DIALECTICAL VIEW OF THE WORLD

The Wave Model
(Selected Lectures)

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Vol. 3

Dynamic Model of Elementary Particles

Part 2. Fundamentals

2014

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Contents

Foreword

An analysis of the results obtained in the DM theory, which were considered in the previous Lectures, shows the advantage of the given theory. The latter led us to numerous discoveries. For this reason, we can say that we went on the right way in our understanding the regularities of nature, the structure of matter-space. This way is different in principle from usually accepted in physics.

Continuing consideration of the DM theory, we will turn now in these Lectures to those basic phenomena, which influenced on the creation of quantum electrodynamics (QED) – the key theory of modern physics The noncontradictory and logically irreproachable description of these phenomena in the framework of the DM repeatedly reaffirms rightfulness of our relation toward rejection of modern concepts and theories, including QED, based on the Standard Model (SM).

The Dynamic Model is not a casual invention or a fruit of imagination. This model (theory) naturally originates from a new approach in physics based on dialectics. Dialectical philosophical system with its logic supersedes Aristotelian with its formal logic of limited possibilities dominated all the time in physics.

This is well known that correct statement of a problem is half of the success to get a right solution. Obviously, for this reason, the Dynamic Model has turned out such efficient. Its solutions gave rise the domino effect in physics: a chain reaction occurred when a fundamental change of our view on elementary particles structure caused the discovery of new fundamental parameters, which in turn led to a change of basic notions, which then resulted in another change of the accepted theories, and so on in linear sequence.

It should be repeated and stressed especially that Dynamic Model of Elementary Particles has revealed one of the great mysteries: why the *speed c* (equal to the speed of light), which is in the famous formula, $E = m_0 c^2$, plays the fundamental role for the internal energy E of a *quiescent* particle. An answer is very simply to be found, if we only will rest on the DM.

Namely, the speed c is the innate property of elementary particles, being the basis speed of their wave exchange (interaction) with ambient at the subatomic, atomic and gravitational levels, both in rest and motion. Therewith, m_0 is the associated mass of a particle, quiescent as a whole. Accordingly, E is the energy of wave exchange of matter-space-time of an elementary particle at the levels; or intrinsic dynamic energy of the particle which is regarded as a pulsating microobject of the Universe.

In this Volume, we will analyze a series of the known phenomena (solved by the SM), reconsidering them on the basis of the DM theory, and present the solutions for those physical phenomena, which are inaccessible for solutions in the framework of the modern physics theories. With this, we have in mind primarily the key theories of modern physics, quantum mechanics (QM) and quantum electrodynamics (QED).

Lecture 1

The Hydrogen Atom in View of the DM

1. Introduction

The hydrogen atom represents a simplest binary proton-electron system. According to the *Dynamic Model* (DM), which is the wave theory of micro objects of atomic and subatomic levels [1-5], the hydrogen atom is the wave system of the longitudinal-transversal structure. It is a stable wave formation of the binary spherical-cylindrical wave field. Wave *exchange* continuously is going on between the *longitudinal* (*spherical*) wave field of the proton and *transversal* (*cylindrical*) wave field of the orbiting electron.

It makes sense to recall in this Lecture again that the DM uses the notion of *exchange* instead of *interaction* because of the following significant features. The notion of *exchange* is stipulated by the wave structure and the wave behavior of "elementary" particles. This notion embraces both the dynamic equilibrium of "elementary" particles with the ambient wave field, *at rest and motion*, and their *wave interactions* with other particles and objects. Thus, the notion of *exchange* is a more appropriate notion from the point of view of a specific behavior of elementary particles regarded as the wave formations. Wave exchange takes place at the fundamental frequency inherent in the atomic and subatomic levels of the Universe, which, as has been repeatedly shown earlier, is in the exafrequency wave band and equal to $\omega_e = e/m_e = 1.869161968 \times 10^{18}\ s^{-1}$ [5].

Thus, according to the dynamic model, the *H*-atom represents a conjugate paired dynamic system with the central spherical microobject, proton, having an internal structure (which will not be considered here, now) and the *orbiting* electron. Both proton and electron are in a dynamic equilibrium between themselves and environment through the wave process of the frequency ω_e. The *spherical wave field of the proton* is closely coupled with the *cylindrical wave field of the orbiting electron* and, in a relatively less degree, with the ambient field-space. *Longitudinal oscillations* of the proton's wave shell in the radial direction provide its exchange (interaction) with the electron and environment. In other words, in the hydrogen atom it takes place the mutual overlapping (bonding) of the two

fields: the spherical wave field of the proton and the cylindrical wave field of the orbiting electron, and their merging throughout the hydrogen atom. It is the necessary condition for the existence of the entirely balanced system, which is the hydrogen atom.

The proton-electron system (H-atom) is stable and neutral because inside the *H*-atom and between the *H*-atom as a whole and the ambient field of matter-space-time the persistent dynamic equilibrium exchange takes place. Under ionization, the dynamic equilibrium inside the H-atom and between the *H*-atom and the ambient field-space is broken. In this case, *H*-atom, as H^+-ion (proton), is regarded as a charged particle with the charge equal, in value, to the electron charge, but with the opposite sign. Thus, the value of the charge gives the correct amplitude measure of violation of dynamic equilibrium. An uncompensated exchange of the field of proton, because of the lost of the electron, exhibits itself in ionized *H*-atom (H^+-ion) as exafrequency exchange of the proton directly with the ambient field-space at the fundamental frequency ω_e. That allows ascribing the positive charge to the H^+-ion, equal in value to the electron charge.

The stable states of the *H*-atom form, in the exafrequency wave field, the *spectrum of dynamically stationary states* (defined by characteristic values of arguments of Bessel functions [6, 7]) and generate the *background spectrum of zero level radiation* responding, as it turned out, to the black-body radiation of approximately 2.73 *K* temperature [8, 9].

We will show below the derivation of the both aforementioned spectra as simple and clear as possible. For this aim, we will lay stress mainly on the wave motion of the electron along the orbit taking into account that one half-wave of the fundamental tone of the electron is placed on the Bohr first orbit (it follows from the strict solution of the wave equation, which is described by the Bessel wave function of the order $\frac{1}{2}$ [3, 6]). But at first let us to present essential energy relations originated from the theory of the dynamical model of the *H*-atom, which are necessary for further consideration.

Thus, the hydrogen atom is a simplest paired centrally symmetric proton-electron system. According to the DM, the hydrogen atom is also a pure wave dynamic formation. It means that a proton, just like an electron or any elementary particle, is in a state of continuous dynamic exchange (equilibrium) with environment through the wave process of the definite unchanged fundamental frequency ω (recalling a micropulsar).

From the above definition it follows that elementary particles of the Dynamic Model, being unceasingly pulsating microobjects, can be regarded as unexhausted sources of the so-called zero point energy (the energy of “quantum vacuum”, in the language of modern physics).

Longitudinal oscillations of the *spherical* wave shell of the proton provide an interaction in radial direction (more correctly, *exchange* of matter-space and motion-rest) with the surrounding field-space and with the orbiting electron. The orbital motion of the electron is

associated with the transversal *cylindrical* wave field. Therefore, the common three-dimensional wave equation,

$$\Delta\hat{\Psi} - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}}{\partial t^2} = 0\,, \tag{1}$$

is valid for both cases. Both dynamic constituents of the proton-electron system have to be described, respectively, by *spherical* and *cylindrical* wave functions.

We will show now the derivation of the energy spectrum of the *H*-atom, being in equilibrium with the wave field-space of the Universe, resting on the wave equation (1) and on fundamental notions of the DM. The derivation of the background radiation-absorption spectrum of the *H*-atom will be considered in the next Lecture.

2. Derivation of energy states

Spherical and *cylindrical* wave functions satisfying the wave equation (1) have, respectively, the following form:

$$\hat{\Psi} = \hat{R}_l(kr)\Theta_{l.m}(\theta)\hat{\Phi}_m(\varphi)\hat{T}(\omega t)\,, \tag{2}$$

and

$$\hat{\Psi} = \hat{R}_m(k_r r)\hat{Z}(k_z z)\hat{\Phi}_m(\varphi)\hat{T}(\omega t)\,. \tag{3}$$

The *longitudinal* and *transversal* components of the spherical-cylindrical field are described over *spherical* (spatial coordinates r, θ, φ) and *cylindrical* (spatial coordinates r, z, φ) realizations of the wave equation (1), which comes in both cases to one time equation and three spatial equations.

According to the solutions of (1), electron transitions in atoms depend on the structure of feasible atomic radial shells, *i. e.*, on radial solutions (functions) of the equation. Radial components, $\hat{R}_l(kr)$ and $\hat{R}_m(k_r r)$, of spherical and cylindrical functions (2) and (3), respectively, are uniquely determined by the general structure of the following radial equations:

$$\rho^2\frac{d^2\hat{R}_l}{d\rho^2} + 2\rho\frac{d\hat{R}_l}{d\rho} + (\rho^2 - l(l+1)\hat{R}_l = 0\,, \tag{4}$$

and

$$\frac{d^2\hat{R}}{d(k_r r)^2} + \frac{1}{k_r r}\frac{d\hat{R}}{d(k_r r)} + \left(1 - \frac{m^2}{(k_r r)}\right)\hat{R} = 0\,, \tag{5}$$

where $\rho = kr$.

In the *central spherical wave field* of the hydrogen atom, amplitude of radial oscillations of the spherical shell of the proton, originated from solutions of (4) [3], has the form,

$$A_{sph} = \frac{A\hat{e}_l(kr)}{kr}, \tag{6}$$

where

$$\hat{e}_l(kr) = \sqrt{\frac{\pi kr}{2}}(J_{l+\frac{1}{2}}(kr) \pm iY_{l+\frac{1}{2}}(kr)), \tag{7}$$

$$k = \omega / c. \tag{8}$$

Here $J(kr)$ and $Y(kr)$ are Bessel functions; ω is the oscillation frequency of pulsating spherical shell of the proton equal to the fundamental "carrier" frequency of the subatomic and atomic levels [5].

Zeros and extrema of the Bessel cylindrical functions, $J_{l+\frac{1}{2}}(kr)$ and $N_{l+\frac{1}{2}}(kr)$ (or $Y_{l+\frac{1}{2}}(kr)$), are designated, correspondingly, as $j_{(l+\frac{1}{2}),s}$, $y_{(l+\frac{1}{2}),s}$, $j'_{(l+\frac{1}{2}),s}$, and $y'_{(l+\frac{1}{2}),s}$. Analogously, zeros and extrema of the Bessel spherical functions are designated as $a_{l,s} = j_{(l+\frac{1}{2}),s}$, $b_{l,s} = y_{(l+\frac{1}{2}),s}$, $a'_{l,s}$, and $b'_{l,s}$ [6]. All the details concerning the solution of the wave equation (1) can be found, in particular, in [3, 10, 11].

The amplitude energy of the pulsating shell takes the following form

$$E_{sph} = \frac{m_0\omega^2 A_{sph}^2}{2} = \frac{m_0\omega^2}{2}\left(\frac{A}{kr}\right)^2 |\hat{e}_l(kr)|^2 = \frac{m_0 c^2 A^2}{2r^2}|\hat{e}_l(kr)|^2, \tag{9}$$

where m_0 is the proton mass, A is the constant equal to the oscillation amplitude at the sphere of the wave radius ($kr = 1$). Let $kr_0 = z_{l,1}$ and $kr_s = z_{l,s}$, where $z_{l,s}$ and $z_{l,1}$ are zeros of Bessel functions $J_{l+\frac{1}{2}}(kr)$, then the following relation between radial shells is valid:

$$r_s = r_0\left(\frac{z_{l,s}}{z_{l,1}}\right). \tag{10}$$

The subscript l indicates the order of Bessel functions and s, the number of the root. The last defines the number of the radial shell. Zeros of Bessel functions define the radial shells with zero values of radial displacements (oscillations), *i.e.*, the shells of stationary states.

In the *cylindrical wave field*, the energy E_{cyl}, as the sum of energies of two mutually perpendicular potential-kinetic oscillations of the orbiting electron, is equal (in the simplest case) to

$$E_{cyl} = m_e\upsilon^2 = m_e\omega^2 A_{cyl}^2 = m_e\omega^2\left(\frac{a}{\sqrt{kr}}\right)^2 = 2\pi m_e \upsilon A_{cyl}\nu, \tag{11}$$

where m_e is the mass of the electron; r is the radius of its orbit; ν is the frequency of its oscillations with the amplitude

$$A_{cyl} = \frac{a}{\sqrt{kr}}; \tag{12}$$

and $\upsilon = \omega A_{cyl}$ is the amplitude velocity of the oscillations.

Because $k = \frac{\omega}{c}$, Eq. (11) reduces to

$$E_{cyl} = h\nu, \tag{13}$$

where $h = \frac{2\pi m_e c a^2}{r} = 2\pi m_e \upsilon A_{cyl}$ is an elementary action.

If $r = r_0$ (the Bohr radius) and $kr = \frac{\omega}{c} r_0 = \frac{\upsilon_0}{c}$, where $\omega r_0 = \upsilon_0$ is the Bohr velocity, then amplitude of oscillations A_{cyl} is equal to the Bohr radius: $A_{cyl} = \frac{a}{\sqrt{kr}} = r_0$.

Thus, the oscillation amplitude a at the Bohr orbit r_0, has the value

$$a = r_0 \sqrt{\frac{\upsilon_0}{c}} = \sqrt{\frac{h r_0}{2\pi m_e c}} = 4.52050647 \times 10^{-10}\, cm, \tag{14}$$

where $h = 2\pi m_e \upsilon_0 r_0 = 6.6260693(11) \times 10^{-27}\, erg \times s$ is the Planck constant,

$r_0 = 0.5291772108(18) \times 10^{-8}\ cm$, $m_e = 9.10938291 \times 10^{-28}\ g$ and

$c = 2.99792458 \times 10^{10}\, cm \times s^{-1}$.

Since the steady equilibrium exchange (interaction) between spherical and cylindrical fields in the hydrogen atom takes place invariably, the equality

$$E_{cyl} = \Delta E_{sph} \tag{15}$$

is always valid. Hence, with allowance for (9), (10) and (13), the following equation is valid

$$h\frac{c}{\lambda} = \frac{m_0 c^2 A^2}{2r_0^2}\left(\frac{\left|\hat{e}_p(kr_m)\right|^2 z_{p,1}^2}{z_{p,m}^2} - \frac{\left|\hat{e}_q(kr_n)\right|^2 z_{q,1}^2}{z_{q,n}^2}\right) \tag{16}$$

or

$$\frac{1}{\lambda} = \frac{m_0 c A^2}{h 2 r_0^2}\left(\frac{\left|\hat{e}_p(kr_m)\right|^2 z_{p,1}^2}{z_{p,m}^2} - \frac{\left|\hat{e}_q(kr_n)\right|^2 z_{q,1}^2}{z_{q,n}^2}\right) \tag{16a}$$

Thus, we have arrived at the spectral formula of the hydrogen atom presented in an comprehensive expanded form unknown yet, unfortunately, for majority of physicists (although it was published for the first time in 1996 [1, Vol.2]), *i.e.*, in the form where instead of quantum numbers *m* and *n* are roots of Bessel functions – right radial solutions. Therefore, we should regard the resulting form of the solution, expressed by the roots $z_{k,l}$, as a truly correct mathematical presentation of the spectral formula. In essence, Eq. (16) is the *generalized spectral formula*, it embraces all the elementary optical atomic spectra [3].

For example, at $p=q=0$, zeros of Bessel functions $J_{0+\frac{1}{2}}(z_{0,s})$ are equal to $z_{0,s}=s\pi$ [6] and

$$\left|\hat{e}_0(kr_s)\right|^2=1. \tag{17}$$

Under this condition, Eq. (16) is transformed into a well-known elementary spectral formula for the hydrogen atom:

$$\frac{1}{\lambda}=R\left(\frac{1}{m^2}-\frac{1}{n^2}\right), \tag{18}$$

where *m* and *n* are integers, and

$$R=\frac{m_0cA^2}{2hr_0^2} \tag{19}$$

is the Rydberg constant. A graph of the electron transitions in *H*-atom is presented in Fig. 1.

Taking into account in (19) that $R=\dfrac{R_\infty}{(1+m_e/m_0)}=109677.5833\,cm^{-1}$, we find the value of the oscillation amplitude *A* at the sphere of the wave radius ($r=\lambda\!\!\!^{-}$, in this case $kr=1$):

$$A=r_0\sqrt{\frac{2hR}{m_0c}}=9.00935784\cdot10^{-13}\ cm. \tag{20}$$

Assuming in the formula (6) that *kr* is equal to the first extremum of the spherical function of the zero order, unequal to zero,

$$kr=a'_{0,2}=4.49340946, \tag{21}$$

the first *maximal amplitude of radial oscillations* gets the value

$$\langle A_s\rangle=\left(\frac{1}{\sqrt{2}}\right)\frac{A}{kr}=1.41776041\cdot10^{-13}\ cm. \tag{22}$$

The center of mass of the proton, performing such oscillations, forms a *dynamic spherical volume with the radius equal to the amplitude of the oscillations (22) and this volume can be regarded as a nucleus of the proton.*

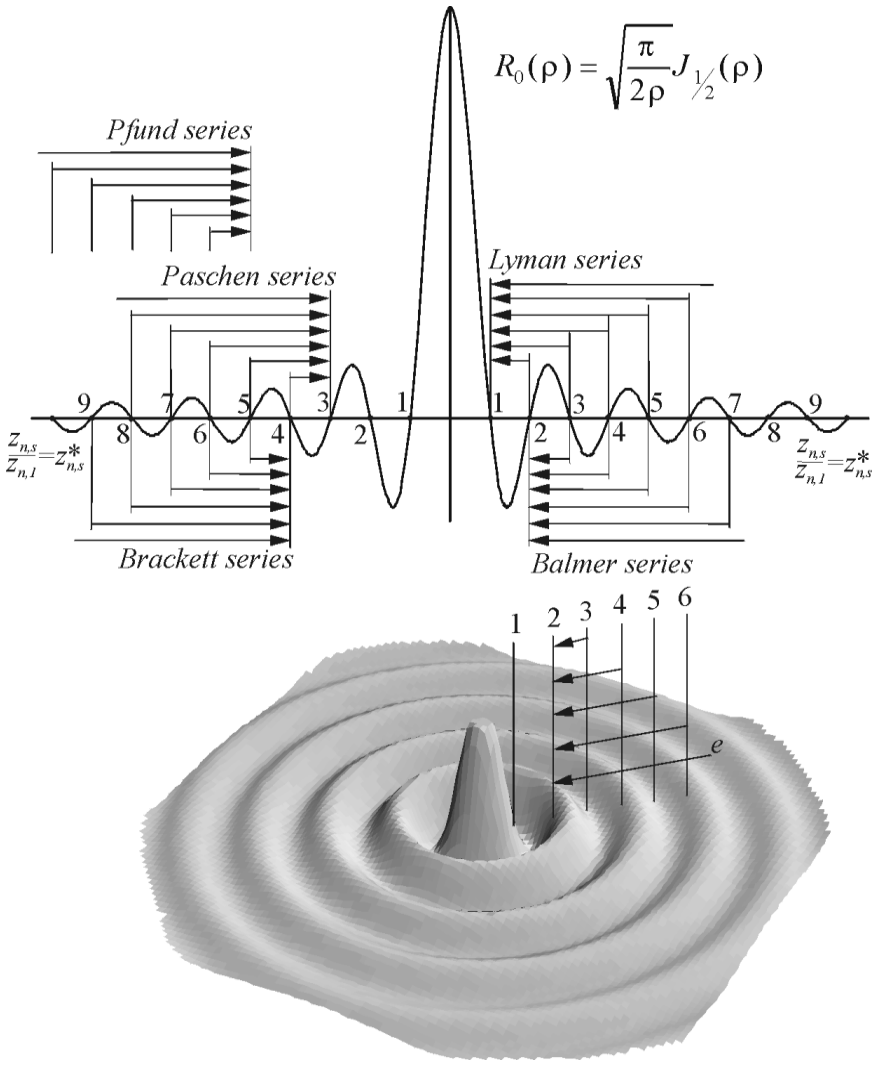

Fig. 1. A two-dimensional graph of electron transitions in *H*-atom corresponding to the particular solutions (18).

3. An analysis of the solution

The zeros of Bessel functions define the wave shells with zero values of the solutions of the wave equation (1), *i.e.*, the shells with zero radial displacements at the level of the subatomic field of matter-space-time.

In dialectics, the extremes (maxima and minima) and zeros of the physical probability, described by the wave equation (1), are significant in an equal degree. Zero values of the wave spherical field of probability define the radial shells of zero probability, on which the radial displacements (radial oscillations) are absent. Naturally, they are the shells of stationary states. Thus, zero probability reflects solely the absence of radial displacements.

On the contrary, shells of extreme values of the wave field of probability define domains of more intensive radial displacements and, accordingly, these shells describe nonstationary (unstable) states.

Thus, the sense of the extremes and zeros of the wave field of probability in dialectics is determined by the concrete nature of a phenomenon or an object in question. To the point, the quantum mechanics formalism, accentuating attention just to maxima of the wave function squared, is unable to describe qualitative peculiarities of probabilistic processes [12-14]. About the latter we will speak in the following Lectures of Vol. 4.

If we will assume that the Rydberg constant (19) is the constant also for the domain of the wave shell of the fundamental radius $\lambda\!\!\!^{-}_e$, then the constant (20) in this domain will have the following value,

$$A_m = \lambda\!\!\!^{-}_e \sqrt{\frac{2Rh}{m_0 c}} = 2.731396376 \cdot 10^{-12}\ cm\,. \tag{23}$$

This quantity is at the level of the fundamental quantum of measures $\Delta = 2\pi \lg e$ [15] (see Vol.1, L.7), and it is the *characteristic amplitude of oscillations* on the wave sphere ($z_{n,s} = kr = 1$).

In the cylindrical field, amplitude of the rate of oscillations is defined by the expression

$$\upsilon = \frac{\omega a}{\sqrt{kr}}\,. \tag{24}$$

Along with exchange of energy between the proton (basis) and the electron (superstructure) in the hydrogen atom, providing the stable state of such a binary proton-electron system, it takes place also exchange of the system as a whole (the hydrogen atom) with the surrounding field of space of matter. For this reason, the equation of exchange should be presented as

$$E_f = \Delta E_s + \delta E\,, \tag{25}$$

where δE takes into account exchange of the proton-electron system (hydrogen atom) with environment.

Thus, the equation of exchange takes the form

$$h\nu = R\left(\frac{e_p^2(kr_m)z_{p,1}^2}{z_{p,m}^2} - \frac{e_q^2(kr_n)z_{q,1}^2}{z_{q,n}^2}\right) + \delta E\,. \tag{26}$$

Energetic transitions in the hydrogen atom occur during an extremely short time. Therefore, the term δE is a very small one, and it was not taken into account at the derivation

of spectral formula (16a). The contribution of the δE energy is reflected in the fine structure of spectral lines of radiation and absorption (we will consider this issue in the next Lecture).

The transitional process runs almost instantly and, therefore, it is perceived as a discrete jump (change) of energy. Undoubtedly, an electron-proton system passes through all intermediate energetic states, but the experiment detects only the already terminal states of rest-motion.

The radiation under transition from a higher-lying (exited) energy state into a lower-lying energy state is accompanied with an appearance of the wave of exchange; its frequency is determined by the equation of exchange (26). This wave relates to the subatomic level of rest-motion of matter-space-time. It embraces a vast world of particles laying beyond the experimental possibilities of modern physics for their detecting. An integral value of the energy related with such a wave is equal, according to (26), to $h\nu$.

Through the theory of black-body radiation, M. Planck put forward a quite correct hypothesis that the radiation and absorption occur by the quantity of energy $h\nu$, which were called energy quanta. Recall that $h = 2\pi m_e \upsilon_0 r_0$ is the orbital moment of momentum of the electron in the hydrogen atom moving along the orbit of the Bohr radius r_0 with the Bohr speed υ_0.

Einstein, formally approaching this problem and not troubling himself with a serious analysis, supposed a very simplified mechanical model of radiation (absorption). According to his model, in the transitions of atoms from one state into another, a quantum of light, called a *photon*, is radiated. By Einstein, the photon moves into an *empty space* with the speed c and has wave properties.

Thus, a wave of radiation (absorption) was presented in the form of mystic quanta of energy. The quantum (photon), in accordance with Einstein's model of radiation, exists only in motion with the speed c and has, therefore, the zero rest mass, $m_0 = 0$. Moreover, it appears instantly, regardless of all the laws of nature, *i.e.*, photon is formed with the infinite speed.

This is the total negation of transient processes, without which an appearance and the formation of new states of objects of matter-space-time is impossible. The transient process is the inalienable attribute of any change of any state in Nature and it cannot happen with infinite speed and with an infinite gradient. For this and other reasons, Einstein's hypothesis on the light quanta (photons) has no scientific justification.

Some properties of an electron on the first Bohr orbit of *H*-atom were ascribed to the mystic *photon*. In particular, it concerns the *moment of momentum* (the *radial action* or so-called *Planck's action*) equal to $\hbar = m_e \upsilon_0 r_0$, where υ_0 and r_0 are the parameters of the first Bohr orbit having no right relation to the wave of exchange.

As was shown earlier, the *rest mass* of any particle of the microworld *does not exist*. The so-called in modern physics "rest" mass is, actually, associated (dynamic) and is the parameter, characterizing the wave exchange of matter-space-time with the surroundings wave field-space (see Vol. 2, L.2). If the associated ("rest") mass is equal to zero, as it is ascribed to photon, it means that photon is an imaginary (mystic) object because it does not exist in reality. All it should be understood that it is nonsense to speak about energy of massless objects.

Looking ahead, we should say that according to the shell-nodal (molecule-like) atomic model all atoms are spherical molecule-like formations of *H*-atoms to which we refer proton, neutron, and hydrogen atom. With that, coupled *H*-atoms being the constituents of complicated atoms, and located in the nucleon nodes of the atoms (by two H-atoms per node), *keep their relative individuality*. It means that the formula (26) for the hydrogen atom is also valid for any atom (element) of the Mendeleev's Periodic Table and energy states of atoms are described by a whole spectrum of the roots of Bessel functions that is confirmed by approximate calculations, at $\delta E = 0$, carried out by the authors of [3] and presented there.

By virtue of a definite correlation and, hence, impact of *H*-atoms, located in neighboring nodes of the same atom, on each other, quantitative parameters of atomic spectra of different atoms do not coincide with the spectrum of the individual (isolated) hydrogen atom, they are some different. But qualitatively all the spectra of different atoms are similar [3] because hydrogen atoms, constituents of the atoms, located in the atomic nucleon nodes are responsible for emission and absorption of energy by all atoms.

Thus, as follows from solutions of the wave equation (1), quantum numbers of optical terms of (26) are actually roots of the Bessel functions (the latter were long ago calculated and published by British Royal Society [6]). These roots, being the direct radial solutions, give a right structure of the spectral formula filled in such a case of a more comprehensive content.

4. Other specific features of the proton-electron system

Let us look at the system from the following side. It is not so difficult to imagine that *H*-atom is a system of "parallel" connection of two particles: a proton and its satellite, an electron (Fig. 2). What follows from this?

The system of *H*-atom is characterized by absolute parameters of the dispositions, r_c and r_{orb}, and speeds, υ_p and υ_{orb}, and by the relative parameters, r_0 and υ_0 (Fig. 2a). Because $M_p r_c = m_e r_{orb}$, the absolute momenta of the *H*-atom (or the proton) and the electron will be related as

$$M_p \upsilon_p = m_e \upsilon_{orb} . \qquad (27)$$

The relative speed of their motion is defined by the Bohr speed

$$\upsilon_0 = \upsilon_{orb} + \upsilon_p . \tag{28}$$

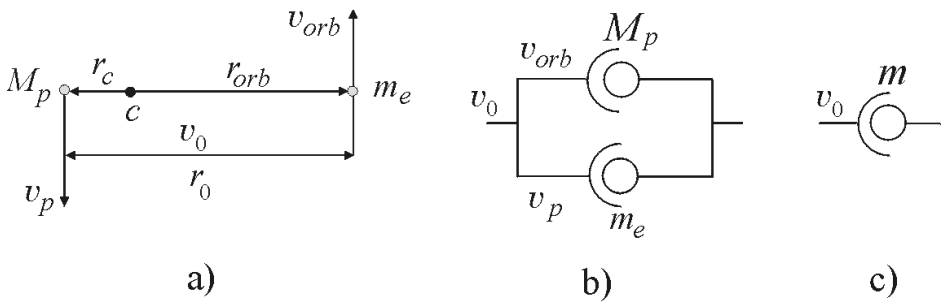

Fig. 2. The *H*-atom system.

On the basis of the above relationships, the speed of electron motion relatively to the center of masses can be presented as

$$\upsilon_0 = \upsilon_{orb} + \frac{m_e}{M_p}\upsilon_{orb} = \upsilon_{orb}\frac{M_p + m_e}{M_p} . \tag{29}$$

Accordingly, the absolute momenta will be equal to the relative momentum of the system with the relative mass m and relative speed υ_0:

$$M_p\upsilon_p = m_e\upsilon_{orb} = \frac{M_p m_e}{M_p + m_e}\upsilon_0 = m\upsilon_0 , \tag{30}$$

where

$$m = \frac{M_p m_e}{M_p + m_e} \tag{31}$$

is the relative mass of *H*-atom. Such a value of the relative mass is stipulated for the parallel connection of masses M_p and m_e, their absolute rotary motion is conditionally shown in Fig. 2b in the form of circles with arcs. Under such a parallel connection, the law of addition of inverse masses (analogous to the law of addition of resistors in electric circuits) is valid:

$$\frac{1}{m} = \frac{1}{M_p} + \frac{1}{m_e} . \tag{32}$$

As follows from the equation (31), the relative (reduced or resulting) mass of *H*-atom is presented in the following form

$$m = \frac{m_e}{1 + m_e / M_p} . \tag{33}$$

The resulting mass defines the Rydberg constant of *H*-atom:

$$R_H = \frac{R}{1 + m_e / M_p} = 109677.5831\ cm^{-1}. \tag{34}$$

For completeness of the picture, it makes sense at the end of this Lecture to remind the data presented earlier in Lecture 2 of Vol. 2 concerning the geometrical relations between wave shells of an electron and a proton in the hydrogen atom regarded as a paired proton-electron system.

The hydrogen atom is a coupled system of a proton and an electron-satellite of the mass m_p and m_e, respectively. The displacement of the proton relative to the center of mass of the system (see Fig. 2) is

$$r_c = \frac{m_e}{m_p} r_{0rb}, \tag{35}$$

where r_{0rb} is the radius of the electron orbit relative to the center of mass of the system being in the stationary state.

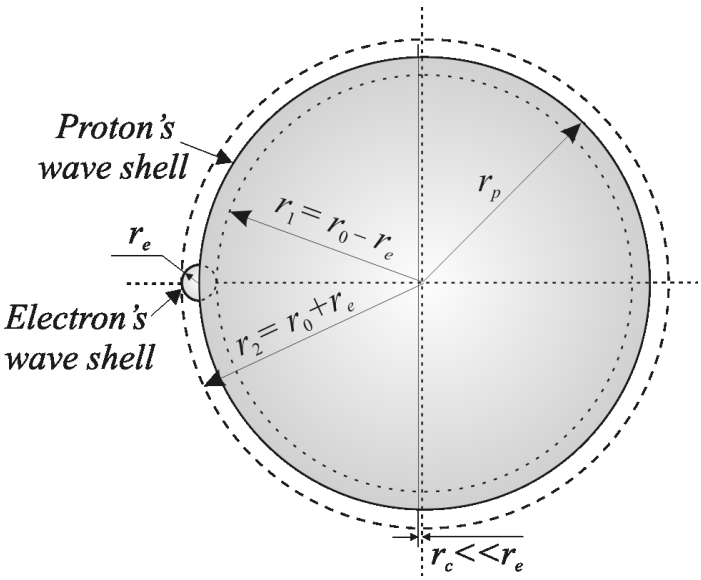

Fig. 3. Geometrical relations in a coupled dynamic system – *the electron-proton*.

The distance between the centers of the masses of the proton and electron (the Bohr radius) is

$$r_0 = r_c + r_{0rb} = r_{0rb}(1 + \frac{m_e}{m_p}) = 5.2917721092 \times 10^{-9} cm. \tag{36}$$

The radius of the electron wave sphere, the electron radius (see (22), L. 2), has the value of $r_e = 0.417052597 \times 10^{-9} cm$. Therefore, diametrically opposite points of the electron sphere are disposed from the center of the mass of the proton at the distances (Fig. 3),

$$r_1 = r_0 - r_e = 4.87471912 \times 10^{-9} cm \tag{37}$$

and

$$r_2 = r_0 + r_e = 5.708824706 \times 10^{-9} cm\,, \tag{38}$$

The radius of the proton shell ((27) in L.2,),

$$r_p = 5.28421703 \times 10^{-9} cm\,,$$

is approximately equal to the Bohr radius r_0 (36), $r_p \approx r_0$. This means that the electron wave sphere is immersed approximately by half ($\Delta r_1 = 0.40972305 \times 10^{-9}\ cm$) in the proton wave sphere (atmosphere) and moving in it with the speed $\upsilon_0 = \alpha c$, and the other half ($\Delta r_2 = 0.424607676 \times 10^{-9}\ cm$) of the electron sphere is raised over the proton atmosphere. In this sense, the paired proton and electron can compare with the planet Jupiter and its Great Red Spot – a vortex (which is larger than the Earth) moving in Jupiter's atmosphere and partly rising over it. This vortex is stable and may be is a permanent feature of the planet.

5. Conclusion

The *H*-atom represents a paired dynamic system of quasi-spherical structure with the orbiting electron-satellite. The spherical component (ionized *H*-atom, proton) relates to the *spherical wave field* of exchange (interaction). The electron-satellite (its motion) relates to the *cylindrical wave field* of exchange. The spherical field is a field of contents (the basis of *H*-atom) and the cylindrical field is a field of the form (the superstructure of *H*-atom). Accordingly, the general wave equation (1) in spherical and cylindrical coordinates must be valid for the description of the hydrogen atom [3]. Solutions of the equation, including in particular presented in this Lecture, have proven this supposition. Recall that the latter, along with the dialectical logic, was accepted by the authors of [3] as a main postulate of the Wave Model.

Taking into account the *orbital* (circular) motion of the *electron-wave*, where the *electron-particle* is regarded as *the node of the wave orbit*, the *generalized formula of optical spectra* of the hydrogen atom was obtained in result of the solution of (1). It was realized for the first time in physics. Note also that this result originates uniquely and unambiguously only from the Wave Model.

As we already know, in view of the DM, both constituents of the hydrogen atom are the vortical formations in matter-space from the mater-space itself. A trajectory of the electron-vortex, orbiting around of the proton-vortex with the speed υ_0 (the first Bohr speed), circumscribes a vortical torus immersed by half (see Fig. 3) in the wave atmosphere (shell) of the proton-vortex, closely encompassing the proton around.

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Lecture 2

Dynamic Peculiarities of the H-atom System

1. Introduction

In the framework of the DM, the wave approach allows derivation of an elementary optical spectrum (see (18), L.1) by the different ways. We will show this with an example of the simplest variant of the derivation which is different from that one already considered. But before embarking on this, we intend to give in this Lecture yet more information characterizing the hydrogen atom as the dynamic wave system. Accordingly, we supplement the data already presented in L. 1 with other data, which are also the effect of the wave structure and behavior of elementary particles joined in the dynamic proton-electron system. In particular, we intend to show the specific fundamental relations existed between characteristic parameters of spherical and cylindrical components in the proton-electron system. These parameters are amplitudes of the velocities, the wave action, potential and kinetic energies at circular motion-rest of the electron, and probabilities of energy states in the system.

2. Fundamental relations in the proton-electron system

The hydrogen atom is a classical example of the system of the binary spherical-cylindrical field. In the *spherical* subfield, possible amplitudes of the velocities of microobjects are defined by the formula,

$$\upsilon = \frac{\upsilon_s}{kr}, \qquad (1)$$

where υ_s is the amplitude of velocity of the spherical field, corresponding to the condition $kr = 1$; $k = \frac{2\pi}{\lambda} = \frac{1}{\lambda\!\!\!^{-}}$ is the wave number corresponding to the fundamental frequency ω_e [1, 2] of the field of exchange – the *constant* quantity.

The expression (1) is the *effect of constancy of the energy flow in the elementary spherical field*, which is described by the cylindrical functions of the order ½ . However, it is approximately valid also for spherical fields, which are described by the spherical functions of higher orders, under the condition $kr >> 1$ [3].

If r_0 is the radius of the first stationary shell and υ_0 is the velocity on the shell, then, at the constant *k*, we have the following relations for the radii and velocities of the stationary shells:

$$r = r_0 n \ , \qquad \upsilon = \frac{\upsilon_0}{n} . \tag{2}$$

In an elementary spherical field, *n* is an integer. It is inherent in the homogeneous spherical field. The distance between shells, in such a field, is constant and equal to r_0. As a result, we arrive at the important conclusion that *in the spherical field the elementary action is the constant*:

$$\hbar = m_e \upsilon r = m_e \frac{\upsilon_0}{n} r_0 n = m_e \upsilon_0 r_0 = const . \tag{3}$$

In the homogeneous *cylindrical* subfield of the *H*-atom, the velocity is defined by the formula

$$\upsilon = \frac{\upsilon_c}{\sqrt{kr}} . \tag{4}$$

Because *k* is the constant, we obtain the following relations for the stationary shells:

$$r = r_0 n , \qquad \upsilon = \frac{\upsilon_0}{\sqrt{n}} . \tag{5}$$

The formulas (4) and (5) are approximately valid for the heterogeneous cylindrical fields under the condition $kr >> 1$.

According to the theory of circular motion [3, 4], the energetic measures of rest and motion are presented by the opposite, in sign, kinetic and potential energies equal in value. Because any insignificant part of an arbitrary trajectory is equivalent to a small part of a circumference, any wave motion of an arbitrary microparticle (and, in an equal degree, a micro and megaobject) is characterized by the kinetic and potential energies also equal in value and opposite in sign:

$$E_k = \frac{m\upsilon_k^2}{2} , \qquad E_p = \frac{m(i\upsilon)_p^2}{2} = -\frac{m\upsilon_p^2}{2} . \tag{6}$$

Because an insignificant part of an arbitrary trajectory is equivalent to a small part of a straight line, *any wave motion* of an arbitrary microparticle (and, in an equal degree, a macro-

and megaobject) *is characterized by the kinetic and potential energies* also equal in value and opposite in sign. Therefore, the total potential-kinetic energy of any object in the Universe is equal to zero:

$$E = E_k + E_p = 0, \tag{7}$$

and its amplitude value is equal to the difference of kinetic and potential energies:

$$E_m = E_k - E_p = m\upsilon^2. \tag{8}$$

Thus, because the circular motion is the sum of two mutually perpendicular potential-kinetic waves, the amplitude energy of an orbiting electron is

$$E = m\upsilon_m^2 = m\omega^2 A_m^2 = \frac{m\omega^2 A^2}{kr} = \frac{m\omega^2 A^2}{(\omega/\upsilon)r} = \frac{mA^2\upsilon}{r}\omega = \hbar_e\omega. \tag{9}$$

where A is amplitude of the *traveling wave*. Let us rewrite (9) as

$$E = \hbar_e\omega = h_e\nu = \frac{h_e\upsilon}{\lambda_e}, \tag{10}$$

where λ_e is the electron wave of the *H*-atom space,

$$\hbar_e = \frac{mA^2\upsilon}{r} \qquad \text{and} \qquad h_e = \frac{2\pi mA^2\upsilon}{r} \tag{11}$$

are the *radial* and *azimuth electron actions*, respectively.

In the space of the stationary field of *standing waves*, we have the similar relations:

$$\hbar_e = \frac{ma^2\upsilon}{r} \qquad \text{and} \qquad h_e = \frac{2\pi ma^2\upsilon}{r}, \tag{12}$$

where $a = 2A$ is amplitude of the standing wave.

On the other hand, the electron is in a *spherical field* of the *H*-atom, where its action $m_e\upsilon r = \hbar$ is the *constant* value. Hence, at $r = r_0$, we have $a = r_0, \upsilon = \upsilon_0$ and

$$\hbar_e = m_e\upsilon_0 r_0. \tag{13}$$

Under the perturbations, the wave atomic space of the wave frequency $\omega = \frac{\upsilon_0}{\lambda\!\!\!^{-}_e}$ induces outside the atomic space the external waves of the same frequency, but with the speed c and wavelength λ, so that

$$\omega = \frac{\upsilon_0}{\lambda\!\!\!^{-}_e} = \frac{c}{\lambda\!\!\!^{-}} . \tag{14}$$

Therefore, the electron energy can be presented also as

$$E = \hbar_e \omega = h_e \nu = \frac{h_e c}{\lambda} = \frac{(1/2) h_\lambda c}{\lambda} , \tag{15}$$

where $h_e = 2\pi m_e \upsilon_0 r_0$ is the action of the electron (an *elementary wave action*), $h_\lambda = 4\pi m_e \upsilon_0 r_0$ is the *wave action of the wave of the fundamental tone*. With that, the electron's wave energy is equal its kinetic energy on the orbit:

$$E = \hbar_e \omega = m_e \upsilon_0 r_0 \omega = m_e \upsilon r \omega = \frac{m_e \upsilon r \omega_{orb}}{2} = \frac{m_e \upsilon^2}{2} , \tag{16}$$

where $\omega = \frac{1}{2}\omega_{orb}$ is the circular wave frequency of the fundamental tone and ω_{orb} is the circular frequency of electron's revolution along the orbit, for which $\upsilon = r\omega_{orb}$; the relation $\upsilon_0 r_0 = \upsilon r$ is the effect of the constancy of the energy flow in the elementary spherical field or the constancy of the elementary wave action $m\upsilon r = \hbar$.

Thus, the energy of overtones ωn (see (4) and (9)) is

$$\varepsilon = m_e \upsilon^2 = m_e \upsilon_0 \omega a_0 n = \hbar \omega n = h \nu n . \tag{17}$$

In such a case, for the Bohr orbit, the following ratio (for the total energy) is valid:

$$\frac{\upsilon^2}{\upsilon_\sigma^2} = \frac{h\nu n}{\varepsilon_\sigma} = \frac{h\nu n}{kT} , \tag{18}$$

where υ_σ is the most probable speed, ε_σ is the most probable quantum of energy, $h = 2\pi m_e \upsilon_0 r_0$ is the Planck azimuth wave action, and $T = \frac{\varepsilon_\sigma}{k}$ is the most probable relative energy (the "absolute" temperature).

The probability of energy states *w* are described by the approximate Gauss' formula

$$w = C \exp(-\frac{\upsilon^2}{\upsilon_\sigma^2}) = C \exp(-\frac{h\nu n}{\varepsilon_\sigma}) = C \exp(-\frac{h\nu n}{kT}) , \tag{19}$$

Hence, according to Eq. (18), the mean value of excitation energy (of a shell of the *H*-atom) is

$$\langle \varepsilon_\nu \rangle = \frac{\sum h\nu n \Delta w_n}{\sum \Delta w_n} = h\nu \frac{\sum_{n=0}^{\infty} n \exp(-nh\nu / kT)}{\sum_{n=0}^{\infty} \exp(-nh\nu / kT)} = \frac{h\nu}{\exp(h\nu / kT) - 1}. \tag{20}$$

3. Elementary optical spectrum; Rydberg constant

An elementary optical spectrum (see (18), L.1), following from the generalized (universal) spectral formula ((16a), L. 1) as its particular case, can be obtained in the framework of the wave approach by other ways. This justifies in favor of the validity of the wave concepts applied to elementary particles and atoms, *i.e.*, in favor of the DM.

Let us assume that the electron orbit is in the plane $z = 0$. Because the *electron is the node of the wave orbit*, hence, the boundary orbital conditions at the instant $t = 0$ must express the equality to zero of potential azimuth displacements in the node during one revolution [3]:

$$\mathrm{Re}\, e^{-i(\frac{1}{2}\varphi + \varphi_0)}\Big|_{\varphi=0} = \mathrm{Re}\, e^{-i(\frac{1}{2}\varphi + \varphi_0)}\Big|_{\varphi=2\pi} = 0. \tag{21}$$

These conditions are realized for the traveling electron wave in the positive direction if, *e.g.*, $\varphi_0 = \pi / 2$. In such a case, Ψ-function of the electron takes the form

$$\Psi_{\frac{1}{2}}^{+} = Ai \frac{e^{i(\omega t - kr)}}{\sqrt{kr}} e^{-i(\frac{1}{2}\varphi + \frac{\pi}{2})} e^{-ik_z z} \tag{22}$$

The function (22) describes the *wave of the fundamental tone of the electron* λ_e. Its length is equal to the doubled length of the electron orbit of the Bohr radius r_0 [3]:

$$\lambda_e = 4\pi r_0. \tag{23}$$

The wave motion of the fundamental tone occurs *in the nearest layers of the wave atmosphere* of the *H*-atom, almost at its surface. The *equilibrium wave interchange of energy* takes place between the *H*-atom and the surrounding field of matter-space-time. However, under the perturbations, the electron wave (23) *can replicate itself in the cosmic wave* of the same frequency (see (17), L. 8, V. 2):

$$\lambda = \frac{c}{\upsilon_0} 4\pi r_0. \tag{24}$$

The inverse quantity of this wave is the Rydberg constant:

$$R = \frac{1}{\lambda} = \frac{\upsilon_0}{4\pi r_0}\frac{1}{c} = \frac{1}{T_0 c}. \tag{25}$$

The electron realizes transitions of the *H*-atom from the *n*-th into *m*-th energetic state; it is the wave motion with energy of the transition (15). The law of conservation of energy, at such an extremely fast "quantum" transition, can be presented by the equality:

$$E_m + \frac{hc}{\lambda} = E_n. \tag{26}$$

Taking into account the equations (2) and (6), potential energy of the electron in the spherical field of the *H*-atom takes the values,

$$E = -\frac{m\upsilon_0^2}{2}\frac{1}{n^2}. \tag{27}$$

As a result, we arrive at the following equation of the energetic balance:

$$h\frac{c}{\lambda} = E_n - E_m = \frac{m\upsilon_0^2}{2}\left(\frac{1}{m^2} - \frac{1}{n^2}\right). \tag{28}$$

Rewriting the latter, we come to the equation in the more common form:

$$\frac{1}{\lambda} = \frac{m\upsilon_0^2}{2hc}\left(\frac{1}{m^2} - \frac{1}{n^2}\right). \tag{29}$$

where

$$R = \frac{m\upsilon_0^2}{2hc} = \frac{\upsilon_0}{4\pi r_0 c} \tag{30}$$

is the Rydberg constant. Thus, in the strict correspondence with the wave theory, we have arrived at the elementary spectral formula (29) for the *H*-atom (see also [5]).

The presented above formula of elementary optical spectra is a particular case of the general formula of energetic transitions ((16a), L. 1), which follows from the strict solutions presented in L. 1 (all the details are in [3]).

4. Conclusion

In the framework of the DM, resting on the concept on the wave structure and behavior of elementary particles and their complex formations (atoms, molecules, etc.), the peculiar fundamental relations that were found for the H-atom, as the wave binary proton-electron system, were presented here. In particular, we have considered characteristic dynamic

parameters of the spherical and cylindrical components of the system. It concerns amplitudes of the velocities, the wave action, potential and kinetic energies at circular motion-rest of the electron, the probability of energy states and the mean value of excitation energy.

The derivation of an elementary optical spectrum (29) ((18), L.1) was realized here by another way that differs from the one demonstrated in previous Lecture 1.

Thus, taking into account the data presented in L. 1 (and in other Lectures of Vol. 1 and 2), we have learned now yet more information about behavior of the hydrogen atom regarded as the dynamic wave formation composed of two elementary particles.

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Lecture 3

Microwave Background Radiation of Hydrogen Atoms

1. Introduction

Background radiation of hydrogen atoms has never been and still is not considered in modern physics. Such a strange relation to this phenomenon has formed naturally and exists till now because of the domination of quantum mechanical concepts on the structure of atoms officially accepted and fully formed among scientists for the long time. These concepts originate from the Bohr Theory and kept its essential features unquestioned, unfortunately, hitherto by mainstream physicists adhering to the Standard Model. In accordance with one of the accepted features, an *atom does not emit energy being in equilibrium*. However, there are more than sufficient reasons to doubt that this established statement (regarded as a sacred dogma) is true. We will consider this matter here.

We believe that it should not surprise anybody that the *H*-atom has background radiation. Similarly as any electronic system at the macrolevel, an individual (free) *H*-atom and, apparently, any *H*-atoms of composite atoms (located in atomic nucleon nodes, according to the shell-nodal atomic model), being elementary electronic systems of the atomic level, are characterized by natural background radiative noise caused by a *current noise of orbiting electrons*.

It should be understandable that the microwave background radiation (MBR) of an individual *H*-atom has extremely small intensity and, therefore, observation of the radiation is effective just on an immense scale of abundance of *H*-atoms that takes place in cosmic space. Measurements of the MBR carried out intensively in last decades in Cosmos with use of artificial satellites [1, 2] have verified, actually, and proved these theoretical predictions. The measurements in cosmos have confirmed thus the validity of the Dynamic Model. However, unfortunately, the data obtained on the research satellites were used in modern physics and astrophysics in support of the fantastic idea. Namely, the data of measurements were begun

treated as an indirect confirmation of the Big Bang hypothesis of the origin of the Universe. The latter was and still is the urgent point of natural science.

In this Lecture we will show that the *microwave background radiation observed in Cosmos* (CMB) is none other than the zero level (background) radiation of hydrogen atoms which are the main constituent of the Universe. The MBR of hydrogen atoms naturally originates from the Dynamic Model of elementary particles (DM). According to the latter, the equilibrium states of the *H*-atom form, in the exafrequency wave field, not only the *spectrum of dynamically stationary energy states* (that was considered in previous Lecture, Eq. (16a)) but also generate the *background spectrum of zero level radiation* responding to the black-body radiation of approximately 2.73 *K* temperature.

According to the DM, exchange of energy between the proton and the orbiting electron in real conditions *occurs on the background of oscillations* of the center of mass of the proton and on the background of exchange with the surrounding wave field-space of a different nature. Therefore, the equation of exchange (interaction) is presented generally as $E_{cyl} = \Delta E_{sph} + \delta E$ ((26), L. 1), where δE takes into account various perturbations of motion of the orbiting electron.

The electron in the hydrogen atom, moving around the proton along an orbit (both in equilibrium stationary and exited states), *constantly* exchanges the energy with the proton at the *fundamental frequency* inherent in the subatomic level, ω_e ((33), L. 3, V. 2). This exchange process between the electron and proton has the dynamically equilibrium character and *runs on the background of the superimposed oscillatory field*. The latter is characterized by a system of radial standing waves, which define “zero level exchange” [3, 4] in a dynamically equilibrium state of the atom.

2. The background radiation spectrum: derivation

Thus, the frequency spectrum of the zero level exchange must be defined from the following equation,

$$\frac{1}{\lambda} = R\left(\frac{1}{n^2} - \frac{1}{(n+\delta n)^2}\right), \tag{1}$$

which takes into account possible perturbations of the electron’s orbital motion through the term $\delta n = \dfrac{\delta r}{r_0}$ being the relative measure of background perturbations δr of the orbital radius r_0 (the Bohr radius) at the level of zero exchange.

The value of δr is defined by two constituents, *i.e.*, consists of two terms:

$$\delta r = \delta r_0 - \frac{r_e}{r_0}\delta r_e . \qquad (2)$$

The first of them, δr_0, takes into account background perturbations of the orbital motion of an electron regarded as the whole as a point-like particle.

According to the DM, an electron, like a proton or any elementary particle, is a specific dynamic (spherical) formation with the radius of its own spherical wave shell $r_e = 4.17052597 \times 10^{-10}\ cm$ (see (22), L. 2, V. 2), which is approximately in ten times less than the Bohr radius r_0. Oscillations of the center of mass of the electron itself, as a whole, with respect to the center of mass of the hydrogen atom, reduce the effective value of δr_0. The second term in (2), $\left(\frac{r_e}{r_0}\right)\delta r_e$, with the minus sign takes into account this circumstance.

In the spherical wave field of the hydrogen atom, both quantities, δr_0 and δr_e, are determined, as follows from radial solutions of the wave equation [5], giving us amplitude of radial oscillations of the spherical shell, $A_{sph} = \frac{A\hat{e}_l(kr)}{kr}$ (see (4) and (6), L. 1), by roots of Bessel functions $z_{k,l}$, $kr = z_{k,l}$ [6], and depend on the value of the constant A.

Thus, the term δr_0 has the form,

$$\delta r_0 = \frac{Ae_p(z_{p,s})}{z_{p,s}} = \frac{A}{z_{p,s}}\sqrt{\frac{\pi z_{p,s}}{2}\left(J_p^2(z_{p,s}) + Y_p^2(z_{p,s})\right)} . \qquad (3)$$

The value of the constant A in (3) is equal to $A = r_0\sqrt{\frac{2hR}{m_0 c}} = 9.00935784 \cdot 10^{-13}\ cm$ (see (20), L. 1).

The term δr_e has the analogous form,

$$\delta r_e = \frac{A_e e_m(z_{m,n})}{z_{m,n}} = \frac{A_e}{z_{m,n}}\sqrt{\frac{\pi z_{m,n}}{2}\left(J_m^2(z_{m,n}) + Y_m^2(z_{m,n})\right)} . \qquad (4)$$

The constant A_e in (4) differs from A entered in (3); it is defined from the analogous formula,

$$A_e = r_e\sqrt{\frac{2Rh_e}{m_0 c}} , \qquad (5)$$

where r_e is the theoretical radius of the wave shell of the electron mentioned above (the electron radius for brevity). It should be recalled that it is determined in the DM from the

formula of mass of elementary particles ((21), L. 2, V. 2) at the conditions that $\varepsilon_r = 1$ and $m = m_e = 9.109382531 \times 10^{-28}\, g$.

Accordingly, the quantity h_e entered in (5), equal to

$$h_e = 2\pi m_e \upsilon_0 r_e = 5.222105849 \times 10^{-28}\, erg \cdot s\,, \tag{6}$$

is the orbital action of the electron, analogous to the Planck constant h, caused by electron's proper rotation around its own center of mass with the speed υ_0. The rotation is realized during the electron orbiting around the proton with the same Bohr speed,

$$\upsilon_0 = 2.187691263 \cdot 10^8\, cm \cdot s^{-1}. \tag{7}$$

Substituting all quantities in (5), we obtain

$$A_e = 1.993326236 \times 10^{-14}\, cm\,. \tag{8}$$

The final condition concerns the choice of the numerical factor β_n multiplied by $\left(\frac{r_e}{r_0}\right)\delta r_e$ in the case of the roots $z_{p,s} = j'_{p,s}$. The matter is that roots $y_{p,z}$ represent equilibrium kinetic radial shells, whereas $j'_{p,s}$ represent extremes of potential shells [5, 7] exhibited under the excitation of the hydrogen atom (note that $j'_{0,2} = j_{1,1}$, $j'_{0,3} = j_{1,2}, \ldots$, where $j_{p,s}$ are zeros of Bessel functions characterizing potential shells). Hence, for the exited atom, the value δr will be slightly differing from the equilibrium value defined by (2).

We take into account the above circumstance, varying insignificantly the smallest (second) term in (2) by the empirical numerical factor β_n. Accordingly, the equality (2) takes now the following subcorrected form:

$$\delta r = \delta r_0 - \beta_n \frac{r_e}{r_0} \delta r_e\,. \tag{9}$$

Thus, we have arrived at the following resulting formula for δn:

$$\delta n = \frac{\delta r}{r_0} = \sqrt{\frac{2Rh}{m_0 c}} \cdot \frac{e_p(z_{p,s})}{Z_{p,s}} - \beta_n \frac{r_e^2}{r_0^2} \sqrt{\frac{2Rh_e}{m_0 c}} \cdot \frac{e_m(z_{m,n})}{Z_{m,n}}\,. \tag{10}$$

where R is the Rydberg constant, $r_e = 4.17052597 \times 10^{-10}\, cm$ is the radius of the wave shell of the electron (the electron radius).

On the basis of (1), with allowance for (10) and taking into account the Bessel's functions of the zero order, $p = q = m = 0$, characteristic for the proton-electron system in an

equilibrium state, we arrive at the spectrum of the zero wave perturbation – the *background spectrum* of the hydrogen atom:

$$\frac{1}{\lambda} = R\left(\frac{1}{n^2} - \frac{1}{\left(n + \sqrt{\frac{2Rh}{m_0 c}} \cdot \frac{e_p(z_{p,s})}{Z_{p,s}} - \beta_n \frac{r_e^2}{r_0^2}\sqrt{\frac{2Rh_e}{m_0 c}} \cdot \frac{e_m(z_{m,n})}{Z_{m,n}}\right)^2}\right), \qquad (11)$$

where $n = 1, 2$; β_n are numerical factors taking into account the fact of an excitation of the hydrogen atom on the zero level and using by this reason the first unequal to zero roots of Bessel functions, $j'_{0,2}$ and $j'_{0,3}$ (Table 1), corresponding to the extremes of the first potential radial shells. The results of calculations by the formula (11) under the above conditions are presented in Tables 2 and 3.

Table 1

The roots of Bessel functions, $z_{p,s}$ and $z_{m,n}$ [6], and the numerical factors β_n used for the calculations by Eq. (11); n = 1, 2.

s	$Z_{p,s}$	$Z_{m,n}$	β_1 (n=1); β_2 (n=2)
1	$y_{0,1}$ = 0.89357697	$y'_{0,1}$ = 2.19714133	
2	$y_{0,2}$ = 3.95767842 $j'_{0,2}$ = 3.83170597	$y'_{0,1}$ = 2.19714133 $j'_{1/2,1}$=1.16556119	β_1=1.203068949 β_2=1.018671584
3	$y_{0,3}$ = 7.08605106 $j'_{0,3}$ = 7.01558667	$y'_{0,1}$ = 2.19714133 $j'_{1/2,1}$=1.16556119	β_1=1.203068949 β_2=1.018671584

Thus, we see that at $p = 0$ the zero of the second kinetic shell is equal to $z_{0,2} = y_{0,2} = 3.95767842$; hence, from (1) it follows that

$$\lambda = 0.106315\,cm \qquad (12)$$

The zero level of wave exchange (interaction with environment) is not perceived visually and integrally characterized by the absolute temperature of zero exchange. It exists as a standard energetic medium in the Universe where the hydrogen atom is the more abundant substance of cosmic space.

The wave (12) is within an extremum of the spectral density of equilibrium cosmic microwave background. The absolute temperature of zero level radiation with this wavelength is

$$T = \frac{0.290}{\lambda} = 2.72774\,K\,. \qquad (13)$$

Table 2

The terms, 1/λ, of the background spectrum (11) of the hydrogen atom; $n = 1$.

s	$Z_{p,s}$	$Z_{m,n}$	β_n	1/λ, cm^{-1} Eq. (11)	λ, *cm*	T, K	$T_{exp,}$, K [2]
1	$y_{0,1}$	$y'_{0,1}$		41.751724	0.023951	12.10805	
2	$y_{0,2}$	$y'_{0,1}$		9.40602023	0.106315	2.72774	2.728 ± 0.002
	$j'_{0,2}$	$j'_{1/2,1}$	β_1	9.67863723	0.103320	2.80680	
3	$y_{0,3}$	$y'_{0,1}$		5.240486	0.190822	1.51974	
	$j'_{0,3}$	$j'_{1/2,1}$	β_1	5.255841	0.190265	1.52419	

Tablica 3

The terms, 1/λ, of background spectrum (11) of the hydrogen atom; $n = 2$.

s	$Z_{p,s}$	$Z_{m,n}$	β_n	1/λ, cm^{-1} (11)	λ, *cm*	T, K
1	$y_{0,1}$	$y'_{0,1}$		5.219748	0.191580	1.5137
2	$y_{0,2}$	$y'_{0,1}$		1.1758681	0.850436	0.3410
	$j'_{0,2}$	$j'_{1/2,1}$	β_2	1.211154	0.825659	0.3512
3	$y_{0,3}$	$y'_{0,1}$		0.6550701	1.526554	0.18997
	$j'_{0,3}$	$j'_{1/2,1}$	β_2	0.6582849	1.519099	0.1909

The temperature (13) is close to the temperature of “relict” background measured by NASA's Cosmic Background Explorer (COBE) satellite to four significant digits ($2.728 \pm 0.002\,K$) [2].

Unfortunately, modern physics erroneously interprets the nature of origination of cosmic microwave background. The latter is regarded as a “relict” background radiation left after the Big Bang. This hypothesis has turned out to be doubt and subjected last time to close scrutiny, especially due to the new data obtained also by Hubble Space Telescope. There are

many publications on this subject; in particular, in the book „*Bye Bye Big Bang, Hello Reality*" by William C. Mitchell (2002) [8], it is discussed many of the open questions concerning the groundlessness of the Big Bang hypothesis (see also [9, 10]).

3. The blackbody form of the background radiation

Let us consider the equilibrium radiation in a volume of an arbitrary cavity, which serves as a model of a "black body". We will do it here also from the unknown earlier (up to the first publications on this subject [4, 5]) point of view, following the wave approach accepted in dialectical physics. In this case, to compute the number of standing waves in the cavity, it is quite sufficient to compute a number of fundamental oscillations, taking into account that one *H*-emitter corresponds to every elementary standing wave. This extremely simplest way of the Planck's law derivation is as follows:

During the one wave period of the fundamental tone, the electron on the Bohr orbit twice runs the azimuth orbit (see (23), L. 2), hence, the *linear density of elementary half-waves* n_{lin} placed on Bohr orbits is

$$n_{lin} = \frac{1}{\lambda / 2} \qquad \text{or} \qquad n_{lin} = \frac{1}{\pi \lambda\!\!\!^{-}}, \tag{14}$$

The *volumetric density* can be determined from the equality,

$$n_{\upsilon ol} = n_x n_y n_z = n_{lin}^3 = \frac{1}{\pi^3 \lambda\!\!\!^{-3}} = \frac{8\nu^3}{c^3} \tag{15}$$

and the *spectral density* – by the ratio,

$$n_\nu = \frac{dn_{\upsilon ol}}{d\nu} = \frac{24\nu^2}{c^3}. \tag{16}$$

Because every standing wave is related to one *H*-emitter of the mean energy $\langle \varepsilon_\nu \rangle$ ((20), L. 2), the spectral density of radiation will be equal to

$$u_\nu = n_\nu \langle \varepsilon_\nu \rangle = \frac{3}{\pi} \frac{8\pi\nu^2}{c^3} \frac{h\nu}{\exp(h\nu / kT) - 1}. \tag{17}$$

A part of the density of spectral flux of energy, $u_\nu c$, through an elementary area of $\Delta S = \pi r^2$, along all directions, defines the *energetic spectral luminosity* of atomic space:

$$r_\nu = u_\nu c \frac{\Delta S}{4\pi r^2} = \frac{1}{4} u_\nu c. \tag{18}$$

Hence, we arrive at

$$r_\nu = \frac{3}{\pi}\frac{2\pi\nu^2}{c^2}\frac{h\nu}{\exp(h\nu/kT)-1}, \tag{19}$$

and the integral luminosity (the Stefan-Boltzmann law) takes the following form:

$$R_e = \sigma_e T^4, \tag{20}$$

where

$$\sigma_e = \frac{3}{\pi}\sigma = \frac{2\pi^4 k^4}{5c^2 h^3} \tag{21}$$

If we introduce the mean spectral-temperature coefficient of radiation ζ (in the capacity of qualitatively similar states of atoms) and the multiplier

$$\varepsilon_\varsigma = \left(\frac{3}{\pi}\right)\varsigma, \tag{22}$$

then

$$R_e = \varepsilon_\varsigma \sigma T^4. \tag{23}$$

Planck's law is an approximate guideline; therefore, the factor $3/\pi$ in the above formulas has no principal meaning. In practice, the deviation from Planck's law is connected with the empirical spectral and integral coefficients of radiation. Accordingly, an application of the law to real systems, for example to the stars, is possible only with essential assumptions.

4. The hyperfine splitting of the ground states: the Lamb Shift

An important proof of the correctness of the background radiation formula (11) and, hence, of basic features of the elementary particles structure, originated from the DM, are the values of differences of background energetic states corresponding to Bessel functions $j'_{0,2}$ and $y_{0,2}$.

As it turned out the *theoretical* values obtained for the $(j'_{0,2} - y_{0,2})_{n=1}$ (Table 2) and $(j'_{0,2} - y_{0,2})_{n=2}$ (Table 3) terms differences, $\Delta\left(\frac{1}{\lambda}\right)cm^{-1}$ [11], *coincide* with high precision with the most accurate *experimental* values obtained for the 1*S* and 2*S* Lamb shifts in the hydrogen atom: $L_{1,s} = 8172.837(22)$ MHz and $L_{2s-2p} = 1057.8446(29)$ MHz [12] (Table 4).

The above data is a strong blow on to the concept of "*virtual particles"* of quantum electrodynamics (QED), which were invented initially just to account for the so-called "*anomalous*" magnetic moment of an electron (we will consider this matter in the next

Lecture) and the splitting between the ground states in the hydrogen atom, determined in 1947 by W. E. Lamb and R. C. Retherford and called latter the Lamb shift.

Table 4

The frequency gaps, Δν, between the nearest background terms in the hydrogen atom.

n	s	Terms differences	$\Delta(1/\lambda)$, cm^{-1}	Δν, MHz	$\Delta\nu_{exp}$, MHz [12]
1	2	$(j'_{0,2} - y_{0,2})_{n=1}$	0.272617	**8172.852**	**8172.837(22)**
	3	$(j'_{0,3} - y_{0,3})_{n=1}$	0.015355	460.3313	
2	2	$(j'_{0,2} - y_{0,2})_{n=2}$	0.0352859	**1057.84466**	**1057.8446(29)**
	3	$(j'_{0,3} - y_{0,3})_{n=2}$	0.0032148	96.37727	

Unfortunately, physicists, instead of study the world, have begun by this way (introducing imaginable *virtual* particles) to construct a subjective *virtual world*. As a result the theory of quantum electrodynamics, considered now as the great achievement of modern ("*virtual*" in essence) physics, has been developed. Let us to recall in this connection the well-known opinion of Richard P. Feynman regarding to this subject, who is one of the major creators of the QED: „*The theory of quantum electrodynamics describes Nature as absurd from the point of view of common sense…*" [13].

The above cited public utterance of Feynman represents *in medias res* the recognition of inability of physicists of that time to suggest adequate reasonable concepts concerning cognition of phenomena of nature.

We confirm the rightfulness of Feynman's opinion concerning aforesaid "*absurdity*" of the key theory of modern physics, which is the QED, and show this in our works, including those considered in these Lectures. In particular, the DM enables to explain logically and simply, without resting on the QED concept of virtual particles, along with the Lamb shift also the nature of the "anomaly" of the magnetic moment of the orbiting electron [3, 14].

5. Conclusion

In 2006 the Nobel Prize in Physics has been awarded to two physicists "*for their discovery of the blackbody form and anisotropy of the cosmic microwave background radiation*" (CMB) [16]. They were initiators and leaders of a large team of researchers and engineers having implemented the unique project on measuring the CMB. Measurements showed that the background spectrum is characterized by a relatively high degree of isotropy (up 0.01%) and almost perfectly matches the spectrum of a blackbody radiation with the temperature of around 2.73 K.

These measurements directly proved, in fact, the validity of the concept of dialectical physics that the sources of the CMB radiation of the temperature of 2.73 K are most likely the MBR of hydrogen atoms of cosmic space [3-5]. However, as we have seen, a resulting explanation of the measurement data has been done by the authoritative group of physics (regarded in modern physics as "credible") involved in the CMB project, including sponsors, subjectively without taking into account the discovery of the MBR of hydrogen atoms, well-known to that time for physicists from publications appeared beginning from 2001 [3-5].

Keeping silent about this fact, ignoring thus in essence, as if there is not the discovery, physicists have shown by this manner that they do not wish to admit an alternative point of view (different from their own) according to which the MBR existed in cosmic space belongs, in all likelihood, to hydrogen atoms filling the space. Why this phenomenon, one of the unique phenomena found in the last decades, has not been (and still is not) subjected to comprehensive verification by modern physics and, quite opposite, as we see, is tacitly ignored?

Let us remember the history related to this phenomenon. For the first time the cosmic microwave background radiation was found by radio physicists in 1965. At that time astrophysicists-theorists, adhering to the "Big Bang" hypothesis (1946) of G. A. Gamow, took at once unhesitatingly this hypothesis as the basis for explaining the found radiation because the supposed existence of the latter has followed from their favourite Big Bang hypothesis. Since then the fantastic hypothesis came to the fore of astrophysics, and it is used now in astrophysics as the standard cosmological model.

From that time the CMB has become regarded as a residual thermal radiation of continuously expanding and, hence, cooling cosmic space (across the Universe). This is going on allegedly after the hypothetical Big Bang of the so-called cosmological "singularity" – a region characterized by infinite density, temperature and curvature; but saying simply, out of nothing.

The "Big Bang", as is believed resulted in the birth of the Universe, happened (according to the last estimates) approximately 13.7 billion years ago. An extravagant idea of the Big Bang has received the wide publicity. At present time a bad manner is considered even to doubt the reality of the hypothetical event allegedly happened in the above mentioned time in the far past. Brainwashing by the media proved so successful that the word "hypothesis" has almost disappeared from circulation. And the majority of innocent people, including children, pupils and students, took for granted (as a dogma) that myth.

Thus, in the case of the CMB, we deal with the radiation objectively existing in cosmic space, which is equilibrium and almost isotropic with wavelength in maximum of about $\lambda = 0.1\,cm$. The numerical value lies within the maximum of the spectral density of the equilibrium blackbody radiation corresponding to the absolute temperature of about 2.7 K.

Sources of electromagnetic radiation in a wide spectral band of frequencies, including optical and microwave, are *excited atoms*. Among them, following logic and common sense, without imagination, it should be seek the cause of the CMB radiation. Thus, assuming that a source of the cosmic microwave radiation are excited atoms, let us ask ourselves, which of the elements of the periodic table can actually be considered as the most likely element responsible for the observed radiation?

No one, apparently, will be surprised that the hydrogen atoms first of all have attracted particular attention as the most expected source responsible for the cosmic microwave background radiation. Really, hydrogen is the most abundant element in the Universe (about 92%), being the main constituent of stars and interstellar gas. Therefore, an assumption that hydrogen emits and absorbs not only in *optical*, but also in the *microwave* region of the spectrum, and, hence, is responsible for the CMB radiation, has had a common sense.

Modern physics learned quite a lot about emission and absorption of electromagnetic waves by atoms, but most probably not everything, so the above assumption makes sense. Although hydrogen is the most studied element, nevertheless, about its possible radiation in the *microwave* spectral band has not been even a hint in the literature on physics up to 2001.

As was mentioned in Introduction, the hydrogen atom, considering as an elementary electronic system of the atomic scale, "noises" on the threshold of sensitivity like any electronic device. Moreover, the “noise” is going while hydrogen is in an unexcited equilibrium state. According to the DM, hydrogen generates the “noise” by continuously emitting and absorbing electromagnetic waves in the *microwave frequency range*. The fact that nobody up till did know nothing about this phenomenon should not be surprising. Do not forget, at the present stage of the development of our far imperfect civilization, natural sciences, including physics, are still at the beginning way of infinite comprehension of Nature.

Measurement results of the CMB radiation constitute the direct evidence and are the basis for recognition of rightness of the hypothesis that hydrogen – the most widespread element in Space – is the only source of the CMB. The CMB problem (like many others) could not and cannot be solved in principle in the framework of modern abstract-mathematical theories such as quantum mechanics and elementary particles physics, and in general, cannot be solved by fitting methods as it is going, as a rule, in modern theories of the Standard Model. The solution of the above problem has required qualitatively new theories based on adequate concepts about the physical (not abstract-mathematical) structure of atoms and their constituent elementary particles, on the concepts which as far as possible would be close to the truth.

As a result of scientific search in the above indicated direction, a new physical theory, the Wave Model (WM), has been developed. It rests only on one postulate, which, that is important in principle, is adequate to reality. According to the latter, all phenomena and

objects in the Universe have a wave nature (no one can question this fact) and, consequently, their behaviour, as we have assumed (as proven to be rightly, judging by the results), must obey the universal wave equation.

Thus, relying on solutions of the universal (classical) wave equation ((1), L. 1) and the Dynamic Model of elementary particles (DM), as well as on the Shell-Nodal Atomic Model (SNAM) [5, 15], it was found that elementary classes of optical spectra are determined in a general case by the universal formula of energy transitions ((16a), L. 2). From the latter, as one of the particular solutions, the spectral formula of the background radiation (11) follows in natural way.

Summarizing at the end, it makes sense to specify briefly the following important points touched in this Lecture.

1. In the framework of the DM, the *microwave background radiation of hydrogen atoms* (11) *was discovered theoretically*. An existence of an electromagnetic background in such a *microwave band* in reality *has been confirmed experimentally* by measurements in cosmic space. The background radiation *spectrum* is exactly that of a “black body” with approximately 2.73 *K* temperature. The aforementioned spectrum, as well as the generalized optical spectrum of the hydrogen atom ((16a), L. 2), was found in the DM due to taking into account the *orbital* (circular) motion of the *electron-wave*, where the *electron-particle* is regarded as *the node of the wave orbit*.

2. A coincidence of the background spectrum of the hydrogen atom of the absolute temperature in maximum of 2.73 *K* (11) with the observed cosmic microwave background spectrum [2] of the same temperature *provides strong evidence for an existence of zero level radiation of hydrogen* (and, hence, any) atoms in the Universe.

3. The unique theoretical solution (11) has revealed the generality of the nature of two remarkable phenomena detected in the 20th century – the Lamb shift *in atomic spectra* and the "relict" microwave background *in cosmic space*. The CMB and the Lamb shift have the same source of their origination – hydrogen. The unity of the nature of both phenomena is manifested in the fact that the energetic gaps between the spectral lines of the background spectrum of hydrogen coincide with high precision with the most accurate *experimental* values obtained for the 1*S* and 2*S* Lamb shifts in the hydrogen detected at the atomic level.

4. The results presented and other data obtained in the framework of the new approach, once more *confirm the validity of the DM, the validity of the dynamic wave behavior of microobjects of atomic and subatomic levels*, where the hydrogen atom represents a paired dynamic proton-electron system of quasispherical structure. The spherical component (an ionized hydrogen atom, proton) relates to the spherical wave field of exchange (interaction). The orbiting electron-satellite (its motion) relates to the cylindrical wave field of exchange. From the point of view of dialectics, the spherical field is a field of *basis* of the hydrogen atom, and the cylindrical field is a field of its *superstructure*.

5. An ascription by modern physics of the origin of cosmic microwave background (CMB) radiation to the mythical "Big Bang" is subjective and unfounded. There are none convincing arguments, and, moreover, direct evidences, in favour of the validity of the above hypothesis. A discovery of the zero level radiation of hydrogen atoms *questions, thus, the Big Bang hypothesis* of the origin of the Universe.

6. The data obtained casts doubt also the quantum mechanical (QM) *probabilistic model*, which excludes an electron's *orbital motion, i.e.*, the motion *along a trajectory in principle* that is laid down by its basis postulates.

7. The *background radiation is inherent for any atoms having orbiting electrons*. This follows from the WM, according to which atoms are considering as shall-nodal (molecule-like) wave microformations having two hydrogen atoms maximum in a nucleon atomic node.

8. The discoveries of an existence of the microwave background radiation of hydrogen atoms and the nature of the Lamb shifts open a new chapter in theoretical and applied atomic spectroscopy.

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Lecture 4

Orbital Magnetic Moment of the Electron in the Hydrogen Atom

1. Introduction

Elementary sources of magnetization of substances are *circular* atomic currents created by *orbiting* electrons in atoms. Each atomic current being a closed circuit of atomic dimensions is considered as an elementary magnetic dipole characterized by a definite *magnetic moment*, which is *orbital* in its essence.

However, modern physics, along with the *orbital magnetic moment* of the electron bound in an atom, hypothesized and then has accepted subjectively, as an axiom, an existence of electron's *own magnetic moment* – named the *spin magnetic moment*, regardless of whether the electron is bound in an atom, or is in a free state. Although up till now there are none convincing experiments with *free electrons*, which could prove an existence of the *own* (spin) magnetic moment of an electron.

An introduction of the hypothetic notions of *spin* ($s = \frac{1}{2}\hbar$, where $\hbar = m_e \upsilon_0 r_0$ is the electron's *orbital moment of momentum*), the Bohr magneton ($\mu_B = \frac{e\hbar}{2m_e c} = \frac{e\upsilon_0 r_0}{2c}$) and the electron's *spin magnetic moment* ($\mu_{e,s} = g_e \frac{1}{2}\mu_B$, where $|g_e| = 2(1+\alpha_e)$ is the electron *g-factor*, and α_e is the so-called *magnetic moment anomaly* of the electron) was made, thus, unfoundedly and is one of the greatest faults of modern physics. You will see this.

We will consider both aforesaid moments, *orbital* and *spin*, so as they are viewed in the framework of the DM. In this Lecture, we begin our consideration from the derivation of the *orbital magnetic moment* of the electron in the hydrogen atom. The details concerning this matter one can find, in particular, in the works [1, 2].

2. Derivation

The wave motion of the hydrogen atom, as a paired proton-electron system of the field of exchange, generates in the simplest case (in equilibrium) an elementary electric (longitudinal) moment, the moment of the basis,

$$N_e = e(r_0 + \delta r_0) \tag{1}$$

and the corresponding magnetic (transversal) moment, moment of the superstructure [3],

$$\mu_e = \frac{\upsilon_0}{c} N_e = \frac{\upsilon_0}{c} e(r_0 + \delta r_0). \tag{2}$$

The term δr_0 includes all small deviations of the orbital radius caused by different reasons during the orbiting wave motion of the electron. Namely, the term δr_0 takes into account the following three main additional motions that perturb (modulate) trajectory of the orbiting electron.

1. The circular motion of the center of masses of the hydrogen atom, because the hydrogen atom, as a whole, oscillates in the spherical field of exchange with the amplitude (characteristic for the wave sphere, at $kr = 1$) defined by the fundamental wave radius $\lambda\!\!\!^{-}_e$.

2. Oscillations of the wave shell together with the orbiting electron and oscillations of the center of mass of the hydrogen atom with the amplitude defined by the Bohr radius r_0 and the first root of the spherical Bessel functions of the zero order $z_{0,s} = b'_{0,1}$ [4], (responding to the extremum of the first kinetic shell);

3. Oscillations of the center of mass of the electron itself, as a whole, with respect to the center of mass of the hydrogen atom, defined by the radius of the wave shell of the electron r_e and the roots of Bessel functions responding to zero and maximum of the first kinetic shell, $y_{0,1}$ i $y'_{0,1}$.

The total magnetic moment of the electron is defined by the sum of all terms of μ_e considered above:

$$\mu_e = \mu_{e,orb} + \delta\mu_{e,1} + \delta\mu_{e,2} + \delta\mu_{e,3}, \tag{3}$$

where

$$\delta\mu_{e,1} = \frac{e\upsilon_0}{c}\delta r_{0,1}, \qquad \delta\mu_{e,2} = \frac{e\upsilon_0}{c}\delta r_{0,2}, \qquad \delta\mu_{e,3} = \frac{e\upsilon_0}{c}\delta r_{0,3}. \tag{4}$$

Hence,

$$\mu_e(th) = \frac{e\upsilon_0}{c}\left[r_0 + \delta r_{0,1} + \delta r_{0,2} + \delta r_{0,3}\right]. \tag{5}$$

Thus the first major term defining the magnetic moment of the electron, bound in the hydrogen atom, is equal to

$$\mu_{e,orb} = \frac{\upsilon_0}{c} e r_0 = 657.510152 \times 10^{-22}\, g \times cm \times s^{-1} = 1854.801894 \times 10^{-26}\, J \times T^{-1}. \qquad (6)$$

Half of this value,

$$\frac{1}{2}\mu_{e,orb} = \frac{\upsilon_0}{2c} e r_0 = \mu_B = 927.400947(80) \times 10^{-26}\, J \times T^{-1}, \qquad (7)$$

is called in physics the *Bohr magneton*.

We assume that the Rydberg constant ((3.19), L.1) is also the constant for the domain of the wave shell ($z_{p,s} = 1$) of the fundamental wave radius $\lambda\!\!\!^{-}_e$ (20). Then the constant in this domain will have the following value

$$R = \frac{m_0 c A^2}{2h\lambda\!\!\!^{-}_e^2} \qquad (8)$$

From this expression it follows that the oscillation amplitude A=A_m at the sphere of the wave radius $\lambda\!\!\!^{-}_e$ ($kr = 1$) is defined by the equation,

$$A_m = \lambda\!\!\!^{-}_e \sqrt{\frac{2Rh}{m_0 c}}. \qquad (9)$$

The amplitude (9) defines the radius of the circular motion of the center of mass of the hydrogen atom. It is the first term in value of δr_0 in (2),

$$\delta r_{0,1} = \lambda\!\!\!^{-}_e \sqrt{\frac{2Rh}{m_0 c}} = 2.730651941 \times 10^{-12}\, cm, \qquad (10)$$

because the hydrogen atom, as a whole, oscillates with this amplitude in the spherical field of exchange. This quantity is the characteristic amplitude of oscillations on the wave sphere ($z_{p,s} = kr = 1$).

From the previous sections it also follows that the wave motion causes oscillations of the wave shell, including the orbiting electron, and the center of mass of the hydrogen atom, with the amplitude (28). These oscillations also superimpose on the orbital motion of the electron defining the second term in value of δr_0, which we must take into account for the calculation. The constant A in the amplitude (28) has the form (39) (for the case of $z_{p,s} = z_{0,s}$, when $|\hat{e}_0(kr_s)|^2 = 1$), hence the second constituent of δr_0 is

$$\delta r_{0,2} = \frac{r_0}{z_{0,s}} \sqrt{\frac{2Rh}{m_0 c}} \,. \tag{11}$$

In the simplest case we take the first root of the spherical Bessel functions of the zero order $z_{0,s} = b'_{0,1} = 2.79838605$ [4], responding to the extremum of the first kinetic shell [3]. Then

$$\delta r_{0,2} = \frac{r_0}{b'_{0,1}} \sqrt{\frac{2Rh}{m_0 c}} = 3.219483546 \cdot 10^{-13}\, cm \,. \tag{12}$$

Like a proton or any elementary particle, an electron is a spherical dynamic formation. Therefore oscillations of the center of mass of the electron itself, as a whole, with respect to the center of mass of the hydrogen atom, also occur. The third (smallest in value) constituent of δr_0 takes into account these oscillations; its amplitude is presented as

$$\delta r_{0,3} = \frac{r_e}{z_{0,s}} \sqrt{\frac{2Rh_e}{m_0 c}} \,, \tag{13}$$

where r_e is the theoretical (22) wave radius of the electron, and

$$h_e = 2\pi m_e \upsilon_0 r_e \tag{14}$$

is the *orbital action* of the electron (analogous to the Planck constant *h*) produced at its own rotation around its own center of mass with speed υ_0, realized during the electron orbiting around the proton with the same speed.

In this case, owing to more indeterminacy, we take the two nearest roots $z_{0,s}$ of Bessel functions: $y'_{0,1} = 2.19714133$ equal to the extremum of the first kinetic shell, and $y_{0,1} = 0.89357697$ [4] equal to the zero of the first kinetic shell. In view of this, (13) yields the value

$$\delta r_{0,3} = r_e \frac{(y_{0,1} + y'_{0,1})}{2 y_{0,1} y'_{0,1}} \sqrt{\frac{2Rh_e}{m_0 c}} = 1.568981598 \cdot 10^{-14}\, cm \,. \tag{15}$$

Thus the theoretical value of the total magnetic moment (3) of the electron $\mu_e(th)$ in an expanded form is presented as

$$\mu_e(th) = \frac{e\upsilon_0}{c} \left[r_0 + \left(\frac{c}{\omega_e} + \frac{r_0}{b'_{0,1}} \right) \sqrt{\frac{2Rh}{m_0 c}} + r_e \frac{y_{0,1} + y'_{0,1}}{2 y_{0,1} y'_{0,1}} \sqrt{\frac{2Rh_e}{m_0 c}} \right]. \tag{16}$$

The values of the fundamental quantities, not appearing earlier in the paper but used for the calculation by (67), taken from CODATA [5], are as follows:

$$r_0 = 0.5291772108(18) \times 10^{-8}\ cm$$

$$h = 6.6260693(11) \times 10^{-27}\ erg \times s$$

$$m_0 = 1.67262171(29) \times 10^{-24}\ g$$

$$c = 2.99792458 \times 10^{10}\ cm \times s^{-1}$$

The value of the electron mass we used,

$$m_e = 9.10938253(18) \times 10^{-28}\ g\ , \tag{17}$$

was calculated from the recommended value for the Planck constant over 2π [5], $\hbar = \frac{h}{2\pi}$, taking into account that $\hbar = m_e \upsilon_0 r_0 = 1.05457168(18) \times 10^{-27}\ erg \times s$ and knowing the magnitudes of υ_0 (53) and r_0. For comparison, the CODATA recommended value for m_e is $9.1093826(16) \times 10^{-28}\ g$.

The substitution of numerical values for all quantities entered in (16) gives the following theoretical values for the total magnetic moment of the electron and its constituents:

$$\begin{aligned} \mu_e(th) &= (657.510152 + 0.3392873572 + 0.04000253739 + \\ &+ 0.001949481777) \times 10^{-22}\ g \times cm \times s^{-1} = 657.8913914 \times 10^{-22}\ g \times cm \times s^{-1} \end{aligned} \tag{18}$$

In SI units [3], since

$$1T = \frac{10^4}{\sqrt{4\pi}}\ cm \times s^{-1}\ ,$$

Eq. (18) is rewritten as

$$\begin{aligned} \mu_e(th) &= (1854.801894 + 0.957111963 + 0.112845073 + \\ &+ 0.00549938656) \times 10^{-26}\ J \times T^{-1} = 1855.877351 \times 10^{-26}\ J \times T^{-1} \end{aligned} \tag{19}$$

The ratio of the electron's *orbital magnetic moment* $\mu_{e,orb} = \frac{e\upsilon_0 r_0}{c}$ to its *orbital moment of momentum* $\hbar = m_e \upsilon_0 r_0$,

$$\frac{\mu_{e,orb}}{\hbar} = \frac{e}{m_e c} = \frac{m_e \omega_e}{m_e c} = \frac{1}{\lambda\!\!\!^{-}_e} = k_e\ , \tag{20}$$

coincides with the same ratio obtained in the Einstein–de Haas experiment and is equal to the wave number k_e of the fundamental frequency ω_e.

From this it follows that the electron does not have the spin of one half of its orbital moment of momentum, $s_e = \frac{1}{2}\hbar$, just like the electron does not have the corresponding magnetic moment of one half of the orbital magnetic moment of the electron [6].

If we subtract the value $\mu_B = 927.400947(80)\times 10^{-26}\ J\times T^{-1}$ (7) of one Bohr magneton (ascribed, as turned out erroneously [7], to the spin magnetic moment) from (19), we obtain the following absolute value,

$$\mu_e = \mu_e(th) - \mu_B = 928.476404\times 10^{-26}\ J\times T^{-1}, \tag{21}$$

which coincides with the absolute 2002 CODATA recommended value accepted for the magnet moment of the electron (within uncertainty in the last two figures):

$$\mu_{e,CODATA} = 928.476412(80)\times 10^{-26}\ J\times T^{-1}. \tag{22}$$

The smallest in value term (15) in the resulting expression (19) contains indeterminacy in the weight contributions of two items defined by two roots of Bessel functions, $y_{0,1}$ and $y'_{0,1}$. These roots correspond to the zero and extremum of the first kinetic shell of the electron. If we introduce a small empirical coefficient for this term, that is justified in the framework of the indicated indeterminacy, $\beta = 1.00155$, then the last term in (18) will be

$$\delta\mu_{e,3} = \frac{e\upsilon_0}{c} r_e \frac{\beta(y_{0,1} + y'_{0,1})}{2y_{0,1}y'_{0,1}} \sqrt{\frac{2Rh_e}{m_0 c}} = 5.50792\times 10^{-29}\ J\times T^{-1}. \tag{23}$$

In this case the theoretical magnetic moment of the electron takes the value

$$\mu_e(th) = 1855.877359\times 10^{-26}\ J\times T^{-1} \tag{24}$$

As a result, the theoretical value of μ_e coincides completely with the current (recommended) experimental one (22):

$$\mu_e = \mu_e(th) - \mu_B = 928.476412\times 10^{-26}\ J\times T^{-1}. \tag{25}$$

We see that among all terms, the only quantity entered in (64), namely $\delta\mu_{e,3}$, has a direct relation to the electron proper (spin) magnetic moment, caused by the rotation of the electron around its own axis of symmetry. On this basis, we have the right to ascribe the value (23) to the electron spin magnetic moment, so that its value is

$$\mu_s = \delta\mu_{e,3} = 5.50792\times10^{-29}\ J\times T^{-1}. \tag{26}$$

Obviously, the contribution of the term (26) to the total magnetic moment of the electron (24) is insignificant and is less than 0.0003%.

The erroneousness of the introduction in physics of the $\frac{1}{2}\hbar$ value for the electron's proper moment (spin) and the introduction of the corresponding value $\mu_B = \frac{e\upsilon_0 r_0}{2c}$ (called the Bohr magneton) to the electron's spin magnetic moment is analyzed in detail in Ref. [6, 7].

3. Discussion

The magnetic moment of an electron is defined in modern physics by the equality

$$\mu_e = g_e \frac{1}{2}\mu_B = (1+a_e)\mu_B, \tag{27}$$

where g_e is the electron g factor,

$$\mu_B = \frac{e\hbar}{2m_e c} \tag{28}$$

is the Bohr magneton, and

$$a_e = \frac{g_e - 2}{2} \tag{29}$$

is called the magnetic moment anomaly of the electron. The latter shows by how much the expected value of one Bohr magneton, following from semi-classical field theories where $g = 2$, exceeds the observed value of the magnetic moment of the electron, known now experimentally to 12 significant figures [8]:

$$g_e = 2.0023193043768(86). \tag{30}$$

The value ± 86 in (30) is the remaining uncertainty. Thus, because (as follows from (28))

$$\mu_B = 927.400947(80)\times10^{-26}\ J\times T^{-1}, \tag{31}$$

the magnetic moment of the electron is

$$\mu_e = -928.476410(80)\cdot10^{-26}\ J\cdot T^{-1}. \tag{32}$$

The precise value of g is derived in the framework of quantum electrodynamics (QED), taking into account small terms related to quantum chromodynamics (QCD). Therefore it is

assumed that the experimental determination of the magnetic moment of the electron, bound in the hydrogen (and hydrogen like) atoms, such as the determination of the Lamb shift, provides one of the most sensitive tests of QED.

The best theoretical value of a_e by QED, including small electroweak and Hadronic terms, [9] is

$$a_e(th) = 1.1596521535(12) \times 10^{-3}\,. \tag{33}$$

The derivation of α_e with such a high precision is regarded in physics as one of the advantages of QED, because other methods of precise derivation have not been found till now.

It makes sense to show here the current theoretical value of $a_e(th)$ in concise form, derived now [8] up to the forth order in the fine-structure constant α:

$$\begin{aligned} a_e(th) = 0.5\left(\frac{\alpha}{\pi}\right) - 0.328478965579...\left(\frac{\alpha}{\pi}\right)^2 + 1.181241456...\left(\frac{\alpha}{\pi}\right)^3 - \\ -1.5098(384)\left(\frac{\alpha}{\pi}\right)^4 + 4.382(19) \times 10^{-12} = 1.1596521535(12) \times 10^{-3} \end{aligned}, \tag{34}$$

where

$$\alpha = \frac{e^2}{4\pi\varepsilon_0 \hbar c} = 7.297352533 \times 10^{-3}\,, \tag{35}$$

is the fine-structure constant [10]; with this $\varepsilon_0 = 8.854187817... \times 10^{-12}\ F \times m^{-1}$ is the so-called "*permitivity of free space*" (or "*electric constant*").

Let us turn again to the presented above formulas: (16) and (27) (taking into account (34)), which actually describe the same quantity – the magnetic moment of the electron, and compare them. By this way we will compare two theoretical approaches:

(1) the new approach (dialectical) presented here and

(2) the modern approach (quantum electrodynamical, "virtual") accepted currently in physics.

The derivation of the equation (27) rests on the concept of *virtual* (invented) particles. Therefore, the expanded form of the equation (27) is extremely complicated. Actually, the coefficient $1.5098(384)$ of the α^4 term in (34) (calculated with big uncertainty, ± 384) consists of more than *one hundred huge 10-dimensional integrals*.

In fact, we deal here with the masterly mathematical fitting (adjusting), which reached in the course of more than 55 years, passed after the work by H. A. Bethe [11] and T. A. Welton [12], of the highest extent of perfection due to the hard efforts of many skilled theorists over the World.

Whereas, Eq. (16), derived on the basis of the Dynamic Model of Elementary Particles, does not contain any integrals, but nevertheless logically and non-contradictory leads to the same precise value of μ_e.

Additional comments for the above comparison are not necessary. The simplicity, clear logic and precision of the shown above new alternative calculations justify in favor of the validity of the wave approach realized in the DM.

4. Conclusion

For the first time in physics, thanks to the DM, the *orbital magnetic moment* of the electron in the hydrogen atom (with its so-called "anomaly") has obtained the simple, correct and logically non-contradictory solution. Its magnitude is higher approximately in two times with respect to the magnitude ascribed and accepted in modern physics for the momentum.

The ratio of the *orbital magnetic moment* of the electron,

$$\mu_{e,orb} = \frac{e\upsilon_0 r_0}{c}, \tag{36}$$

to its *orbital moment of momentum*,

$$\hbar = m_e \upsilon_0 r_0, \tag{37}$$

(called in physics the "*gyromagnetic*" ratio) completely coincides with the ratio obtained in Einstein–de Haas's and Barnet's experiments; namely,

$$\frac{\mu_{e,orb}}{\hbar} = -\frac{e}{m_e c}. \tag{38}$$

According to the DM, the exchange charge is defined from the equality,

$$e = m_e \omega_e. \tag{39}$$

Therefore, substituting (39) into (38), we see that the "gyromagnetic" ratio (38) is nothing more as one more (unknown up till in modern physics) of the expressions of the wave number k_e corresponding to the fundamental frequency of atomic and subatomic levels, ω_e; actually,

$$\frac{e}{m_e c} = \frac{\omega_e}{c} = \frac{1}{\lambda\!\!\!^{-}_e} = k_e, \tag{40}$$

This result is valid not only for the orbiting electron in a free hydrogen atom, but also for the motion of an electron along an orbit in hydrogen atoms located (and, hence, bound up) in

nodes of nucleonic molecules, which are in essence all the rest elements of the Periodic Table, according to the Shell-Nodal Atomic Model [13].

Thus, in modern physics, only a half of the true value (36), *i.e.*, $\mu_{e,orb} = \frac{1}{2}\frac{e\upsilon_0 r_0}{c}$, (as turned out to be erroneously) is ascribed to the orbital magnetic moment of the electron. It happened historically due to a great error made by theorists while calculating the orbital magnetic moment of the electron moving along a proton in the classical Bohr atomic model.

The lost half of the moment at the calculations was ascribed, subjectively, to the non-existent proper magnetic moment of the electron, which became to be called the *spin magnetic moment*. This happened beginning from 1925 when Uhlenbeck and Goudsmit have suggested a hypothesis, according to which an electron (considered at that time as a spherical particle) may have its own proper (rotational) mechanical moment and, hence, it must have its own proper (rotational) magnetic moment corresponding to the mechanical one. Such an idea has turned out to be inadequate to the physical model of an electron existing to that time. Then, to avoid this difficulty, the *electron spin* became considered as an *intrinsic property* of electrons, which did not relating to none mechanical motion (rotation).

From the results presented in this Lecture it follows that the electron does not have the own mechanical moment, *spin*, of one half of its orbital moment of momentum, $s_e = \frac{1}{2}\hbar$, just like the electron does not have the corresponding *spin magnetic moment* of one half of the orbital magnetic moment of the electron (called the Bohr magneton μ_B) with taking into account the tiny term of the so-called "anomaly", α_e ($1.1596521535\times10^{-3}$): $\mu_{e,s} = (1+\alpha)\mu_B$.

Conclusion presented in this Lecture is very important. Actually, it is difficult to imagine modern physics theories without use of such a "fundamental physical" property as is spin. Therefore, we will continue the discussion of this topic in the following two Lectures, uncovering somewhat more of the details, confirming validity of the above conclusion.

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Lecture 5

Electron "Spin": the Great Error of Modern Physics

1. Introduction

In this Lecture we use almost completely without editing on the merits and not changing the style of writing the paper published in the author's book [1].

A very gross error was made by theorists to explain the experimental results obtained by Einstein and de Haas in their measurements of magnetomechanical (gyromagnetic) ratio [2]. From the resulting data it follows that the ratio of the magnetic moment $\mu_{e,\exp}$ of an electron, moving along the Bohr orbit (they relied on the Bohr model of an atom), to its mechanical moment $\hbar = m_e \upsilon_0 r_0$ is equal to

$$\frac{\mu_{e,\exp}}{\hbar} = -\frac{e}{m_e c}. \tag{1}$$

This result exceeded twice the expected value, which followed from the calculations made by theorists:

$$\frac{\mu_{e,theor}}{\hbar} = -\frac{e}{2m_e c} \tag{2}$$

(minus sign indicates that the direction of the moments are opposite).

Clearly in this situation it would be prudent to carefully check the validity of the relevant basic formulas used in the derivation of the theoretical ratio (2). By definition, that modern physics holds still, the calculation of the orbital magnetic moment of an electron in an atom is realized by a simple formula, which determines the magnetic moment of a closed circular loop of electric current,

$$\mu_{orb} = \frac{I}{c} S, \tag{3}$$

where I is an average value of circular current, S is the area of the circuit (orbit), c is the speed of light.

In accordance with the definition of electric current used in electrical engineering, considered as a flow of electric charge ("electron fluid") in a conductor, the calculation of the average value of electric current generated by the orbiting electron was carried out (as proven to be here, poorly thought-out and wrong) by the following formula

$$I = \frac{e}{T_{orb}}, \tag{4}$$

where T_{orb} is the period of electron revolution along the orbit, e is the electron charge. Hence,

$$\mu_{orb,theor} = \frac{I}{c} S = \frac{e}{cT_{orb}} S = \frac{e\upsilon_0}{c2\pi r_0} \pi r_0^2 = \frac{\upsilon_0}{2c} e r_0, \tag{5}$$

that led to the ratio (2) of the moments twice less than the experimentally obtained value (1). It is obvious, one needed to find the error. However, for some reason no one did not put the question, is formula (4) valid or not? This circumstance first had to draw the attention of theorists. The matter is that we are not dealing with a current of "electron fluid" (or "electron gas"), but with a current generated by a single electron charge, moreover, while moving along a closed circuit.

We filled the gap in this matter by revealing shortcomings and finding an answer to the question posed above. Here are our arguments.

2. Current generated by an orbiting electron

1. Let us consider what the average value of current in fact is created by a single (discrete) charge moving along a closed path (Fig. 1).

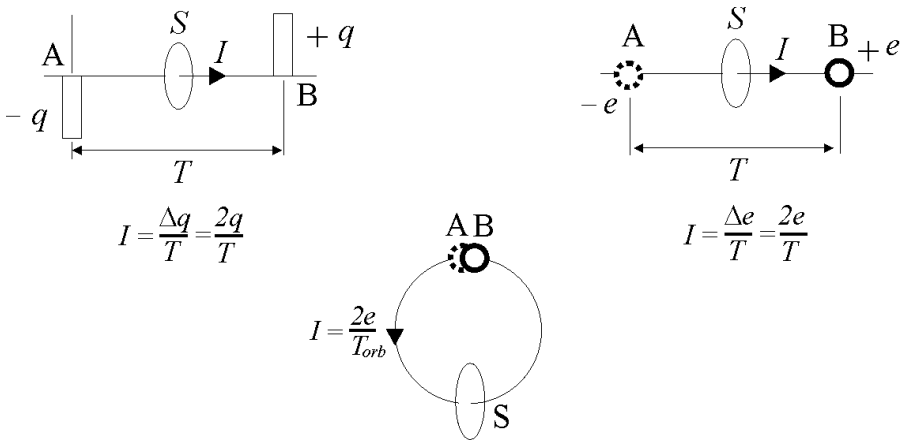

Fig. 1. The charge transfer of the electron, *e*, through any cross-section *S* of a conductor.

In a general case, the charge transfer of the electron, *e*, through any cross-section *S* along any path during the time *T* is accompanied with disappearance of the charge from one side (-*e*, point A) and appearance on the other side (+ *e*, point B) of an arbitrary cross-section, as shown in Fig. 1.

Let us explain once again. During a period of time *T*: disappearance of the charge from the left side means REDUCTION of the charge at this side from the value of +*e* down to 0, i.e. the reduction on the amount of charge –*e*. And appearance of the charge on the right side of the cross-section means GAIN of the charge at this side from the value of 0 up to +*e*, i.e. the gain on the amount of charge +*e*. Thus, during the time *T*, the complete charge change is $\Delta e = +e - (-e) = 2e$. Hence, an average rate of the charge change (current *I*) during the time *T* is

$$I = \frac{\Delta e}{T} = \frac{(+e-(-e))}{T} = \frac{2e}{T} \tag{6}$$

And in the case of a circular orbit, when points A and B coincide, the electron, bearing the charge *e*, passes through the cross-section S with an average speed

$$I = \frac{2e}{T_{orb}}, \tag{7}$$

where T_{orb} is the period of electron's revolution on a circular orbit.

Additionally, let us come to the derivation (7) by the traditional way, without disturbing the existing logic in the accepted concept of determining the average current. To do this, for more clarity, we deform the orbit compressing it, as shown in Fig. 2. As a result, we obtain something like a closed two-wire line.

How many times do you think, one orbital electron moving along the closed loop (i.e., during one complete revolution, T_{orb}) and passing in the vicinity of the point "O", first up (the average current in the left half of the trajectory is $I_{left} = e/(1/2)T_{orb}$) and then down (the average current on the right half of the trajectory is $I_{right} = e/(1/2)T_{orb}$), creates a transverse (vortical) magnetic field at that point?

As they say "no brainer" that two times: at first moving on the left side and then moving on the right side of the loop near the centre "O". It's like as 2 charges slipped... I wonder, is it? In this case the usual formula obtained from the definition of the average current adopted in physics ($I = q/T$) is not violated. The average value of current on both sides and, therefore, around a whole closed two-wire line is the same and equal to

$$I = I_{left} = I_{right} = \frac{2e}{T_{orb}}$$

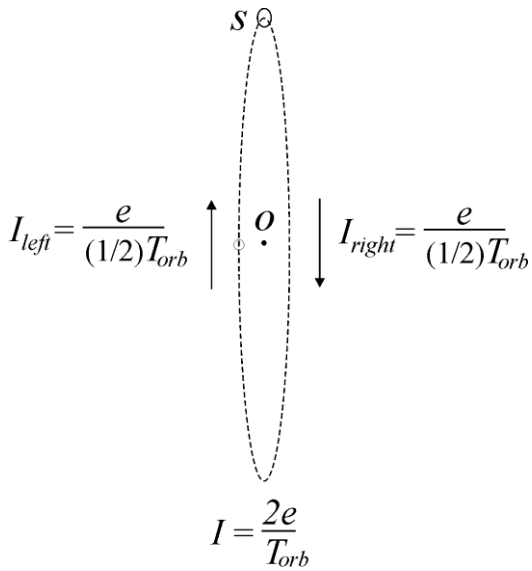

Fig. 2. An average current in a closed two-wire line.

2. Since the electron just like any other elementary particle manifests duality, i.e. exhibit the behaviours of both waves and particles, it is reasonable and necessary without any doubts to derive the formula of the average current for the case of the wave motion of the electron.

а) Let's begin with the one-dimensional problem. From the well-known solution of the wave equation for the string of a length *l*, fixed at both ends, it follows that only one half-wave of the fundamental tone is placed at its full length, $l = \frac{\lambda_1}{2}$. If we join the ends of the string together, then we obtain a circle of the length $l = 2\pi r_0$ with one node. As a result, we come to the equality

$$2\pi r_0 = \frac{\lambda_1}{2} = \frac{\upsilon_0 T_0}{2}, \qquad (8)$$

where υ_0 is the wave speed in the string, T_0 is the wave period.

б) In the simplest case of three-dimensional solutions of the wave equation for a spherical field [3], we arrive at the same equation (8): only one half-wave of the fundamental tone is placed on the Bohr orbit, and the electron is in a node of the wave.

Thus (according to (8)), the wave period of the fundamental tone at the wave surface of the radius r_0 is equal to

$$T_0 = \frac{4\pi r_0}{\upsilon_0} \,. \tag{9}$$

An average value of electric current as the harmonic magnitude is determined by the known formulas:

$$I = \frac{2}{iT}\int_0^{T/2} I_m e^{i\omega t} dt = \frac{2}{\pi} I_m \quad \text{or} \quad I = \frac{1}{2\pi i}\int_0^{2\pi} I_m e^{i\varphi/2} d\varphi = \frac{2}{\pi} I_m \tag{10}$$

In the expression (10), the amplitude I_m of the elementary current is

$$I_m = \left(\frac{dq}{dt}\right)_m = \omega_0 e = \frac{2\pi e}{T_0} \,, \tag{11}$$

where ω_0 is the angular frequency of the fundamental tone of the electron orbit. Thus, substituting (11) into (10), we obtain

$$I = \frac{4e}{T_0} \,. \tag{12}$$

or, as $T_0 = 2T_{orb}$,

$$I = \frac{2e}{T_{orb}} \,. \tag{13}$$

Other options to derive an average value of current generated by an individual electron moving in a circular orbit are presented in [2]. They all give the same magnitude defined by the formula (13), but not by (4). The definition of electric current and the relevant problem of electron spin are analyzed in detail in the fundamental book "*Atomic Structure of Matter-Space*" (2001) [3]. It's quite comprehensive book in which all the questions that just might be are analysed, and their solutions are presented. In particular, a small fragment of the book, namely paragraphs 9 and 10 of Chapter 9 (from 453 to 494 pages), which examines the concept of current, is available online on the internet in PDF format [4].

Thus, a problem of the average current was solved by the authors of [3], an erroneous expression (4) was corrected. The resulting formula for the circular current (13) differs by the multiplier 2 from the erroneous formula (4). Unfortunately, the latter is still remained in physics for the explanation of the Einstein-de Haas measurement data and other phenomena...

Substituting the average value of current (13) into (3), we arrive at the correct formula for the orbital magnetic moment of an electron (logically, physically and mathematically conditioned), which at anybody can no longer call doubts.

$$\mu_{orb} = \frac{I}{c} S = \frac{2e}{cT_{orb}} \pi r_0^2 = \frac{\upsilon_0}{c} e r_0 . \tag{14}$$

Accordingly, the ratio of the orbital magnetic moment (14) to its mechanical moment (the moment of its orbital momentum, $\hbar = m_e \upsilon_0 r_0$), taking into account the sign (the opposite direction of moments), is equal to

$$\frac{\mu_{orb}}{\hbar} = -\frac{\upsilon_0 e r_0}{c m_e \upsilon_0 r_0} = -\frac{e}{m_e c} . \tag{15}$$

The resulting ratio of the moments, the theoretical derivation of which was given above, coincides with the ratio of the moments (the gyromagnetic ratio) (1) obtained in Einstein-de Haas and Barnett experiments.

3. Conclusion

The true absolute value of the intrinsic magnetic moment of an electron bound in an atom (that have not been considered here) is negligible compared to the relatively huge value ascribed to it at half the orbital magnetic moment (and called the Bohr magneton). What is its precise value and how it was calculated one can find in [5].

We have shown here, hope it was made clear and convincingly enough, that if 100% trust the experimental results, theorists should be first to find an obvious mistake in the formula used by them for the calculation of electric current generated by an individual electron moving on the Bohr orbit, but did not engage in fantasy. The strength of electric current *I* is the only variable physical quantity (calculated according to its definition) that determines the magnitude of the magnetic moment at constant values of *c* and *S* (see Eq. (3)).

In the mathematical formulation of the definition of electric current accepted in physics for the particular case, which is the motion of a single charge along a closed path, one had to be careful and think (for good reason there is a saying: "look before you leap, cut once"). It is an elementary logical task, cope with it and school children and students, but it has never been put forward for consideration, although this task is fundamentally important and, moreover, good for the development of logical thinking of physicists.

It seems simple, "as the rake", but for some reason, the problem under consideration was not resolved by theorists at that time. Apparently, so necessary revision was not taken into

account because of their firm belief in validity and universality of the formula (4). Therefore, to get out of the situation with which they were faced owing to the result (2), theorists preferred to follow the trodden path of their predecessors and put forward the postulate about the allegedly existing in reality an intrinsic mechanical moment of the electron, which was called then an electron spin.

Namely to find the missing half in the calculations, resulted in the ratio (2), to fit the latter to the experimental ratio (1), they groundlessly *ascribed* to the electron, in addition to its real fundamental (intrinsic) properties, such as mass and charge, a virtual (mythical) and, therefore, an unreal "fundamental characteristic" property, *spin*. As a consequence, it appeared at once the mythical *electron spin magnetic moment* associated (conjugated) with the mythical spin, the absolute value of which was called the *Bohr magneton*, μ_B:

$$\mu_{spin} \equiv \mu_B = \mu_{orb,theor} = \frac{\upsilon_0}{2c} er_0 \tag{16}$$

With the help of a mythical spin magnetic moment, theoreticians "closed the gap" in their calculations of the gyromagnetic ratio (2). Thus, the "lost" (in their calculations) half of the orbital magnetic moment of the electron, bound in an atom, was called by theorists the electron spin magnetic moment. Then this "lost" orbital half (under the name of spin magnetic moment or the Bohr magneton) was fastened to the half of the orbital magnetic moment (5) that they received theoretically:

$$\mu_{e,theor} = \mu_{orb,theor} + \mu_{spin} = \frac{\upsilon_0}{2c} er_0 + \frac{\upsilon_0}{2c} er_0 = \frac{\upsilon_0}{c} er_0 \tag{17}$$

Put together the two halves, actually, of the same orbital magnetic moment, have been named the *total magnetic moment* of an electron in an atom, $\mu_{e,theor}$. As a result of such an obvious and explicit fitting, the complete coincidence with the experimentally obtained gyromagnetic ratio (1) was achieved:

$$\frac{\mu_{e,theor}}{\hbar} = \frac{\mu_{orb,theor} + \mu_{spin}}{\hbar} = \frac{\mu_{e,\exp}}{\hbar} = -\frac{e}{m_e c} \tag{18}$$

It was an epoch-making error; it marked the beginning of the present spin mania in physics, which continues to this day. Unfortunately, if to say honest, in result of such an explicit blunder, physics has taken the wrong way. At the present time, modern physics cannot exist without the notion of spin. Apparently, to someone, it was truly necessary to discard the humanity in his cognition of nature to centuries ago, directing physics in a wrong direction to create a virtual reality: driving physics in a dead end, to hinder the development of our civilization. Consciously or not, but in this kind of virtual (absurd) creations of the 20th century, many eminent theoretical physicists of that time took part...

As was noted, the relatively enormous absolute value of $\frac{1}{2}\hbar$ was attributed to electron spin that is comparable with a half value of electron's angular orbital moment. With this, it is believed that an existence of the intrinsic mechanical moment, spin, of the electron of such a magnitude was confirmed experimentally. However, where is the direct evidence? Where are experiments to determine the spin *on free electrons*, but not on the electrons which bound to atoms? They are not.

Thus, we see that explaining a series of phenomena observed experimentally, physicists, using the mythical (fabricated, postulated) concepts such as the electron spin, considered here, or like virtual particles of quantum electrodynamics, draw a distorted picture of reality. In fact, they create virtual, mythical world (science fiction).

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Lecture 6

On the Electron Spin of $\hbar/2$

1. Introduction

We have learned from previous Lectures that the notion of *spin* has appeared in physics due to a primitive blunder made during a theoretical description of Einstein's-de Haas's experiment. As a result of such a fault, the formal fitting of the erroneous theoretical ratio of the moments, to which has come theorists, to the true ratio obtained experimentally has been performed. This fitting was achieved quite subjectively by an attribution to an electron the hypothetical property, according to which an electron has its own (called "spin") mechanical and magnetic moments.

In scientific literature till now there is no little or less convincing and trustworthy information about experiments with *free electrons* on the detection of own (spin) moments, which electrons allegedly have. Therefore, it is not surprising that an existence in reality of such an invented property calls natural doubts

In this Lecture, using some additional arguments, we will show again, that the ratio of electron's *orbital magnetic moment*, derived just in the framework of the DM, to its *orbital moment of momentum* is equal to the same ratio that was obtained in Einstein's-de Haas's and Barnet's experiments, namely, that

$$\frac{\mu_{orb}}{\hbar} = -\frac{e}{mc}. \tag{1}$$

We recall that appearance of the notion of electron spin of the $\frac{1}{2}\hbar$ value is a direct consequence of the *erroneous* theoretical formula derived for the electron's *orbital magnetic moment* μ_{orb} that, in turn, naturally has led to the *erroneous ratio* of the latter to the electron's *moment of momentum* $\hbar$ on the Bohr orbit:

$$\frac{\mu_{orb}}{\hbar} = -\frac{e}{2mc}. \tag{2}$$

Atomic magnetism is created by moving charges in the atoms that make up a material. Therefore, the fault with the formula for the value of μ_{orb} in the hydrogen atom is a result of the incorrect determination of electric *current* generated by the orbiting electron. The current has been calculated in the framework of the *mechanical model* of uniform motion of the electron regarded, in a classical spirit of the definition of current, as a flow of electric charge ("electron liquid") in a conductor.

According to such a primitive mechanical model, disregarding the closed electron motion along a circle and peculiarities of the wave motion, the *average value of orbital current*, caused by the orbiting electron in the hydrogen atom, was accepted to be equal to the ratio,

$$I = \frac{e}{T_{orb}}, \tag{3}$$

where T_{orb} is the period of electron's revolution along an orbit.

As proven to be from comprehensive analysis carried out by the authors of the theory based on the dialectical approach and wave concepts considered in these Lectures [%], the resulting formula (3) is erroneous. Being accepted in physics as true, it gave rise to all further inevitable fittings of theoretical data to the data obtained in subsequent experiments where magnetic properties manifest themselves in studying phenomena.

By definition of the 1930's, the magnetic moment of a closed electric circuit, in a specific case of the orbiting electron in the hydrogen atom, is determined by the following formula,

$$\mu_{orb} = \frac{I}{c} S, \tag{4}$$

where I is the average value of current on the orbit, and S is the area of the orbit.

In the formula (4), the ratio $\Gamma = \frac{I}{c}$ is *circulation* [1] (we will discuss this notion in Lecture 8). However, in physics, the Γ-ratio is regarded as the *current in the magnetic system of units, CGSM*. Note in this connection that the relation between "*electric*" current I and the so-called "*current" in the CGSM system* (circulation Γ) was verified experimentally as far back as in 1856 by Kohlrausch and W. Weber.

Resting upon the incorrect ratio (3) and the accepted definition (4), the incorrect orbital magnetic moment was obtained by theorists in the form,

$$\mu_{orb} = \frac{\upsilon_0}{2c} e r_0 . \tag{5}$$

The latter led to the erroneous ratio (2). The value (5) (as (2) and (3)) is half as much the real ratio obtained experimentally by A. Einstein and De Haas [2-3]. This is inconsistent also with S.J. Barnett's experiments [4, 5], *etc*. At that time, instead of seeking the error in the

theoretical derivation of the aforementioned expressions, the hypothesis-fitting about allegedly the existence of the own moments of the atoms was unreasonably and hastily accepted.

Following this hypothesis, the *proper magnetic moment* μ_s equal, in magnitude, to the erroneous orbital magnetic moment μ_{orb} (5) was attributed to the electron. Further, naturally, in order to reduce in correspondence with the proper magnetic moment μ_s, the "*proper moment of momentum*" $\hbar_s$ (called "*spin*"), of the $\frac{1}{2}\hbar$ value, was introduced as well. From that time the electron spin began considered in physics as the fundamental constant, along with already existing truly fundamental physical constants such as the electron mass and charge.

Thus, the correspondence of the theory to the experiment was achieved in result of the mathematical adjustment:

$$\frac{\mu_{orb}+\mu_s}{\hbar}=\frac{e}{mc}. \qquad (6)$$

Dirac's *relativistic wave theory of spin* (1928) [6], created for the proof of the correctness of an introduction of the spin of such a value, "proved" it. From that time, the further development has led to the electron being regarded, not as a particle defined by three spatial coordinates, but as a top-like structure, possessing an angular momentum of its own.

Dirac noted in this connection [7] that the aim is
"*not so much to get a model of the electron as to get a simple scheme of equations which can be used to calculate all the results that can be obtained from experiment*".

As a result, due to the gross fitting, the formal correspondence of the "theory" with the experiment was realized. We state it resting upon the data [1], which convincingly show that Eq. (3) for the average value of current of the orbiting electron is erroneous. Accordingly, all equations obtained on its basis (including (2) and (6), *etc*.) are incorrect as well.

Let us turn to this problem on the basis of calculation of the wave motion of the orbiting electron, considering the electron as a *particle-wave*. The electron (particle), being the discrete part of the wave, is represented by the wave node.

2. Orbital moments

From the well-known solution of the wave equation for a string with the length *l* fixed at both ends, $l=\frac{\lambda}{2}n$ (where $n=1,2,3,...$), follows that *one half-wave of the fundamental tone* $\nu_1=\frac{\upsilon_0}{\lambda_1}$ (where υ_0 is the wave speed in the string) is placed on its whole length *l*: $l=\frac{1}{2}\lambda_1$.

If the ends of the string are joined together, forming a string circle of the length $l = 2\pi r_0$ with one node, we have

$$2\pi r_0 = \frac{1}{2}\lambda_1 \qquad \text{and} \qquad \nu_1 = \frac{1}{T_1} = \frac{\upsilon_0}{4\pi r_0}. \tag{7}$$

Similar to the case of the wave field of a string, only a *half-wave of the fundamental tone* is placed on the Bohr first orbit, and the electron is in the node of the wave. Actually, in the simplest case of the spherical field, elementary radial solutions of the wave equation are equal to

$$\hat{R}_l(\rho) = \frac{A\hat{e}_l(\rho)}{\rho}, \tag{8}$$

where

$$\hat{e}_l(\rho) = \sqrt{\frac{\pi\rho}{2}} H^{\pm}_{l+1/2}(\rho) = \sqrt{\frac{\pi\rho}{2}}\left(J_{l+1/2}(\rho) \pm iN_{l+1/2}(\rho)\right); \tag{9}$$

A is the constant factor; $\rho = kr$; $H^{\pm}_{l+1/2}(\rho)$, $J_{l+1/2}(\rho)$ and $N_{l+1/2}(\rho)$ (or $Y_{l+1/2}(\rho)$) are the Hankel, Bessel and Neumann functions, correspondingly; $k = \frac{\omega}{c}$ is the wave number.

The argument ρ can take values within the interval from $\rho_1 = kr_0$ to $\rho = \infty$. The radial parameter r_0 (the Bohr radius) is the radius of the sphere-shell, separating the proper space of the hydrogen atom (with its "atmosphere") from the surrounding field-space of matter. This shell of the radius r_0 is the boundary shell of the wave atomic space, from below, while the upper boundary shell is boundless.

At $l = 0$, the simplest solution is

$$\hat{R}_0(\rho) = A\hat{e}_0(\rho)\rho^{-1} = A\sqrt{\frac{\pi\rho}{2}} H^{+}_{1/2}(\rho)\rho^{-1} = A(\sin\rho + i\cos\rho)\rho^{-1}, \tag{10}$$

The condition

$$\operatorname{Re} R_0(kr) = \frac{A\sin kr}{kr} = 0 \tag{11}$$

defines the radii of potential spheres (shells), situated from each other at the distance of a radial half-wave,

$$kr = n\pi \qquad \text{or} \qquad r = \frac{n}{2}\lambda_r. \tag{12}$$

On the boundary shell (coinciding with the first Bohr orbit r_0), the condition (12) takes the form

$$r_0 = \frac{\lambda_r}{2} \qquad \text{or} \qquad \lambda_r = 2r_0 . \tag{13}$$

Hence, the radii of stationary shells turn out to be multiple to the radius of the boundary shell,

$$r = \left(\frac{n}{2}\right)\lambda_r = r_0 n . \tag{14}$$

A *radial* wave of the boundary shell defines the *azimuth* wave of the shell,

$$\lambda_0 = 2\pi\lambda_r = 4\pi r_0 , \tag{15}$$

which is the elementary wave of the fundamental tone (analogous to λ_1 in Eq. (7) for a string circle). Accordingly, the wave period of the fundamental tone, on the wave surface of the radius r_0, is

$$T_0 = \frac{4\pi r_0}{\upsilon_0} . \tag{16}$$

Because one half-wave is placed on the orbit, the average value of current I, as a harmonic quantity, is determined by the integrals:

$$I = \frac{2}{iT}\int_0^{T/2} I_m e^{i\omega t} dt = \frac{2}{\pi} I_m \text{ or} \qquad I = \frac{1}{2\pi i}\int_0^{2\pi} I_m e^{i\varphi/2} d\varphi = \frac{2}{\pi} I_m . \tag{17}$$

The amplitude of the elementary current is defined as

$$I_m = \left(\frac{dq}{dt}\right)_m = \omega e , \tag{18}$$

where ω is the frequency of the fundamental tone of the electron orbit, equal to

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{4\pi r_0 / \upsilon_0} = \frac{\upsilon_0}{2r_0} , \tag{19}$$

$T = 2T_{orb}$ is the wave period. Hence, the average current of the electron orbit is

$$I = \frac{4e}{T} = \frac{2e}{T_{orb}} \qquad \text{or} \qquad I = \frac{2}{\pi}\frac{\upsilon_0 e}{2r_0} = \frac{1}{\pi}\frac{\upsilon_0 e}{r_0} . \tag{20}$$

Taking (4) into consideration, we find *the orbital magnetic moment of the electron*, as the *magnetic moment of harmonic wave of the fundamental tone*,

$$\mu_{orb} = \frac{1}{\pi}\frac{\upsilon_0 e}{c r_0}\pi r_0^2 = \frac{\upsilon_0}{c} e r_0 . \tag{21}$$

From this it follows that the ratio of the orbital magnetic moment of the electron to the moment of its orbital momentum is

$$\frac{\mu_{orb}}{\hbar_{orb}} = \frac{\upsilon_0 e r_0}{cm\upsilon_0 r_0} = \frac{e}{mc}. \tag{22}$$

Just this formula was confirmed experimentally. It undoubtedly proves the inconsistency of the hypothesis on the electron's spin of $\frac{1}{2}\hbar$.

3. Current in circular motion

The motion *in inner space* of a circular trajectory, along two successive half-circumferences, occurs in one direction (clockwise or anticlockwise) (Fig. 1a).

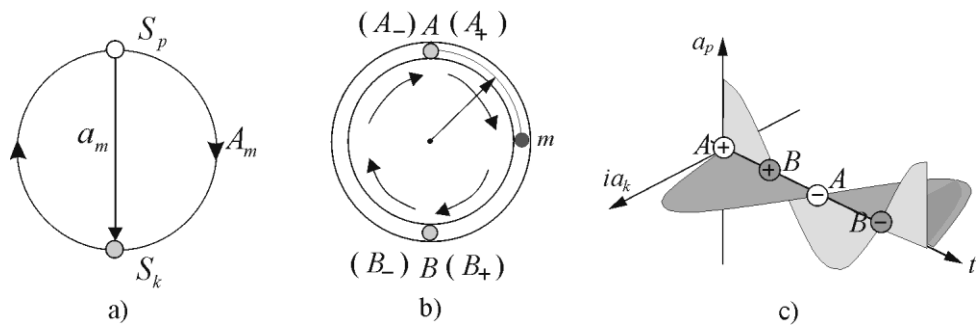

Fig. 1. Amplitudes of displacement, a_m and A_m, in a wave of the fundamental tone on a circumference (a); S_p and S_k are potential and kinetic points (nodes) of the wave. A circular mathematical pendulum (b) and a graph of the potential-kinetic field of its motion (c).

Simultaneously, the same motions *in outer space*, as mutually relative ones, are opposite-directed. This fact shows the contradictoriness of the circular motion. If S_p is an arbitrary potential point of a wave of the fundamental tone (*i.e.*, its node), then, the conjugated diametrically opposite point S_k will be the kinetic point of the wave (its loop). In the longitudinal wave of the fundamental tone, the rectilinear amplitude of displacement is equal to the diameter of a circumference, $a_m = 2r$. The amplitude of the curvilinear displacement along a circumference is equal to half-circumference, *i.e.*, a quarter-wave: $A_m = \pi r$.

For the independent proof of the formula (20), let us analyze the motion of the circular mathematical pendulum. The circular pendulum of mass m is connected with an elastic spring, fixed in a point A inside of an absolutely smooth horizontal transparent hollow ring of radius r (Fig. 1b). The spring is shown, conditionally, in the form of a thin thread. The point A is a point of the unstable states of rest: A_+ and A_- (potential points). The point B is a point of the equilibrium state, represented by the two states of motion: B_+ and B_- (kinetic points).

Two circular motions represent the complete swing of the pendulum. The swing starts in the point A in the state A_+. In this state, the spring is completely compressed and the displacement from the equilibrium state B is equal to the kinetic amplitude of displacement with the positive sign: $+a = +\pi r$. The pendulum passes the point B with the positive maximal velocity in the kinetic state B_+. Then, it reaches the point A in the potential state A_-. In this state, the displacement is equal to the kinetic amplitude of displacement with the minus sign: $-a = -\pi r$.

The half-period of the swing is completed in the state A_-. Along with this, one circular motion is completed. The second half-period begins from the state A_-. Then, the pendulum passes the point B in the kinetic state B_- with the negative maximal velocity and returns in the initial state A_+. The period of the swing is T and the half-period $T_{orb} = \frac{1}{2}T$ is the time of one revolution along a circle.

The potential-kinetic displacement of pendulum along a circle is

$$\hat{a} = a_p + ia_k = ae^{i\omega t} = a\cos\omega t + ia\sin\omega t, \tag{23}$$

where a_p and ia_k are the potential and kinetic displacements, $a = \pi r$ is the amplitude of displacement from the equilibrium state B up to the point of rest A. The field of potential-kinetic velocity

$$\hat{\upsilon} = \frac{d\hat{a}}{dt} = i\omega a e^{i\omega t} \tag{24}$$

is characterized by the average value of velocity

$$\upsilon = \frac{2}{T}\int_{-T/2}^{0} \hat{\upsilon}dt = \frac{2}{T}ae^{i\omega t}\Big|_{-T/2}^{0} = \frac{4}{T}a = \frac{4\pi r}{T} = \frac{2\pi r}{T_{orb}}, \tag{25}$$

where T_{orb} is the half-period of oscillation (the time of one revolution along a circle). If the circular motion is periodic, the form of the function of velocity does not matter, because the average velocity in all cases (including the uniform motion) will be equal to the ratio of the circumference length by the period of revolution (25).

The uniform motion along a circle is the amplitude wave motion with the wave period T lasting two periods of revolutions (of one circular motion). Each wave motion represents by itself the synthesis of two plane polarized unit oscillations-waves along mutually perpendicular directions.

The potential-kinetic mass of the pendulum, $\hat{m} = me^{i\omega t} = m_p + im_k$ describes its potential-kinetic state. It represents the mass potential-kinetic wave. The potential-kinetic field of change of state of the mass is the wave field of the potential-kinetic charge:

$$\hat{q} = \frac{d\hat{m}}{dt} = i\omega\hat{m}\,. \tag{26}$$

In turn, the field of change of the potential-kinetic charge is the field of potential-kinetic (kinematic) current:

$$\hat{I} = \frac{d\hat{q}}{dt} = \frac{d^2\hat{m}}{dt^2} = i\omega\hat{q} = -\omega^2\hat{m}\,. \tag{26a}$$

In potential points, A_+ and A_-, specific wave states of mass and charge are equal, respectively, to

$$A_+: \quad \hat{m}(0) = me^{i\omega t}\Big|_{t=0} = m\,, \qquad \hat{q} = i\omega\hat{m}(0) = i\omega m\,. \tag{27}$$

$$A_-: \quad \hat{m}(0) = me^{i\omega t}\Big|_{t=T/2} = -m\,, \qquad \hat{q} = i\omega\hat{m}(0) = -i\omega m\,. \tag{28}$$

Analogously, in the kinetic points, B_+ and B_-, we have

$$B_+: \quad \hat{m}(\tfrac{1}{4}T) = me^{i\omega t}\Big|_{t=T/4} = im\,, \qquad \hat{q} = i\omega\hat{m}(\tfrac{1}{4}T) = -\omega m\,. \tag{29}$$

$$B_-: \quad \hat{m}(\tfrac{3}{4}T) = me^{i\omega t}\Big|_{t=3T/4} = -im\,, \quad \hat{q} = i\omega\hat{m}(\tfrac{3}{4}T) = +\omega m\,. \tag{30}$$

Thus, in the potential points, the charges are potential; in the kinetic points, the charges are kinetic.

The average value of the potential current, in any cross-section, is defined by the formula:

$$iI = \frac{2}{T}\int_{-T/2}^{0}\hat{I}dt = -\frac{2}{T}\omega^2\int_{-T/2}^{0}\hat{m}dt = \frac{2}{T}mi\omega e^{i\omega t}\Big|_{-T/2}^{0} = \frac{4qi}{T} = \frac{2qi}{T_{orb}}\,, \tag{31}$$

where $q = m\omega$ is the amplitude of the kinematic charge.

Analogously, the average value of the kinetic current, in any cross-section, is

$$I = \frac{4q}{T} = \frac{2q}{T_{orb}}\,. \tag{32}$$

In the uniform motion along a circumference, as an amplitude wave, the value of current in a cross-section of any point B (Fig. 2) has the same value:

$$I = \frac{2}{T}\int_{T/4}^{3T/4} Idt = \frac{2}{T}\int_{T/4}^{3T/4} dq = \frac{2}{T} q\Big|_{T/4}^{3T/4} = \frac{2}{T}\big((\omega m) - (-\omega m)\big) = \frac{4}{T} m\omega = \frac{4q}{T} = \frac{2q}{T_{orb}}. \tag{33}$$

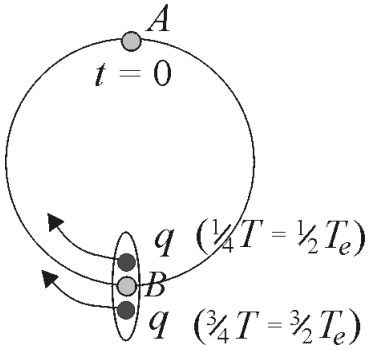

Fig. 2. On the calculation of average current, flowing through a cross-section *B*, if only one charge *q* circulates.

4. Proper moments

Of course, an electron has its own magnetic field and magnetic moment and moment of momentum. But the last is essentially smaller in comparison with the orbital moment. Let us imagine that the proper moment of momentum of the Earth is equal to one half of its orbital moment of momentum. The Earth cannot endure such a huge moment and will be destroyed. The same situation will meet an electron with the "spin" equal to $\frac{1}{2}\hbar$.

Let us estimate the possible values of electron's *proper* magnetic moment and spin. This is not so difficult to perform relying on the formula (21), which is also valid for the electron's proper motion. According to this expression, the possible limiting value of the *electron magnetic moment of its own* can be estimated by the following formula

$$\mu_{pr,\max} = \left(\frac{\upsilon_e}{c}\right) e r_e. \tag{34}$$

In motion, the field of any microparticle, including an electron, is cylindrical, representing a wave trajectory, where an amplitude component of the oscillation speed of the cylindrical field is

$$\upsilon = \frac{\omega a}{\sqrt{kr}}. \tag{35}$$

Here, a is the constant of the field, equal to the amplitude of oscillations at the wave cylindrical surface under the condition $kr = 1$. The formula (35) determines the relation between the speeds and radii of two arbitrary wave surfaces-shells:

$$\upsilon = \left(\frac{r_0}{r}\right)^{1/2} \upsilon_0 . \tag{36}$$

If we rely upon the Bohr radius and speed, r_0 and υ_0, then the speed υ_e of the field at the surface of the electron wave shell with the radius r_e must be equal to

$$\upsilon_e = \left(\frac{r_0}{r_e}\right)^{1/2} \upsilon_0 , \tag{37}$$

Taking it into account, we arrive at

$$\mu_{pr,\max} = \left(\frac{r_e}{r_0}\right)^{1/2} \frac{\upsilon_0}{c} e r_0 = \left(\frac{r_e}{r_0}\right)^{1/2} \mu_{orb} \approx 0.28 \cdot \mu_{or} , \tag{38}$$

where

$$r_e = \left(\frac{m}{4\pi\varepsilon_0}\right)^{1/3} = 4.169586759 \cdot 10^{-10} cm \tag{39}$$

is the theoretical [1, 8] radius of the electron wave sphere; $r_0 = 5.291772083 \times 10^{-9} cm$ is the Bohr radius; $\varepsilon_0 = 1\, g \times cm^{-3}$ is the absolute unit density; $m = 9.10938188 \times 10^{-28} g$ is the electron mass.

The following *proper moment of momentum* of the electron, at most, could be:

$$\hbar_{pr,\max} = m\upsilon_e r_e = \frac{mc}{e} \mu_{pr,\max} = \frac{mc}{e} \left(\frac{r_e}{r_0}\right)^{1/2} \mu_{orb} = \left(\frac{r_e}{r_0}\right)^{1/2} \hbar_{orb} , \tag{40}$$

where

$$\hbar_{orb} = \frac{h}{2\pi} = m\upsilon_0 r_0$$

is the electron's *orbital moment of momentum* and h is the electron's *orbital action,* the Planck constant $h = 6.62606876 \times 10^{-34}\, J \times s$.

Again, the same standard relation (as for the orbital moments), in this case for the electron's proper moments, takes place between the possible magnetic moment (38) and the moment of momentum (40):

$$\frac{\mu_{pr,\max}}{\hbar_{pr,\max}} = \frac{e}{mc}. \tag{41}$$

5. The central ("*electric*") and transversal ("*magnetic*") electron charges

It makes sense to look again at the obtained expressions related to the electron charge. That can help, in a definite extent, to understand its possibly true nature, because

"*… a good theory of electron structure still is lacking… There is still no generally accepted explanation for why electrons do not explode under the tremendous Coulomb repulsion forces in an object of small size. Estimates of the amount of energy required to "assemble" an electron are very large indeed. Electron structure is an unsolved mystery…*" [9].

The ratio of the moment (21) and the orbital moment of electron's momentum on the Bohr first orbit $\hbar_{orb} = m\upsilon_0 r_0$,

$$\frac{\mu_{orb}}{\hbar_{orb}} = \frac{\upsilon_0 e r_0}{c m_e \upsilon_0 r_0} = \frac{e}{m_e c} = \frac{\omega_e}{c} = k_e. \tag{42}$$

defines the *wave number* k_e of the subatomic wave field of matter-space, the *fundamental frequency* of the field (Fig. 2),

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

and the corresponding *fundamental wave radius*,

$$\lambda\!\!\!^{-}_e = \frac{c}{\omega_e} = 1.603886998 \cdot 10^{-8}\, cm. \tag{44}$$

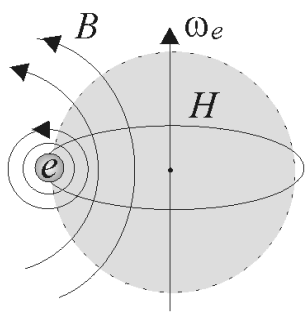

Fig. 2. An orbiting electron *e* in a space of the hydrogen atom and its transversal kinetic cylindrical *B*-field.

The *fundamental wave diameter* $2\lambda\!\!\!^{-}_e = 0.32\,nm$ correlates with the average value of lattice parameters in crystals, defining an average discreteness of space at the subatomic level of exchange (interaction). Thus, the formula (42) is in conformity with the experiment (if we will transform the common "electric" and "magnetic" units into the objective units of nature [1, 8]).

The electron charge enters in the expression for the total energy of the orbiting electron (where it is regarded as the charge *e* of the *central* field):

$$E = \frac{m\upsilon_0^2}{2} - \frac{e^2}{4\pi\varepsilon_0 r_0}. \tag{45}$$

Because $\frac{e^2}{4\pi\varepsilon_0 r_0^2} = \frac{m\upsilon_0^2}{r_0}$ and the electron mass is $m = 4\pi\varepsilon_0 r_e^3$ [8] (see Eq. (39)), we obtain

$$e^2 = 4\pi\varepsilon_0 m\upsilon_0^2 r_0 = \frac{4\pi\varepsilon_0 r_e^3 m\upsilon_0^2 r_0}{r_e^3} = \frac{m^2\omega_e^2\upsilon_0^2 r_0}{\omega_e^2 r_e^3} = \frac{q_e^2\upsilon_0^2 r_0}{\upsilon_e^2 r_e}. \tag{46}$$

Taking into account that in the cylindrical field $\upsilon_0^2 r_0 = \upsilon_e^2 r_e$, we have

$$e = q_e = m\omega_e. \tag{47}$$

It means that the *central* "potential" ("*electric*") charge *e* and the *transversal* "kinetic" ("*magnetic*") charge q_e of the electron are equal in value. We can arrive at the same conclusion on the basis of one more consideration. The orbiting electron forms the cylindrical wave field, which is limited from below by the electron radius r_e. Along the axis of the trajectory, each electron state corresponds to a part of the orbit, equal to the electron's diameter with the area of the cylindrical surface

$$S = 2\pi r_e d_e = 4\pi r_e^2. \tag{48}$$

On this surface, the transversal electron flow is defined by the transversal (cylindrical) charge

$$q_e = S\upsilon_e\varepsilon_0 = 4\pi r_e^2\upsilon_e\varepsilon_0. \tag{49}$$

On the other hand, the central electron flow is defined by the longitudinal (spherical) charge

$$e = 4\pi r_e^2\upsilon_e\varepsilon_0. \tag{50}$$

Accordingly, we again arrive at the conclusion that $e = q_e$.

The formula (47) and the data of the work [10] (devoted to the detail description of the wave behaviour of elementary particles) allow considering the electron as a particular

discrete physical point of an arbitrary level of matter-space-time pulsing at the fundamental (carrier) frequency of the subatomic level of matter-space-time ω_e. The electron mass is defined as the *elementary* (*limiting*) *amplitude mass of the wave exchange* of the physical space; and the *charge* – as the *limiting rate (power) of exchange*, $e = \frac{dm}{dt} = \frac{4\pi\varepsilon_0\varepsilon_r r_e^2 dr_e}{dt} = 4\pi\varepsilon_0 r_e^2 \upsilon_e$ (the relative density $\varepsilon_r = 1$ at the subatomic level), or the *elementary quantum of power of mass exchange*.

Recall again that the new notion *exchange*, used here, reflects behavior of an electron (as any elementary particle) in its dynamic equilibrium with the ambient wave 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 [10], belonging to one of the interrelated levels of the Universe.

6. Once more about the magnetic moment

The *electron orbital magnetic moment* and the *electron orbital moment of momentum* are the different measures of the same wave process. Indeed, any system, for example, a metallic rod suspended by a thin elastic thread, can be regarded as a closed system (of course, under a definite approximation). Let its initial moment of momentum be equal to zero. This means that its, as a solid, moment of macromomentum, L_{macro}, and the total moment of micromomenta of all orbital electrons, L_{micro}, form the *total moment of momentum* of the system equal to zero:

$$L_\Sigma = L_{macro} + L_{micro} = 0\,. \tag{51}$$

Under the action of external fields, the ordering of moments of momentum of individual orbital electrons can take place. As a result, the general change of the moment of micromomenta, ΔL_{micro}, arises. It is accompanied with an appearance of the moment of macromomentum of the rod as a whole, ΔL_{macro}, so that

$$\Delta L_\Xi = \Delta L_{macro} + \Delta L_{micro} = 0\,. \tag{52}$$

Let us now introduce the kinetic ("magnetic") moment of the orbital electron, as the product of its orbital moment of momentum $\hbar$ by the wave number $k_e = \frac{\omega_e}{c}$ of the field of the subatomic level:

$$\mu_{orb} = k_e\hbar = \frac{\omega_e}{c} m\upsilon r = \frac{\upsilon}{c} er \tag{53}$$

In such a case, the equality (52) can be presented as

$$k_e \Delta L_{macro} + (-\sum_n k_e \hbar_n) = 0 \quad \text{or} \quad k_e \Delta L_{macro} - \sum_n \mu_{orb,n} = 0 \,. \tag{54}$$

If N is the number of ordered orbits, participating in a given process, we arrive at

$$\frac{\sum_n \mu_{orb,n}}{k_e \Delta L_{macro}} = \frac{\sum_n \mu_{orb,n}}{k_e \sum_n \hbar_{orb,n}} = 1 \quad \text{or} \quad \frac{\sum_n \mu_{orb,n}}{\sum_n \hbar_{orb,n}} = \frac{N\mu_{orb}}{N\hbar_{orb}} = \frac{\mu_{orb}}{\hbar_{orb}} = k_e \,. \tag{55}$$

Hence, we have

$$\frac{\mu_{orb}}{\hbar_{orb}} = k_e \,. \tag{56}$$

This means that the "orbital magnetic moment" is, in essence, another expression of the orbital moment of momentum, which is one of the measures of the orbital motion.

Thus, the ratio of the orbital magnetic moment to the moment of momentum of the electron completely corresponds to Einstein's-de Haas's experiment:

$$\frac{\mu_{orb}}{\hbar} = \frac{e}{mc} = k_e = \frac{\omega_e}{c} \,. \tag{57}$$

This magnitude, in accordance with the objective theory of electromagnetic processes, is equal to the wave number k_e of the fundamental frequency ω_e.

These results provide justification to assume that the electron spin of the value $\frac{1}{2}\hbar$ is the theoretical myth. All relativistic equations, including Schrödinger's equation, were built on the basis of negation of *contains* and *causes*. The description of nature was made on the basis of *forms* and *effects*, which only were recognized as the "scientific reality". Following the fully developed approach, the researcher must deal with sensations and their interpretation is the matter of creative fantasy of the free game of notions. Accordingly, a physical theory must not answer the question "*why*", but must answer only the question "*how*". In such situation, a talent of the mathematical matching of calculations to the experiment is especially appreciated. By this way, the great successes were obtained, but an understanding of the nature of phenomena has not been achieved. The mathematical constructions, farther and farther from reality, astonishingly complicated its understanding and are, in essence, physically senseless.

We can arrive at the above conclusion by many ways. In order to convince everybody finally, let us consider additionally this issue from the following alternative points.

The orbital *circulational* (magnetic) *moment* of electron is

$$\mu_{orb} = \frac{\upsilon_0}{c} e r_0 = \frac{e}{mc}\hbar \,. \tag{58}$$

The *moment of current*, corresponding to the circulational moment (58), is

$$P_I = \upsilon_0 e r_0 = \hbar\omega_e = m r_0^2 \omega_e \omega_\upsilon = J_m \omega_e \omega_\upsilon , \tag{59}$$

where $\upsilon_0 = \omega_\upsilon r_0$, $\hbar = m_e \upsilon_0 r_0$.

The moments of circulation and current describe the field of negation; hence, we should call them the measures of negation. In this case, the equation (59) can be presented as

$$P_I = i\hbar\omega_e = i J_m \omega_e \omega_B . \tag{60}$$

The *moment of momentum* of an orbiting electron (on the Bohr orbit) in a similar form is

$$\hbar = m\upsilon_0 r_0 = m r_0^2 \omega_B = J_m \omega_B . \tag{61}$$

Since we deal with the wave field of the frequency ω_e, as the wave parameter, the *moment of momentum*, should be presented by the following expression:

$$\hat{\hbar} = J_m \omega_B e^{i(\omega_e t - k_e s)} . \tag{62}$$

The rate of change of this momentum in time is equal to the *moment of current*

$$\frac{d\hat{\hbar}}{dt} = i\omega_e J_m \omega_B e^{i(\omega_e t - k_e s)} = i\omega_e \hat{\hbar} = P_I \tag{63}$$

or

$$\frac{d\hat{\hbar}}{dt} = P_I \qquad \text{and} \qquad \frac{P_I}{\hat{\hbar}} = i\omega_e = i\frac{e}{m} . \tag{64}$$

Thus, Einstein's-de Haas's experiments (and the other similar) actually verified *Newton's elementary law for the rotational motion* at the level of mass exchange of the microworld:

$$\frac{dL}{dt} = M = \omega L \qquad \text{and} \qquad \frac{M}{L} = \omega = \frac{e}{m} , \tag{65}$$

where $L = m\upsilon a$ is the *moment of momentum* and *M* is the *moment of* the "*dynamical force*".

In common experiments, the moment of "force" is represented by the moment of "kinematic force". The moments of *kinematic* and *dynamic* forces are defined, correspondingly, by the expressions:

$$M = m\frac{d\upsilon}{dt} \cdot a , \qquad M = \upsilon\frac{dm}{dt} \cdot a = \upsilon e \cdot a . \tag{66}$$

Experiments showed that in the "electrostatic" field of the fundamental frequency ω_e, both moments were proven to be equal. In this is the sense of Einstein's-de Haas's (and similar) experiments. A half of the momentum of "force" $\frac{1}{2}M$ cannot be considered here.

If we determine a gradient of the wave momentum (62), we arrive at

$$\frac{d\hat{\hbar}}{ds} = ik_e\hat{\hbar} = \frac{1}{c}P_I = \mu_{orb} \qquad \text{and} \qquad \frac{\mu_{orb}}{\hat{\hbar}} = ik_e = i\frac{e}{mc}. \tag{67}$$

In this equality, we deal with the *circulational* (*magnetic*) *moment* of the Bohr orbit. It also is related to Newton's law for rotational motion. Just the last expression, by cutting off by a half and, hence, having become the erroneous one, $i\frac{e}{2mc}$, led to the theoretical spin boom in physics and to further falling into the abyss of the "development" of inadequate atomic notions and physics on the whole.

7. Conclusion

Thus, *the orbital magnetic moment of the electron* can be regarded as the *magnetic moment of harmonic wave of the fundamental tone*,

$$\mu_{orb} = \frac{\upsilon_0}{c}er_0. \tag{68}$$

A ratio of the magnetic moment to the moment of momentum of the orbiting electron in the hydrogen atom, derived theoretically in the framework of the DM, corresponds completely to the ratio obtained in Einstein's-de Haas's and Barnet's experiments:

$$\frac{\mu_{orb}}{\hbar} = \frac{e}{mc} = k_e = \frac{\omega_e}{c}. \tag{69}$$

In accordance with the objective theory of electromagnetic processes presented in [1], this ratio defines the wave number k_e corresponding to the fundamental (carrier) frequency ω_e of the subatomic and atomic levels. The ratio (69) is also valid for the *limiting* values of the *possible own* (proper) *electron moments*, angular and magnetic (41),

$$\frac{\mu_{pr,\max}}{\hbar_{pr,\max}} = \frac{e}{mc}. \tag{70}$$

That is why when longitudinally polarized charged particles are trapped in a magnetic field B the orbit angular frequency and the so-called spin frequency are the same, $\omega_c = \omega_s = \frac{eB}{mc}$ [11].

Thus, the results presented in this and previous two Lectures provide convincing argumentation for the assertion, which till now has not been challenged by anyone, that the electron spin of the $\frac{1}{2}\hbar$ value is an unreal erroneous parameter introduced in physics subjectively without a thorough substantiation.

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Lecture 7

The Neutron Magnetic Moment

1. Introduction

The first precise derivation of the neutron magnetic moment (NMM) on the basis of the Dynamic Model of Elementary Particles (DM), beyond quantum electro- and chromodynamics, is considered in this Lecture. A new insight into the nature of the NMM differs in principle from that one that is widespread currently in physics. The material of this Lecture is naturally tied with the subject set forth in preceding Lectures, devoted to the precise derivation of the electron orbital magnetic moment in the hydrogen atom. Derivation of the formulas for the given moments inherent in both particles, charged and uncharged (an *electron* bound in the hydrogen atom and the *neutron*), is based on usage of the same notions and fundamental constants-parameters following from the theory of the DM. Therefore, the results under consideration here are the further evidence, along with many others, in favor of validity of the DM.

The following natural questions made their appearance after the first experimental observation of the neutron magnetic moment.

What is the nature of origin of the magnetic moment of the *electrically neutral* particle, which is the neutron?

Accordingly, how it is possible to derive theoretically the precise value of the moment?

Obviously, the answers to these questions are still hidden in the mysterious structure of the neutron. The Standard Model (SM) is unable to explain convincingly enough the latter without use of invented hypothetical particles (quarks, gluons, etc.) just like it is unable to explain for this reason the phenomenon of existence in the neutron (and in the proton as well) of the strictly defined magnetic moment. This means that the concepts of the SM on the structure of elementary particles are not adequate to reality, and, hence, are erroneous in essence. The above problems of the SM are currently the realm of the theory of Quantum Chromodynamics (QCD). The QCD studies numerous observable properties of nucleons, including their magnetic moments, and on the basis of the resulting data makes a try for building appropriate submodels in the framework of the general SM. All other theories of modern physics are also unable for shedding any light on the structure of nucleons and on the nature of their magnetic moments.

An understanding of the structure of nucleons is still one of the key problems in physics. According to the QCD hypothesis, neutrons can have a magnetic moment because they consist, as is believed, of the mystical charged constituents – so-called quarks – hypothetical particles ("hypothetical" because they are never seen as free particles). For this reason, the QCD theory cannot produce a clear unified explanation of the observed features obtained in experiments on accelerators, which become more and more complicated and very expensive.

Thus, from our point of view, the absence of an essential achievement in understanding the nature of nucleons' magnetic moments and, hence, the nucleons' structure is a result of the well-known imperfection of the Standard Model of Elementary Particles (SM). This is why magnetic moments of nucleons are currently regarded by theorists as "abnormal", recognizing by this their inability to give in the framework of the SM a transparent explanation of the origin of the observed phenomena.

From experimental data it follows that the ratios of the proton and neutron magnetic moments, μ_p and μ_n, to the nuclear magneton, μ_N, are equal, respectively, to the following values:

$$\frac{\mu_p}{\mu_N} = 2.792847356(23) \tag{1}$$

and

$$\frac{\mu_n}{\mu_N} = -1.91304273(45)\,, \tag{2}$$

where

$$\mu_N = \frac{e\hbar}{2m_0 c} = 5.05078324(13)\times 10^{-27}\ \ J\times T^{-1} \tag{3}$$

is the nuclear magneton. These data were taken from the "CODATA recommended values".

In order to explain the above "abnormality", physicists did not find anything better of the concept of "virtual particles", which has been already used for explaining the magnetic moment "anomaly" of the electron [1-5]. According to this concept, strong interaction of hadrons (baryons and mesons – composite particles made of the so-called quarks) is conditioned by their mutual transformation. In particular, it is assumed that the neutron, related to the family of baryons, emits a virtual negative π-meson and is transformed on the definite time into a proton. According to QCD, π-mesons are a specific kind of a quark-antiquark pair. So that the neutron magnetic moment is considered as a result of the continuous motion of these charged virtual particles (negative π-mesons). Analogously, the proton is virtually "dissociate" on the definite time, but on a neutron and a positive virtual π-meson, and "abnormality" of its magnetic moment is a result of the continuous motion of a positive virtual π-meson.

Different assumptions are used in order to obtain a simultaneous fitting of the theoretical ratio to the experimental ratio for the neutron and proton magnetic moments. A first-order calculation for proton/neutron magnetic moments based on the quark model one can find, for instance, in the textbook by Giffiths [6]. One of the fundamental studies based on the above approach can be found in [7].

A modern trend in the theory of magnetic moments of nucleons is the use of a three-quark model of nucleons with *up*, *down*, and *strange* quarks [8-14]. The value of -2/3 obtained in this model for the neutron/proton magnetic moment ratio is nearly the experiment value [15]. The current CODATA data gives

$$\frac{\mu_n}{\mu_p} = -0.68497934(16) \approx -\frac{2}{3}. \qquad (4)$$

In the work by G. Strobel [16], differences between magnetic moments of a proton and neutron are explained in the three quark model by allowing the strange quark wave function to be spin-dependent. Namely he assumes that the wave functions for the spin parallel and the spin antiparallel quarks differ. In one of the last works on this subject [17], an approximate fitting to the experimental ratio is achieved owing to introducing a difference between the constituent quarks masses in the nucleon of about 15%. A general overview of the theory of “strangeness” in the nucleon one can find also in [18-21].

Among other works on this subject, one can mention also the work by R. Mills [22]. He derives the magnetic moment of a neutron as the sum of: the magnetic moment of a so-called “constant orbitsphere” of charge $-e$ and mass m_n (which correspond to the β particle), the magnetic moment of a proton, and “the magnetic moment associated with changing an up quark/gluon to a down quark/gluon”.

In spite of many attempts by QED and QCD to explain the magnetic moment of nucleons, the problem is still open, and physicists seek new ways for a less complicated solution. Here is an opinion by E. Beise who represents leading researchers in their area [23]. ”The ratio of the proton and neutron magnetic moments one can understand from their valence quark structure, as well as ratios of other baryon magnetic moments. But the absolute magnitudes cannot yet be calculated within the context of QCD, nor the dynamical distributions of charge and magnetism either”. And so on.

The current experimental value of the neutron magnetic moment, according to the CODATA 2006 recommended values, is

$$\mu_n = -0.96623641(23) \times 10^{-26} \ J \times T^{-1}. \qquad (5)$$

This quantity is approximately in 1.46 times less in absolute value than that for the proton.

A reason of the difference between two magnetic moments, of a proton and neutron, is not yet clearly understood by modern physics. Both magnetic moments are studying exceptionally in the framework of quantum electro- and chromodynamics.

There are no, more or less, serious works on this subject with use of classical approaches. In our opinion, the current status quo in this area is a result of the sad fact that physicists (based on the SM exhausted itself completely) *still do not know the true nature of mass and charges of elementary particles*. They also know nothing about the origin of magnetic charges. And what is more, the fundamental error of physics, namely an assignment of a non-existed proper angular moment (spin) of the $\hbar/2$ value [24] first to an electron, and later on to nucleons and other particles-"fermions", makes it impossible in principle to solve the problem of magnetic moments of nucleons without different fittings. Accordingly, an abstract mathematical fitting is currently the main method on the way to achieve a correspondence of the resulting theoretical data with experiment.

Fortunately, at present, owing to the DM developed as an alternative to the SM, which is beyond QED and QCD [25], and the works on its basis revealing a groundlessness of an introduction in physics of the notion of electron spin [24, 26], the above and other questions accumulated in modern physics have obtained convincing and relatively simple solutions. Let us recall some notions of the DM needed for a theoretical description of the neutron and proton magnetic moments.

According to the DM, a nucleon just like any elementary particle, including an electron, is a dynamic spherical microformation being in a continuous dynamic equilibrium with environment through the wave process of the strictly definite fundamental frequency ω_e inherent in the atomic and subatomic levels. Owing to the DM, the rest mass does not exist. And that we usually call as the mass of elementary particles is actually the *associated mass* which is the *measure of exchange* (interaction) of matter-space-time.

It is very important at the consideration of nucleon (neutron and proton) magnetic moments. The DM distinguishes *longitudinal exchange* and *transversal exchange* (the latter will be considered in the next Lecture). Therefore, two notions of mass exist, correspondingly, the *associated mass in the longitudinal exchange* and the *associated mass in the transversal exchange*. The latter exhibits itself in cylindrical fields generated during the motion of particles.

As we already know, the formula of *associated mass* in the *longitudinal exchange* has the following form,

$$m = \frac{4\pi r^3 \varepsilon_0 \varepsilon_r}{1 + k^2 r^2}, \tag{6}$$

where r is the radius of the wave spherical shell of a particle; $\varepsilon_0 = 1\ g \times cm^{-3}$ is the *absolute unit density* and ε_r is the *relative density*;

$$k = \frac{2\pi}{\lambda} = \frac{\omega}{c} \tag{7}$$

is the wave number corresponding to one of the *fundamental frequencies*, ω_e or ω_g, of the field of exchange (which are characteristic of the subatomic level of the Universe). Two fundamental frequencies define, respectively, electromagnetic (including strong), ω_e, and gravitationa, ω_g, interactions [27, 28]. The DM deals with physical quantities expressed in the absolute system of units by integer powers of three *basic units* of *matter, space,* and *time* (*g, cm,* and *s*).

The charge in the DM is an alternate quantity and defined as the *rate of mass exchange* at the fundamental frequency. Two notions of charge correspond to two aforementioned notions of mass: the *longitudinal* ("*electric*") *charge* and the *transversal* ("*magnetic*") *charge*. The transversal charge appears at the motion of particles. Just the transversal charge defines the distinction of the proton magnetic moment as against the neutron magnetic moment.

The following relation connects the exchange charge *Q*, both longitudinal and transversal, with the associated mass *m*:

$$Q = m\omega; \tag{8}$$

its dimensionality is $g \times s^{-1}$. Thus, according to the DM, every particle of the mass *m* has the definite exchange charge. The *exchange charge of an electron* at the *longitudinal exchange* and at the level of the fundamental frequency ω_e is

$$e = m_e\omega_e = 1.702691582 \times 10^{-9}\ g \times s^{-1}, \tag{9}$$

where $m_e = 9.10938215(45) \times 10^{-28}\ g$, and the fundamental frequency of the subatomic level is

$$\omega_e = 1.869162534 \times 10^{18}\ s^{-1}. \tag{10}$$

The electron's exchange charge of the absolute value (9) is regarded in the DM as the *minimal quantum of the rate of exchange of matter-space-time*.

Principal elements of the DM theory and the notion of central exchange are considered in detail in Lectures of Vol. 2 (see also [25], accessible online in Internet). The transversal exchange is responsible for the difference of the proton magnetic moment as compared to the neutron magnetic moment. The transversal exchange and proton magnetic moment are the subjects of the subsequent Lectures.

We proceed now to derive the magnetic moment of a neutron. This derivation follows, as was mentioned above, the approach and the data of the work [26] devoted to the electron orbital magnetic moment that has been considered in previous three Lectures 4-6.

Accordingly, we consider the presented here material as a natural continuation of our discussion devoted to the nature of magnetic moments of elementary particles, constituents of atoms. Along with fundamental parameters inherent in the DM, presented above (without them the derivation is not possible), we use 2006 CODATA recommended values.

2. Derivation

Although the true structure of neutrons has actually remained a mystery, one of the main features firmly known from experiment is that neutrons are composed of a proton and an electron, and the neutron mass is the combination of these constituents. Thus, to all appearances, a neutron is a binary system of proton and electron. An energy excess with respect to energy of its ground state, formed by a free proton and a free electron is 0.78 MeV. Free neutrons decay by beta decay $n \to p + e^- + \tilde{\nu}_e$ with a mean life of 885.7 *s*. During decay, a part of the energy excess carries away an antineutrino.

This fact along with other data known from the literature allows us to regard an individual neutron as a paired system, similar to the hydrogen atom, in an excited state. In other words, we have the right to suppose that neutrons in a free state are a kind of the unstable isotopes of the protium, of the simplest hydrogen atom, ${}^1_1H$ (the common, stable isotope of hydrogen, as distinct from deuterium and tritium) [28]. Thus, in the case of a neutron, we actually deal with an expanded paired wave system, and natural specific features of wave motion of the system and its constituents must be taken into consideration as perturbations.

According to the DM [25], the wave motion with incessant exchange causes oscillations of the wave shell and the centre of mass of a nucleon, with the amplitude

$$A_s = \frac{A\hat{e}_l(kr)}{kr}, \tag{11}$$

where

$$A = r_0\sqrt{\frac{2hR}{m_0 c}}, \tag{12}$$

$$\hat{e}_l(kr) = \sqrt{\frac{\pi kr}{2}}\left(J_{l+1/2}(kr) \pm iY_{l+1/2}(kr)\right), \tag{13}$$

$$k = \frac{\omega}{c} = \frac{1}{\lambda\!\!\!^{-}}, \; kr = z_{p,s}, \tag{14}$$

A is the constant factor; r_0 is the radius of the wave shell of a nucleon equal to the Bohr radius; $J(kr)$ and $Y(kr)$ are Bessel functions; k is the wave number; ω is the oscillation frequency of the pulsating spherical shell of the nucleon equal to the fundamental "carrier"

frequency of the subatomic and atomic levels ω_e (we consider here only the "electromagnetic" field level); $z_{p,s} = kr$ are the roots (zeros and extrema) of the Bessel cylindrical functions, $J_{l+1/2}(kr)$ and $N_{l+1/2}(kr)$ (or $Y_{l+1/2}(kr)$). They are designated, correspondingly, as $j_{l+1/2,s}$, $y_{l+1/2,s}$, $j'_{l+1/2,s}$, and $y'_{l+1/2,s}$. Analogously, zeros and extrema of the Bessel spherical functions are designated as $a_{l,s} = j_{l+1/2,s}$, $b_{l,s} = y_{l+1/2,s}$, $a'_{l,s}$, and $b'_{l,s}$ [29].

Being a dynamic wave microformation, a nucleon oscillates also as a whole in a node of the spherical wave field of exchange [26, 28] with the amplitude,

$$\Psi = \frac{A_m}{z_{p,s}}, \tag{15}$$

where

$$A_m = \lambda\!\!\!^{-}_e \sqrt{\frac{2Rh}{m_0 c}}, \tag{16}$$

$$\lambda\!\!\!^{-}_e = \frac{c}{\omega_e} \tag{17}$$

is the *wave radius*, ω_e is the fundamental frequency of the subatomic level. The amplitude A_m is the characteristic amplitude of oscillations on the sphere of the wave radius (at $z_{p,s} = kr = 1$), and it is the radius r_m of oscillatory motion of the center of mass of the nucleon.

As the proton mass is $m_0 = 1.672621637(83) \times 10^{-24}\, g$, the fundamental frequency of the subatomic level is $\omega_e = 1.869162534 \times 10^{18}\, s^{-1}$, the Planck constant is $h = 6.62606896(33) \times 10^{-27}\, erg \times s$, and the speed of light is $c = 2.99792458 \times 10^{10}\, cm \times s^{-1}$, the Rydberg constant R and the wave radius $\lambda\!\!\!^{-}_e$ are equal, correspondingly, to

$$R = \frac{R_\infty}{1 + \frac{m_e}{m_0}} = 109677.5833\ cm^{-1}, \tag{18}$$

and

$$\lambda\!\!\!^{-}_e = 1.603886514 \times 10^{-8}\, cm. \tag{19}$$

As has been repeatedly noted earlier, the wave radius $\lambda\!\!\!^{-}_e$ (19) is equal to one-half of the average value of interatomic distances in crystals that is not a random coincidence. The latter shows the wave character of interaction of nodes in crystals just at the fundamental frequency ω_e (10) (details on this matter one can find in [27, 28]).

Hence, the radius r_m of oscillatory motion of the center of mass of the neutron in the wave field has the value

$$r_m = A_m = \lambda\!\!\!^{-}_e \sqrt{\frac{2Rh}{m_0 c}} = 2.73065189 \times 10^{-12}\, cm\,. \tag{20}$$

The wave motion of a nucleon as a central object of the field, with respect to a displacement *r*, generates an *elementary longitudinal* (“*electric*”) *moment*, moment of the basis,

$$p_E = qr\,, \tag{21}$$

and the corresponding *transversal* (“*magnetic*”) *moment*, moment of the superstructure,

$$\mu = \frac{\upsilon}{c} qr\,, \tag{22}$$

where $q = m\omega_e$ is the *exchange charge*, and υ is the *oscillatory speed* of the nucleon shell. It should be stressed once more that the *exchange charge q* (defined as the *rate of exchange of matter-space-time*) is inherent in all dynamic microobjects viewed in the framework of the DM. The absolute value of the electron exchange charge *e* represents the *minimal quantum of the rate of exchange*, $e = m_e \omega_e$.

In a case of a free neutron, as an exited paired proton-electron wave system, the exchange of the spherical wave field of a proton and the wave field of an oscillating electron (realized with a certain strength dependent on the values of the corresponding exchange charges) are mutually balanced, like in the hydrogen atom, but during the mean life of a neutron. The latter is also the time of an existence of the definite magnetic moment observed at measurement.

The spectrum of amplitudes (11) is defined by roots of Bessel functions, $z_{p,s} = kr$, hence, the spectrum of *amplitude magnetic moments* of the nucleon, corresponding to the amplitude (11), is described [28] by the formula,

$$\mu = \frac{\upsilon}{c} q \frac{A\hat{e}_l(z_{p,s})}{z_{p,s}}\,. \tag{23}$$

The subscript *p* in the roots $z_{p,s}$ indicates the order of Bessel functions and *s*, the number of the root. The last defines the radial spherical shell number. Zeros of Bessel functions define the radial shells with zero values of radial displacements (oscillations), *i.e.*, the shells of stationary states [28].

One of the constituents of the displacement *r* is defined by the amplitude r_m (20) with which the neutron oscillates as a whole in the spherical field of exchange. Assuming that

$\upsilon = \upsilon_0 = \alpha c$ (where $\alpha = 7.2973525376 \times 10^{-3}$ is the fine-structure constant), the exchange charge $q = e$, and $z_{p,s} = z_{0,s}$, so that under these conditions $|\hat{e}_0(kr_s)|^2 = 1$, we arrive at the corresponding elementary quantum of the neutron magnetic moment of the following value,

$$\mu_m = \frac{\upsilon_0}{c} eA_m = -3.392873403 \times 10^{-23} g \times cm \times s^{-1} = \\ = -0.9571119163 \times 10^{-26} \ J \times T^{-1} \tag{24}$$

The quantity obtained is, in absolute value, the *main constituent of magnetic moments of nucleons*, both a proton and a neutron. The quantity (24) insignificantly differs in absolute value from the experimental value (5) obtained for the neutron.

Small deviations of the amplitude (16), *i.e.*, deviations of the predominated wave motion, are appeared mainly owing to the natural reason. The matter is that the wave shell oscillates with respect to the center of mass of the neutron. These small deviations, defined by the formula (11), superimpose on the oscillatory motion of the nucleon with the amplitude (20), defining thus the second in value term responsible for the neutron magnetic moment. According to (11), for the case of $z_{p,s} = z_{0,s}$, this additional term is defined by the value of oscillations of the wave shell of the radius r_0 with the amplitude

$$\delta r_1 = \frac{r_0}{z_{0,s}} \sqrt{\frac{2Rh}{m_0 c}} . \tag{25}$$

The neutron magnetic moment is measured during the mean life of the neutron being in a free state. So we deal with a paired proton-electron metastable system, where the only electron, slightly remote from the inner space of the neutron, is in a highly exited energetic state outside near the wave spherical shell of the neutron. Therefore, we have the right to take a root of Bessel functions responding to one of the zeros for the somewhat remote neutron wave shell with respect to the first one. Let us take the zero $z_{0,s} = y_{0,12} = 35.34645231$ [29], responding to the solution of the radial equation for one of the *kinetic* neutron shells [27, 28, 30, 31]; and then we have

$$\delta r_1 = \frac{r_0}{y_{0,12}} \sqrt{\frac{2Rh}{m_0 c}} = 2.548871862 \times 10^{-14} \, cm , \tag{26}$$

where $r_0 = 0.52917720859 \times 10^{-8} \, cm$ is the Bohr radius.

Thus, according to the above obtained data, the oscillatory-wave motion of the neutron generates, first, the magnetic (transversal) moment of the value μ_m (24). Second, small deviations of this motion, caused by perturbations of neutron's oscillations as a whole in the spherical field of exchange and defined by (26), generate an additional term:

$$\delta\mu_1 = \frac{e\upsilon_0}{c}\delta r_1, \tag{27}$$

which must be taken into account.

According to the DM, an electron is a spherical dynamic microformation, like a proton or any elementary particle. Therefore, oscillations of the centre of mass of the electron itself, as a whole, with respect to the center of mass of the neutron, also take place. Hence, all formulas of the DM, obtained for the dynamic spherical microobjects, are valid for the electron as well. The second, smallest in value, additional term in a final formula for μ must take these oscillations into account [26]; their amplitude is defined by the equation,

$$\delta r_2 = \frac{r_e}{z_{0,s}}\sqrt{\frac{2Rh_e}{m_0 c}}, \tag{28}$$

where r_e is the wave radius of the electron [28]. The latter is derived from the formula of mass of elementary particles (6), where $m = m_e$, $k = k_e = \frac{\omega_e}{c}$, $r = r_e$. Calculations give

$$r_e = 4.17052597 \times 10^{-10}\, cm. \tag{29}$$

The physical quantity

$$h_e = 2\pi m_e \upsilon_0 r_e \tag{30}$$

is the limiting *proper* (*own*) *action* of the electron (analogous to the Planck *orbital* action defined by the expression, $h = 2\pi m_e \upsilon_0 r_0$) under the condition that the limiting oscillatory speed of the wave shell of the electron is equal to the Bohr speed, $\upsilon_0 = \alpha c = 2.187691254 \times 10^8\ cm \times s^{-1}$.

For the case of the term (28), we take the root of Bessel functions $z_{0,s} = j_{0,12} = 36.91709835$ responding to the zero of the twelfth potential shell. In view of this, (28) yields the value

$$\delta r_2 = \frac{r_e}{j_{0,12}}\sqrt{\frac{2Rh_e}{m_0 c}} = 5.3994661 \times 10^{-16}\, cm. \tag{31}$$

Thus, the total magnetic moment of the neutron μ_n contains three constituents:

$$\mu_n = \mu_m + \delta\mu_1 + \delta\mu_2 = e\frac{\upsilon_0}{c}(r_m + \delta r_1 + \delta r_2). \tag{32}$$

In view of the above considered, the expanded form of the theoretical value for the total neutron magnetic moment, $\mu_n(th)$, takes the following form,

$$\mu_n(th) = \frac{e\upsilon_0}{c}\left[\left(\lambda\!\!\!^{-}_e + \frac{r_0}{y_{0,12}}\right)\sqrt{\frac{2Rh}{m_0 c}} + \frac{r_e}{j_{0,12}}\sqrt{\frac{2Rh_e}{m_0 c}}\right]. \tag{33}$$

The substitution of numerical values for all quantities entered in (33) gives the following theoretical values for three constituent moments (one major and two additional) and for the total magnetic moment of the neutron:

$$\begin{aligned}\mu_n(th) &= -(0.3392873403 + 0.003167008 + 0.0000670891)\times 10^{-22}\ g\times cm\times s^{-1} = \\ &= -0.342521437\times 10^{-22}\ g\times cm\times s^{-1}\end{aligned} \tag{34}$$

In the SI units, the dimensionality of magnetic moments is expressed in $J\times T^{-1}$. Hence, since $1T = \frac{10^4}{\sqrt{4\pi}}\ cm\times s^{-1}$ [28], the numerical values of Eq. (34) in these units are the following,

$$\begin{aligned}\mu_n(th) &= -(0.957111915 + 0.008933964 + 0.0001892549)\times 10^{-26}\ J\times T^{-1} = \\ &= -0.96623513\times 10^{-26}\ J\times T^{-1}\end{aligned} \tag{35}$$

We see that the resulting theoretical value of $\mu_n(th)$ practically coincides with the "2006 CODATA recommended value" accepted for the magnetic moment of the neutron:

$$\mu_{n,CODATA} = -0.96623641(23)\times 10^{-26}\ J\times T^{-1}. \tag{36}$$

3. The associated nature of the neutron magnetic moment

In the framework of the DM, using specific notions inherent in it, the neutron magnetic moment can be also estimated with sufficient precision in another way. Here is how it can be done.

The *state vector S* of a dynamic wave object with the *associated* mass *m*, relatively to some wave axis, is defined (see L. 4 of Vol. 1) as

$$S = mr\ , \tag{37}$$

where *r* is amplitude of a harmonic displacement.

The following *momentum* defines a general change of the state

$$P = \frac{dS}{dt} = \frac{dm}{dt}r + m\frac{dr}{dt}\ , \tag{38}$$

where

$$P_d = \frac{dm}{dt} r = qr \tag{39}$$

is the *dynamic momentum*, and

$$P_k = m\frac{dr}{dt} = m\upsilon \tag{40}$$

is the *kinematic momentum*.

The dynamic momentum P_d is simultaneously the *moment of the rate of mass exchange* , *i.e.*, the moment of $q = \frac{dm}{dt}$ [28]. At the level of basis, (39) represents the electric moment, but at the level of superstructure P_d represents the magnetic moment.

In a simplest case of the *harmonic wave*, the *dynamic* and *kinematic momenta* can be presented as

$$P_d = (m\omega)r = qr \tag{41}$$

$$P_k = mr\omega = m\upsilon \tag{42}$$

At the same time, the *dynamic* and *kinematic moments* of the *momenta* (41) and (42), L_d and L_k, are equal to each other. Actually, we have

$$L_d = \frac{dm}{dt} r \cdot r = mr^2\omega = J\omega \tag{43}$$

$$L_k = m\frac{dr}{dt} \cdot r = m\omega r^2 = J\omega \tag{44}$$

If we suppose that the neutron moment of inertia is equal to

$$J = \frac{2}{5} m_n r_0^2 , \tag{45}$$

(as for a homogeneous spherical ball of the mass m_n) then, according to (43), the dynamic moment of momentum of the neutron at the level of the limiting (fundamental) frequency ω_e, will be equal to

$$\begin{aligned} L_{d,\max} &= \frac{2}{5} m_n r_0^2 \omega_e = 3.506753661 \times 10^{-23} \ g \times cm^2 \times s^{-1} = \\ &= 9.892369438 \times 10^{-27} \ J \times T^{-1} \times cm \end{aligned} \tag{46}$$

where

$$m_n = 1.674927211(84) \times 10^{-24} \ g ,$$

$$r_0 = 0.52917720859 \times 10^{-8} \ cm ,$$

$$\omega_e = 1.869162534 \times 10^{18} \ s^{-1} .$$

A radius of the neutron wave shell r_n depends on frequency conditions of wave exchange (*i.e.*, on the value of $k = \frac{\omega}{c}$ entered in (6)) and is within the interval of $r_n \in (r_{\max}, r_0)$. At the level of low and middle frequencies under the condition $k^2 r_n^2 << 1$, the formula of mass (6) is simplified; and a radius of the limiting neutron wave sphere takes the value

$$r_{\max} = \sqrt[3]{\frac{m_n}{4\pi\varepsilon_0}} = 0.5108130981 \times 10^{-8}\, cm. \tag{47}$$

Hence, for the beginning of the interval, the minimal value of the dynamic moment of neutron momentum is equal to

$$\begin{aligned} L_{d,\min} &= \frac{2}{5} m_n r_{\max}^2 \omega_e = 3.267586148 \times 10^{-23}\ g \times cm^2 \times s^{-1} = \\ &= 9.217690341 \times 10^{-27}\ J \times T^{-1} \times cm \end{aligned} \tag{48}$$

The rational golden section of the interval of the moments is

$$(L_d)_{gs} = L_{d,\min} + 0.618(L_{d,\max} - L_{d,\min}) = 9.634642023 \times 10^{-27}\ J \times T^{-1} \times cm \tag{49}$$

The *centimeter*, the reference unit of space, enters in the above formulas as the parameter of the atomic field of matter-space-time.

Hence, a value of the *neutron magnetic moment* responding to the golden section (the divine proportion) is

$$(\mu_n)_{gs} = \frac{(L_d)_{gs}}{cm} = 9.634642023 \times 10^{-27}\ J \times T^{-1} \tag{50}$$

that is close, in absolute value, to the average numerical value accepted (according to the CODATA 2006 data) for the neutron magnetic moment, $\mu_n = -9.6623641(23) \times 10^{-27}\ J \cdot T^{-1}$.

The mass of the neutron, as mass of any particle in the DM, has the wave *associated* nature. Accordingly, the neutron moments are, in essence, *associated* moments; they have the field character reflecting the wave exchange of matter-space-time.

4. Conclusion

A theoretical derivation of the observable quantity of the neutron magnetic moment μ_n was realized for the first time in physics owing to the DM [25]. The latter, after it was first put forward in 1996, has allowed reconsidering a series of the phenomena observed in nature, both explicable and inexplicable by the SM dominated presently in modern physics. The DM not only demonstrates new ways in learning these phenomena, but made that in a better way.

The derivation of neutron magnetic moment μ_n has been performed with regard of wave features for the behavior of a neutron viewed as a combined proton-electron wave system. A relatively high precision and a less complicated way of the derivation by the DM distinguish the latter from theories of quantum electro- and chromodynamics, which are continuously trying for long time, but as we see unsuccessfully, to solve the neutron problem.

Followed by precise derivations of the electron magnetic moment [26], the cosmic microwave background radiation ("relict" background) [32], and the Lamb shift [33], carried out on the basis of the DM as well, the derivation of the neutron magnetic moment, considered in this Lecture, is the next of the stringent confirmations in favor of the validity of the DM. At the derivations in all cases we use new fundamental constants originated from the DM and the standard "CODATA recommended values" for other known constants, in particular, the data presented in [34].

Thus, the discovery of the veritable nature and the correct absolute value of the electron charge *e*, made in the DM, due to which the electron is now regarded as an *elementary quantum of the rate of mass exchange* of the dimensionality $g \times s^{-1}$, and the discovery of the *fundamental frequency of atomic and subatomic levels* ω_e, have made it real the theoretical derivation of μ_n, just like the derivation of μ_e [26], the Lamb shift [33], and *etc*.

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Lecture 8

Transversal Exchange

1. Introduction

Before proceeding to the derivation of the proton magnetic moment, we must to learn about a new notion, which is called in the DM as *transversal exchange*. It is the notion opposite to the notion of *longitudinal exchange* in the longitudinal-transversal structure of wave fields-spaces in the Universe. The matter is that the *transversal mass* and the *transversal charge* in the transversal exchange are the major components defining a precise value of the observed proton magnetic moment. Therefore, we begin this Lecture from consideration of the next new principal notions originated from the Dynamic Model (DM) related this time with the aforesaid *transversal exchange*.

The development of systems of units in physics led to the sad fact that two parameters, *current* and *circulation*, characterizing different subfields (longitudinal and transversal, "electric" and "magnetic") of the unit longitudinal-transversal field have obtained the same name – *current*, although in principle, because of their dimensionalities and physical meaning, they are radically different.

This fact is reflected, in particular, in the erroneous presentation in modern physics, both in form and contents, the *elementary laws of electrodynamics*, Ampere's and Biot-Savart. The above faults, inherent also in Maxwell's equations, are uncovered in detail in the framework of the DM of dialectical physics. The oldest puzzle of physics concerning magnetic charges (known as "magnetic monopoles") obtains herein the natural solution.

The laws of electrodynamics are based on concepts of the 19th century physics. Now at the beginning of the 21st century these laws request essential reconsideration in the light of the found faults caused by outdated views. A theoretical basis, philosophical and mathematical, on which the aforementioned reconsideration has became possible, is the Dialectical Model of the Universe (dialectical physics) presented mainly in three books [1-3] and numerous publications. This issue is already considered in Vol. 1 of the Lectures.

A series of the discoveries of the DM, listed in [4], started from uncovering the nature of mass and charge of elementary particles, makes it possible to perform the corresponding

corrections in physics. Physical notions, unknown earlier, such as related to the transversal exchange, along with the notions of longitudinal exchange: exchange charge, the fundamental frequency and fundamental wave radius of atomic and subatomic levels, *etc*., cardinally extend our understanding reality.

We intend here to reconsider on the new notions two elementary laws of electrodynamics, namely Ampere's law and the Biot-Savart law, in order to present them in correct form and contents in accordance with the DM. These laws deal with the magnetic, transversal, field caused by a current and dependent on the distance from the current. From the DM it follows that the Biot-Savart law is the differential version of Ampere's law.

For this goal, we must first of all explain principal notions used in this work and give the corresponding definitions. Basing on axioms of dialectical physics, related to the wave nature of the World, we begin from the elucidation of basic attributes of longitudinal-transversal (spherical-cylindrical) wave fields and their potential-kinetic structure. Further, we will show how we have arrived at such fundamental notions as the associated mass and exchange charge at transversal exchange. The latter parameters are responsible for the transversal, "magnetic" exchange (interaction).

One of the principal physical quantities entered in resulting formulas related with the transversal exchange is the *circulation* Γ. We turn a special attention to elucidation of its physical meaning.

An indissoluble bond of longitudinal and transversal, electric and magnetic, fields is reflected in a binary nature of the behavior of the electron charge. The electron shows itself as the spherical electric (scalar) charge and, simultaneously, it is the cylindrical magnetic (vector) charge, or a "magnetic monopole". We pay a special attention to this property here.

2. Embeddedness and other parameters of the wave physical space

According to the DM [5], internal and external spaces of all objects at all levels of the Universe are *mutually overlapped* (penetrated, permeated), *embedding in each other*. With this, below laying spaces are the basis spaces for spaces (objects) of the upper laying levels, and so on.

Microobjects of the corresponding level are regarded as specific physical spherical points (like vortices or compressions, or thickening in space from the space itself, *etc*.) pulsating in space; and their masses do have the dynamic associated nature.

In view of this, we regard *mass m* of physical space as an *amount of the physical space* of an *embeddedness* ε defined by the equality,

$$m = \varepsilon V = \varepsilon_0 \varepsilon_r V \qquad (1)$$

where V is the volume of the space. The embeddedness $\varepsilon = \varepsilon_0 \varepsilon_r$ is, in other words, the *density* of the space, where ε_r is the *relative density* and $\varepsilon_0 = 1\, g \times cm^{-3}$ is the *absolute unit density* of the space.

If we reduce an amount of space m to the unit embeddedness ($\varepsilon_r = 1$), we can rewrite (1) as

$$m = \varepsilon_r (\varepsilon_0 V) = \varepsilon_r V_0, \tag{2}$$

where $V_0 = m$, because in the aforementioned meaning

$$g = cm^3. \tag{3}$$

For the more accurate description of the wave physical space, we operate with the *kinematic vector-speed E* at the level of the basis wave space. To stress its directed character, one can use the symbol ***E***. The reference dimensionality of the vector-speed E is $cm \times s^{-1}$.

The dynamic vector, conjugate to the kinematic E-vector, is defined as

$$D = \varepsilon E = \varepsilon_r \varepsilon_0 E. \tag{4}$$

We see that the D-vector is a vector of the *density of momentum of physical space* with the embeddedness ε. Actually, its dimensionality, as follows from (4), is $[D] = [\varepsilon_0][E] = \frac{g}{cm^3} \cdot \frac{cm}{s} = g \times cm^{-2} \times s^{-1}$.

The vectors D and E are used for the description of *longitudinal* wave field. The analogous pair of the vectors, H and B, presents the *transversal* wave field:

$$H = \varepsilon B = \varepsilon_r \varepsilon_0 B. \tag{5}$$

The vectors D and E describe the *spherical* ("electric") wave field of the basis space; while H and B describe the *cylindrical* ("magnetic") wave field of the same basis space.

Along with the "right" embeddedness $\varepsilon = \varepsilon_r \varepsilon_0$, we operate also with the "inverse" embeddedness $\mu = \mu_r \mu_0$, where

$$\mu = \frac{1}{\varepsilon}, \qquad \mu_0 = \frac{1}{\varepsilon_0} \qquad \text{and} \qquad \mu_r = \frac{1}{\varepsilon_r}. \tag{6}$$

Then, the equalities (4) and (5) take the form

$$E = \mu_r \mu_0 D, \qquad B = \mu_r \mu_0 H. \tag{7}$$

We postulate the validity of the equality $\varepsilon_r = 1$ for the basis space. This is quite natural, because, at the basis level, the embeddedness, in essence, relates to the space itself, *i.e.*, the *self-embeddedness* of the space takes place in this case.

3. The longitudinal-transversal nature of wave fields

In wave field-spaces, the *central field-space* of exchange is inseparable from its *negation*, which is represented by the *transversal field-space* of exchange [6]. The central (longitudinal) field of exchange is described by two vectors, *E* and *D*, the transversal field is described by the analogous vectors, *B* and *H*. Thus, the *B* vector is the *speed-strength vector* and the H vector is a *vector of the density of momentum* of the transversal exchange.

Both fields-spaces (central and transversal) form the unit *contradictory* (that is designated by the symbol ^) *longitudinal-transversal field-space* with the following vectors:

$$\hat{A} = E + iB \qquad \text{and} \qquad \hat{C} = D + iH \ . \tag{8}$$

In a general case, each vector of exchange (*E, D, B,* and *H*) has the contradictory(that is also designated by the symbol ^) *potential-kinetic* character. Therefore, more correctly, (8) must be presented in the following form:

$$\hat{A} = \hat{E} + i\hat{B} \qquad \text{and} \qquad \hat{C} = \hat{D} + i\hat{H} \ , \tag{9}$$

where *i* is the *unit of negation* of the central field by the transversal field. Thus, the letter *i* indicates the transversal character of the field of $\hat{B}$ and $\hat{H}$ vectors as against the central field of *E* and *D* vectors. Simultaneously, the letter *i* indicates the *potential* character of the corresponding vectors, as the negation of the kinetic ones, because

$$\hat{E} = E_k + iE_p \ , \qquad \hat{B} = B_k + iB_p \ , \quad \text{and} \quad \hat{D} = \varepsilon_0 \varepsilon_r \hat{E} \ , \qquad \hat{H} = \varepsilon_0 \varepsilon_r \hat{B} \ . \tag{10}$$

Obviously,

$$A_k = E_k + iB_k \ , \qquad C_k = D_k + iH_k \tag{11}$$

and

$$A_p = E_p + iB_p \ , \qquad C_p = D_p + iH_p \ . \tag{12}$$

Each above vector of exchange belongs to the generalized vector of exchange

$$\hat{\Psi} = \Psi_k + i\Psi_p \ , \tag{13}$$

where $\hat{\Psi} \in (\hat{E}, \hat{B}, \hat{D}, \hat{H}, \hat{A}, \hat{C})$. This vector satisfies the wave equation

$$\Delta\hat{\Psi} - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}}{\partial t^2} = 0\,, \tag{14}$$

where $\Delta = \nabla^2 = \nabla\cdot\nabla$ is the scalar differential operator (Laplacian); in Cartesian coordinates $\Delta = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$. Eq. (14) falls into the three scalar equations:

$$\Delta\hat{\Psi}_x - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}_x}{\partial t^2} = 0\,, \qquad \Delta\hat{\Psi}_y - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}_y}{\partial t^2} = 0\,, \qquad \Delta\hat{\Psi}_z - \frac{1}{c^2}\frac{\partial^2\hat{\Psi}_z}{\partial t^2} = 0\,. \tag{15}$$

The field-space of the vectors of exchange repeats the structure of fields of matter-space-time, which have the longitudinal-transversal character. The longitudinal-transversal field of exchange $\hat{A} = \hat{E} + i\hat{B}$ is an image of the *longitudinal-transversal structure of the World*. At the subatomic level, it is called the *electromagnetic* field, in which the field of the *transversal* exchange (or more correctly the transversal subfield of the longitudinal-transversal field) is termed the "*magnetic field*" and the longitudinal exchange – the "*electric field*". The *binary field-spaces* are the basis of space of the Universe.

Strictly speaking, the electromagnetic field must be called by only one name: the "electric" (or "magnetic") longitudinal-transversal field with the *longitudinal-transversal charges*. This is a very important question of logical semantics of the field, which inclines to the definite concepts.

The binary fields-spaces are elementary links in a chain of mutually negating longitudinal-transversal spaces-fields, which form the multidimensional spatial structure of matter-space-time of the Universe.

Now let's get down directly to the description of new notions originated from the DM related to the transversal exchange, which presents the qualitatively opposite phenomenon with respect to the longitudinal exchange in the dialectically interrelated longitudinal-transversal exchange.

4. Associated mass and exchange charge at the transversal exchange

The fields of *transversal exchange* are, mainly, the fields of *cylindrical structure*. The transition from the Cartesian coordinates to the cylindrical reference space is defined by the equalities:

$$x = r\cos\varphi\,, \qquad y = r\sin\varphi\,, \qquad z = z\,. \tag{16}$$

The cylindrical space is the product of the radial, axial, azimuth, and time wave subspaces:

$$\hat{\Psi} = \hat{\Psi}_{cyl} = C_{cyl}\hat{R}(k_r r)\hat{Z}(k_z z)\hat{\Phi}(\varphi)\hat{T}(\tau)\,, \tag{17}$$

where C_{cyl} is the scale factor.

An equation of the cylindrical space (in cylindrical coordinates) has the form:

$$\frac{\partial^2\hat{\Psi}}{\partial(k_z z)^2}+\frac{\partial^2\hat{\Psi}}{\partial(k_r r)^2}+\frac{1}{r}\frac{\partial^2\hat{\Psi}}{\partial k_r r}+\frac{1}{r^2}\frac{\partial^2\hat{\Psi}}{\partial\varphi^2}=k^2\frac{\partial^2\hat{\Psi}}{\partial\tau^2}, \tag{18}$$

where $k^2=k_r^2+k_z^2$, $\tau=\omega t$. It falls into the one time equation,

$$\frac{d^2\hat{T}}{d\tau^2}=-\hat{T}, \tag{19}$$

and the three spatial equations:

$$\frac{d^2\hat{Z}}{d(k_z z)^2}=-\hat{Z}; \qquad \frac{d^2\hat{\Phi}}{d\varphi^2}=-m^2\hat{\Phi}; \tag{20}$$

$$\frac{d^2\hat{R}}{d(k_r r)^2}+\frac{1}{k_r r}\frac{d\hat{R}}{d(k_r r)}+\left(1-\frac{m^2}{(k_r r)^2}\right)\hat{R}=0. \tag{21}$$

The product of solutions of these equations determines a general solution for the cylindrical space [3]:

$$\hat{\Psi}_{cyl}=C_{cyl}\hat{R}_m(k_r r)e^{-ik_z z}e^{-im\varphi}e^{i\omega t}, \tag{22}$$

at that

$$\hat{R}_m(k_r r)=\sqrt{\frac{\pi}{2}}\hat{H}_m^{\pm}(k_r r), \tag{23}$$

where $\hat{H}_m^{\pm}(k_r r)$ is Bessel's function of the third kind, or Hankel's function, and m is the order of the function.

Hankel's function is equal to the following sum (difference) of Bessel's functions of the first and second kinds, $J_m(k_r r)$ and $N_m(k_r r)$:

$$\hat{H}_m^{\pm}(k_r r)=J_m^{\pm}(k_r r)\pm iN_m^{\pm}(k_r r). \tag{24}$$

Bessel's function of the second kind is also called Neumann's function. We will call all above-mentioned functions simply Bessel's functions.

Bessel's function (24) is approximately described by the following formula,

$$\hat{H}_m^{\pm}(k_r r)\approx\frac{e^{i\left(\frac{m\pi}{2}+\frac{\pi}{4}\right)}}{\sqrt{k_r r}}e^{\pm ik_r r}. \tag{25}$$

In this case, the radial multiplicative component of the cylindrical space (23) takes the form

$$\hat{R}(k_r r) \approx \frac{\hat{A}}{\sqrt{k_r r}} e^{\pm i k_r r}, \tag{26}$$

where $\hat{A} = Ae^{i\left(\frac{m\pi}{2}+\frac{\pi}{4}\right)}$ and $k_r r = \frac{r}{\lambda\!\!\!^{-}_r}$ is an argument of the cylindrical function (expressed through the wave radii), defining the expansion of space in a radial direction.

The argument of the radial function cannot have a zero value. Its magnitude is restricted by some minimal radius of the axial line (or a tube of current), which represents the physical wave trajectory of motion in a cylindrical wave process. Under the constant flow of energy through the cylindrical surface, the expression (26) is strict.

The definite cylindrical wave surface corresponds to every value of the argument. The extremes and zeros of potential and kinetic components of the radial function define the cylindrical surfaces of the potential and kinetic extremes and zeros.

As follows from solutions of the wave equation, (22) and (26), the density of oscillatory-wave energy (or pressure) in the *cylindrical* field-trajectory, at the constant mean power of energy flow in a radial direction, has the form,

$$\hat{p} = \frac{p_m}{\sqrt{k_r r}} \exp i(\omega t - k_r r). \tag{27}$$

The *speed of transversal exchange* is defined (like at longitudinal exchange) as

$$\hat{\upsilon} = \upsilon(k_r r) \exp i\omega t, \tag{28}$$

where $k_r = k = \frac{\omega}{c}$ is the wave number corresponding to the fundamental frequency of the field of exchange ω.

Like for the spherical field-space (see (9) in L. 2, Vol. 2), the following relation is valid for the *speed in the cylindrical field-space*:

$$\hat{\upsilon} = -\frac{k_r}{\varepsilon_0 \varepsilon_r i\omega} \frac{\partial \hat{p}}{\partial (k_r r)}. \tag{29}$$

On the basis of the above equalities, taking into account that $\frac{d\hat{p}}{d(k_r r)} = -\frac{\hat{p}}{2k_r r}(1 + 2k_r r i)$, we get that the density $\hat{P}$ of oscillatory-wave energy at the wave characteristic surface of the radius *a* is defined by the following equality,

$$\hat{p} = \frac{2a\varepsilon_0\varepsilon_r}{1+4(k_r a)^2}(1-2k_r ai)i\omega\hat{\upsilon}\,. \tag{30}$$

Hence, the power of *field exchange* at a section of cylindrical surface of the length *l*, $S = 2\pi al$, related to the cylindrical field around a trajectory of the moving proton, in our case (with allowance for $\frac{d\hat{\upsilon}}{dt} = i\omega\hat{\upsilon}$) will be defined as follows:

$$\hat{p}S = \frac{4\pi a^2 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2}(1-2k_r ai)\frac{d\hat{\upsilon}}{dt}, \tag{31}$$

Thus, we have arrived at the dynamic equation of *field exchange*,

$$\hat{p}S = \hat{m}\frac{d\hat{\upsilon}}{dt}, \tag{32}$$

in which the first factor,

$$\hat{m} = \frac{4\pi a^2 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2} - ik_r\frac{8\pi a^3 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2}, \tag{33}$$

presents the *associated field mass* at transversal exchange.

A general equation of the transversal exchange in the radial direction must have the form

$$(m_0 + \hat{m})\frac{d\hat{\upsilon}}{dt} = \hat{F}\,, \tag{34}$$

where m_0 is the *rest mass* of the particle (assuming that it seems to be exists); the term $\hat{F}$ expresses some additional exchange (to the field exchange) – the power of exchange *with an object* in the ambient space.

Substituting in equation (34) instead of $\hat{m}$ its expanded value (33) (and considering that $\frac{d\hat{\upsilon}}{dt} = i\omega\hat{\upsilon}$**),** we arrive at the common equation of motion accepted in physics from Newton's times and presented in view of the DM in such a particular form, which describes the transversal wave exchange,

$$\left(m_0 + \frac{4\pi a^2 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2}\right)\frac{d\hat{\upsilon}}{dt} + R\hat{\upsilon} = \hat{F}\,. \tag{35}$$

In this equation,

$$R = 2k_r a\omega\frac{4\pi a^2 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2} \tag{36}$$

is the *coefficient of wave resistance*, or the *dispersion* of rest-motion at transversal exchange.

Thus the equation of powers of exchange (35) is presented in a classical form of Newton's second law, describing the motion in the field-space with the resistance *R*. At such a description, the expression in brackets represents the *effective* mass *m* of the particle:

$$m = m_0 + \frac{4\pi a^2 l \varepsilon_0 \varepsilon_r}{1 + 4(k_r a)^2}. \tag{37}$$

Eq. (32) describes exchange of motion. However, we are interested in the mass exchange, which is defined by exchange charges $q = \frac{dm}{dt}$. In this case, the field component of mass exchange (32) has to be presented in the following form:

$$\hat{p}S = \frac{d\hat{m}}{dt}\hat{\upsilon} \qquad \text{or} \qquad \hat{p}S = \hat{q}\hat{\upsilon}, \tag{38}$$

where $\hat{q}$ is the *active-reactive* charge of exchange. Then, Eq. (35) takes the form

$$m_0 \frac{d\hat{\upsilon}}{dt} + \frac{4\pi a l \upsilon \varepsilon_0 \varepsilon_r}{1 + 4(k_r a)^2} i\hat{\upsilon} + R\hat{\upsilon} = \hat{F}, \tag{39}$$

where $\upsilon = \omega a$ is the speed at the cylindrical surface. The tangential field of exchange *B*, which is negation of the longitudinal field of exchange *E* (see, for example, (8)), is described by the *speed-strength vector B* (14), which can be presented as

$$\hat{B} = i\hat{\upsilon}, \tag{40}$$

where *i* is the unit ("indicator") of negation. Thus, we have

$$m_0 \frac{d\hat{\upsilon}}{dt} + \frac{4\pi a l \upsilon \varepsilon_0 \varepsilon_r}{1 + 4(k_r a)^2} \hat{B} + R\hat{\upsilon} = \hat{F} \tag{41}$$

or

$$m_0 \frac{d\hat{\upsilon}}{dt} + q_\tau \hat{B} + R\hat{\upsilon} = \hat{F}. \tag{42}$$

It should recall again that elementary particles according to the DM are dynamic pulsating microobjects, so that their masses have *associated* character. Accordingly, the notion of the rest mass does not inherent for such microobjects in principle. Thus, it is accepted in the DM that in the transversal field of exchange, just like in the longitudinal exchange, the rest mass of a particle m_0 is equal to zero.

Thus, we arrive at the following formula for the *associated transversal mass* m_τ and the *associated transversal charge* q_τ:

$$m_\tau = \frac{4\pi a^2 l \varepsilon_0 \varepsilon_r}{1+4(k_r a)^2}, \tag{43}$$

$$q_\tau = \omega m_\tau = \frac{4\pi a l \upsilon \varepsilon_0 \varepsilon_r}{1+4(k_r a)^2}. \tag{44}$$

Supposing that a part of the cylindrical surface *l*, equal to half of the wave-trajectory, $l = \frac{1}{2}\lambda_Z$, is associated with a particle, we obtain

$$m_\tau = \frac{2\pi a^2 \lambda_Z \varepsilon_0 \varepsilon_r}{1+4(k_r a)^2}, \tag{45}$$

$$q_\tau = \omega m_\tau = \frac{2\pi a \lambda_Z \upsilon \varepsilon_0 \varepsilon_r}{1+4(k_r a)^2}. \tag{46}$$

Hence, *linear densities* of the *associated transversal mass* m_λ and *transversal exchange charge* q_λ are equal, correspondingly, to

$$m_\lambda = \frac{2\pi a^2 \varepsilon_0 \varepsilon_r}{1+4(k_r a)^2}, \tag{47}$$

and

$$q_\lambda = \omega m_\lambda = \frac{2\pi a \upsilon \varepsilon_0 \varepsilon_r}{1+4(k_r a)^2}. \tag{48}$$

Because in reality $k_r a << 1$, the above formulas are simplified and are as follows:

$$m_\tau = 2\pi a^2 \lambda_Z \varepsilon_0 \varepsilon_r, \qquad q_\tau = 2\pi a \lambda_Z \upsilon \varepsilon_0 \varepsilon_r, \qquad m_\lambda = 2\pi a^2 \varepsilon_0 \varepsilon_r, \qquad q_\lambda = 2\pi a \upsilon \varepsilon_0 \varepsilon_r. \tag{49}$$

At the equality of *longitudinal* and *transversal* exchanges, the corresponding masses [3],

$$m = \frac{4\pi a^3 \varepsilon_0 \varepsilon_r}{1+k^2 a^2} \qquad \text{and} \qquad m_\tau = \frac{2\pi a^2 \lambda_Z \varepsilon_0 \varepsilon_r}{1+4k^2 a^2}, \tag{50}$$

are equal as well. Recall that, as it has been considered earlier, at the field level $\varepsilon_r = 1$.

From (50) it follows that

$$\lambda_Z = 2a \frac{1+4k^2 a^2}{1+k^2 a^2} \approx 2a. \tag{51}$$

5. The notion of circulation, Γ

As follows from (49), under the constant *linear density of the transversal charge* q_λ, the cylindrical field of *tangential speed* $\upsilon = B$, at an arbitrary distance r from the axis of the field, is equal to

$$\upsilon = \mu_0 \mu_r \frac{q_\lambda}{2\pi r}, \tag{52}$$

where $\mu_0 = \frac{1}{\varepsilon_0}\ cm^3 \times g^{-1}$ and $\mu_r = \frac{1}{\varepsilon_r}$ are, respectively, the absolute and relative unit volume densities.

According to its dimensionality, the physical quantity $q_\lambda = 2\pi a \upsilon \varepsilon_0 \varepsilon_r$ is the *linear density of tangential (transversal) flow of speed* υ, or the *circulation* Γ of the *density of momentum* $H = \varepsilon_r \varepsilon_0 B$, *i.e.* $q_\lambda = \frac{dq_\tau}{dz} = \Gamma$. Actually, according to the definition of the above circulation, we have

$$\Gamma = 2\pi r \varepsilon_0 \varepsilon_r \upsilon = 2\pi r \varepsilon_0 \varepsilon_r B = 2\pi r H\ . \tag{53}$$

Thus, we can rewrite the formula for the *cylindrical field of tangential speed* (52) in the following form,

$$B = \mu_0 \mu_r \frac{\Gamma}{2\pi r}\ . \tag{54}$$

The *circulation* Γ, or the *linear density of the transversal charge*, points to the longitudinal motion in the cylindrical wave field, and therefore, it is the *vector* magnitude,

$$\boldsymbol{\Gamma} = \boldsymbol{q}_\lambda = \frac{d\boldsymbol{q}_\tau}{dz}.$$

Let's continue now our consideration of the notion of circulation taking into account the laws of orbital motion.

In the *spherical* field at the level of wave oscillations, the following correlation takes place between the oscillatory (circular) speed and radial distance:

$$\upsilon r = const\ . \tag{55}$$

This equality expresses Kepler's second law. Because in this case $\vec{\upsilon} d\vec{r} = \upsilon dr$ (Fig. 1), the law can be rewritten in the following form:

$$\oint \upsilon dr = 2\pi r \upsilon = 2\pi r B = \Gamma_B\ , \tag{56}$$

where Γ_B is the *kinematic action* in the cylindrical field, or *circulation of the speed-strength* $\upsilon = B$.

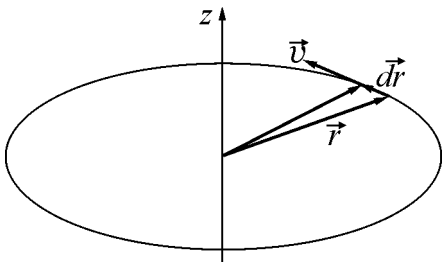

Fig. 1. A graph of the circular motion.

The circulation can be presented through the current flowing along the z-axis of the cylindrical field. Simple manipulations lead us to the following equalities:

$$2\pi rB = \frac{\omega}{c\varepsilon_0} 2\pi r\lambda\!\!\!^{-}\varepsilon_0 B = \frac{\omega q_\tau}{c\varepsilon_0} = \mu_0 \frac{I}{c} \qquad \text{or} \qquad \Gamma = 2\pi r\varepsilon_0 B = \frac{I}{c}, \tag{57}$$

where

$$e = q_\tau = 2\pi r\lambda\!\!\!^{-}\varepsilon_0 B \tag{58}$$

is the *charge of the transversal exchange*, and

$$I = \omega e \tag{59}$$

is the current of exchange. In this case, circulation Γ is the *dynamic action* in the cylindrical field, or the *circulation of the density of momentum H*.

Let us reveal the correlation between the current of charge exchange $I = \frac{dq}{dt}$ and circulation Γ by another way.

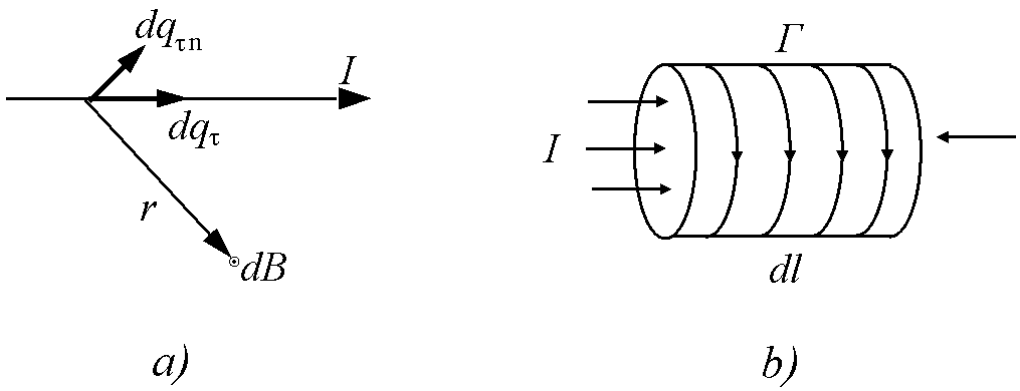

Fig. 2. Some characteristic directions (*a*); an element of a vortex cylindrical field (*b*).

In a steady-state wave exchange, the *total exchange of mass* through transversal sections of a cylindrical tube and a lateral surface *S* (see Fig. 2) is balanced, hence,

$$d^2M_\tau - d^2M_S = 0\,. \tag{60}$$

After dividing this equality by the time differential *dt*, we have

$$dq_\tau - dq = 0 \qquad \text{or} \qquad dq_\tau = dq\,, \tag{61}$$

where q_τ and *q* are, respectively, the *transversal* and *longitudinal* charges:

$$q_\tau = \frac{dM_\tau}{dt} \qquad \text{and} \qquad q = \frac{dM_S}{dt}\,. \tag{62}$$

Linear density of the transversal charge is

$$\Gamma = \frac{dq_\tau}{dl}\,, \tag{63}$$

hence,

$$\Gamma dl = dq_\tau \tag{64}$$

At the basis level, the speed of wave exchange is equal to the speed of light *c*, and

$$dl = cdt\,. \tag{65}$$

As a result, we arrive at the circulation equation of exchange:

$$\Gamma = \frac{1}{c}\frac{dq}{dt} = \frac{1}{c}I\,. \tag{66}$$

Historically, the circulation Γ was referred to as the current $I_m = \frac{1}{c}I$ in the magnetic system of units CGSM.

6. Conclusion

Thus, the new notions, originated from the DM, concerning *transversal exchange*, as an inseparable part of the interrelated longitudinal-transversal exchange, have been considered in this Lecture. The principal parameters of wave physical field-space characterizing its longitudinal-transversal nature were analyzed.

The longitudinal-transversal character of the field-space is expressed by the corresponding vectors of exchange: kinematic vectors – *vectors-speeds*, *E* and *B*, and

dynamic vectors – vectors of the *density of momentum of physical space*, *D* and *H*. These vectors reflect the *longitudinal-transversal structure of the World*. Each of the vectors has the contradictory *potential-kinetic* nature. The vectors *D* and *E* describe the *spherical* ("electric") wave field of the basis space; while the *H* and *B* vectors describe the *cylindrical* ("magnetic") wave field of the same basis space.

The *transversal* subfield of the longitudinal-transversal field is termed the "*magnetic field*" and the *longitudinal* field of exchange – the "*electric field*". The *binary field-spaces* are the basis of the material-ideal structure of the Universe.

The nature of origin of the *associated transversal mass* and the *exchange transversal charge* in transversal exchange has been revealed. A derivation of the corresponding formulas for mass and charge in transversal exchange were presented.

The new notion, *circulation*, related to the *transversal exchange*, has been considered here in all the details. Current and circulation are the different physical notions in principle.

The current of exchange, $I = \frac{dq}{dt} = \omega e$, as the *first derivative of the rate of mass exchange q*, has the dimensionality $g \times s^{-2}$. The circulation $\Gamma = \frac{1}{c} I$ is the *dynamic action* in the transversal (cylindrical) field, or the *circulation of the density of momentum H*, its dimensionality is $g \times cm^{-1} \times s^{-1}$.

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Lecture 9

Elementary Laws of Transversal Exchange

1. Introduction

We proceed now to consideration of the laws of *transversal exchange*, which are related with an interaction of currents through *cylindrical* (transversal, called "magnetic") fields generated by these currents. The first one is Ampere's law expressing transversal exchange (interaction) of two wave cylindrical fields caused by two rectilinear currents. The second law is called the Biot-Savart Law, which represents in essence the differential presentation of the formula for the speed-strength, $B = \mu_0 \mu_r \dfrac{\Gamma}{2\pi r}$, in the transversal exchange.

The notion of circulation, inherent in the transversal exchange and considered in previous Lecture, is used here. The physical meaning of new notions, such as the moment of current $\hat{P}_I$ and moment of circulation $\hat{P}_\Gamma$, will be discussed as well. What does represent by itself the *magnetic* (transversal) *charge* of the electron is revealed at that.

2. Exchange (interaction) of two cylindrical fields; Ampere's law

We will derive now the power of exchange (or the "force" of interaction, if one speaks on the language of modern physics) of two cylindrical fields caused by two rectilinear parallel currents. The scheme of exchange with an indication of principal vectors is drawn in Fig. 1.

In a plane of the symmetry, the lines of exchange pierce the plane at the right angle and the total velocity-strength of the fields of two charges is

$$\mathrm{V} = 2\upsilon \cos\theta, \tag{1}$$

where $\upsilon = \mu_0 \mu_r \dfrac{\Gamma}{2\pi r}$ (see (52) and (53), L. 8), $|\mathrm{V_k}| = |\mathrm{V_p}| = \mathrm{V}$. The density of energy of exchange is

$$w = \frac{\varepsilon_0 \varepsilon_r \mathrm{V}^2}{2}. \tag{2}$$

The resulting power ("force") of exchange is determined by integrating the density of the energy w with respect to area S over the whole infinite plane of symmetry:

$$F = \int w dS. \tag{3}$$

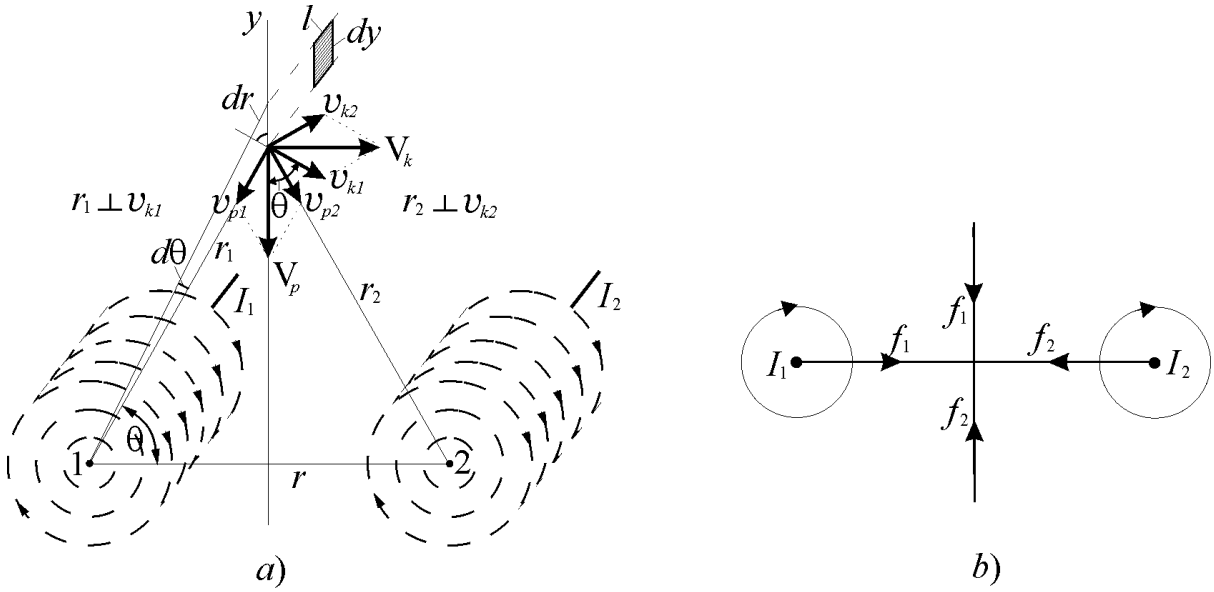

Fig. 1. *a*) Longitudinal-transversal speeds of the potential-kinetic field of exchange of two rectilinear currents (υ_p and υ_k are potential and kinetic speeds of a mean field of the exchange); *b*) a graph of longitudinal-transversal power of exchange. Potential and kinetic vectors are mutually perpendicular.

Thus, the power of exchange of two cylindrical surfaces of the length l along the plane of symmetry is

$$F = \int \frac{\varepsilon_0 \varepsilon_r \mathrm{V}^2}{2} dS. \tag{4}$$

Because (see Fig. 1) $r_1 = r_2 = \dfrac{r}{2\cos\theta}$, $dr_1 = \dfrac{r\sin\theta}{2\cos^2\theta} d\theta$, the differential dS is

$$dS = ldy = l\frac{dr_1}{\sin\theta} = \frac{lrd\theta}{2\cos^2\theta} \tag{5}$$

Taking into account (1) and (5), the differential dF is

$$dF = \frac{\varepsilon_0 \varepsilon_r \mathrm{V}^2}{2} dS = \frac{\mu_0 \mu_r \Gamma^2 \cos^2 \theta l d\theta}{\pi^2 r} \tag{6}$$

Hence, transversal exchange (interaction) of two wave cylindrical fields caused by two rectilinear currents is described by the formula

$$F = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{\mu_0 \mu_r \Gamma^2 l \cos^2 \theta d\theta}{\pi^2 r} = \frac{\mu_0 \mu_r \Gamma^2 l}{2\pi r}. \tag{7}$$

Because

$$B = \mu_0 \mu_r \frac{\Gamma}{2\pi r},$$

(see (52), L. 8), the formula of the exchange (7) takes the form:

$$F = B\Gamma l. \tag{8}$$

Denoting the circulation Γ by the symbol I_m, we obtain

$$\mathrm{I}_m = \frac{1}{c}\mathrm{I}. \tag{9}$$

If now to multiply this equality by *dt*, we arrive at the following formal equality

$$dq_m = \frac{1}{c} dq, \tag{10}$$

where $dq_m = \mathrm{I}_m dt = \Gamma dt$ is the *circulation charge*.

The physical quantities, I_m and dq_m, are regarded in physics as the current and charge in the magnetic system of units.

We see that there are two kinds of physical charges, “electric” and “circulation”. Both charges are related to themselves through the basis wave speed *c* as

$$q_m = \frac{1}{c} q. \tag{11}$$

The charges, q_m and *q*, expressed in the different units of measurement describe different properties of exchange and cannot be regarded as the same physical quantities.

Thus, the correct forms of the law, presented by the equalities (7) and (8), in the theory of transversal (magnetic) fields must be the following:

$$F = \frac{\mu_0 \mu_r \Gamma^2 l}{2\pi r}, \qquad \text{and} \qquad F = B\Gamma l; \tag{12}$$

or, because $\Gamma = \frac{1}{c} I$ ((66), L. 8),

$$F = \frac{\mu_0 \mu_r}{c^2} \frac{\mathrm{I}^2 l}{2\pi r}, \qquad \text{and} \qquad F = \frac{1}{c} B\mathrm{I} l . \tag{13}$$

where $\mu_0 = \frac{1}{\varepsilon_0} = 1 cm^3 \times g^{-1}$ and $\mu_r = \frac{1}{\varepsilon_r}$ are, correspondingly, the unit *absolute* and *relative volume densities*; herein $\varepsilon_0 = 1\, g \times cm^{-3}$ is the *absolute unit density* and ε_r is the *relative density* of the space; the dimensionality of the current I is $g \times s^{-2}$, and the dimensionality of circulation Γ (as the *linear density of the charge*) is $g \times s^{-1} \times cm^{-1}$.

Equations (12) and (13) express an elementary law of electrodynamics discovered first by Ampere. However, their resulting presentation shown above, originated from the DM, differs both in form and contents from the modern presentation accepted in physics, in SI units. The use of true dimensionalities for all physical magnitudes in the above equations, expressed through integer powers of basic units of matter-space-time (*g*, *cm*, and *s*), is one of the characteristic features of the theory under consideration. True dimensionalities originate from the true meaning of the quantities uncovered in the framework of the DM.

Although equations (13) do not differ *in form* from analogous equations presented in Gaussian units, but *in contents*, they essentially *differ*. It is, in particular, because the Gaussian system operates with physical measures expressed by obscure fractional powers of basic units of matter-space-time (*e.g.*, current I has the dimensionality $g^{1/2} \times cm^{3/2} \times s^{-2}$), and μ_0 has also the strange magnitude and dimensionality, although, actually, the constant μ_0 accepted in modern physics is the dimensionless unit (see Supplement), *etc*.

Thus, the *vector power of exchange*, or the "force of interaction", has the form (12). Strictly speaking, the vector F, as the power of interchange of two currents, is the bipolar vector. Actually, *F* is the summarized power of exchange: $F = f_2 - f_1$, where f_1 is the power transmitted by the current I_1, and f_2 is the power absorbed by the same current (see Fig. 1b).

Because of the symmetry of the fields of exchange, we can state that $f_2 = -f_1 = f$; therefore, $F = 2f$, *i.e.*, half of the total power is related to one current I, or to one element of the interaction:

$$f = \frac{1}{2} F = \frac{\mu_0 \mu_r \Gamma^2 l}{4\pi r} . \tag{14}$$

Eq. (14) defines both the central, or longitudinal, power of exchange generated by the kinetic ("magnetic") field and the non-central, or transversal, power of exchange (Fig. 1b), because in this and other relevant formulas $\Gamma_k = \Gamma_p = \Gamma$ ($|\upsilon_k| = |\upsilon_p|$ and $|\mathrm{V}_k| = |\mathrm{V}_p| = |\mathrm{V}|$).

3. The differential form of the speed-strength *B*; the Biot-Savart law

Let us to elucidate now the relation between the local cylindrical field of tangential speed-strength *B* (at an arbitrary distance *a* from the axis of the field, Fig. 2) and the circulation Γ.

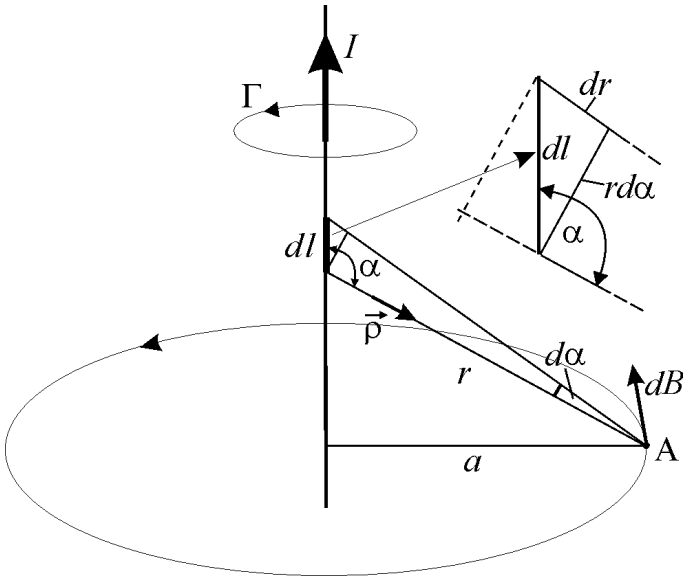

Fig. 2. The speed-strength of the transversal field *B* in a point A or, in other words, magnetic field of a current element *dl* (the infinitesimal length of conductor carrying electric current I).

A differential *dB* of circulation $B = \mu_0 \mu_r \dfrac{\Gamma}{2\pi a}$ ((54), L. 8) is as follows,

$$dB = \frac{\mu_0 \mu_r \Gamma dl \sin\alpha}{4\pi r^2}. \tag{15}$$

Let us verify the correctness of this formula. In the point A (Fig. 2), the total speed-strength must be equal to the integral of *dB* (15). Integrating the latter on a whole infinite length of a rectilinear current, we actually arrive at the aforementioned formula of circulation,

$$B = \int_{-\infty}^{+\infty} \frac{\mu_0 \mu_r \Gamma \sin\alpha}{4\pi r^2} dl = \int_0^{\pi} \frac{\mu_0 \mu_r \Gamma \sin\alpha}{4\pi a} d\alpha = \mu_0 \mu_r \frac{\Gamma}{2\pi a}, \tag{16}$$

where $dl = \dfrac{r d\alpha}{\sin\alpha}$ and $a = \dfrac{r}{\sin\alpha}$.

The differential presentation (15) of circulation $B = \mu_0 \mu_r \dfrac{\Gamma}{2\pi a}$ expresses the Biot-Savart Law. It can be written in the following forms:

$$dB = \frac{\mu_0 \mu_r \Gamma dl \sin\alpha}{4\pi r^2} = \frac{\mu_0 \mu_r dq_\tau \sin\alpha}{4\pi r^2} = \frac{\left|(d\vec{q}_\tau \times \vec{\rho})\right|}{4\pi \varepsilon_0 \varepsilon_r r^2}, \tag{17}$$

where Γdl is the differential of transversal power of exchange (the transversal charge dq_τ); dB is the differential of speed-strength; $\vec{\rho}$ is the unit vector of radius-vector r.

Thus, in the vector presentation, the law (15) has the form,

$$d\vec{B} = \frac{d\vec{q}_\tau \times \vec{\rho}}{4\pi\varepsilon_0\varepsilon_r r^2}, \qquad \text{or} \qquad d\mathbf{B} = \frac{\mu_0\mu_r}{4\pi}\frac{\Gamma[d\boldsymbol{l},\boldsymbol{\rho}]}{r^2}. \tag{18}$$

The formula (18) is analogous to the differential form of the law of longitudinal exchange

$$d\vec{E} = \frac{dq\cdot\vec{\rho}}{4\pi\varepsilon_0\varepsilon_r r^2}. \tag{19}$$

Thus, in longitudinal-transversal fields of matter-space-time at longitudinal-transversal exchange, we must operate both the *scalar longitudinal* (“electric”) exchange charges and *vector transversal* (“magnetic”) exchange charges.

4. The moment of circulation; magnetic moment and magnetic charge

Let us consider the exchange process in a cylindrical space of a round cross-section, *e.g.*, in a copper wire. A wave field of current of exchange of azimuthal symmetry is presented in the following form [1],

$$\hat{I} = I_0(k_r r)e^{-ikz}e^{-i\omega t}. \tag{20}$$

Elementary relations originated from this equation: the axial gradient, $\frac{d\hat{I}}{dz}$, and the rate of change of current, $\frac{d\hat{I}}{dt}$, are as follows:

$$\hat{I}_\lambda = \frac{d\hat{I}}{dz} = -ik\hat{I} = -i\omega\frac{I}{c} = -i\omega\hat{\Gamma}, \qquad \text{and} \qquad \frac{d\hat{I}}{dt} = -i\omega\hat{I}, \tag{21}$$

where

$$\hat{\Gamma} = \frac{\hat{I}}{c} \tag{22}$$

is the *axial* (longitudinal) *circulation*, equal to the transversal circulation, because the transversal circulation is related to current by the same equality. The transversal current always surrounds the longitudinal (axial) current. Because the longitudinal and transversal masses of exchange are equal, the longitudinal and transversal currents are equal as well.

If the axial current is closed, and a circuit of the current is circular of the radius *a*, then the moment $\hat{P}_I$ of current $\hat{I}$ and moment $\hat{P}_\Gamma$ of circulation $\hat{\Gamma}$ are determined by the following formulas:

$$\hat{P}_I = \hat{I}S = \hat{I}\pi a^2, \tag{23}$$

$$\hat{P}_\Gamma = \hat{\Gamma}S = \hat{\Gamma}\pi a^2. \tag{24}$$

From this it follows that

$$\hat{P}_\Gamma = \frac{\hat{I}}{c}S = \frac{\hat{P}_I}{c}. \tag{25}$$

An elementary quantum of the circulation is equal to

$$\hat{\Gamma} = \frac{\hat{I}}{c} = \frac{i\omega e}{c} = ike. \tag{26}$$

Hence, the amplitude value of the moment of circulation $P_{\Gamma,m}$, that is the amplitude measure of the orbital magnetic moment μ_m, is

$$P_{\Gamma,m} = \mu_m = \frac{I}{c}S = \frac{\omega e}{c}\pi a^2. \tag{27}$$

Because only half-wave of the fundamental tone is placed on the cylindrical wave shell (like on the spherical wave shell, at the equator), its length is twice of the circumference of the cylinder; so that $2\omega a = \upsilon$, accordingly, the following relation takes place:

$$\mu_m = \frac{I}{c}S = \frac{\pi}{2}\frac{\upsilon e}{c}a. \tag{28}$$

Hence, the mean magnetic moment is

$$\mu = \frac{2}{\pi}\mu_m = \frac{\upsilon}{c}ea = \frac{\upsilon}{c}P_e, \tag{29}$$

where $P_e = ea$ is the moment of the electron charge.

At the electromagnetic field level, the “threshold” speed of oscillations is equal to the first Bohr speed, $\upsilon = \upsilon_0$; and the amplitude *a* of the wave is equal to the Bohr radius r_0, hence, we have

$$\mu = \frac{\upsilon_0}{c}er_0, \qquad \text{or} \qquad \mu = \alpha e r_0 \tag{30}$$

where the fundamental ratio,

$$\alpha = \frac{\upsilon_0}{c},$$

as shown in [2], expresses the scale correlation of threshold states of conjugated oscillatory-wave processes at different levels of the Universe, including electromagnetic (remember L. 8 and L. 9, Vol. 2). In modern physics, the nature of this ratio, presented (in the SI units) in the form, $\alpha = \frac{e^2}{4\pi\varepsilon_0\hbar c}$, where ε_0 is the so-called "electric constant" of the pseudo dimensionality $F \times m^{-1}$ and e is the electron charge in coulombs, C [3, 4], is not understood properly and is called the "fine-structure constant".

Presenting the *magnetic moment* μ (30), in the same form as the *electric moment*, $P_e = ea$, we arrive at the following expression,

$$\mu = e_H a , \tag{32}$$

where

$$e_H = \frac{\upsilon_0}{c} e \tag{33}$$

is the transversal ("*magnetic"*) *charge* of the electron.

The latter equality expresses an *indissoluble bond* of longitudinal and transversal, electric and magnetic, fields. The electron is the *spherical electric* (scalar) *charge* and, simultaneously, it is the *cylindrical magnetic* (vector) *charge*, or "monopole". In other words, an electron is the *quantum of the longitudinal-transversal spherical-cylindrical* ("electromagnetic") *field* of the subatomic level of matter-space-time, presenting an indissoluble pair of $e - e_H$, source — vortex. The source e is the quantum of the spherical subfield, and the vortex e_H is the quantum of the cylindrical subfield of the unified spherical-cylindrical field.

5. Conclusion

The physical quantity $\Gamma = 2\pi r\varepsilon_0\varepsilon_r B = \frac{1}{c}\mathrm{I}$ of the dimensionality $g \times cm^{-1} \times s^{-1}$, being the parameter of the *transversal* ("magnetic") subfield, is the circulation of the *vector of density of momentum* $H = \varepsilon_0\varepsilon_r B = \frac{B}{\mu_0\mu_r}$; whereas the current I (of the dimensionality $g \times s^{-2}$) is the parameter of the *longitudinal* ("electric") subfield.

Thus, circulation Γ is the parameter, which joins in a single whole the electric and magnetic (longitudinal and transversal) constituents of the united field.

Since the circulation Γ is inseparable from the current I, we can conditionally call Γ the *current circulation, i.e.*, the circulation related to the given current. Just this inseparable relation of the circulation and current led, unfortunately, to the erroneous name of circulation the current.

The circulation Γ was first termed as the "*current in the magnetic system of units*" and was denoted by the symbol I_m. But further, the subscript *m* has been omitted and circulation Γ has become denoted simply by the letter I, tacitly accepting by this action that the dimensionality of circulation is in amperes as for current.

The above-indicated shortcoming has affected on all the other formulas related with participation of transversal constituents of longitudinal-transversal fields, including Ampere's law and the Biot-Savart Law, considered in this Lecture, and on Maxwell's equations (not touched here), *etc*.

This confusion remains in electrodynamics up to present. It is convincingly seen from Table 1, where the relevant physical parameters discussed here: correct, both in form and contents, originated from the Dynamic Model [1], and incorrect, accepted in modern physics, are assembled together and presented for comparison and analysis.

Table 1

Two presentations of elementary laws of electrodynamics, Ampere's law and the Biot-Savart law: correct (left) obtained in the framework of dialectical physics (the DM) and incorrect (right) accepted in modern physics, and relevant fundamental parameters.

Correct presentation both in form and contents (originated from the Dynamic Model, [1])		**Incorrect presentation** both in form and contents (accepted in modern physics)	
Ampere's law $F = \mu_0\mu \dfrac{\Gamma^2 l}{2\pi r}$,	The Biot-Savart law $d\mathbf{B} = \dfrac{\mu_0\mu_r}{4\pi}\dfrac{\Gamma[d\boldsymbol{l},\boldsymbol{\rho}]}{r^2}$	Ampere's law $F = \mu_0\mu \dfrac{\mathrm{I}^2 l}{2\pi r}$,	The Biot-Savart law $d\mathbf{B} = \dfrac{\mu_0\mu_r}{4\pi}\dfrac{\mathrm{I}[d\boldsymbol{l},\boldsymbol{\rho}]}{r^2}$
B is the *speed-strength* vector, $cm \times s^{-1}$		**B** is the *magnetic induction* vector, T $(1T = 10^4\, Gs = 10^4\, g^{1/2} \times cm^{-1/2} \times s^{-1})$	
$\Gamma = \dfrac{1}{c}\mathrm{I}$ is the *circulation*, $g \times cm^{-1} \times s^{-1}$ (The dimensionality of electric current I is $g \times s^{-2}$; the speed of light *c*, $cm \times s^{-1}$)		I is the *electric current*, A $(1A = \dfrac{c_r}{10}\, g^{1/2} \times cm^{3/2} \times s^{-2}$, where $c_r = \dfrac{c}{cm \times s^{-1}} = 2.99792458 \times 10^{10})$	

$\mu_0 = \frac{1}{\varepsilon_0} = 1\ cm^3 \times g^{-1}$ and $\mu_r = \frac{1}{\varepsilon_r}$ are, correspondingly, the unit *absolute* and *relative volume densities*. Herein, $\varepsilon_0 = 1\ g \times cm^{-3}$ is the *absolute unit density* and ε_r is the *relative density* of the space.	$\mu_0 = 4\pi \times 10^{-7}\ H \times m^{-1}$ (henry per meter) is the *magnetic constant*. However, actually, because $1H = 10^7\ m$, we have $\mu_0 = 4\pi$. ---------- Simultaneously, according to "2006 CODATA" [5, page 4], $\mu_0 = 4\pi \times 10^{-7}\ N \times A^{-2}$. Hence, because $N \times A^{-2} = \frac{10^7}{c^2}$, we have, actually, $\mu_0 = \frac{4\pi}{c^2}\ cm^{-2} \times s^2$

Below are Table 2 and Table 3 with the data on μ_0 and ε_0, taken from original Tables, I and XLIX, published in [5].

Table 2

"*Table I. Some exact quantities relevant to the 2006 adjustment*" [5, page 7].

Quantity	Symbol	Value
magnetic constant	μ_0	$4\pi \times 10^{-7}\ N \cdot A^{-2} = 12.566370614... \times 10^{-7}\ N \cdot A^{-2}$
electric constant	ε_0	$(\mu_0 c^2)^{-1} = 8.854187817... \times 10^{-12}\ F \cdot m^{-1}$

Table 3

"*TABLE XLIX. An abbreviated list of the CODATA recommended values of the fundamental constants of physics and chemistry based on the 2006 adjustment*" [5, page 94].

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
magnetic constant	μ_0	$4\pi \times 10^{-7}$ $= 12.566370614... \times 10^{-7}$	$N \cdot A^{-2}$ $N \cdot A^{-2}$	(exact)
electric constant $1/\mu_0 c^2$	ε_0	$8.854187817... \times 10^{-12}$	$F \cdot m^{-1}$	(exact)

Thus the development of systems of units led to the sad fact that two parameters, *current* and *circulation*, characterizing different subfields (*longitudinal* and *transversal*, "electric" and "magnetic") of the unit *longitudinal-transversal* field have obtained the same name – current, although in principle, in their dimensionalities and physical meaning, they are different. This fact is reflected, in particular, in the erroneous presentation in modern physics, both in form and contents, the elementary laws of electrodynamics, Ampere's and Biot-Savart. The right form of the laws was derived and presented here.

An important feature of the approach used here, which is based on the Dialectical Model of the Universe [6], is that all physical quantities are characterized by dimensionalities expressed by only integer powers of basic units: the *centimeter* as a unit of length, the *gram* as a unit of mass, and the *second* as a unit of time.

Along with the circulation, the problem of magnetic charges (former "magnetic monopoles") has obtained the natural solution in the DM as well. The electron, as a *quantum of the longitudinal-transversal spherical-cylindrical* ("electromagnetic") field of the subatomic level of matter-space-time, is the quantum of the spherical subfield, and simultaneously it is the quantum of the cylindrical subfield, the "magnetic monopole" or the vortex of the unified spherical-cylindrical field.

Note at the end that Ampere's and Biot-Savart laws describe not only wave cylindrical fields generated by "electric" currents and their interchange (interaction), but also the wave fields of pulsating and rotating cylinders (and moving pulsating or rotating spheres) and their interactions in different media (that was not considered here).

Supplement

The ratio of two units of the SI system (*newton* and *ampere squared*) artificially introduced as the dimensionality of μ_0, is equal, actually, to the ratio of the objective units of time and space, *second* and *centimeter* squared,

$$\frac{N}{A^2} = \frac{10^5}{\left(\frac{c_r}{10}\right)^2} \frac{dyn}{(CGSE_I)^2} = \frac{10^5}{\left(\frac{c_r}{10}\right)^2} \frac{g \times cm \times s^{-2}}{(g^{1/2} \times cm^{3/2} \times s^{-2})^2} = \frac{10^7}{c^2}\ cm^{-2} \times s^2 , \tag{34}$$

where $c_r = \dfrac{c}{1\ cm \times s^{-1}}$ is the relative speed of light (the dimensionless magnitude). It is the inverse value of speed squared. This ratio is a senseless from many points of view. In this case, we have

$$\mu_0 = 4\pi \times 10^{-7}\ N \times A^{-2} = \frac{4\pi}{c^2}\ cm^{-2} \times s^2 . \tag{35}$$

Accordingly, resting upon the definition of ε_0 presented in the above Tables, we arrive at

$$\varepsilon_0 = \frac{1}{\mu_0 c^2} = \frac{1}{4\pi}. \tag{36}$$

But in the SI units, $\varepsilon_0 = 8.854187817... \times 10^{-12}\ F \times m^{-1}$.

We leave the resulting data without further comments, because the absurdity of a subjective introduction in physics of the quantities, ε_0 and μ_0, of the aforementioned, to put it mildly, strange "dimensionalities", $F \times m^{-1}$, $N \times A^{-2}$, and $H \times m^{-1}$ (henry per meter), and magnitudes, and placing them in a series of the "*fundamental physical constants of physics and chemistry*" is obvious. All details concerning this matter one can find in [1] (see also [3]).

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Lecture 10

The Proton Magnetic Moment

1. Introduction

The first precise derivation of the *proton magnetic moment* based on the Dynamic Model of Elementary Particles (DM), beyond quantum electro- and chromodynamics, is a subject of the discussion in this Lecture. Longitudinal and transversal exchange interactions and corresponding to them *longitudinal* and *transversal* exchange charges inherent in fields and objects in the DM, are taken into account at the derivation. The results presented here, along with other original solutions considered already in the present Lectures such, in particular, as concerning the derivation of the electron and neutron magnetic moments, confirm once more an advantage of the DM in comparison with the Standard Model (SM) of modern physics inadequate as follows from the comprehensive analysis.

The current experimental value of the *proton magnetic moment*, according to the 2006 CODATA internationally recommended values, is

$$\mu_p = 1.410606662(37) \times 10^{-26} \ J \times T^{-1}. \qquad (1)$$

In absolute value, this moment approximately in 1.46 times more than that one which was obtained experimentally for the *magnetic moment of the neutron*,

$$\mu_n = -0.96623641(23) \times 10^{-26} \ J \times T^{-1}. \qquad (2)$$

The nature of the moments and the reason of such a difference between the observed quantities, both in magnitude and in sign, are not yet clearly understood by modern physics [1-18]. In our opinion, which has been repeated several times in the Lectures, a problem in general (and in particular, concerning magnetic properties of nucleons under consideration here) exists because contemporary physics, based on the SM, does not know hitherto the *true nature of charges*. As everyone knows, just charges are responsible for the magnetic properties of elementary particles. Therefore, how one can build adequate theories of atomic magnetism caused by charges, knowing nothing about what are charges?

Disadvantages of the SM are well known, but all attempts of physicists to improve this model end in failure. The matter is that the fundamental primordial problem of physics, which is still the *problem on the nature of mass and charge* of elementary particles, could not and *cannot be solved in principle* by the existing theories because they are based on inadequate abstract-mathematical postulates and the formal logic. That is what cannot understand majority of physicists so far, unfortunately.

A qualitatively new wave approach in physics based on dialectical logic, developed in the last two decades, has *solved the problem of the nature of mass and charge*. This solution was realized in the framework of the DM [19], which is a part of the Dialectical Model of the Universe (remember Lectures of Vol. 1). According to the DM, *mass* of elementary particles has the *associated* character and is the *measure of exchange* of matter-space-time, and the rest mass does not exist; and the *charge* is the measure of *the rate of the exchange*.

The present Lecture is a natural continuation of previous Lectures devoted to the derivation of the electron and neutron magnetic moments [20, 21], and of the Lamb shift in the hydrogen atom [22]. The derivation of the proton magnetic moment, like the derivation of analogous moments of other particles, is not possible without use of new fundamental parameters discovered in the framework of the DM. All new parameters and fundamental constants used here were already thoroughly discussed. For this reason, their definition will be repeated not always further.

In the derivation of the proton magnetic moment, an essential role plays the *transversal exchange*. Therefore, let us remember once more some characteristic features of such a principal notion, which is the notion of exchange in the DM.

The notion of *exchange*, used instead of *interaction*, is one of the principal notions in the DM. The latter distinguishes the *longitudinal* exchange and the *transversal* exchange, as two opposite sides of the process of interaction of particles with surrounding fields and particles themselves. The *longitudinal exchange* is characteristic for *spherical fields* of particles at rest and motion. The *transversal exchange* is characteristic for *cylindrical fields* of moving particles only.

The rate of mass exchange defines the *exchange charge*, its dimensionality is $g \times s^{-1}$. Two exchange charges, corresponding to two kinds of exchange, are: the *longitudinal* ("*electric*") exchange charge and the *transversal* ("*magnetic*") exchange charge. The transversal charge is generated during motion of particles. The central exchange has been considered in detail in Lectures of Vol. 2 (see also [19]), the transversal – in previous two Lectures.

Now some words about nucleons. What is their behavior? In general, the *neutron*, regarded in the DM as a proton-electron system and being unstable in a free state, is an electrically neutral microformation as a whole. A *positive* (longitudinal) exchange charge of the core of the neutron is *compensated* by the opposite, *negative*, transversal exchange charge

of an electron being in a state of motion in the neutron. Accordingly, a moving neutron does not generate the transversal exchange charge because transversal exchange is not inherent in neutral particles. And, as in the case of the hydrogen atom, that is the proton-electron system as well, the constituent electron defines a negative magnetic moment of the neutron.

A single free *proton* has the *central* (longitudinal) *exchange charge*, equal in value to the minimal quantum of the rate of mass exchange *e*, which is *not compensated* (as against of the exchange charges in the neutron). For this reason, during motion, the positively charged proton generates the *transversal charge*, which contributes to the resulting transversal, magnetic, field. Thus, both exchanges and corresponding to them exchange charges, *longitudinal* and *transversal*, define an appearance, and a strictly definite value, of the proton magnetic moment.

On the basis of the DM, the proton magnetic moment is derived with the high precision in full correspondence with the experimental data. We will show this.

2. A general formulation for deriving of the proton magnetic moment

The spectrum of *amplitude magnetic moments* of nucleons (protons and neutrons) as dynamic (wave) microformations, in accordance with the DM, is described by the formula,

$$\mu = \frac{\upsilon_0}{c} q \frac{A\hat{e}_l(z_{p,s})}{z_{p,s}}, \tag{3}$$

where

$$A = r_0 \sqrt{\frac{2hR}{m_0 c}} \tag{4}$$

is the constant,

$$\hat{e}_l(kr) = \sqrt{\frac{\pi kr}{2}} (J_{l+1/2}(k_e r) \pm iY_{l+1/2}(k_e r)), \tag{5}$$

$$k_e = \frac{\omega_e}{c} = \frac{1}{\lambda\!\!\!^{-}_e}, \tag{6}$$

$$z_{p,s} = k_e r. \tag{7}$$

Here υ_0 and r_0 are the Bohr speed and radius, respectively; c is the speed of light; q is the charge of *exchange* of the nucleon with environment, $g \times s^{-1}$ [19]; A is the constant; $J(kr)$ and $Y(kr)$ (or $N(kr)$) are Bessel functions; k_e is the wave number; ω_e is the oscillation frequency of the pulsating spherical shell of the proton equal to the fundamental "carrier" frequency of the subatomic and atomic levels; $z_{p,s}$ are roots of Bessel functions [23]. The subscript p in $z_{p,s}$ indicates the order of Bessel functions and s, the number of the root. The

last defines the number of the radial shell. Zeros of Bessel functions define the radial shells with zero values of radial displacements (oscillations), *i.e.*, the shells of stationary states.

An *elementary quantum of the magnetic moment of a nucleon* in a node of the spherical field [24] is equal to

$$\mu = \frac{\upsilon_0}{c} q A_m , \tag{8}$$

where A_m is amplitude with which a nucleon as a whole oscillates in a node of the spherical wave field of exchange,

$$A_m = \lambda\!\!\!^{-}_e \sqrt{\frac{2Rh}{m_0 c}} = 2.73065189 \times 10^{-12}\ cm , \tag{9}$$

where

$$\lambda\!\!\!^{-}_e = \frac{c}{\omega_e} = 1.603886514 \times 10^{-8}\ cm \tag{10}$$

is the wave number, ω_e is the fundamental frequency of the subatomic level,

$$\omega_e = 1.869162534 \times 10^{18}\ s^{-1} . \tag{11}$$

The amplitude A_m is the *characteristic amplitude* of oscillations on the sphere of the wave radius ($z_{p,s} = kr = 1$).The Rydberg constant is

$$R = \frac{R_\infty}{1 + \frac{m_e}{m_0}} = 109677.5833\ cm^{-1} . \tag{12}$$

Other fundamental quantities used here are: the proton mass $m_0 = 1.672621637(83) \times 10^{-24}\ g$, the Planck constant $h = 6.62606896(33) \times 10^{-27}\ erg \times s$, and the base speed of exchange $c = 2.99792458 \times 10^{10}\ cm \times s^{-1}$.

The exchange charge *q*, being the measure of the *rate of exchange of matter-space-time*, or briefly the *power of mass exchange*, is defined as

$$q = \frac{dm}{dt} = S \upsilon \varepsilon , \tag{13}$$

where *S* is the area of a closed wave surface separating the inner and outer spaces of an elementary particle, υ is the oscillatory speed of exchange at the separating surface, ε is the absolute-relative density. The exchange charge *q* and the Coulomb charge q_C (presented in the CGSE units) are related as

$$q = q_C \sqrt{4\pi\varepsilon_0} , \tag{14}$$

where $\varepsilon_0 = 1\, g \times cm^{-3}$ is the absolute unit density.

The value of μ defined by the equality (8), $\mu = \frac{\upsilon_0}{c} qA_m$, is the *main constituent* of the magnetic moment of both nucleons (neutron and proton). But in this formula, for the case of a free proton, the *total exchange charge q*, along with the minimal quantum of the rate of *longitudinal* mass exchange, includes an *additional transversal exchange charge* of the positive sign generated by the moving proton.

At the same time a nucleon, as a dynamic, pulsating microobject in accordance with the DM, *oscillates* with respect to its own center of mass with the amplitude (4). The *perturbations in motion* caused by the aforesaid oscillations of definite amplitude superimpose on the motion of the nucleon. Hence, the *second* in value term to the nucleon magnetic moment (8) is defined (in this case $z_{p,s} = z_{0,s}$) by the following formula,

$$\delta\mu_1 = \frac{q\upsilon_0}{c} \frac{r_0}{z_{0,s}} \sqrt{\frac{2Rh}{m_0 c}}\,. \tag{15}$$

The charge *q* in (15), *for the case of a neutron*, regarded as a proton-electron system, is defined by only the electron exchange charge, so that $q = -e$, which is mutually balanced with opposite in sign the central longitudinal proton exchange charge.

For the free proton, whose exchange with the surrounding field is not compensated with the opposite in sign exchange charge of the electron because of lack of the latter, the total exchange charge of the proton *q* is defined by both the *non-compensated longitudinal positive exchange charge* of the proton, $+e$, and the supplementary *associated transversal exchange charge*, Δe_p, generated during its motion:

$$q = +e + \Delta e_p\,. \tag{16}$$

where

$$+e = 1.702691582 \times 10^{-9}\ g \times s^{-1}. \tag{17}$$

Thus, according to (3), the circular wave motion of the proton generates the magnetic (transversal) moment μ (8). Small deviations of the motion generate an additional magnetic moment (15), which must be taken into account for the total magnetic moment of the proton.

Thus, the theoretical value of the *total magnetic moment* of the proton $\mu_p(th)$ must be defined by the following equation,

$$\mu_p(th) = \frac{(e + \Delta e_p)\upsilon_0}{c} \left(\lambda\!\!\!^{-}_e + \frac{r_0}{z_{0,s}} \right) \sqrt{\frac{2Rh}{m_0 c}}\,. \tag{18}$$

In this formula, the unknown magnitude is the *supplementary exchange charge* of the proton, Δe_p, generated during the non-compensated transversal exchange with environment of the moving proton. The roots of Bessel functions $z_{0,s}$, which define wave shells of the proton, can be easy chosen from a series of roots obtained from solutions of the wave equation [25]. Other values entered in (18) were presented above.

3. Solutions for the cylindrical space

The transversal supplementary exchange charge Δe_p was unknown earlier. As follows from the DM, it is a very important physical quantity [24]. The fundamental notion of transversal exchange is directly connected with the longitudinal exchange. The principal parameters of the wave physical space and longitudinal-transversal and potential-kinetic structure of wave fields were considered in the previous Lectures.

The *general solution* for the *cylindrical space* (variable parameters are *r*, *z*, φ, and *t*) has the form,

$$\hat{\Psi}_m = C_\Psi \hat{R}_m(k_r r) e^{-ik_z z} e^{-im(\varphi+\varphi_0)} e^{i\omega t}, \tag{19}$$

where *m* is the order of the function; φ_0 is the initial phase of the azimutal wave.

The *radial constituent* of the wave function (19), $\hat{R}_m(k_r r)$, is defined by Bessel functions of the third kind (Hankel function), $\hat{H}_m^{\pm}(k_r r)$:

$$\hat{R}_m(k_r r) = \sqrt{\frac{\pi}{2}} \hat{H}_m^{\pm}(k_r r) = \sqrt{\frac{\pi}{2}} \left(J_m^{\pm}(k_r r) \pm i N_m^{\pm}(k_r r) \right). \tag{20}$$

$J_m(k_r r)$ and $N_m(k_r r)$ are Bessel's functions, respectively, of the first and second kinds.

In the cylindrical field, the *order of the radial function m defines the number of waves*, which are placed on the definite orbit. In a simplest case, only half-wave can be placed on the orbit. So that such an orbit will be described by the function of the $m = 1/2$ order. Accordingly, as a solution, we choose the function

$$\Psi_{1/2} = A \sqrt{\frac{\pi}{2}} (J_{1/2}(\rho) + i N_{1/2}(\rho)) e^{-i(1/2\varphi+\varphi_0)} e^{-ik_z z} e^{i\omega t} \tag{21}$$

or

$$\Psi_{1/2}^{+} = Ai \frac{e^{i(\omega t - kr)}}{\sqrt{kr}} e^{-i(1/2\varphi+\varphi_0)} e^{-ik_z z}, \tag{22}$$

where an initial phase of the azimuth component of the radial divergent wave, φ_0, is defined on the basis of the boundary conditions.

Naturally, the “radial divergent wave” is not the full name of the wave, because it represents the wave structure of radial, azimuth, and axial waves-spaces. The axial wave, represented by the function (22), propagates along *Z*-axis in the positive direction. The convergent radial wave $\Psi^{-}_{1/2}$ corresponds to the divergent one,

$$\Psi^{-}_{1/2} = Ai\frac{e^{i(\omega t+kr)}}{\sqrt{kr}}e^{-i(1/2\varphi+\varphi_0)}e^{-ik_z z} \quad . \tag{23}$$

Both waves form *the dynamic stationary wave field in the radial direction*, expressed mathematically by the standing radial wave:

$$\Psi_{1/2} = \Psi^{+}_{1/2} + \Psi^{-}_{1/2} = ia\frac{\cos kr \cdot e^{i\omega t}}{\sqrt{kr}}e^{-i(1/2\varphi+\varphi_0)}e^{-ik_z z} . \tag{24}$$

Simultaneously, the $\Psi_{1/2}$-wave is the travelling wave in the azimuth and axial directions, positive and negative with respect to the Z-axis, correspondingly:

$$\left(\Psi_{1/2}\right)^{+} = ia\frac{\cos kr}{\sqrt{kr}}e^{-i(1/2\varphi+\varphi_0)}e^{i(\omega t-k_z z)} \tag{25}$$

and

$$\left(\Psi_{1/2}\right)^{-} = ia\frac{\cos kr}{\sqrt{kr}}e^{i(1/2\varphi+\varphi_0)}e^{i(\omega t+k_z z)} . \tag{26}$$

Both waves form the standing wave in the radial and axial directions:

$$\Psi_{1/2} = ia\frac{\cos kr}{\sqrt{kr}}e^{i(1/2\varphi+\varphi_0)}\cos k_z z \cdot e^{i\omega t} . \tag{27}$$

However, in the azimuth direction, it is the travelling wave along the electron orbit. If we are not interested in the description of the axial wave, we can omit the axial component and consider only the radial-azimuth subspace:

$$\Psi_{1/2} = ia\frac{\cos kr}{\sqrt{kr}}e^{i(1/2\varphi+\varphi_0)} \cdot e^{i\omega t} . \tag{28}$$

The distance *r* from the axial line increases. In this case, the radial multiplicative component of the cylindrical space (20) takes the following approximate form,

$$\hat{R}(\rho) \approx \frac{\hat{A}e^{\pm i\rho}}{\sqrt{\rho}} , \tag{29}$$

where $\hat{A} = Ae^{i\left(\frac{m\pi}{2}+\frac{\pi}{4}\right)}$, and $\rho = k_r r$ is an argument of the cylindrical function defining the expansion of space in the radial direction; $k_r = k = \frac{\omega_e}{c} = \frac{1}{\lambda\!\!\!^{-}_r}$ is the wave number corresponding to the fundamental frequency of the field of exchange at the atomic and subatomic levels, ω_e.

Considering the transversal exchange in Lecture 8, we have arrived at the following formulas for the *associated transversal mass* m_τ and the *associated transversal charge* q_τ (taking into account that at the field level $\varepsilon_r = 1$):

$$m_\tau = \frac{4\pi a^2 l \varepsilon_0}{1 + 4(k_r a)^2}, \tag{30}$$

$$q_\tau = \omega m_\tau = \frac{4\pi a l \upsilon \varepsilon_0}{1 + 4(k_r a)^2}. \tag{31}$$

These formulas will be used for final deriving of the proton magnetic moment.

4. The proton magnetic moment

Motion of a proton has the wave character and represents a cylindrical ray-wave. Therefore, we must take into account the supplementary associated charge and mass generated at the transversal exchange in the cylindrical field. The supplementary associated mass m_τ of the ray element l is defined by the formula (30).

An element l of the ray can be defined by the following way. According to the approach developed in [24], we have to recognize that the *elementary quantum of the rate of mass exchange e* exists in the four states:

$$+e, \quad -e, \quad +ie, \quad -ie \tag{32}$$

The first two quanta have relation to the *longitudinal* (“electric”) exchange, the rest two quanta – to the *transversal* (“magnetic”) exchange, which (please, remember) is the negation of the first one in full agreement with dialectical logic. An elementary transversal magnetic charge-flux at the level of the Bohr radius r_0 is equal to

$$ei = \upsilon i \varepsilon_0 S = 2\pi r_0 l i \upsilon \varepsilon_0, \tag{33}$$

where $\varepsilon_0 = 1\, g \times cm^{-3}$ is the absolute unit density, $e = 1.702691582 \times 10^{-9}\ g \times s^{-1}$ is the charge of exchange of the proton with environment equal in absolute magnitude to the electron

exchange charge, and $r_0 = 0.52917720859 \times 10^{-8}\, cm$ is the Bohr radius. Hence, as follows from the equality (33), an element *l* of the ray-wave is defined from the expression,

$$l = \frac{e}{2\pi r_0 \upsilon \varepsilon_0}. \tag{34}$$

Under the condition $\upsilon = c$, the element *l* takes the minimal value equal to:

$$l = \frac{e}{2\pi r_0 c \varepsilon_0} = 1.708182574 \times 10^{-12}\, cm. \tag{35}$$

Hence, the supplementary associated transversal mass of the proton, Δm_p, defined from (30), is

$$\Delta m_p = \frac{4\pi r_0^2 l \varepsilon_0}{1 + 4k_e^2 r_0^2} = 4.187602162 \times 10^{-28}\, g, \tag{36}$$

The exchange charge, $q = \frac{dm}{dt}$ (13), is regarded in the DM [19, 24] as the rate of mass exchange. Its amplitude value is equal to the product of the associated mass by the fundamental frequency of exchange at the subatomic level ω_e,

$$q = m\omega_e. \tag{37}$$

Hence, the *supplementary exchange charge* Δe_p, corresponding to the supplementary associated transversal mass (36), is equal to

$$\Delta e_p = \Delta m_p \omega_e = 7.827309069 \times 10^{-10}\, g \times s^{-1}. \tag{38}$$

Thus, the *total charge of exchange* of the proton wave shell with environment takes the following value,

$$q = e + \Delta e_p = 2.485422489 \times 10^{-9}\, g \times s^{-1}. \tag{39}$$

Let us turn now to the formula (18) and choose the root of Bessel functions $z_{0,s}$ entered in the second term of this expression. Similar as in the case of the derivation of the neutron's magnetic moment, we select the radial solution near the twelfth wave shell. Owing to the more uncertainty, we take the average value of the two nearest roots $z_{0,s}$, namely $a'_{0,11} = 32.95638904$, equal to the extremum of the eleventh potential spherical shell, and $y_{0,12} = 35.34645231$, which is equal to the zero of the twelfth kinetic shell.

Under all above conditions, the formula (18) for the proton magnetic moment takes the form,

$$\mu_p(th) = \frac{(e+\Delta e_p)\upsilon_0}{c}\left(\lambda\!\!\!^{-}_e + r_0\frac{(a'_{0,11}+y_{0,12})}{2(a'_{0,11}y_{0,12})}\right)\sqrt{\frac{2Rh}{m_0 c}}\,, \tag{40}$$

where $\upsilon_0 = \alpha c = 2.187691254\times 10^8\ cm\times s^{-1}$ (α is the fine-structure constant [26]).

The substitution of all numerical values for quantities entered in (40) yields the following theoretical values for the total magnetic moment of the proton and its two constituents:

$$\begin{aligned}\mu_p(th) &= (4.952571882 + 0.04790508144)\cdot 10^{-23}\ g\times cm\times s^{-1} = \\ &= 5.000476963\times 10^{-23}\ g\times cm\times s^{-1}\end{aligned} \tag{41}$$

After conversion (41) from objective units of matter (*g*), space (*cm*), and time (*s*) to SI system of units, since $1T = \frac{10^4}{\sqrt{4\pi}}\ cm\times s^{-1}$, $\mu_p(th)$ gets the following numerical values:

$$\begin{aligned}\mu_p(th) &= (1.397094734 + 0.0135137738)\times 10^{-26}\ J\times T^{-1} = \\ &= 1.410608508\times 10^{-26}\ J\times T^{-1}\end{aligned} \tag{42}$$

Thus, we have obtained theoretically the value of μ_p, which practically coincides with the current "2006 CODATA recommended value" (1) accepted for the magnetic moment of the proton. The absolute coincidence of the obtained theoretical value (42) with the averaged experimental (recommended) value $\mu_p = 1.410606662(37)\times 10^{-26}\ J\times T^{-1}$ (1) is easily achieved if one introduces a small empirical factor β for the second term. Such an adjustment is justified in the framework of the approach accepted here, because this imperceptible factor corrects indeterminacy in the weight contribution each of two selected shells (roots of Bessel functions). The factor β takes into account this circumstance.

Thus finally, the formula for the magnetic moment of the proton (40) takes the form,

$$\mu_p(th) = \frac{(e+\Delta e_p)\upsilon_0}{c}\left(\lambda\!\!\!^{-}_e + r_0\frac{1}{\beta}\frac{(a'_{0,11}+y_{0,12})}{2(a'_{0,11}y_{0,12})}\right)\sqrt{\frac{2Rh}{m_0 c}} \tag{43}$$

At the factor β equal to 1.000136546 , we arrive at the complete coincidence of the resulting numerical value of the proton magnetic moment, obtained theoretically in the framework of the DM, with the averaged experimental value (1) accepted for use in physics:

$$\mu_p(th) = (1.397094734 + 0.013511928) \times 10^{-26}\ J \times T^{-1} = \\ = 1.410606662 \times 10^{-26}\ J \times T^{-1} \tag{44}$$

5. Conclusion

For the first time in physics, due to the DM, a precise derivation of the proton magnetic moment was realized in practice. It was accomplished beyond QED and QCD theories, which are unable to made this in principle. Thus, the unique result was achieved in the framework of the Dynamic Model with taking into account the wave structure and behavior of elementary particles.

A concept of longitudinal and transversal exchange interactions, realized by *longitudinal* and *transversal* exchange charges inherent in fields and objects in the DM, has played its key role at the derivation of electron and nucleon magnetic moments.

Along with the previous derivations of electron and neutron magnetic moments [20, 21], and the Lamb "shift" in the hydrogen atom [22], the derivation of the proton magnetic moment has became, thus, next of the stringent tests in favor of the validity of the concepts about the *associated nature of mass* of elementary particles and on the *exchange nature of their charges*. According to the definition, the *charge* is regarded in the DM as the measure of the *rate of mass exchange* of particles; its dimensionality is $g \times s^{-1}$.

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Lecture 11

The Mass Spectrum of Elementary Particles

1. Introduction

The dialectical view of the world, which is under consideration in all present Lectures, is different from that one laid down in the Standard Model (SM) of modern physics. In this Lecture, we present the next unique research results obtained in the framework of the dialectical approach accepted in the Dynamic Model (DM). This time our consideration concerns some new aspects in a general description of the nature of *elementary particles* [1] related with their masses.

A new view on the mass spectrum of elementary particles has been fully formed in the DM due to disclosure of unknown earlier regularities, more precisely, due to the found correlation in values of their masses. We mean the correlation with the fundamental period-quantum $\Delta = 2\pi \lg e$ of the Decimal Code of the Universe [2]. This issue is revealed here as detailed as possible.

A comparative analysis of the mass spectra of some elementary particles and selected ancient metrological measures, presented here as an example, reveals the correlation of both spectra with Δ. The discovery of the correlation confirms the reality of the existence of second kind laws, the laws of an ideal side of the material-ideal world, to which the Law of the Decimal Code belongs. We have considered this issue earlier (see Lectures of Vol. 1). The resulting mass spectrum of reference measures of some groups of elementary particles is drawn at the end of this Lecture.

Decay of particles-nucleons leads in result to the appearance of numerous fragments in the form of different short-lived particles of more light masses. This process runs in such a way under which the *existent harmony in nature does not break*. Adherence of formed particles to the Law of the Decimal Code is naturally realized in the Universe in all cases without exception, as essence of its being. In particular, the multiplicity of values of masses of new wave objects – particles, derivatives of decay, to the fundamental quantum-period Δ of the Decimal Code must be saved.

Actually, observations show that the given condition is satisfied in Nature: the values of masses of all new particles formed during particle decay are multiple to the fundamental period-quantum Δ.

The periodic law of measures, which was formulated on the basis of the obtained results, reflects the periodic essence of all processes and the wave behavior of all objects in the Universe. We discuss an appearance of the periodic law in measures of some fundamental parameters of elementary particles such as the speed of exchange c, the electron mass m_e, the period-quantum of time T_e.

All the above enumerates questions, touched briefly in this introduction, are considered in this Lecture. Additionally, at the beginning, it is useful to recall the fundamental features of incessant motion of all particles in the Universe, and to recollect what energy they have in this natural dynamic state.

2. Universality of circular motion in the Universe and energy of objects

All physical phenomena run in nature with a continuous transformation of the kinetic field into the potential field, and *vise versa*, *i.e.*, they have the wave character. All objects in the Universe have also the wave nature. For this reason, the structure of expressions, representing wave fields of all phenomena and objects, must reflect the potential-kinetic peculiarity inherent in the wave fields.

From the DM it follows that the potential and kinetic energies are equal in value and opposite in sign and the *total* potential-kinetic energy of any object in the Universe is equal to zero [3]. We present below some fragments of the description concerning the above statement considered earlier in the Lectures of Vol. 1. This material is necessary for further consideration and understanding of the essence set out in the Lecture related to the nature of an appearance of particles with the definite values of masses.

At the *circular* motion-rest, the energy of an object of the mass m (expressed by the vector measures) can be presented in the following forms:

$$\hat{E} = \int \hat{\mathbf{F}} d\hat{\mathbf{r}} = \int m\hat{\mathbf{v}} d\hat{\mathbf{v}} = -\int k\hat{\mathbf{r}} d\hat{\mathbf{r}} = -\frac{k\hat{\mathbf{r}}^2}{2} = \frac{m\hat{\mathbf{v}}^2}{2}, \qquad (1)$$

or

$$\hat{E} = \frac{m\mathbf{v}_k^2}{2} + \frac{m\mathbf{v}_p^2}{2} + \frac{2m\mathbf{v}_k\mathbf{v}_p\cos\alpha}{2} = \frac{m\upsilon^2}{2} + \frac{m(i\upsilon)^2}{2} + \frac{2m\mathbf{v}_k\mathbf{v}_p\cos(\pi/2)}{2} = 0, \qquad (2)$$

where (see Fig. 1)

$$\hat{\mathbf{v}} = \frac{d\hat{\mathbf{r}}}{dt} = \hat{\mathbf{v}}_k + \hat{\mathbf{v}}_p = \upsilon\boldsymbol{\tau} + i\upsilon\mathbf{n} \qquad \text{or} \qquad \hat{\mathbf{v}} = \frac{d\hat{\mathbf{r}}}{dt} = \omega r\boldsymbol{\tau} + i\omega r\mathbf{n}, \qquad (3)$$

$\upsilon = \omega r$ and $\hat{\mathbf{v}}_k = \dfrac{d\hat{\mathbf{r}}_p}{dt} = \upsilon\boldsymbol{\tau}$ is the kinetic tangential velocity, $\hat{\mathbf{v}}_p = \dfrac{d\hat{\mathbf{r}}_k}{dt} = i\upsilon\mathbf{n}$ is the potential normal velocity, $k = \omega^2 m$.

From (2) it follows that the energetic measures of rest and motion are represented by the opposite, in sign, *kinetic* and *potential energies* equal in value:

$$E_k = \frac{m\upsilon_k^2}{2}, \qquad E_p = \frac{m(i\upsilon_p)^2}{2} = -\frac{m\upsilon_p^2}{2} \tag{4}$$

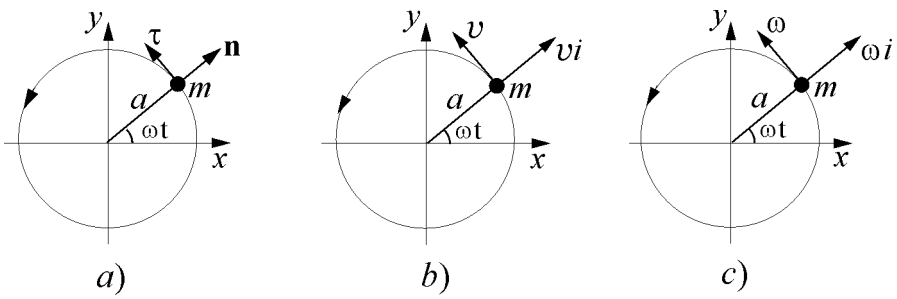

Fig. 1. The kinematics of motion-rest along a circumference: *a*) the tangential $\boldsymbol{\tau}$ and normal $\mathbf{n}$ units vectors; *b*) $\mathbf{v}_p = i\omega a\mathbf{n} = i\upsilon\mathbf{n}$ is the potential velocity, $\mathbf{v}_k = \omega a\boldsymbol{\tau} = \upsilon\boldsymbol{\tau}$ is the kinetic velocity; *c*) $\boldsymbol{\omega}_p = i\omega\mathbf{n}$ is the potential specific velocity, $\boldsymbol{\omega}_k = \omega\boldsymbol{\tau}$ is the kinetic specific velocity.

Because an insignificant part of an arbitrary trajectory is equivalent to a small part of a straight line, *any wave motion* of an arbitrary microparticle (and, in an equal degree, a macro- and megaobject) *is characterized by the kinetic and potential energies* also equal in value and opposite in sign. Therefore, the total potential-kinetic energy of any object in the Universe is equal to zero:

$$E = E_k + E_p = 0, \tag{5}$$

and its amplitude is equal to the difference of kinetic and potential energies:

$$E_m = E_k - E_p = m\upsilon^2. \tag{6}$$

Under the motion along a circumference (as in particular it takes place with the electron in H-atom), the potential-kinetic vector energy of a material point is equal to zero. By virtue of this, the circular motion is the optimal (equilibrium) state of the field of rest-motion, where "attraction" and "repulsion" are mutually balanced, which, in turn, provide for the steadiness of orbital motion in the micro- and macroworld.

The *quantitative equality* of "attraction" and "repulsion" is accompanied, simultaneously, by the *qualitative inequality* of the *directions* of fields of rest and motion, which generates the *eternal circular wave motion*.

In order to break such a motion, it is necessary to destroy this system entirely. However, in this case, a ***vast number of new circular wave motions of more disperse levels will appear as a result***. With this, *masses of the resulting wave formations* (particles, according to the DM) belonging to dipper microlevels of the Universe, with respect to the initial higher level system, *take strictly definite values, which are multiple* to the period-quantum of the Decimal Base Δ. About this regularity in the formation of particles, we will speak now.

3. Microlevels of the Universe

A general scheme of microlevels in the Universe can be imagined only on the basis of the present knowledge about the structure and the nature of microobjects obtained from experience. We take also into account the new data on the atomic structure originated from the strict solutions of the general wave equation (will be considered in the next volume of the Lectures).

If we will go from the molecular level to the lower laying levels of matter-space-time, it should be noted the following sequence:

1) The <u>*first molecular level*</u>. Its basis is made of *nucleon molecules*, structural units according to the Shell-Nodal Atomic Model (SNAM) of dialectical physics [3]. In modern physics, according to the mononuclear (monocentric) quantum-mechanical atomic model, they are called *atoms*.

According to the SNAM, *all atoms* of the Periodic Table, excepting the hydrogen atom, beginning from the nucleon molecule ("atom") of helium, with $Z \geq 2$ are the *nucleon molecules* as multicentric structures.

2) The <u>*second molecular level*</u> or the <u>*level of nucleon molecules*</u>. *All atoms* of the Periodic Table, excepting the hydrogen atom, being *multicentric formations* (according to the SNAM), belong to this level. The main structural units are *nucleons* (protons and neutrons). According to modern atomic and nuclear physics, it is the *atomic level*.

3) The <u>*atomic level*</u> or the <u>*nucleon level*</u>. Its representatives are *H-atoms* to which we refer *protons*, *neutrons* and the *hydrogen atoms*. Main structural units are *g-nucleons* – *subnucleons* of the neutrons. The *g-nucleon* in a spectrum of elementary particles is termed the muonic neutrino ν_μ. As earlier physicists assumed, its mass is equal to 68.5 m_e; that is, (as it will be shown below) this value approximately corresponds to its true mass. Only the first element of the Periodic Table, hydrogen, and all its isotopes, can be regarded as the *atom* (of course, along with protons and neutrons). The rest elements of the Periodic Table are *nucleon molecules*.

4) The *subnucleonic level*. *Electrons* and *positrons* belong to this level.

5) Etc.

We term microparticles by the general name "$\hat{\boldsymbol{k}}$ -particles". Any concrete $\hat{\boldsymbol{k}}$ -particle is the definite representative of $\hat{\boldsymbol{K}}$ -group of particles that is written as $\hat{\boldsymbol{k}} \in \hat{\boldsymbol{K}}$. The dialectics of recurrence-nonrecurrence, uniformity and difference, requires the qualitative distinction of particles of any level. In other words, the dialectics of quantity-quality pierces both mega- and macroworlds of the Universe. It means that the contradictory symmetry of quantity-quality, material-ideal of the dialectical material-ideal Universe excludes the mechanical principles of an identity of any particles and indicates that they are material-ideal formations, that denoted by the symbol "^" [1].

The particles $\hat{e}$, $\hat{g}$, $\hat{\gamma}$, $\hat{\mu}$, $\hat{\pi}$... belong, correspondingly, to $\hat{\boldsymbol{E}}$, $\hat{\boldsymbol{G}}$, $\hat{\Gamma}$, $\hat{\boldsymbol{M}}$, $\hat{\Pi}$,... -groupes.

Within every group, masses of particles differ. Some average mass, which depends on the theory representing it, is indicated in published tables of elementary particles masses. Therefore, it is impossible to speak about the full objectivity of particles masses values accepted in physics.

Thus, $\hat{\boldsymbol{k}}$ -particles belonging to any $\hat{\boldsymbol{K}}$ -group have, more or less, similar structures at the level of material basis. This structure defines their approximate quantitative equality. But they have distinct superstructures reflecting their qualitative difference. Therefore, the brief symbol of any particle, strictly speaking, needs to be represented by the general symbol of the material-ideal field of measures as:

$$\hat{\boldsymbol{k}} = \boldsymbol{k} + \boldsymbol{ik}, \qquad \hat{\boldsymbol{K}} = \boldsymbol{K}_\alpha + \boldsymbol{iK}_\beta, \tag{7}$$

where $\boldsymbol{K}_\alpha$ is the basis and $\boldsymbol{iK}_\beta$ is the superstructure of the $\hat{\boldsymbol{K}}$ -group; α–symbol expresses an insignificant and unessential distinction at the basis level; β–symbol reflects, in a general case, an essential qualitative distinction, pointing to an existence of qualitative subgroupes of $\boldsymbol{iK}_\beta$-substructure; $\boldsymbol{i}$ is the ideal unit (the unit of polar negation).

The material $\boldsymbol{k}$ -basis of $\hat{\boldsymbol{k}}$ -particle forms the quantitative (*quantum*) $\boldsymbol{k}$ –structure, and the ideal $\boldsymbol{ik}$-superstructure forms the qualitative (*qual*) $\boldsymbol{ik}$-structure. The latter has its fine superstructural field basis consisting of objects by *n* orders smaller than particles of this group. Specifically these objects are perceived as the "*field level of matter*". For simplicity, we will (not infrequently) omit the symbol "^", expressing the material-ideal structure of objects.

According to the wave equation solutions, atoms are neutron molecules of a spherical form. Their outer neutron shells determine the physical-chemical properties (quantitative-qualitative features) of the atoms [3-5].

In the language of dialectics, neutrons as material-ideal formations are the basis of an atom, its material base; whereas the neutron organization, the mutual disposition (structural geometry of superstructure) of the neutrons, is properly the atom. This means that the *atom is an ideal formation of neutrons* of the definite superstructure. Moreover, the number of types of ideal subgroupes of neutrons $\boldsymbol{iN}_\beta$ determines the number of forms of organizations of neutrons, which is expressed by the definite atomic structures (atoms).

Thus, atoms are ideal formations of the material neutron level, where proper neutrons correspond to every atomic formation, *e.g*. carbon, aluminum, titanium, *etc*. neutrons; that is, the neutrons contain the "genetic code" (at the level of proper superstructure) of those or other ideal atomic objects.

Masses of elementary particles M_n, whose groupes are above $\hat{\boldsymbol{G}}$-group, but below groupes of isotopes of the first elements of the Periodic Table, are approximately multiple to an average mass of $\hat{g}$-particle,

$$M_n = nm_g\,. \tag{8}$$

Therefore, we assume that the main structural units of such particles are *g*-particles which contain information on possible configurations of "elementary" particles. In view of the fact that all formations of "elementary" particles above $\hat{\boldsymbol{G}}$-group, up to the first elements of periodic table, are unstable, it should be recognized that at present in the Universe $\hat{g}$-particles dominate with the ideal code-information capable of forming the ideal superstructure only of the neutron level. It means that these are mainly neutron $\hat{g}$-particles.

4. Measures of masses and the fundamental period-quantum Δ

In the last decades, the mass of *g*-particle has been accepted as equal to zero, which from viewpoint of the theory, set forth for the first time in the work [1], is incorrect. As follows from this theory, the mean value of mass m_g, within the decimal scale, is approximately equal to the fundamental measure in a quarter of the fundamental period-quantum, $\frac{1}{4}(2\pi \lg e)$, where *e* is the base of natural logarithms.

If a quarter of mass of π^+-meson is used as the measure of m_g then we will have

$$m_g = \frac{1}{4} m_{\pi^+} = 68.28158353\ m_e\,, \tag{9}$$

where

$$m_{\pi^+} = 273.1263341\ m_e\,. \tag{10}$$

Introducing the unit of mass in one hectoelectron of mass, 1 *hem*=100m_e, we can write that

$$m_g = \frac{1}{4} m_{\pi^+} = 0.6828158353 \ \ hem. \tag{11}$$

The mass of π^+-meson is on the level of the fundamental quantum $(2\pi \lg e)$ *hem.* We will term the last the reference measure of mass of ***Π***-group (π-meson group) particles,

$$m_\pi = (2\pi \lg e) \ hem = 2.728752708 \ \ hem \approx 2.7288 \ \ hem. \tag{12}$$

This mass determines the reference mass of ***G***-group particles

$$m_g = \frac{1}{4}(2\pi \lg e) \ hem = \frac{\pi}{2} \lg e \ hem = \frac{\lg i}{i} \ hem = 0.6821881770 \ \ hem \tag{13}$$

where i is the ideal unit. The G-group is represented by g-particles of some difference in masses. In any experiment, we deal with the various representatives of particles of this group.

A system of two g-particles forms a γ-particle (γ-quantum) with the reference mass of Γ-group equal to the fundamental half-period (half-quantum)

$$m_\gamma = \frac{1}{2}(2\pi \lg e) \ hem = 2\frac{\lg i}{i} \ hem = 1.364376354 \ \ hem. \tag{14}$$

A system of three g-particles represents a μ-particle (μ-meson) with the reference mass of M-group equal to three quarters of the fundamental quantum:

$$m_\mu = 3(\frac{\pi}{2} \lg e) \ hem = 3\frac{\lg i}{i} \ hem = 2.046564531 \ \ hem \tag{15}$$

A system of four g-particles forms a π-meson, which belongs to ***Π***-group of particles with the reference mass in one fundamental quantum (12), etc.

Thus, the simplest decay reactions, within specific qualities of elementary particles, take the following form (by the language of mass):

$$\pi \to \mu + g, \quad (2\pi \lg e) \ hem = \frac{3}{4}(2\pi \lg e) \ hem + \frac{1}{4}(2\pi \lg e) \ hem, \tag{16}$$

$$\pi \to \gamma + \gamma, \quad (2\pi \lg e) \ hem = \frac{1}{2}(2\pi \lg e) \ hem + \frac{1}{2}(2\pi \lg e) \ hem, \tag{17}$$

$$\mu \to \gamma + g, \quad \frac{3}{4}(2\pi \lg e) \ hem = \frac{1}{2}(2\pi \lg e) \ hem + \frac{1}{4}(2\pi \lg e) \ hem, \tag{18}$$

$$\gamma \to g + g, \quad \frac{1}{2}(2\pi \lg e) \ hem = \frac{1}{4}(2\pi \lg e) \ hem + \frac{1}{4}(2\pi \lg e) \ hem. \tag{19}$$

The details of mass spectra of the particles within the definite group will be considered further below.

To demonstrate the universality of the fundamental measure-quantum Δ, we will supplement the above reactions, (16) – (19), with the metrological series of some ancient measures of mass (their *relative* measures, values of *cardinal numbers*).

The ancient Rome ounce of mass is 2.7288 *dg*. The relative measure of its mass $m_{o,r}$ is equal to the fundamental period-quantum $\Delta = 2\pi \lg e = 2.72875...$; *i.e.*, $m_o = (2\pi \lg e)$ *dg* and $m_{o,r} = 2\pi \lg e$ (to within the fourth sign after comma). The series obtained for comparison is as follows (indicated only equalities of the relative measures of the masses):

1) π-meson ⇒ ounce, $m_{\pi,r} = m_{o,r}$;

2) μ -meson ⇒ three quarters of an ounce, $m_{\mu,r} = \frac{3}{4} m_{o,r}$;

3) γ -quantum ⇒ two quarters of an ounce: $m_{\gamma,r} = \frac{2}{4} m_{o,r}$;

4) *g* -particle ⇒ a quarter of an ounce, $m_{g,r} = \frac{1}{4} m_{o,r}$.

Below is an analogous series with the (relative) Old Russian measures [1] (absolute measures are expressed in grams, *g*):

1) π-meson ⇒ 16 pochkas = 64 pirogs, $m_{\pi,r} = m_{16\ \text{pochkas}} = m_{64\ \text{pirogs}} = 2.7288$;

2) μ-meson ⇒ 12 pochkas = 48 pirogs, $m_{\mu,r} = m_{12\ \text{pochkas}} = m_{48\ \text{pirogs}} = 2.0466$;

3) γ -quantum ⇒8 pochkas = 32 pirogs, $m_{\gamma,r} = m_{8\ \text{pochkas}} = m_{32\ \text{pirogs}} = 1.3644$;

4) g -particle ⇒4 pochkas = 16 pirogs, $m_{g,r} = m_{4\ \text{pochkas}} = m_{16\ \text{pirogs}} = 0.6822$.

The spectra of measures shown above represent the manifestation of the second kind law – an ideal law (non-physical, non-material): the law of the Decimal Code of the Universe, reflecting an Ideal Beginning of the Universe [1].

Physical laws are the first kind laws – the laws of absolute necessity, whereas the second kind laws are the laws of a reasonable choice; figuratively speaking, they are the laws of "Cosmic Will" (Cosmic Reason) caused by the Ideal Beginning of the Universe.

5. The periodic law of measures

In Lecture 10 of Vol. 2, we have shown that during formation of superstructure, the *beam speed* of a wave is transformed into the *screw speed*. Hence, the *absolute* speed of an object-satellite, moving along the screw trajectory is equal to

$$\hat{C} = c + i\upsilon, \tag{20}$$

where $i\upsilon$ is the *frontal kinetic speed of the superstructure*, negating the speed of the basis.

In turn, when the frontal speed $i\upsilon$, as the beam speed υ, exceeds the light speed c, *i*.e., the wave of superstructure becomes the base wave, one more superstructure rises, *etc*. As a result, the absolute speed of the n-wave level takes the following form

$$\hat{C} = nc + i\upsilon . \tag{21}$$

This allowed to state that the *speed of light c is the fundamental period-quantum* of the field of speed of material-ideal exchange by matter-space-time and the modulus of speed of an arbitrary level of basis-superstructure is determined, to within the period c, by the formula

$$\left|\hat{C}\right| = \sqrt{c^2 + \upsilon^2} . \tag{22}$$

The speed $\hat{C}$ presented above is a particular case of the found regularity. Generally, the structure of measures, reflecting the periodic essence of the Universe, can be expressed in the following form:

$$\hat{D} = n\delta + id\delta . \tag{23}$$

Here, δ is the physical parameter (magnitude), $\hat{D}$ is the general meaning of its measure;

n is the number of periods-quanta δ, $d\delta$ is the fractional value of its measure;

i is the ideal unit (the unit of polar negation [1], see L. 7, Vol. 1 [6]).

The fractional value $d\delta$ relates to superstructure, that marked by the unit of negation i which represents here the unit of superstructure. The formula (23) can be regarded as an analytical expression of the ***Periodic Law of Measures***.

If $\hat{D}$ is the scalar measure, then its quantitative value is defined by the *norm*,

$$D = n\delta + d\delta , \tag{24}$$

and if $\hat{D}$ represents the polar value, then its general measure is defined by the *modulus*,

$$D_m = \left|\hat{D}\right| = \sqrt{(n\delta)^2 + d\delta^2} . \tag{25}$$

6. Fundamental periods-quanta

Thus, the periodic essence of the Universe is reflected in fundamental parameters as, for example, the fundamental speed of exchange c and the electron mass m_e. Let us consider these parameters in some more detail.

The speed of processes in the Universe, according to dialectical physics, is not limited by anything. It is defined by the following equality,

$$\hat{C} = cn + i\upsilon \,. \tag{26}$$

Confining only by the level of basis-superstructure, we have

$$\hat{C} = c + i\upsilon \,. \tag{27}$$

The graph-formula of the wave of basis-superstructure corresponding to the superlight speed (27), in a simplest case of the cylindrical circular wave, is shown in Fig 1. Such a wave has the structure with central and orbital objects,

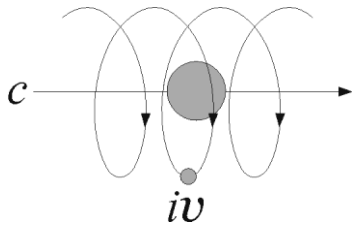

Fig. 1. The basis-superstructure of longitudinal-transversal wave of the superlight speed.

The complex of basis-superstructure is characterized by the wave of basis-superstructure of the complex type,

$$\hat{\Lambda} = \lambda + i2\pi a \,, \tag{28}$$

and by the corresponding wave radius,

$$\hat{R}_\lambda = \frac{\hat{\Lambda}}{2\pi} = \lambda\!\!\!^{-} + ia \,. \tag{29}$$

The modulus of the complete wave, as the polar quantity, is equal to the length of the unit screw trajectory (Fig. 2),

$$\Lambda_m = \left|\hat{\Lambda}\right| = \sqrt{\lambda^2 + (2\pi a)^2} = 2\pi \cdot \left|\hat{R}_\lambda\right| , \tag{30}$$

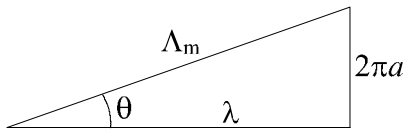

Fig. 2. The trigonometric relations between the unit screw trajectory and the wavelength of the basis and superstructure.

where θ is the polar angle of the trajectory and

$$tg\theta = \frac{2\pi a}{\lambda} = \frac{\upsilon}{c}, \tag{31}$$

At this trajectory, motion of a particle of the superstructure occurs with the total speed

$$C_m = \sqrt{c^2 + \upsilon^2}, \tag{32}$$

and the period,

$$T = \frac{\hat{\Lambda}}{\hat{C}} = \frac{\lambda + i2\pi a}{c + i\upsilon} = \frac{(c + i\upsilon)T}{c + i\upsilon}. \tag{33}$$

During motion of a particle of the mass m along the circular orbit, that is the wave motion, the motion at the level of the basis with the period τ,

$$\tau = \frac{2\pi a}{c} = \frac{\upsilon T}{c} = \frac{\upsilon}{c}T, \tag{34}$$

also occurs. So that it makes sense to speak about the total wave period,

$$\hat{T} = T + i\tau, \tag{35}$$

and the wave length,

$$\hat{\Lambda} = c\hat{T}. \tag{36}$$

It is necessary to assume that the limiting frequency ω_e is the fundamental quantum-period of frequency; therefore, the complete formula of the frequency, according to (21), has the form,

$$\hat{\Omega} = n\omega_e + i\omega. \tag{37}$$

The limiting fundamental frequency ω_e defines the minimal period-quantum of time,

$$T_e = \frac{2\pi}{\omega_e} = 3.361498580 \times 10^{-18}\ s. \tag{38}$$

Accordingly, the complete formula of the period, in a general case, takes the following form,

$$\hat{T} = nT_e + i\tau. \tag{39}$$

An analogous relation is also valid for mass, if as the period-quantum of mass will be taken the electron mass (an elementary quantum of associated mass):

$$\hat{M} = nm_e + im. \tag{40}$$

Multiplying this equality by the fundamental frequency ω_e, we obtain the formula of associated powers of exchange (associated charges),

$$\hat{Q} = ne + iq \ . \tag{41}$$

The electron mass, according to (40), can be presented as

$$\hat{M} = m_e + im \ , \tag{42}$$

where *im* is the mass of the electron satellite, m_e is the electron mass, and by the graph-formula as it is drawn in Fig. 3.

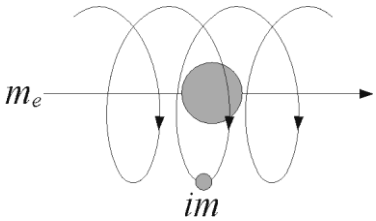

Fig. 3. The graph-formula of a period-quantum of the electron mass.

Note in addition that under high speeds, accessible in laboratory conditions, it is necessary to operate with *fictitious masses* of particles m_υ, substituting the real wave motion by the mechanical "relativistic" motion ([3], see sect. 2.2.6, pages 317-323):

$$m_v = \frac{m}{\sqrt{1 - \frac{\upsilon^2}{c^2}}} \ . \tag{43}$$

And, when a moving wave-particle passes at the level of superstructure and the speed υ considerably exceeds the light speed (the period-quantum of speed), $\upsilon >> c$, we will have

$$\tilde{m}_v = \frac{m}{\sqrt{\upsilon^2 / c^2 - 1}} i \approx \frac{c}{\upsilon} im \ , \tag{44}$$

which means the formation of the superstructure for *m* of the same type as shown in Fig. 1for m_e.

It should be also noted that the formula (43) ceases to be valid at the transition of speed through the value exceeding its period-quantum.

7. The periodicity of measures of masses

Let us imagine the norm of the complete value of the mass $\hat{M} = nm_e + im$ (40), as the scalar measure, in the following form,

$$M = \tilde{n} m_e = (n + \Delta n) m_e, \tag{45}$$

where

$$\tilde{n} = n + \Delta n = qnt(M)$$

is the quantitative (*qnt*), or relative, measure of mass; in that *n* is the discrete (discontinuous) integer component, and Δn is the indiscrete (continuous) fractional component of the measure.

As $\tilde{n}$ increases, the formula (45) "runs through" the masses of ***G***-group of particles. As soon as the discrete component *n* will reach the integer value *n*=68 and the indiscrete one Δn will reach the "magic" value,

$$\Delta n = 25 \times 2\pi \lg e - 68 = 0.6821881769209206737492 3..., \tag{46}$$

the boundary particle of ***G***-group – *g*-quantum – with the mass

$$m_g = (68 + \Delta n) m_e = 25 \times 2\pi \lg e \times m_e \tag{47}$$

is formed, that is equivalent to the condition

$$e^{2\pi} = 10^{\frac{m_g}{25 m_e}}. \tag{48}$$

Above this level, masses are coded by measures of m_g:

$$\hat{M} = k m_g + i m, \tag{49}$$

with the norms

$$M = (k + \Delta k) m_g = (k + \Delta k) \times 25 \times 2\pi \lg e \times m_e. \tag{50}$$

At $\Delta k = 0$ and *k* = 2, 3, 4, ..., the next levels are formed, namely, the levels of γ-, μ-, and π-particles with the following reference measures:

$$m_\gamma = 2 \times 25 \times 2\pi \lg e \times m_e, \text{ that is equivalent to the condition } e^{2\pi} = 10^{\frac{m_\gamma}{50 m_e}}, \tag{51}$$

$$m_\mu = 3 \times 25 \times 2\pi \lg e \times m_e, \quad \Rightarrow \quad e^{2\pi} = 10^{\frac{m_\mu}{75 m_e}}, \tag{52}$$

$$m_\pi = 4 \times 25 \times 2\pi \lg e \times m_e, \quad \Rightarrow \quad e^{2\pi} = 10^{\frac{m_\pi}{100 m_e}}. \tag{53}$$

Generally, at any *k*, we have the following spectrum of reference measures:

$$m_k = k \times m_g = k \times 25 \times 2\pi \lg e \times m_e, \tag{54}$$

that is equivalent to the condition,

$$e^{2\pi} = 10^{\frac{m_k}{k25m_e}}. \qquad (55)$$

The interval $k \in (5;\, 24)$ belongs to the meson $\boldsymbol{K}_k$-group of particles with the following reference masses (in brackets are given their masses in *MeV* and designations of the corresponding particles).

k=5, $\boldsymbol{K}_5$-group, $m_5 = 5 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 341.0940885\, m_e$, (174.30, g)

k=6, $\boldsymbol{K}_6$-group, $m_6 = 6 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 409.3129061\, m_e$, (209.16, γ)

k=7, $\boldsymbol{K}_7$-group, $m_7 = 7 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 477.5317238\, m_e$, (244.02, γg)

k=8, $\boldsymbol{K}_8$-group, $m_8 = 8 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 545.7505415\, m_e$, (278.88, π)

k=9, $\boldsymbol{K}_9$-group, $m_9 = 9 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 613.9693592\, m_e$, (313.74, πg)

k=10, $\boldsymbol{K}_{10}$-group, $m_{10} = 10 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 682.1881769\, m_e$, (348.60, $\pi\gamma$)

k=11, $\boldsymbol{K}_{11}$-group, $m_{11} = 11 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 750.4069946\, m_e$, (383.46, $\pi\mu$)

k=12, $\boldsymbol{K}_{12}$-group, $m_{12} = 12 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 818.6258123\, m_e$, (418.32, $\pi\pi$)

k=13, $\boldsymbol{K}_{13}$-group, $m_{13} = 13 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 886.8446300\, m_e$, (453.18, $\pi\pi g$)

k=14, $\boldsymbol{K}_{14}$-group, $m_{14} = 14 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 955.0634477\, m_e$, (488.04, $\pi\pi\gamma$)

k=15, $\boldsymbol{K}_{15}$-group, $m_{15} = 15 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1023.282265\, m_e$, (522.90, $\pi\pi\mu$)

k=16, $\boldsymbol{K}_{16}$-group, $m_{16} = 16 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1091.501083\, m_e$, (557.76, $\pi\pi\pi$)

k=17, $\boldsymbol{K}_{17}$-group, $m_{17} = 17 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1159.719901\, m_e$, (592.62, $\pi\pi\pi g$)

k=18, $\boldsymbol{K}_{18}$-group, $m_{18} = 18 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1227.938718\, m_e$, (627.48, $\pi\pi\pi\gamma$)

k=19, $\boldsymbol{K}_{19}$-group, $m_{19} = 19 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1296.157536\, m_e$, (662.34, $\pi\pi\pi\mu$)

k=20, $\boldsymbol{K}_{20}$-group, $m_{20} = 20 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1364.376354\, m_e$, (697.20, $\pi\pi\pi\pi$)

k=21, $\boldsymbol{K}_{21}$-group, $m_{21} = 21 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1432.595172\, m_e$, (732.06, $\pi\pi\pi\pi g$)

k=22, $\boldsymbol{K}_{22}$-group, $m_{22} = 22 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1500.813989\, m_e$, (766.92, $\pi\pi\pi\pi\gamma$)

k=23, $\boldsymbol{K}_{23}$-group, $m_{23} = 23 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1569.032807\, m_e$, (801.78, $\pi\pi\pi\pi\mu$)

k=24, $\boldsymbol{K}_{24}$-group, $m_{24} = 24 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1637.251625\, m_e$, (836.64, $\pi\pi\pi\pi\pi$)

Levels of $k \in (25;\, 28)$ interval apparently relate to nucleon levels above which are particles representing supernucleon formations. The fundamental measure of $2\pi \lg e \times 10$ is in this interval, as well as the golden section of the interval equal to

$$25 + \frac{5}{8}(28 - 25) = 26.875.$$

The nucleon mass

$$m_n = 26.87525 \times 25 \times 2\pi \lg e \times m_e = 1833.380726\, m_e \qquad (56)$$

corresponds to the golden section. The interval itself is represented by the spectrum of nucleons with the norms of masses

$$M = (25 + \Delta k) m_g = (25 + \Delta k) \times 25 \times 2\pi \lg e \times m_e\,, \qquad (57)$$

where $\Delta k \in (0;\, 3)$.

Just as *g*-quanta, nucleons are different in mass and structure. The ***A***-group of particles, represented by the Periodic Table, begins from the nucleon level.

Further, levels of reference masses for groups situated above the nucleon interval of $k \in (25;\, 28)$ are as follows (in brackets, there are indicated the particles nearest to the corresponding reference levels of masses; and symbols not infrequently coincide – such is the system of designations):

k=29, $\boldsymbol{K}_{29}$-group, $m_{29} = 29 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 1978.345713\, m_e$, (1010.93$MeV$; π_N, φ)

k=30, $\boldsymbol{K}_{30}$-group, $m_{30} = 30 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2046.564531\, m_e$, (1045.79; η_0)

k=31, $\boldsymbol{K}_{31}$-group, $m_{31} = 31 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2114.783348\, m_e$, (1080.65; η_0)

k=32, $\boldsymbol{K}_{32}$-group, $m_{32} = 32 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2183.002166\, m_e$, (1115.51; Λ)

k=33, $\boldsymbol{K}_{33}$-group, $m_{33} = 33 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2251.220984\, m_e$, (1150.37; H)

k=34, $\boldsymbol{K}_{34}$-group, $m_{34} = 34 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2319.439802\, m_e$, (1185.23; Σ, H)

k=35, $\boldsymbol{K}_{35}$-group, $m_{35} = 35 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2387.658619\, m_e$, (1220.09; B)

k=36, $\boldsymbol{K}_{36}$-group, $m_{36} = 36 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2455.877437\, m_e$, (1254.95; A, f)

k=37, $\boldsymbol{K}_{37}$-group, $m_{37} = 37 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2524.096255\, m_e$, (1289.81; D, π, f, ε)

k=38, $\boldsymbol{K}_{38}$-group, $m_{37} = 38 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2592.315072\, m_e$, (1324.67; Ξ, ε, A_2)

k=39, $\boldsymbol{K}_{39}$-group, $m_{39} = 39 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2660.533890\, m_e$, (1359.53; π, k)

k=40, $\boldsymbol{K}_{40}$-group, $m_{40} = 40 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2728.752708\, m_e$, (1394.39; Λ, Σ)

k=41, $\boldsymbol{K}_{41}$-group, $m_{41} = 41 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2796.971525\, m_e$, (1429.25; E, K_N, K^*)

k=42, $\boldsymbol{K}_{42}$-group, $m_{42} = 42 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2865.100343\, m_e$, (1464.11; l, N)

k=43, $\boldsymbol{K}_{30}$-group, $m_{43} = 43 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 2933.409161\, m_e$, (1498.97; N)

k=44, $\boldsymbol{K}_{44}$-group, $m_{44} = 44 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 3001.627978\, m_e$, (1533.83; Ξ, Λ, f)

k=45, $\boldsymbol{K}_{45}$-group, $m_{45} = 45 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 3069.846796\, m_e$, (1568.69; N)

k=46, $\boldsymbol{K}_{46}$-group, $m_{46} = 46 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 3138.065614\, m_e$, (1603.55; Λ)

k=47, $\boldsymbol{K}_{47}$-group, $m_{47} = 47 \cdot 25 \cdot 2\pi \lg e \cdot m_e = 3206.284431\, m_e$, (1638.41; N)

Etc.

8. Conclusion

Following the dialectical approach, the natural (and very significant, in principle) decision has been made to abandon the mechanical principles and recognize the identity of the wave nature of all objects in the Universe, assuming that every object has a definite *material basis* and an *ideal superstructure*. At that, the superstructure is perceived as the "field level of matter".

In this Lecture, we have acquainted the readers with regularities in the mass spectrum of elementary particles, which was revealed owing to the DM theory. The ordering of the particles by groups with respect to their masses was made during research discussed here.

The found correlation of the mass spectrum with the fundamental metrological period $\Delta = 2\pi \lg e$ demonstrates the harmony which is inherent in all processes and phenomena in nature. It was shown, in particular, that the value of the *neutron mass* corresponds to the *golden section in the mass* interval values related to ***N***-group of particles. Remember, the *neutron* is the base of atomic systems. Atoms, in turn, in accordance with the Shell-Nodal Atomic Model of dialectical physics, are neutron molecules of the quasispherical form, and are ideal formations of the material neutron level [7]. As the main unit of mass having the definite gravitational charge of exchange, the neutron is simultaneously the *fundamental quantum of mass* and the *fundamental graviton*.

We know from previous Lectures that the *electron* is one of the limiting quanta of exchange. As the particle of minimal mass corresponding to the limiting power of exchange *e*, it is interpreted as the elementary quantum of the power of exchange. From the above analysis it is also stated that the *electron* belongs to the ***G***-group of particles which are structural components of the world of elementary particles, including neutrons, and at the same time the electron is the boundary structure of ***E***-group of particles.

The *g-particles* with mass of $68.28m_e$, that is equal to a quarter of the fundamental period-quantum, $\left(\frac{1}{4}\right)2\pi \lg e$, are, apparently, the main structural units of "elementary" particles. An analysis presented here confirms the probability of such an assumption.

It was found the correlation of metrological series of ancient measures with the measures of elementary particles that has been demonstrated on two examples.

The periodicity of some fundamental physical parameters has been considered as well. It was shown, for example, that the *speed of light c* may be interpreted as the *fundamental period-quantum* of the field of speed of the material-ideal exchange. The period of time corresponding to the limiting fundamental frequency ω_e can be considered as the minimal period-quantum of time T_e of atomic and subatomic levels, *etc*.

The universality of the above mentioned fundamental measure-quantum Δ has been demonstrated on all examples presented in the Lecture. All the data confirm an existence in

nature of the second kind laws (ideal laws) that was revealed for the first time in physics by relying on a new approach in research – dialectical [1, 6].

We believe that the results discussed here, related to the realm of the DM theory, are quite sufficient to understand significance for science of the found regularities in the formation of a great variety of elementary particles, which are detected experimentally.

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Lecture 12

The Masses at Exchange

1. Introduction

We continue our discussion about masses of elementary particles. As follows from the previous Lecture, the mass spectrum demonstrates the quantum character of values of masses. In this Lecture, we intend to show that to this conclusion one can come by another way. In particular, this time the consideration will be focused on analyzing solutions of the specific equations formulated for descriptions of material-ideal exchange of the basic three kinds: longitudinal, transversal, and tangential [1].

The aforesaid equations of exchange, the equations of motion-rest in spherical and cylindrical wave fields, were constructed in the framework of the wave concepts, by following the Dynamic Model (DM). The compliance of harmony inherent in the Universe is realized by the subjection of all natural processes, including formation of masses of elementary particles, to the fundamental period-quantum of the Decimal Code of the Universe, Δ. The indicated feature is seen from the specific data obtained from the solutions presented herein.

The characteristic spectrum of fundamental frequencies obtained as a result leads to the corresponding spectrum of associated masses of elementary particles, which are multiple to the elementary quantum of associated mass – the electron mass, m_e.

The special attention is turning to the role played by g-lepton, as to a basic structural unit at the formation of nucleons. The g-lepton is regarded as the fundamental particle; its mass is close to a quarter of the fundamental period Δ. On the basis of g-lepton, like on the basis of nucleons, a corresponding sequential series of the levels of masses can be formed. This topic is touched upon briefly here. The regularities in decay reactions of some particles are shown on a few examples in connection with the issue under consideration here.

2. The masses in the longitudinal field

In a simplest case, motion-rest in the cylindrical field of matter-space-time can be presented, at a part of the axial line of length *dz* (Fig. 1), by the equation of exchange:

$$\rho_z dz \frac{\partial^2 \Psi}{\partial t^2} = F - \left(F + \frac{\partial F}{\partial z} dz \right) = -\frac{\partial F}{\partial z} dz, \tag{1}$$

where ρ_z is the linear density of mass, Ψ is the axial displacement, and F is the power of exchange.

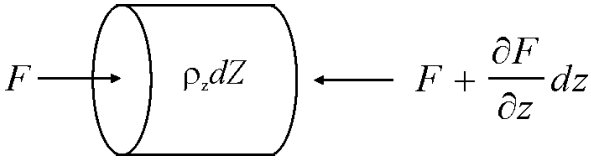

Fig. 1. A graph of power of an elementary longitudinal exchange.

Let w will be the *density of energy of basis*, and p – the density of energy of superstructure. In a linear approximation, the *relative change of energy of exchange* is

$$\frac{pS\partial z}{wS\partial z}, \tag{2}$$

where $wS\partial z$ is the energy of an elementary differential volume $S\partial z$, and $pS\partial z = F\partial z$ is a change of the energy.

Assuming that the relative change of energy of exchange (2) is equal to the *relative linear change of the elementary volume* of space-field, $-\frac{\partial \Psi}{\partial z}$, *i.e.*, that

$$\frac{F\partial z}{wS\partial z} = -\frac{\partial \Psi}{\partial z}, \tag{3}$$

we obtain

$$F = -wS\frac{\partial \Psi}{\partial z}. \tag{4}$$

As a result, the equation of motion-rest (1) takes the form,

$$\frac{\partial^2 \Psi}{\partial t^2} = \frac{wS}{\rho_z}\frac{\partial^2 \Psi}{\partial z^2} \qquad \text{or} \qquad \frac{\partial^2 \Psi}{\partial z^2} = \frac{\rho_z}{wS}\frac{\partial^2 \Psi}{\partial t^2}. \tag{5}$$

An element of a beam is $\partial z = c\partial t$; hence,

$$\frac{\partial^2 \Psi}{\partial t^2} = \frac{wS}{\rho_z c^2}\frac{\partial^2 \Psi}{\partial t^2}, \tag{6}$$

and

$$c = \sqrt{\frac{wS}{\rho_z}}\,. \tag{7}$$

If we consider exchange at the level of Young modulus with the density of energy *E*, then

$$c = \sqrt{\frac{ES}{\rho_z}}\,. \tag{8}$$

and

$$\omega = kc = k\sqrt{\frac{ES}{\rho_z}}\,, \tag{9}$$

where *k* is the wave number, which takes a series of discrete values.

Let us determine the characteristic spectrum of frequencies. For the hard-facing alloys, the Young modulus is approximately within $600-680\,GPa$. In the capacity of a calculated magnitude, we select the characteristic value equal to 654.9, which satisfies the metrological spectrum on the basis of the fundamental measure, quantum-period Δ ($654.9 = (2^2 \times 3 \times 5^{-1})\Delta$) [2]:

$$E = 6.549 \times 10^{11}\ Pa\,. \tag{10}$$

Let the remaining parameters will be defined by the following equalities:

$$l = 2\pi r_0\,, \qquad \rho_z = \frac{m_e}{l}\,, \qquad S = \pi r_0^2\,. \tag{11}$$

Under the above conditions, a formula of the spectrum of characteristic frequencies (9) takes the form,

$$\omega = 4\omega_0 \times r_0 k\,, \tag{12}$$

where

$$\omega_0 = \frac{\pi}{2}\sqrt{\frac{Er_0}{2m_e}} = 6.85091084 \times 10^{15}\ s^{-1} \approx \frac{\omega_e}{272.88}\,. \tag{13}$$

The frequency ω_0 is bound up with the fundamental frequency of atomic and subatomic levels ω_e ((33), L. 3, Vol. 2) by the following characteristic ratio:

$$\frac{\omega_e}{\omega_0} = 272.8103045 \approx 272.8752708\,. \tag{14}$$

The frequency of the fundamental tone ω_0 is the characteristic frequency of *H*-atomic level. If $l = n\lambda$, then $r_0 k = n$ and

$$\omega_n = 4\omega_0 \times n \approx \Delta \times 10^{16} n\ \ s^{-1}\,, \tag{15}$$

where $\Delta = 2\pi \lg e$ is the fundamental quantum-period (see L. 6, Vol.1).

The spectrum of frequencies (15) defines the spectrum of associated masses of elementary particles with the elementary charge *e*:

$$M_n = \frac{e}{\omega_n} = \frac{e}{4\omega_0} \times \frac{1}{n} = \frac{68.5\, m_e}{n}. \tag{16}$$

If $l = n\frac{\lambda}{2}$, then $r_0 k = n\frac{1}{2}$ and

$$\omega_n = 2\omega_0 \times n, \qquad M_n = \frac{e}{\omega_n} = \frac{e}{2\omega_0} \times \frac{1}{n} = \frac{137\, m_e}{n}. \tag{17}$$

At last, at $l = n\frac{\lambda}{4}$, it follows $r_0 k = n\frac{1}{4}$ and

$$\omega_n = \omega_0 \times n, \qquad M_n = \frac{e}{\omega_n} = \frac{e}{\omega_0} \times \frac{1}{n} = \frac{274\, m_e}{n}. \tag{18}$$

Because at $n = 1$, a particle of the mass $M_1 = 274 m_e$ is the π-meson, we will call the frequency ω_0 the *meson frequency*.

At $n = 1, 2, 3, 4,$ we have

$$\begin{aligned} 274\, m_e &\Rightarrow \pi\text{-meson} \\ 137\, m_e &\Rightarrow \gamma\text{-quantum} \\ 91.3\, m_e &\Rightarrow \rho\text{-lepton} \\ 68.5\, m_e &\Rightarrow g\text{-lepton} \end{aligned} \tag{19}$$

Two *g*-leptons form a γ-quantum, three *g*-leptons constitute a μ-meson:

$$205.5\, m_e \Rightarrow \mu\text{-meson}. \tag{20}$$

Particles are capable to the mutual transformation. In particular, π-meson, as four *g*-leptons, can decay following the schemes:

$$\begin{aligned} \pi &\Rightarrow \gamma + \gamma \\ \pi &\Rightarrow \mu + g \\ \pi &\Rightarrow g + g + \gamma. \end{aligned} \tag{21}$$

Evidently, in this series, the first decay is most probable. The μ-meson and γ-quantum decay in a similar way:

$$\begin{aligned} \mu &\Rightarrow \gamma + g \\ \gamma &\Rightarrow g + g. \end{aligned} \tag{22}$$

The *g*-lepton had no luck. Having a relatively big mass, nevertheless, it was eliminated from a series of elementary particles because of the requirements of relativity theory. But afterwards, it was returned to this series under different names: muonic neutrino, electronic antineutrino, *etc*. Such names of *g*-leptons were stipulated by a specific character of the reaction in which they were seen.

Following dialectics, we have to recognize that *g*-lepton exists in the four dialectical states:

$$+g, \quad -g, \quad +ig, \quad -ig. \tag{23}$$

The mass of *g*-lepton is close to a quarter of the fundamental period Δ (in units of the electron mass):

$$m_g = \frac{1}{4}(2\pi \lg e) \times 10^2 m_e \tag{24}$$

that expresses the definite facets of the Eternity.

The ratio of mass of the nucleon m_n to the mass of *g*-lepton m_g is approximately equal to

$$\frac{m_n}{m_g} \approx 3^3 . \tag{25}$$

On the basis of *g*-lepton, the following sequential series of levels of masses and the corresponding decay reactions is formed:

$$\begin{array}{lcl}
2g = \gamma & \Rightarrow & g + g \\
3g = \mu & \Rightarrow & \gamma + g \\
4g = \pi & \Rightarrow & \mu + g \quad \text{or} \quad \gamma + \gamma \\
5g = \mathrm{K}_5 & \Rightarrow & \pi + g \quad \text{or} \quad \mu + \gamma \\
6g = \mathrm{K}_6 & \Rightarrow & \pi + \gamma \\
7g = \mathrm{K}_7 & \Rightarrow & \pi + \mu \\
8g = \mathrm{K}_8 & \Rightarrow & \pi + \pi \\
9g = \mathrm{K}_9 & \Rightarrow & \mathrm{K}_8 + g \\
10g = \mathrm{K}_{10} & \Rightarrow & 2\pi + \gamma \\
\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots & & \\
32g = \Lambda & \upsilon & n + \mathrm{K}_5
\end{array} \tag{26}$$

In this series, K_n is the symbol of the level of mass from *n g*-leptons.

Experiments detect all these structures of the wave field (under some name or without it) forming in a process of transformations.

In 1931 Dirac showed that a field theory could be constructed on the basis of a magnetic monopole *g* with the following value of its elementary charge,

$$g = \frac{\varepsilon_0 hc}{e} = 68.5e. \qquad \text{`(27)}$$

The division of the charge g by the fundamental frequency ω_e gives its associated mass:

$$m_g = 68.5 m_e . \qquad (28)$$

Evidently, g-lepton and the Dirac monopole g are the same particle. At that time, the mass of the monopole was determined incorrectly, therefore, g-lepton was not rendered due attention. Knowing the associated mass of Dirac monopole, we obtain the following radius of its sphere,

$$r_g = \left(\frac{m_g}{4\pi\varepsilon_0} \right)^{1/3} = 1.706 \times 10^{-9}\ cm . \qquad (29)$$

We see that the value of r_g is very close to the rational golden section of the fundamental metrological period Δ:

$$r_g \approx \frac{5}{8} 2\pi \lg e \times 10^{-9}\ cm . \qquad (30)$$

This fact (along with others) gives us the reason to assume that g-lepton is a highly stable particle, which possibly is a constituent of protons, neutrons, and other elementary particles of this series (like a nucleon, which is a constituent of atoms and nucleon molecules). If only this supposition is true, then on the basis of the monopole and the periodic law of space, it is possible to compose the particular spectrum of elementary particles. Namely, in such a spectrum, g-monopole is analogue the hydrogen atom ${}^1_1H$ (protium), γ-quantum is analogue of the deuterium, μ-meson is analogue of the tritium, π-meson is analogue of the helium, *etc*.

3. The masses in the transversal radial field

Let us turn now to the *transversal oscillations* of the beam (see Fig. 2). An equation of exchange in radial direction has the form,

$$\rho_z dz \frac{\partial^2 \Psi}{\partial t^2} = -\frac{\partial Q}{\partial z} dz , \qquad (31)$$

which is analogous to the equation for the longitudinal exchange (1).

Under the transversal exchange (oscillations), when rotation cannot be taken into account, the *total moment of power of exchange* (related to the beam segment dz) can be assumed equal to zero:

$$M - \left(M + \frac{\partial M}{\partial z} dz \right) + Q dz = 0 , \qquad (32)$$

Therefore, $Q = \frac{\partial M}{\partial z}$. It is the *transversal power of exchange*.

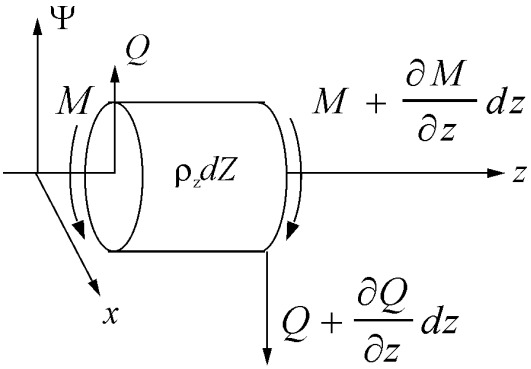

Fig. 2. A graph of an elementary transversal exchange; *M* is the moment of power of exchange; *Q* is the transversal power of exchange.

As it is known, at the transversal oscillations, the following equation is valid,

$$M = EJ\frac{\partial^2\Psi}{\partial z^2}, \tag{33}$$

where

$$J = \frac{\pi r_0^4}{4}. \tag{34}$$

is the moment of inertia of the circular section of the field-space of the radius r_0 relative to the *x*-axis.

Hence, the equation of motion-rest (natural oscillations) (31) takes the following form,

$$\frac{\partial^2\Psi}{\partial t^2} = -\frac{EJ}{\rho_z}\frac{\partial^4\Psi}{\partial z^4} \qquad \text{or} \qquad \frac{\partial^2\Psi}{\partial t^2} = -\frac{EJk^4}{\rho_z}\frac{\partial^4\Psi}{\partial (kz)^4}. \tag{35}$$

Now we will take into account the following known equalities valid for the elementary harmonic wave:

$$\frac{\partial^2\Psi}{\partial t^2} = -\omega^2\Psi \qquad \text{and} \qquad \frac{\partial^4\Psi}{\partial (kz)^4} = \Psi. \tag{36}$$

Thus, we arrive at the following formula,

$$\omega = k^2\sqrt{EJ/\mu}. \tag{37}$$

Taking into consideration the equations (10) and (11), we obtain the following equation for oscillation frequencies,

$$\omega = 2r_0^2 k^2 \frac{\pi}{2}\sqrt{\frac{Er_0}{2m_e}} = 2r_0^2 k^2 \omega_0 = r_0^2 k^2 \omega_\pi , \tag{38}$$

where

$$\omega_\pi = 2\omega_0 = 1.370182168\times 10^{16}\ s^{-1} \approx \frac{\Delta}{2}\times 10^{16}\ s^{-1} \tag{39}$$

is the characteristic frequency.

If $l = n\lambda$, we obtain the following spectrum of frequencies and masses:

$$\omega_n = 2\omega_0 n^2 , \qquad M_n = \frac{e}{\omega_n} = \frac{e}{2\omega_0}\frac{1}{n^2} = \frac{137 m_e}{n^2} . \tag{40}$$

Let be $l = n(\lambda/2)$, then

$$\omega_n = \frac{\omega_0}{2} n^2 , \qquad M_n = \frac{e}{\omega_n} = \frac{2e}{\omega_0}\frac{1}{n^2} = \frac{548 m_e}{n^2} . \tag{41}$$

If an element of the cylindrical space-field is equal to $l = n(\lambda/4)$, then

$$\omega_n = \frac{\omega_0}{8} n^2 , \qquad M_n = \frac{e}{\omega_n} = \frac{8e}{\omega_0}\frac{1}{n^2} = \frac{2192 m_e}{n^2} . \tag{42}$$

For example, at n=1, we have the mass equal to $2192\ m_e$. This mass can be identified with the mass of Λ-hyperon.

4. The masses in the tangential exchange

Let us turn to the elementary equation of the tangential exchange of motion-rest for the cylindrical space-field (Fig. 3):

$$J_l dz \frac{\partial^2 \psi}{\partial t^2} = -\frac{\partial M}{\partial z} dz , \tag{43}$$

where $J_l = \dfrac{m r_0^2}{2l}$ is the linear density of a moment of inertia of the cylindrical space with the length l.

In such a field of motion-rest, the moment of power of exchange M has the form

$$M = G J_\rho \frac{\partial \psi}{\partial z} , \tag{44}$$

where $J_\rho = \frac{\pi r_0^4}{2}$ is the polar moment of inertia of the beam cross-section, and G is the density of the transversal energy of exchange (or a shear modulus of the level of Young's energy density).

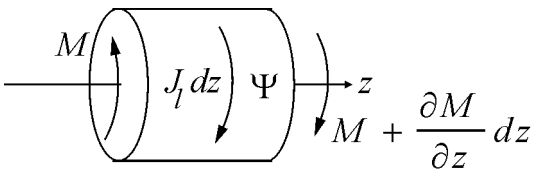

Fig. 3. Transversal circular oscillations of a beam element *dz*; J_l is the linear density of moment of inertia of the beam with the length *l*; Ψ is the angular potential-kinetic displacement.

On the basis of the equations, (43) and (44), we arrive at

$$\frac{\partial^2 \psi}{\partial t^2} = -\frac{GJ_\rho}{J_l}\frac{\partial^2 \psi}{\partial z^2}. \tag{45}$$

The following expressions for the wave speed and frequency follow from (45), respectively:

$$c = \sqrt{\frac{GJ_\rho}{J_l}}, \qquad \text{and} \qquad \omega = kc = k\sqrt{\frac{GJ_\rho}{J_l}}. \tag{46}$$

The shear modulus *G* of gold depends on the temperature at measurement and on the treatment parameters. Therefore, the modulus values, given in reference books and various publications, differ. However, its approximate value is given within $27 - 29.1\,GPa$. Let us assume that the characteristic magnitude of the *annealed* shear modulus is equal to $G = 28.42\ GPa$. Then, in the case of an element of the length equal to the Bohr orbit, $l = 2\pi r_0$, we have

$$\omega = \pi\sqrt{\frac{2Gr_0}{m_e}} \times r_0 k = \omega_c k, \tag{47}$$

where

$$\omega_c = \pi\sqrt{\frac{2Gr_0}{m_e}} = 5.708 \times 10^{15}\ s^{-1}. \tag{48}$$

Under the condition $l = n\lambda$, we obtain

$$\omega_n = \omega_c \times n. \tag{49}$$

The spectrum of frequencies obtained defines the following spectrum of masses:

$$M_n = \frac{e}{\omega_n} = \frac{327.4 m_e}{n}. \tag{50}$$

If $l = n\frac{\lambda}{2}$, then

$$\omega_n = \frac{\omega_c}{2} \times n, \qquad M_n = \frac{e}{\omega_n} = \frac{654.8 m_e}{n}. \tag{51}$$

For $l = n\frac{\lambda}{4}$, we have

$$\omega_n = \frac{\omega_c}{4} \times n, \qquad M_n = \frac{e}{\omega_n} = \frac{1309.6 m_e}{n}. \tag{52}$$

The measure $327.4 m_e$ is the characteristic metrological quantity correlated with the fundamental period-quantum Δ and obeying the spectrum of measures $M = 2^k \cdot 3^l \cdot 5^m \Delta$, where $k, l, m \in Z$ (Eq. (2.8) in L. 6, Volume. 1): $327.4 = (2 \times 3 \times 5^{-1})\Delta \times 10^2$. Therefore, due to the correlation indicated above, the characteristic magnitude of the shear modulus of gold $G = 28.42 \ GPa$, taken for the derivation of the frequency spectrum (50), is proper.

5. Conclusion

Thus, we have considered solutions of the specific equations of the DM constructed to describe longitudinal, transversal, and tangential material-ideal exchanges in the fields of motion-rest [1]. Resulting solutions led to revealing the spectrum of associated masses of particles participating in the processes of exchange (interaction).

The quantum spectrum of fundamental frequencies, obtained in result of the solutions, stipulates the corresponding spectrum of associated masses of elementary particles, presented in units of the electron mass, m_e. The latter is regarded as an elementary quantum of mass. Among other things, it was found that frequency of the fundamental tone $\omega_0 = \frac{\omega_e}{\Delta \times 10^2}$ is one of the characteristic frequencies of the *H*-atomic level.

The g-lepton mass, with respect to other particles, is close to a quarter of the fundamental period Δ. Essential role played by g-lepton, as a structural unit in the formation of nucleons, has been discussed here. From our point of view, argumentations in favour of the stated above role were sufficiently convincing. In all likelihood, as follows from the discussion, it is not so difficult to form on the basis of g-lepton a sequential series of particles analogous to the series of elements constituting Mendeleev's Periodic Table, where nucleons, protons and neutrons, are the basis of the elements.

Thus, we have shown that in the wave cylindrical longitudinal-transversal field of exchange all kinds of oscillations take place. The particles of a wide spectrum of masses corresponding to the frequencies of oscillations, having a quantum character, take part in the motion.

The observed subjection of natural processes, to which, in particular, it relates the formation of elementary particles, to the fundamental period-quantum of the Decimal Code, Δ, once more confirms an existence of strict natural harmony in the Universe revealed by the DM theory.

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Lecture 13

The System-Forming Basic Particles: Electron, g-Particle, and Neutron

1. Introduction

In conclusion to the present series of Lectures, it makes sense to talk about some other tenets of the DM theory, concerning three basis particles, which are *system-forming* for the distinguishing three sublevels of the microlevel of the Universe. We mean the *atomic level* (the level of *nucleon molecules* according to the DM), its basic system-forming unit is the *nucleon*; the *nucleonic level*, the basic unit is g-*particle*; the *subnucleonic level*, the basic unit is the *electron*.

As was shown in previous two Lectures (11 and 12), the system-forming basic particles: $e, g, ..., n, ...$ are referred, correspondingly, to $\boldsymbol{E}, \boldsymbol{G}, ..., \boldsymbol{N}, ...$ groups of the particles spectrum, according to the DM. The values of masses of these particles (as any others) are multiple to the fundamental-period-quantum Δ.

The nature of charge and mass of elementary particles, including electrons, g-particles and nucleons, was revealed in the framework of the DM convincingly shown in our Lectures. Nevertheless, this discovery goes unnoticed (simply being hushed up) so far. So that the nature of the electron charge and mass is still regarded as the great mystery in modern physics based on the Standard Model (officially recognized) from which physics cannot in any way refuse so far. Let us proceed directly to the scheduled topic.

2. The place of the electron in the mass spectrum

It is possible to suppose that at the ***G***-level the electron is a tiny nucleon. Then the *g*-particle (*g*-quantum, *g*-nucleon, or *g*-lepton are synonyms), judging from its reference mass $m_g = 68.22 m_e$, represents a composite atom-molecule of the *g*-nucleon level with the ordinal number $z = 29 - 31$ (if we rely on the Shell-Nodal Atomic Model originated from the strict

solutions of the wave equation [1, 2], applied in this case to the *g*-quantum space). Indeed, the atom at the nucleon level with the mass number 68 is in sectors 29–31 of the Periodic Table.

In this case one can say that all elementary particles consist finally of electrons. The *g*-quantum is the particle with a set of proper shells and composite atmosphere. The radius of its spherical wave shell represents, approximately, the golden section of the fundamental measure $\Delta=2\pi\lg e$, namely,

$$r_g = \left(\frac{m_g}{4\pi\varepsilon_0}\right)^{1/3} \approx \frac{5}{8} 2\pi \lg e \times 10^{-9}\ cm \approx 4r_e\,, \tag{1}$$

where r_e is the radius of the electron sphere (wave shell).

The found relation between radii of two spherical shells, of *g*-quantum and electron, makes it possible to give one more prediction: the spectrum of particles with measures of masses beginning from the electron to *g*-quantum (the constituent of the vast variety of ***G***-group particles) also exists in nature. The last is the most probable. It is necessary also to note that there are two types of electron waves, right and left, corresponding to positrons and electrons. However, we do not know what kind of polarization is actually inherent in the electron and what kind has the positron.

By the radioactive atomic decay, the rebuilding of atoms occurs. Helium – the most important fragment of nucleonic shells of atoms – is rejected in this case. With this, two nodes of the outer shell of helium lost their own electrons. Of course, for all that, the definite modification both on the part of nucleons and on the part of *g*-particles runs its course. As a result, fine fractions in the form of γ-rays and miniature nucleons, electrons, of right and left polarization are rejected. The latter, in the form of the flow of positive and negative electrons, is detected experimentally.

During bombing of targets by fast protons, nucleons decay takes place and nucleonic "helium", in the form of π-mesons, is thrown out. In turn, π-mesons decay into two γ-quanta, each of which generates a pair of *g*-quanta of right and left polarization. In addition, these *g*-quanta can eject electrons.

The above-considered picture of decay corresponds to reality. Therefore, it is possible to state that in the hierarchy of elementary particles the electrons are at the end of the hierarchy chain of ***E***-group particles.

3. The electron as a microgalaxy of the Universe

Returning back to the general formula of measures ((23), L. 11), we find that the ratio of the parameters of superstructure **S** and basis **B** for the one group of physical quantities (see (31) and Fig. 2 in L. 11) is equal to

$$\frac{\mathbf{S}}{\mathbf{B}} = \frac{\upsilon}{c} = tg\theta\,. \tag{2}$$

In a limiting case of the fundamental frequency ω_e, the ratio (2) can be presented in the following forms:

$$\frac{\mathbf{S}}{\mathbf{B}} = \frac{\omega_e}{c} a = k_e a \tag{3}$$

or

$$\frac{\mathbf{S}}{\mathbf{B}} \frac{1}{a} = \frac{\omega_e}{c} = \frac{m_e \omega_e}{m_e c} = \frac{e}{m_e c} = k_e\,, \tag{4}$$

where a is the wave parameter corresponding to the limiting frequency ω_e and $\mathbf{B}a$ is the wave moment of the parameter **B**.

The definite regularity of measures, found and considered here, has been exhibited in Einstein's and de Haas's experiments. The total micro- and macro-, magnetic and kinetic, moments of a metallic sample-cylinder were constants,

$$M_{micro} + M_{macro} = const, \qquad L_{micro} + L_{macro} = const\,. \tag{5}$$

In the course of remagnetization of the cylinder, the microlevel of motion-rest is generated equal in value to the macrolevel of motion-rest:

$$\Delta M_{macro} = -\Delta M_{micro}, \qquad \Delta L_{macro} = -\Delta L_{micro}\,. \tag{6}$$

But, as far as

$$\Delta M_{micro} = \sum \frac{\upsilon_k}{c} e \cdot r_k = \frac{\upsilon e}{c} \frac{\sum \upsilon_k r_k}{\upsilon} \tag{7}$$

and

$$\Delta L_{micro} = \sum m \upsilon_k r_k = m\upsilon \frac{\sum \upsilon_k r_k}{\upsilon}\,, \tag{8}$$

then the ratio of macroparameters ΔM_{macro} and ΔL_{macro} determines the fundamental wave number k_e:

$$\frac{\Delta M_{macro}}{\Delta L_{macro}} = \frac{e}{m_e c} = k_e\,. \tag{9}$$

The conventional theory, based on the mechanical motion, has obtained a ratio of the moments half as large. To save the honor of the theory and to make it agree with the experimental data, the electron "spin", doubling the ratio obtained by the conventional theory, had been introduced. If and only if the problem of measures would be solved and

measures with fractional powers of units would be eliminated from science, then physicists, sooner or later, will arrive at the right way. Unfortunately, now this way is closed for them because of the presence of the absurd dimensionalities in the system of units accepted in physics (beginning from electromagnetism).

Nothing follows from the Einstein and de Haas experiment, except the *law of measures* expressed in particular by the ratio (9). However, we can state that the electron belongs to ***G***-group particles, which are structural components of the world of elementary particles, including nucleons, and that the electron is also the boundary structure of ***E***-group particles.

The *complexity* of the structure of the Universe *increases* both in the motion *up* from one level to the other in the hierarchy of megaobjects and in the motion *down* in the hierarchy of microobjects. It means that the "most elementary" boundary particle of ***E***-class – the electron – is at the same time the most complete particle. The electron, as to its complexity, can compare with a Megagalaxy; therefore, it should be termed the *Microgalaxy of the Universe*. According to the expession ((42), L.11), the structural formula-graph of the electron is as shown in Fig. 1, where $\boldsymbol{m_e}$ is the electron-nucleus of the Microgalaxy of the Universe, and ***im*** is the equatorial galactic orbits of its numerous microstars-satellites.

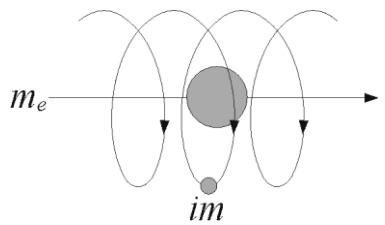

Fig. 1. The structural formula-graph of the electron.

When the mass wave motion of electrons-Galaxies occurs in a cylindrical space of a wire conductor, then, in the surrounding space of the conductor, an aura of electron satellites of ***E***-class particles arises. Thus, these satellites represent the superstructure of the mass wave motion of Galaxies-electrons. These numerous ***im***-particles with their own continuous field of rest-motion form the cylindrical wave magnetic field ***B***. As soon as the speed of the particles of the magnetic field will exceed the quantum-period of speed *c*, the superstructure of the magnetic field, *i.e.* the electric field ***E***, arises (Fig. 2).

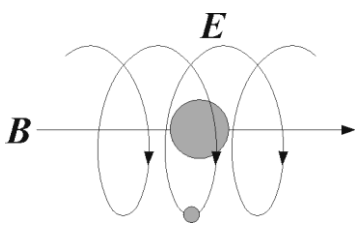

Fig. 2. The structural formula-graph of the formation of the electric field ***E***.

In turn, the *E*-field as the basis forms its own superstructure (the magnetic field), when motion at the level of the superstructure gets over the quantum-period of speed. However, we do not know what level of the magnetic field is generated – former or the new one. If we assume that the arisen field is equal to the former magnetic field *B*, then, at the relevant level, the transformation of the superstructure into the basis and the basis into the superstructure (*i.e*. the basis-superstructure transmutation) takes place.

In such a case, a right rotation particle, *e.g*. the electron, passing through zero during a consequential series of transformations of the matter-space-time field, becomes a particle of a left cylindrical field (the positron). In this sense, the positron is the future of the electron and simultaneously is its past, since in the past the electron was the positron. Such is the dialectics of the actual field of time whose concentration is the electron.

4. External and internal spaces of an atom

According to the DM, the spherical volume of an atom is its *external* space, the space of the Anti-Universe (Anti-Space). It is represented by the antispace of nucleons, which in turn includes the antispace of *g*-particles formed by the electron antispace. Thus, the *external boundary of atoms* is represented by electron spheres (Fig. 3).

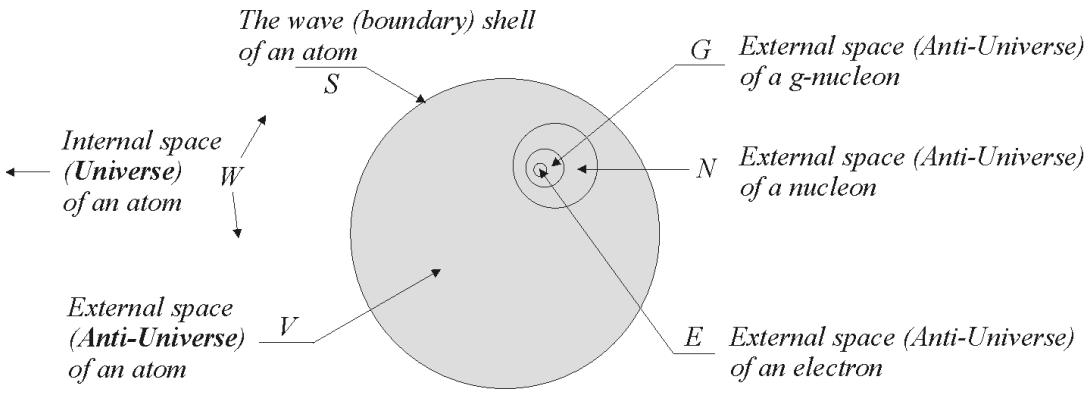

Fig. 3. The atomic space hierarchy of an arbitrary atom, where one nucleon is chosen.

Only one *g*-particle is shown in the nucleon and only one electron is shown in the *g*-particle in Fig. 3. The *internal space of the atom W* is the *whole Universe*, excepting the spherical volume of the space restricted by the wave shell *S*. *V* is the *external space of the atom* and the internal space of the nucleon. *N* is the external nucleon space and the second stage of the external atomic space. *G* is the external space of the *g*-particle and the third stage of the external atomic space; *E* is the external space of the electron and the fourth stage of the external atomic space. The fourth stage of the external atomic space, equal to the sum of all external electron spaces, really composes the external space of the atom. *G*, *N*, *V*, and *W*

spaces represent the first, second, third, and fourth levels of the internal spaces of electrons in the atom. In classical physics, *W*-space is named the interatomic space and all external spaces are named the internal spaces.

Thus, the spaces of all particles in the Universe are *overlapped* [1]. According to the axioms of dialectical physics considered earlier in Vol. 1 of our Lectures, the physical field-space represents by itself an infinite series of spaces *embedded in each other* [2]. This expresses the fundamental idea of dialectical philosophy – the infinite divisibility of matter-space-time according to approaching to the zero field-space, as the ideal formation [3].

The boundary "external" shell *S* of an atom is, strictly speaking, the very internal shell of the infinite atomic space. It defines to a considerable extent the qualitative characteristics of the atom. If the "external" shell of the atom is just beginning to be built with nucleons, then the probability of electron radiation into internal atomic space *W*, in the presence of an additional electric field, is significant. As such the intra-atomic space will be the "conductor" of electrons.

In the case when completion of the external nucleonic shell with nucleons is ending (*i.e.* we have a saturated shell), then the atom will have a low probability of emitting electrons beyond its external space *V* ; hence, we will deal with the "nonconductor" of electrons. Semiconductors are between these extreme states. Atoms of semiconductors have nucleon vacancies and, along with the electron radiation, the nucleonic wave radiation arises. As a result, protons and *g*-nucleons ("heavy electrons") can move relatively free in external *V* and internal *W* atomic spaces. Such atomic space will be characterized by the electron and "hole" (proton and *g*-nucleon) conductivity.

5. Dialectics of basis-superstructure

Using J. Feinberg's terminology, all microparticles could be termed tachyons (from the Greek, tacheos = fast), but their properties do not correspond to Feinberg's predictions.

The hierarchy of atomic spaces shows that the spaces of ***G***-, ***N***-, and ***A***-group particles enter in the internal space of ***E***-class particles (in particular, in the internal space of electrons).

The ***E***-group, as the basis, has its own superstructure – the ***G***-group that we briefly write as

$$\boldsymbol{G} = \mathrm{ad}(\boldsymbol{E}). \tag{10}$$

For the pair of the electron–*g*-particle, we can write

$$g = \mathrm{ad}(e). \tag{11}$$

In turn, the ***G***-group, as the basis, has the ***N***-group as the superstructure:

$$\boldsymbol{N} = \mathrm{ad}(\boldsymbol{G}) \qquad \text{and} \qquad n = \mathrm{ad}(g). \tag{12}$$

At last, ***N***- and ***A***-groups are related with each other as the basis with the superstructure:

$$\boldsymbol{A} = \mathrm{ad}(\boldsymbol{N}) \qquad \text{and} \qquad a = \mathrm{ad}(n). \tag{13}$$

Here, *a* is an atom, *n* is a nucleon.

As the *electron* is the basis for particles of the above-mentioned groups, it is *greater* than *g*-particles, nucleons, and atoms.

Let us agree to designate the *internal space* of particles of any group by the symbol of a corresponding group with the subscript "*isp*"; then for the internal spaces of ***A***-, ***N***-, ***G***-, and ***E***-groups, we have

$$\mathbf{A}_{isp} \subset \mathbf{N}_{isp} \subset \mathbf{G}_{isp} \subset \mathbf{E}_{isp}\,. \tag{14}$$

We designate by the symbol "*esp*" the *external spaces*; their interrelation is opposite to that expressed by (14), namely,

$$\boldsymbol{E}_{esp} \subset \boldsymbol{G}_{esp} \subset \boldsymbol{N}_{esp} \subset \boldsymbol{A}_{esp}\,. \tag{15}$$

Thus, according to (14), an electron contains (its *internal space* includes): *g*-particle, a nucleon, and an atom. But according to (15), with respect to *external spaces* of the particles, the atom is greater than the nucleon, the nucleon is greater than the *g*-particle, and the last is greater than the electron. This is the fundamental dialectical contradiction that is always necessary to keep in mind.

Dialectics of basis-superstructure embraces the Universe on the whole. In particular, matter-space and space-time are bound by the following relations of basis-superstructure:

$$\boldsymbol{S} = \mathrm{ad}(\boldsymbol{M}) \tag{16}$$

and

$$\boldsymbol{T} = \mathrm{ad}(\boldsymbol{S}) \tag{17}$$

or

$$\boldsymbol{T} = \mathrm{ad}(\boldsymbol{S}) = \mathrm{ad}(\mathrm{ad}(\boldsymbol{M})). \tag{18}$$

6. The role of the g-particle

At last, some additional notes concerning the g-particle. The neutron takes a special place in a hierarchy of elementary particles as the stable particle being bound in the atom, *i.e.*, as the main structural unit of matter. The relative mass of the neutron expressed in units of *g*-leptons mass is 28.07576479. Hence, it is possible to assume that the silicon atom ${}^{28}_{14}Si$ with

the mass number 28.0855 – the most widespread elementary particle in nature (at the atomic level) – corresponds to the neutron as to the atom ${}^{28}_{14}G$ of the subatomic *g*-level.

In 1931, Dirac [4, 5] showed that a field theory could be constructed on the basis of magnetic monopoles with the elementary charge

$$g = \frac{\varepsilon_0 hc}{e} = 68.5e\,. \tag{19}$$

Division of the charge *g* of the Dirac monopole by the fundamental frequency ω_e results in the associated mass of *g*-lepton [1],

$$m_g = 68.5\frac{e}{\omega_e} = 68.5m_e\,. \tag{20}$$

It is evident that the *g*-lepton and the Dirac monopole are the same particle. Since the mass of the monopole was determined incorrectly, the *g*-lepton was not rendered its due attention. Knowing the associated mass of the g-lepton (20), we have estimated the radius of its, or the Dirac monopole, wave sphere. Using the formula of mass $m = \frac{4\pi r^3 \varepsilon_0 \varepsilon_r}{1 + k^2 r^2}$ (see Eq. (21) in L. 2, Vol. 1) given that the $k_e^2 r_e^2 << 1$ and $\varepsilon_r = 1$, we have obtained

$$r_g = \left(\frac{m_g}{4\pi\varepsilon_0}\right)^{1/3} = 1.706\times 10^{-9}\ cm\,. \tag{21}$$

As was already mentioned, this *magnitude* is very close to the rational *golden section* of the fundamental metrological period Δ=2πlge,

$$r_g \approx \left(\frac{5}{8}2\pi \lg e\right)\times 10^{-9} cm\,, \tag{22}$$

like the numerical value of the elementary quantum of the rate of mass exchange [6], the electron charge, equal to $e = 1.70269155\times 10^{-9}\ g\times s^{-1}$.

Because of this, we suggest that *g*-lepton is rather a stable particle which, possibly, has for the elementary particle level the same meaning as the neutron has for atoms (nucleon molecules according to the DM). If it is true, then on the basis of the monopole and the periodic law of space, it is possible to compose the spectrum of "elementary" particles, where the g-lepton is the hydrogen analog, γ-quantum is the deuterium analog, μ-meson is the tritium analog, π-meson is the helium analog, *etc*.

7. General conclusion

The *periodic law of measures*, having the complex form, reflects the periodic essence of the Universe – the dialectical bond of basis and superstructure of all objects and fields in Nature.

All basic parameters of the DM considered in our Lectures are subjected to the given law. Here they are: the *basis speed* of exchange *c*; the *fundamental frequencies* of exchange, ω_e and ω_g, and the *fundamental wave radii*, $\lambda\!\!\!^{-}_e$ and $\lambda\!\!\!^{-}_g$, and the *fundamental wave periods*, T_e and T_g, related to the frequencies; the *associated mass of an electron*, m_e; the *elementary exchange charge e* (an elementary quantum of the rate of mass exchange); the *speeds-strengths* of the longitudinal-transversal field, *E* and *B*.

The rate of processes occurring in the Universe *is unconstrained*, and the basis speed of exchange *c* (the speed of light is equal to this value) is the fundamental period-quantum of speed in the field of material-ideal exchange.

The *mass spectrum* of reference measures of elementary particles follows from the periodic law of measures being applied to mass. With this it was found the clear correlation of the spectrum of masses with the fundamental metrological period $\Delta = 2\pi \lg e$.

The *neutron mass* corresponds, as follows from the conducted analysis, to the golden section of the mass interval of the ***N***-group particles.

The *electron* belongs to ***G***-group particles, which are the structural components of the world of elementary particles, including neutrons, and it is the boundary structure of ***E***-group particles.

The *ratio* of the parameters of *superstructure* and *basis* for the one group of physical parameters represents the fundamental parameter – the *wave number*, $k_e = \dfrac{e}{m_e c}$. Just this ratio was obtained for the first time in Einstein's and de Haas's experiments.

Since Newton's times it has been generally agreed that everything in nature moves along its trajectory. This motion was termed mechanical motion. Contemporary physics and quantum mechanics have raised many disputes over this notion. Quantum mechanics had attempted to solve this problem by the uncertainty principle; however the notion of mechanical motion has not been revised.

From the point of view of dialectics, the space of objects and the objects themselves form a single entity. Therefore, in this space, a clear *mechanical motion is impossible in principle*. Moreover, the space of the Universe consists of many wave spaces *enclosed into each other* on various levels of the Universe. Consequently, *any motion is multilevel – consists of many levels of motion*. It means that having emerged on one level, it recurs on all underlying levels and generates a certain motion on overlying levels. Furthermore, each object in the Universe

is a *complicated wave complex*. It means that it "moves" along its trajectory, disappears at one point of the trajectory and emerges at another one. In other words, each object in the Universe exists, while not existing and does not exist, while existing, because it continuously disappears, not disappearing on its way. This is the essence of wave motion.

Let us suppose that the displacement $d\hat{\psi} = \hat{\upsilon} dt$ occurs at the atomic level. This displacement simultaneously generates, with the wave velocity c, the displacement on the subatomic level $dx = cdt$. In turn, on the level lower than subatomic, this motion generates the motion with a velocity much greater [3] than that of the subatomic level and so on. Nothing is known about these levels but it does not mean that they do not exist. At least, recurrence of motion on the subatomic level occurs. Both the motions, local and wave, are related in the following way

$$d\hat{\psi} = \frac{\hat{\upsilon}}{c} dx . \tag{23}$$

The wave level of motion is the *basis* of motion, whereas the displacement is the *superstructure* of the wave motion. Thus, motion and rest are a complicated contradictory process of the basis-superstructure. On the experimental level, it manifests itself in form of waves of matter.

The material states are closely related to the spectrum of ideal states of the Universe. Both spectra form a single–not a single complex of the states of the material-ideal Universe. Thus, the structure of matter levels of the Universe, as *contents*, is inseparably bonded with the structure of their spaces as *forms*. The structure of the real space is *multidimensional*, but this multidimensionality is not identical to the formal mathematical multidimensionality.

All the problems discussed in the present Lectures, and other relevant problems, are considered in detail mainly in the books [1, 2, 7].

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