Dynamic model of elementary particles and the nature of mass and "electric" charge

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Abstract: *The physical model of elementary particles, based on the wave features of their behavior, is described here. Elementary particles are regarded as elementary dynamical structures of the microworld, interrelated with all levels of the Universe, i.e., inseparable from the structure of the Universe as a whole. Between any elementary particles and the ambient field of matter-space-time, as well as between elementary particles themselves, there exists an interchange of matter-space-time occurring both in horizontal (within the same level) and vertical (between different levels) directions. This model allowed revealing the nature of mass and charge of elementary particles that is described here along with other important results originated from such a model.*

Key words: *elementary particles, mass, electric charge, nuclear density*

1 Introduction

The standard model of elementary particles attempts to explain the behavior of the particles, i.e., it focuses on answering the question "How". However, this model encounters difficulties when the question "Why" (or "What") arises. In particular, one of the principal questions, unsolved in physics, is the nature of mass and charge of elementary particles. We know, leaning on the standard model, that the size of the particles does not exceed the size of atomic nuclei that is dictated by the modern nuclear model of atoms.

Everyone can recognize that atoms represent by themselves the structures of one of the levels of the multilevel Universe. Accordingly, it is clear, we should not

consider atoms separately from the general structure of the Universe. It means that a consideration of the problem of structure of any material objects should begin from the precise definition of the principal axioms on the structure of the Universe as a whole.

According to one of the axioms on the general structure of the Universe, which has been formulated in the work [1], mutual transformations of fields with opposite properties (e.g., the potential field $\Longleftrightarrow$ the kinetic field) cause the wave nature of the world. The wave process, appearing at some level, generates waves going deep into an infinite series of embedded field-spaces and induces wave processes at the higher lying levels.

On the basis of this and other relevant axioms, the wave equation, describing the field of matter-space-time, has been solved. As a result, we found the kinematic spatial geometry of wave processes, including those occurring at the atomic and subatomic levels. In particular, these solutions revealed the nature of quasiperiodicity of elementary atomic structure and symmetry (including "forbidden to ordinary crystals" [2]).

According to the obtained solutions, atoms have the quasispherical structure of characteristic shells with potential and kinetic nodal points-extremes of the probabilistic potential. The main structural units of the atoms are *H*-atoms located (maximum by two) in principal potential polar-azimuth nodes-extremes. All known physical properties and phenomena are accounted for by this atomic model, which can be called the *multinuclear atomic model*. It yields the structure and mass of all possible isotopes. In essence, it reveals the "genetic code" of the structural variety in nature.

The nodal shell structure of atoms allows also the understanding of the physics of atomic reactions caused by an inelastic interaction of high-energy particles with substance. Calculated binding energies of filled up nodes and shells and the elementary proper energy of H-atoms in the nodes are in conformity with the experimental data of nuclear physics.

An understanding of atomic properties and atomic structure cannot be achieved without an understanding of the nature of atomic components - "elementary" particles (microobjects, more correctly): protons, electrons, neutrons, etc. On this way, the consideration of the wave nature of the particles, as elementary spherical structures of the subatomic level of the Universe, led us to the precise expression for their mass m and charge q, to the understanding of their nature and other important results [1].

The goal of this paper is to show the readers all major stages on the way of revealing the nature of mass and charge of elementary particles and some of the important consequences originated from this revelation.

2 The physical (dynamical) model of elementary particles; important definitions

Let us imagine an elementary particle as a dynamic spherical formation of a complicated structure being in a dynamic equilibrium with environment through the wave process of the definite frequency ω. Longitudinal oscillations of its wave shell in the radial direction provide an interaction of the particle with other objects and the ambient field of matter-space-time (Fig. 1).

We assume that a spherical wave shell bounds the space of an elementary particle, separating it from the ambient wave field. We call this sphere the *characteristic sphere* of a microparticle. The characteristic sphere restricts the *main part of the microparticle* from its *field part* merging gradually with the ambient field of matter-space-time.

The *main part* (core) is the *basis* of a microparticle, whereas the *field part* represents its *superstructure*. Thus, the basis space of a microparticle is restricted by the characteristic sphere, beyond which there is the space of its superstructure. Such a model interprets a microparticle as a particular discrete physical point of an arbitrary level of matter-space-time, restricted by the characteristic sphere and being in rest in the field-space.

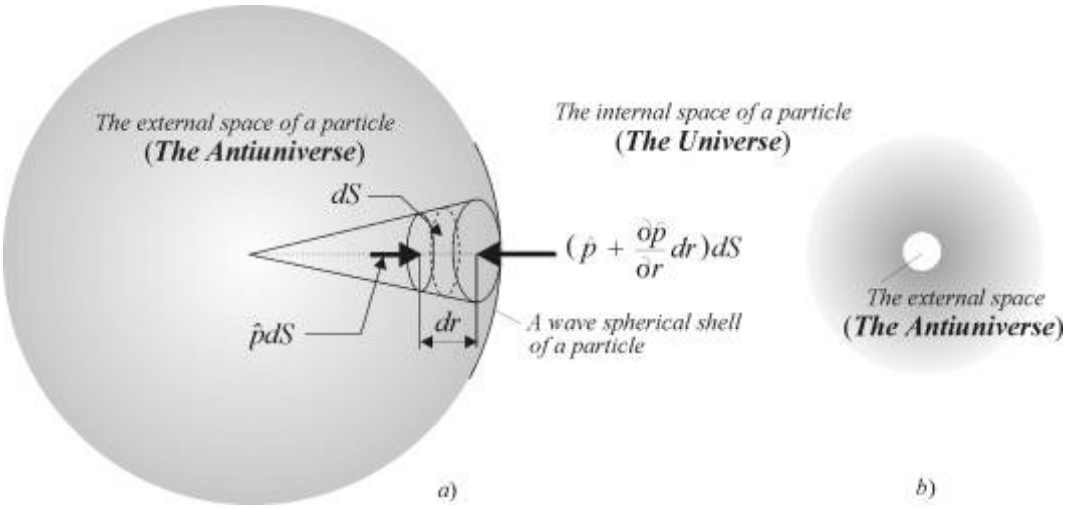

Figure 1. a) An element of the volume of the wave shell in a spherical field of exchange: a particle - ambient field of matter-space-time; $\widehat{p}dS$ and $[\widehat{p} + (\partial\widehat{p}/\partial r)dr]dS$ are powers of exchange of the field with the element of shell of the particle, is the two-dimensional density of exchange, or the pressure of the field of exchange. b) The internal and external parts of an elementary particle.

A ratio of mass dm and volume dV of elementary particles defines their *absolute-relative density* ε

$$\varepsilon = \frac{dm}{dV} = \varepsilon_0 \varepsilon_r \tag{1}$$

in which $\varepsilon_0 = 1\,g/cm^3$ is the *absolute unit density* and ε_r is the *relative density*.

The ratio of mass dm and time dt expresses the volumetric rate of mass exchange of the particles with environment, which we call the *exchange charge*, or merely the charge

$$Q = \frac{dm}{dt} = Sv\varepsilon \tag{2}$$

in which S is the area of a closed surface separating the space of an elementary particle from the surrounding field of matter-space-time, v is some speed of wave exchange (interaction) at the separating surface. It is natural to present the velocity of wave exchange (interaction) in the form

$$\widehat{v} = v(kr)e^{i\omega t} \tag{3}$$

in which $k = 2\pi/\lambda = \omega/c$ is the wave number corresponding to the definite fundamental frequency of the field of exchange ω, characteristic of the subatomic level of the Universe.

Strictly speaking, *the exchange charge is the measure of the rate of exchange of matter-space-time*, or briefly, the *power of mass exchange*. In this wider sense, the area of exchange S does not necessarily concern the closed surface. In case of a microobject of a spherical structure, the measure of exchange charge (2) is

$$\widehat{Q} = 4\pi a^2 \widehat{v}\varepsilon_0\varepsilon_r \tag{4}$$

which a is the radius of the wave shell of the microobject.

In this model, according to definition [3], the inner geometrical space (spherical volume) of an elementary particle, restricted by its wave spherical shell, is the external world of the particle. As the external world of the Universe (Fig. 1b), this space (inside the spherical volume) naturally can be called the Antiuniverse. In this sense, the World (Being and Nonbeing) is presented here through the Universe and the Antiuniverse. Obviously, the spaces of the Universe and the Antiuniverse are closed in each other. Most probably the main essence of life, its mystery, is hidden in the Antiuniverse.

Resting on the aforementioned definitions, we can start the consideration of wave exchange (interaction) of a particle with the ambient field of matter-space-time.

3 The nature of mass of elementary particles; derivation of the formula

In a spherical field (Fig. 1), an equation of powers of exchange of motion (an equation of motion) for an elementary volume of a characteristic spherical shell of a particle, of the area dS and thickness dr, is defined by the equality

$$\frac{d\widehat{v}}{dt}dm = d\widehat{F} \tag{5}$$

in which the speed $\widehat{v}$ and the power of exchange $d\widehat{F}$ are described by the field of binary numbers [4, 5], expressing the potential-kinetic character of exchange.

A resulting action is

$$d\widehat{F} = \widehat{p}dS - \left(\widehat{p} + \frac{\partial \widehat{p}}{\partial r}dr\right) dS$$

Since $dm = \varepsilon_0 \varepsilon_r dr dS$, the equation of exchange (5) will take the following form

$$\varepsilon_0 \varepsilon_r dr dS \frac{d\widehat{v}}{dt} = -\frac{\partial \widehat{p}}{\partial r} dr dS$$

or

$$\frac{d\widehat{v}}{dt} = -\frac{1}{\varepsilon_0 \varepsilon_r} \frac{\partial \widehat{p}}{\partial r} \tag{6}$$

On the basis of the equation (6) and because $\dfrac{d\widehat{v}}{dt} = i\omega\widehat{v}$ (see Eq. (3)), we arrive at

$$\widehat{v} = -\frac{k}{\varepsilon_0 \varepsilon_r \omega} \frac{\partial \widehat{p}}{\partial kr} \tag{7}$$

In a spherical field, a flow of oscillatory energy through an elementary cone is constant. Hence, the speed is decreased inversely to the distance from the center of the spherical field. Consequently, the wave of the density of exchange has the form

$$\widehat{p} = \frac{p_m}{kr} e^{i(\omega t - kr)} \tag{8}$$

in which p_m is the amplitude of the density of exchange at the boundary of the wave zone defined by the condition $kr = 1$.

Joining the equalities (7) and (8), we have

$$\widehat{v} = \frac{\widehat{p}}{\varepsilon_0 \varepsilon_r i\omega}(1 + ikr) \tag{9}$$

On the basis of equations (7) and (9), we find the power of exchange $\widehat{F}_s$ with the ambient field at the boundary of the spherical shell of a particle with the area S and radius $r = a$

$$\widehat{F}_s = \widehat{p}S = \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2}(1 - ika)\widehat{v} i\omega \tag{10}$$

or

$$\widehat{F}_s = \left(\frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} - \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} kai\right) \frac{d\widehat{v}}{dt} \tag{11}$$

The expression in brackets can be regarded as a resulting mass of wave exchange: a particle-environment. It is an *associated field mass* of the particle

$$\widehat{M} = \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} - \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} kai \tag{12}$$

We can present the expression (11) in some other form. Because $\frac{d\widehat{v}}{dt} = i\omega\widehat{v}$, the right part of this expression can be rewritten as

$$\widehat{F}_s = \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} \frac{d\widehat{v}}{dt} + \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} ka\omega\widehat{v} \tag{13}$$

In such a case, the equation of radial exchange of a particle of mass m_0 through the spherical surface, within which the particle is localized, can be presented in the form of the equation of powers

$$m_0 \frac{d\widehat{v}}{dt} = \widehat{F} - \widehat{F}_s \tag{14}$$

in which $\widehat{F}$ is the power of exchange of the particle with an object in the ambient space; the second term, $\widehat{F}_s = \widehat{p}S$, takes into account the exchange of the particle with the ambient field of matter-space-time.

Taking into account (13), the equation of powers of exchange, for the particle with the one radial degree of freedom, can be presented as

$$\left(m_0 + \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} \right) \frac{d\widehat{v}}{dt} + R\widehat{v} = \widehat{F} \tag{15}$$

in which

$$R = \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} ka\omega \tag{16}$$

is the coefficient of resistance or the dispersion of rest-motion at exchange.

The equation of powers of exchange (15) is presented in the classical form of Newton's second law, describing the motion in the field-space with the resistance R. At such a description of motion-rest, the expression in brackets represents the *effective mass m* of the particle

$$m = m_0 + \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} \tag{17}$$

The second term in the formula of effective mass, we call the *associated potential mass* of the particle m_a, or merely the *associated mass of the particle*, or briefly the *mass of the particle*

$$m_a = \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} \tag{18}$$

This is the mass of the particle in the longitudinal (central) exchange.

If in the formula of effective mass (17), the rest mass (own mass) of the particle m_0 is significantly less than the associated one m_a, then the *mass of the particle will be defined only by its associated mass* m_a *and it is the field mass in the central exchange.*

Obviously, the rest mass of the particle m_0 is the associated one with respect to the deeper level of the field of matter-space-time. Therefore, we can assert that *all*

masses of microparticles in the Universe have the associated field character and that their own (proper, rest) masses do not exist.

If such situations are possible, when exchanges of particles with the ambient field of matter-space-time of the subatomic level do not occur, then masses of particles, with respect to this level, are equal to zero and no experiment will find such a world of microparticles. Accordingly, this world will be incognizable for physics.

4 The charge of exchange

The equation (14) describes the exchange of motion, whereas the mass exchange is defined by charges (2). In this case, we present the field component of mass exchange in the following form

$$\widehat{p}S = \frac{d\widehat{m}}{dt}\widehat{v} = \widehat{Q}\widehat{v} \tag{19}$$

Assuming $m_0 = 0$ and taking into account the equality (14), we obtain the following equation of powers of exchange

$$\widehat{Q}\widehat{v} = \widehat{F} \tag{20}$$

The charge of exchange $\widehat{Q}$ has an active-reactive character; it folows from Eqs. (10), (19) and (20) that

$$\widehat{Q} = \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} ka\omega + i \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} \omega = Q_a + iQ_r$$

in which

$$Q_a = \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} ka\omega \tag{21}$$

is the *active charge*, and

$$Q_r = \frac{Q_a}{ka} = m\omega = \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1 + k^2 a^2} \omega \tag{22}$$

is the *reactive charge*.

The active component Q_a defines the dispersion during exchange, which in a steady-state process of exchange is compensated by the inflow of motion and matter from the deeper levels of space. The reactive component of charge Q_r (further for brevity, the *charge of exchange* Q) is connected with the associated mass m by the relation

$$\frac{Q}{m} = \omega, \quad \text{or} \quad Q = m\omega \tag{23}$$

The equation (23) determines the *fundamental frequency of the field of exchange*, which is *the distinctive "time" frequency of exchange at the atomic and subatomic levels* [1].

Using (23), the active charge can be presented as

$$Q_a = Qka \tag{24}$$

The active mass of dispersion at exchange, corresponding to the active charge, is

$$m_a = \frac{Q_a}{\omega} = mka \tag{25}$$

In such a case, the associated mass m should be regarded as the reactive mass.

5 Elementary law of central exchange (interaction)

The simplest potential of speed of exchange in a spherical field has the following form

$$\widehat{\Phi} = A\frac{e^{i[\omega\, t - k(r-a)]}}{r} \tag{26}$$

Let the radial speed of exchange (at the wave spherical surface of a particle) follow the law $v_n = iv_0e^{i\omega t}$. Then, taking into account the boundary conditions $v_n = -\dfrac{\partial\widehat{\Phi}}{\partial r} = iv_0e^{i\omega t}$, we obtain

$$A = \frac{iv_0a^2}{1+ika}$$

On this basis, the potential of spherical field of exchange can be presented as

$$\widehat{\Phi} = \widehat{\varphi}ka + i\widehat{\varphi} \tag{27}$$

in which $\widehat{\varphi}ka$ is the active potential of dispersion, and $\widehat{\varphi}$ is the reactive potential of exchange

$$\widehat{\varphi} = \frac{\widehat{Q}}{4\pi\varepsilon_0\varepsilon_r r} \tag{28}$$

The potential of radial exchange $\widehat{\varphi}$ is determined by the charge wave of exchange

$$\widehat{Q} = Qe^{i[\omega\, t - k(r-a)]} \tag{29}$$

in which Q is the amplitude of charge, determined by expression (22).

The potential (28) will not be changed if we assume that at the field level $\varepsilon_r = 1$. Then, the amplitude (and also the mean value) of the potential will be determined by the equality

$$\varphi = \frac{Q}{4\pi\varepsilon_0 r} \tag{30}$$

in which

$$Q = m\omega = \frac{4\pi a^3\varepsilon_0}{1+k^2a^2}\omega \tag{31}$$

is the amplitude (or mean value) of the charge.

A gradient of the potential of exchange φ defines the intensity (or strength or the rate or the vector) of central exchange E (its amplitude and mean value)

$$E = -\frac{\partial \varphi}{\partial r} = \frac{Q}{4\pi\varepsilon_0\varepsilon_r r^2} \tag{32}$$

The vector of central exchange E defines the dynamic vector D, by the definition equal to

$$D = \varepsilon_0\varepsilon_r E \qquad \text{or} \qquad E = \mu_0\mu_r D \tag{33}$$

This vector represents the density of momentum of exchange of rest-motion.

In accordance with (19), the following power of exchange F corresponds to the strength-rate of exchange E

$$F = \frac{dm}{dt}E = \frac{Q^2}{4\pi\varepsilon_0\varepsilon_r r^2} \tag{34}$$

in which $\varepsilon_0 = 1\, g/cm^3$ is the absolute unit density.

This expression represents the *law of central exchange* of the Coulomb kind. Its general form is

$$F = \frac{Q_1 Q_2}{4\pi\varepsilon_0\varepsilon_r r^2} \tag{35}$$

The speed of exchange at the basis level is equal to c. In this case, the equation of the power of exchange (20) takes the form

$$\widehat{Q}\widehat{c} = \widehat{F} \tag{36}$$

Hence, the (carrier) *energy of mass exchange* (interaction) on the basis level or, in other words, the *dynamic energy* of the subatomic level will be equal to

$$W = \int Qcd\ell = \int \frac{dm}{dt}ccdt = \int c^2 dm \tag{37}$$

in which $\dfrac{d\ell}{dt} = c$ and $d\ell$ is the displacement of the wave front of exchange (at the separating surface of a particle, see Fig. 1). In the case of the differential exchange, we have

$$\Delta W = \Delta m c^2 \tag{38}$$

We arrive at the so-called rest energy of particles, well known in the form $E = m_0c^2$, appeared by chance in Einstein's manipulation of the fictitious mathematical empty spaces. The sense (nature) of this energy is not (and cannot be) properly understood by modern physics in the framework of generally accepted theories.

6 Fundamental frequency and wave radius of the "electrostatic" field

The energy of exchange of a particle with the surrounding field is equal (taking into account (30)) to

$$W = Q\varphi = \frac{Q^2}{4\pi\varepsilon_0 r} \tag{39}$$

In an electrostatic field theory, the following Coulomb energy (in *CGSE* units) corresponds to the energy of exchange (39)

$$W_C = \frac{q_C^2}{r} \tag{40}$$

in which q_C is the Coulomb "electric" charge.

Assuming, naturally, that $W = W_C$, we arrive at the formula of correspondence between exchange charge Q and Coulomb charge q_C:

$$Q = \sqrt{4\pi\varepsilon_0} q_C \tag{41}$$

Hence, the *exchange reactive charge* of an electron at the level of the fundamental frequency is

$$e = e_C\sqrt{4\pi\varepsilon_0} = 1.70269248 \times 10^{-9} g \cdot s^{-1} \tag{42}$$

in which $e_C = 4.80320679 \times 10^{-10}\, CGSE_q$ is the (Coulomb) electron charge.

Thus, the physical quantity (42) is the exchange charge of an electron obtained on the basis of the experimental value of the electron's electric charge.

On the basis of (8), knowing the exchange charge of an electron (42), we find the fundamental frequency of the wave field of exchange (interaction) at the subatomic level (the frequency of "electrostatic" field)

$$\omega_e = \frac{e}{m_e} = 1.86916197 \times 10^{18} s^{-1} \tag{43}$$

and the fundamental wave radius, corresponding to this frequency,

$$\frac{\lambda_e}{2\pi} = \frac{c}{\omega_e} = 1.603886998 \times 10^{-8} cm \tag{44}$$

in which $\omega_e = 9.1093897 \times 10^{-28} g$ is the mass of the electron.

The fundamental wave diameter $D = \lambda_e/\pi = 0.32\, nm$ correlates with the average value of lattice parameters in crystals, defining an average discreteness of space at the subatomic level of exchange (interaction).

7 Unified approach to electromagnetic and gravitational interactions

Taking into account the relation (23), $Q = \omega\, m$, between the charge of exchange Q and the associated mass m, the law of central exchange (35) can be presented as

$$F = \omega^2 \frac{m_1 m_2}{4\pi\varepsilon_0 r^2} \tag{45}$$

This law lies in the foundation of nature. Its particular case is the law of universal gravitation. Discovered by Newton in 1687, its original form is

$$F = G\frac{m_1 m_2}{r^2} \tag{46}$$

Following the general form of the law of central exchange (interaction), (35) or (45), we should present the law of universal gravitation in its correct form. For this aim, obviously, the formula (46) must contain in the denominator the coefficient 4π, which expresses the spherical isotropic character of exchange, and the absolute unite density ε_0, which expresses the interrelation of matter and space (mass and volume, or contents and form [1]). Introducing these multipliers in numerator and denominator of (46), we arrive at

$$F = \gamma\frac{m_1 m_2}{4\pi\varepsilon_0 r^2} \tag{47}$$

in which $\gamma = 4\pi\varepsilon_0 G$.

Comparing now the central exchange presented in the two forms, (45) and (47), we discover the interrelation between the fundamental frequency of the field of exchange at the gravitational level $\omega_g$with the gravitational constant G

$$\omega_g = \sqrt{4\pi\varepsilon_0 G} \tag{48}$$

The important effects originating from this equality can be found in [6].

The fundamental gravitational frequency, obtained from the equality (48), is

$$\omega_g = \sqrt{4\pi\varepsilon_0 G} = 9.159248527 \times 10^{-4} s^{-1} \tag{49}$$

in which $G = 6.6720 \times 10^{-8} g^{-1} \cdot cm^3 \cdot s^{-2}$.

Knowing ω_g and assuming that the gravitational interaction relates to the subatomic level with the basis speed $c = 2.99792458 \times 10^{10} cm \cdot s^{-1}$, we find the wave gravitational radius of a particle

$$r_g = \frac{c}{\omega_g} = 3.273111949 \times 10^{13} cm \approx 327.3 Mkm \tag{50}$$

This radius determines the wave gravitational sphere with the transient wave zone, which divides the spherical space-field of a particle into the near oscillatory domain (domain of basis) and the far wave domain (domain of superstructure).

If the particles form cosmic objects, for example: the stars, then the domain of the gravitational radius (as the transient zone, separating the basis and the superstructure of the field of a star) must be presented by a series of ring-shells. In the solar system, these are presented by the rings of asteroids of the Sun, adjoined to the shell of the gravitational radius. In this domain, big planets cannot exist because, in the process of formation of the Solar system, this transient domain was the place of the most intense motion.

It should be finally noted that the existence of the gravitational frequency and the gravitational radius of elementary particles show the indissoluble bond of micro- and megaobjects of the Universe in the unit complex of the Infinitely Small and Infinitely Big, as the coexisting polar oppositions Yes and No.

8 Conclusion

Recognition of the wave nature of all phenomena in the Universe has requested the development of a physical (dynamical) model of elementary particles, corresponding to such a wave nature, which has been carried out by the authors. The existence and interactions of the particles are, in essence, a continuous process of the wave exchange of matter-space and motion-rest or, for brevity, exchange of matter-space-time. The wider (and, hence, truer) notion exchange is thus more correct because it reflects behavior of elementary particles in their dynamic equilibrium with the ambient field, at rest and motion, and interactions with other objects (and particles themselves). In other words, the notion exchange is more appropriate from the point of view of the physics of the complex behavior of elementary particles, as the dynamic formations, belonging to one of the interrelated levels of the multilevel Universe. (This notion was introduced first in the work [6]).

As follows from the above described, the notion rest mass of elementary particles is not valid, in principle, for such a model. Accordingly, the rest mass of elementary particles does not exist. The associated nature of mass, as the field mass of the central wave exchange, naturally originates from this model.

The power of mass exchange, i.e., the rate of exchange of mass, defines the exchange charge or simply the charge of elementary particles, which is called in contemporary physics the "electric" charge.

The correctness of the dynamical model is reinforced by the fact that from this model it naturally (and logically) originates:

1) the fundamental law of central exchange (35) (of the Coulomb kind), which unifies the fundamental interactions, distinguished in contemporary physics: electromagnetic, gravitational and nuclear (not considered in this paper);

2) the formula of dynamic energy of mass exchange of the subatomic level $W = mc^2$ (see (37) or (38));

3) the fundamental frequency of exchange (43), i.e., the frequency of the so-called "electrostatic" field, which reveals its essence, in particular, non-stationary nature;

4) the fundamental wave radius $\lambda_e/2\pi$ (see (44)), defining the average atomic

diameters and, hence, the average distances λ_e/π (lattice parameter) in ordered material structures (e.g., crystals);

5) the fundamental gravitational frequency (49) and the wave gravitational radius of elementary particles (50), etc.

The interested readers can find other parameters, which have not been presented above, in the works [1, 3, 6].

One of the important effects of the aforementioned model, which should be also stressed here, is an estimation of the value of nuclear density. Accepting in the first approximation, in equation (18), r_0 to be equal to the Bohr radius and assuming at the field level $\varepsilon_r = 1$, we find the mass of the H-atom

$$m = \frac{4\pi r_0^3 \varepsilon_0 \varepsilon_r}{1 + k_e^2 r_0^2} = 1.679337431 \times 10^{-24} g = 1843.523481 m_e \tag{51}$$

in which $r_0 = 5.291772449 \times 10^{-9} cm$; $k_e = \omega_e/c = 6.2348532 \times 10^7 cm^{-1}$ is the wave number, corresponding to the fundamental frequency of the field of exchange (interaction) at the atomic and subatomic levels, $\omega_0 = 1.869161968 \times 10^{18} s^{-1}$; c is the basis speed of this level (speed of light).

As follows from formula (18), the mass of Rutherford's hypothetical atomic nucleus of the radius $r_{nuc} \approx a_{nuc} A^{1/3}$ (if we regard it as an elementary dynamic spherical structure of the subatomic level of the Universe), in which $a_{nuc} \approx 1.37 \times 10^{-13}$ cm must be equal (at $k_e r_0 \ll 1$) to

$$m_{Anuc} = 4\pi A a_{nuc}^3 \varepsilon_0 = A \cdot 4.356146097 \times 10^{-31} g \tag{52}$$

This nucleus with a comparatively small mass cannot play the role, that is attributed to it in modern atomic physics. Moreover, the "mass density" of any such nuclei is insignificant

$$\rho_{nuc} = \frac{4\pi A a_{nuc}^3 \varepsilon_0}{4\pi A a_{nuc}^3/3} = 3\varepsilon_0 \tag{53}$$

Following (18), the limiting nuclear density,

$$\rho_{\max} = \frac{3A\varepsilon_0}{1 + k_e^2 r_0^2} \tag{54}$$

is achieved in the elements of the periodic table in the case of the complete overlapping of spaces of all H-atoms, forming an atom (see details in [1]) with the mass number A.

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