shell is replenished with neutrons up to the number of nucleons necessary to fill the fifth shell, i.e. up to $2 \times 2 \times 25 = 100$, then, according to the homogeneity condition, it turns out that for such an element $Z = 112$, $N = 184$. The latter just coincides with the expected "magic" number N, which was proposed by physicist Vitaly Goldansky in 1966.

The **binding energies of nuclei** in this model (in contrast to the well-known semi-empirical Weizsäcker formula) are calculated with no less accuracy, without resorting to empirical coefficients. It is determined by the mass-energy of nucleon quarks 4×2.2, all proton quarks included in the $p^+ - e^-$-circulation contours $2.75\,(m_1 + 2m_2 + 3m_3 + \dots)$ and the energy of the potential barrier (the energy of the first unfilled shell) $2.75\,z$. The final sum has the form:

$$E_n = 8.8\,z_p + 2.75\,(m_1 + 2m_2 + 3m_3 + \dots + z)\ \text{MeV}, \quad (28)$$

where z_p is the number of protons in the first to fourth shells, z is the total number of protons, m_i is the number of electrons in the i-th shell of the atom, 2.2 is the mass-energy of one quark in MeV.

The **mass number** is calculated based on the energy balance and using the already obtained relationships:

$$A = z_p + 0.625\,(m_1 + 2m_2 + 3m_3 + \dots - z) + (4)_{A<140}\,. \quad (29)$$

For A, in some cases, a correction is necessary that takes into account the presence of four alpha-cluster nucleons on the first shell, which are split off when the nucleus reaches a certain mass. In [15], actual and calculated data on the binding energy and mass numbers for stable isotopes of some elements are given according to formulas (28) and (29), where their good agreement is obvious.

The gravitational constant

The **gravitational constant** is calculated based on the scheme of a single radiation cell of a surface transverse-longitudinal wave, where a medium with an arbitrary mass m circulates along the toroid contour of radius R and at the same time has a spiral rotation with a radius r relative to the toroid longitudinal annular axis [23].

Circulation along R occurs under the action of gravitational forces with acceleration v^2/R, and spiral rotation with r — under the action of surface tension forces with acceleration v^2/r. The components of the surface wave are logically correlate to longitudinal gravitational waves and transverse electromagnetic waves. The ratio of electrical forces to gravitational forces is $c^2 r_e/\gamma m_e$, and it will be such when the elements of the medium circulate along the contour with the largest radius R with the lowest speed and spirally rotate with the smallest radius r with the highest speed, which gives the corresponding equality.

For the transverse component $v = c$, and the smallest dimension r is the diameter of the circumscribed circle around three Planck dimensions $r_\hbar$. For the longitudinal component, the smallest velocity and the largest radius (length of the contour) are determined by formulas (11) and (10) with the use of the largest quantum number $n_m = 390$, determined from (19) under the condition that the entire proton mass $m_p/\cos q_W$ is involved in the circulation contour. As a result, the following formula is obtained:

$$\gamma = \left(1 + \frac{2}{3^{1/2}}\right)^{\frac{2}{13}} a^{1/13} c_0^{16/39} \left(\frac{\cos q_W}{2\pi m_p}\right)^{\frac{12}{13}} w_e \left(\frac{c}{r_e}\right)^{\frac{2}{13}} \times$$
$$\times\,[\text{sec}^{-24/13}]\,, \quad (30)$$

where w_e is the specific volume of an electron, equal to r_e^3/m_e.

The **speed of light** was determined in [24] using the well-known equation for the wave speed on the liquid surface as applied to the above-mentioned radiating cell (toroid), where the first term in the equation reflects the influence of gravity on the wave speed (parameter g), the second — the influence of surface tension (parameter σ)

$$v^2 = \frac{g\lambda}{2\pi} + \frac{2\pi\sigma}{\rho\lambda}\,. \quad (31)$$

A gravitational wave is a compression deformation of the surface wave longitudinal component and its length can be determined by taking $v = c$; in [23] from (31) it is derived (the positive radical expression is taken)

$$\lambda = \frac{\pi r_e a^6 n^6}{c_0^{2/3}} \left[1 + \left(1 - \frac{4 c_0^{2/3}}{a^2 n^2 m_p}\right)^{1/2}\right]. \quad (32)$$

Within the parameters of the contour $n = 1 \dots n_m$, the wavelength is very large (here the parameter n determines the physical size of the radiating cell, in contrast to the proton-electron system), and the wave becomes effectively longitudinal one with negligible electromagnetic "capillary ripples" (the second term under the root in (32) tends to zero). Since longitudinal waves are the result of gravitational forces, they can be considered gravitational waves.

This is confirmed by the discovery of gravitational waves by the LIGO and VIRGO collaborations [23]. On February 11, 2016, oscillations with the frequency of 30–500 Hz were detected, which corresponds to wavelengths of 600,000–10,000,000 m [25, 26]. And these results correspond exactly to the middle of the range of circulation cell emissions at $n = 115$–180.

The cosmological constant

The **cosmological constant** Λ, its origin and nature remain a subject of discussion to this day [27–29]. It defines non-Newtonian gravitational forces and characterizes the curvature of empty space, as if additional mass or energy were introduced into it, and has a dimension of m^{-2}.

However, Λ can be determined taking into account in the Universe to be some constant vortex motion of particles relative to each other, and to be the rotation of unidirectional vortex threads (bosons) with the circumferential velocity υ_0, caused by magnetogravitational equilibrium, see formula (23). It creates the background component of energy, which has not attracted any attention of physicists until now. This rotation introduces additional energy into the vacuum, which can be likened to a kind of cosmic "Brownian motion" creating pressure on the "walls" of space (which is perceived by an external observer as the manifestation of non-Newtonian forces) and must be compensated by gravitational forces [30]. The *balance of pressures* from these forces is

$$\frac{M\varepsilon_0\gamma}{L^3} = \frac{M\upsilon_0^2}{L\Lambda^{-1}}\,, \tag{33}$$

The balance does not depend on the mass of the Universe M, but depends on its parameter L. The main parameter of the Universe L is determined in [4] from the *electromagnetic balance* and, provided that r is equal to the Bohr radius, i.e. the size of the most common hydrogen atom. Finally, the Universe's parameter L takes the following value

$$L = \frac{2\pi c^2}{R_B} \times [\sec^2] = 1.06 \times 10^{28}\ \text{m}. \tag{34}$$

In the end

$$\Lambda = \frac{\varepsilon_0\gamma}{(L\upsilon_0)^2} = (2\pi)^{-1}\left(\frac{a}{c}\right)^4 \varepsilon_0\gamma \times [\sec^{-2}] = $$
$$= 1.49 \times 10^{-52}\ \text{m}^{-2}, \tag{35}$$

and such a value should 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} [31].

Conclusion

All the above results are obtained on the basis of the model that does not have any empirical coefficients, and the numerical results are ultimately the combination of fundamental quantities. Macroanalogies applied to the microworld in this model are similar to physical natural laws that are reproduced at various large-scale levels of matter organization. Thus, it is proven the microworld physical model can be built on the basis of existing physical realities without using the sophisticated mathematical apparatus of the Standard Model of Fundamental Interactions (SM), which inevitably masks the physical essence of phenomena with virtual abstractions. The new realistic model will provide an opportunity to look at microphenomena from a different angle and make them accessible to a wider range of researchers.

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