

# On the Structural Content of Fundamental Properties of Matter and Universal Constants of Physics

Khachatur Kirakosyan

Institute of Chemical Physics, Armenian National Academy of Sciences  
Email: khkirakosyan@gmail.com

**Abstract** This work presents the equations of motion on the basis of which the clear definition of the concept of mass is obtained and the classification of various variants of mass is revealed. Not only the fundamental equations of mechanics but the equations of electrodynamics and thermodynamics have been obtained with the use of the suggested equations of motion. It is shown that the universal constants of physics are the combinations of special dimensional coefficients introduced to impart the dimensional content to physical parameters, the numerical values of mentioned parameters are practically coinciding with the Planck units of length, time, mass and temperature.

**Keywords:** Structure, electron, mass, charge, spin, temperature

## 1 Introduction

The cognitive process of outer world can be characterized in the following way: there is a physical world that influences the sensorial organs of perception of a human being. The human being is processing this information, creates the means to obtain an additional information to describe the different events, and produces a complex of concepts and parameters, sets the relations between them; and this represents the base of physical laws. Generally, the development of each conceptual direction in physics is related to the discovery of new properties of matter and the formation of its universal constant, and the discovered property of matter is provided by the corresponding dimensionality. The most important part of the discovery is the fundamental property of matter, the mass [1] and the parameters associated with it (the force, energy, etc.), because they became the main means in the investigations of heat and electric phenomena, and, henceforth, of all the fields of natural science. However, due to its genesis, the basic notions and the laws relating them (including the notion of "mass" and the laws of motion) contain some uncertainties [2,3] the properties of intrinsic structural relationships that stipulate one or another property of matter are not revealed until now. To date, with the penetration into the interior of the structure of matter and with the discovery of many elementary particles, the problem arises of the computation of their masses, moreover, the origin of mass itself is widely discussed in the modern theories [4,5,6,7,8]. In the Structural Theory (ST), to reveal all the contents of main parameters and physical laws, one imitates the process of cognition simulation in an inverted sequence [9]. If the formed views originated from the macroscopic formations with the further deepening into the microworld, at first we are modeling the particles and phenomena in the ST starting from a certain deep level with the subsequent transition to the particles and phenomena of higher hierarchical levels. It is supposed that by comparing the same phenomena from the points of view of the modeled world and the world of conventional physics one can reveal the structural content of parameters and laws that have the sensuous or any other origins. From this point of view, to reveal the content of the mass and the motion laws, the modeling of initial bodies is carried out starting from a hierarchical level where the mechanism of motion of physical bodies is revealed. In the present work the correspondence between the characteristic parameters of the equations of motion of the ST and the conventional parameters of motion is established, a clear definition of the concept of the "mass" is given, and the classification of different variants of the mass revealing is listed, while the equivalence of mass and energy is also examined. It is shown that the universal constants of physics with the intricate dimensionalities are the combinations of special coefficients introduced only to impart the dimensional content to the corresponding parameters.

## 2 Basic Terms and the Equations of Motion of the ST

In the ST, a hypothesis is put forward on the existence of some particles (the  $\varepsilon$ -particles) that are conditionally of the lowest hierarchical level, and later on from these particles the well-known particles of micro- and macroworld are modeled. The main attribute of  $\varepsilon$ -particles is in their ability to interact with each other; and in the process of the elementary act of interaction (the  $\varepsilon$ -act) there are only two participating particles. The  $\varepsilon$ -act has a strictly defined duration and is realized at a strictly defined distance between particles (the  $\varepsilon$ -intervals), and as a result of interaction the particles are being moved by the same distance. Hence, the number of sequentially realized  $\varepsilon$ -acts is used as a unified universal instrument to determine both the distance and time. Attaching the dimensionalities  $\xi_d$  cm and  $\xi_t$  sec to the  $\varepsilon$ -interval one can determine the dimensional distance and time. It is obvious that  $\xi_d$  and  $\xi_t$  are the constants according to the invariance of  $\varepsilon$ -intervals.

From sixteen  $\varepsilon$  particles, the  $\Delta_i, \Delta_j$  and  $\Delta_k$  elements are modeled which oscillate at mutually perpendicular directions. The relative position of  $\varepsilon$  particles in  $\Delta$  elements is such that the  $\Delta$  elements are always "recognizable" relative to each other, thereby the mutually perpendicular directions of their motion are always implemented. Hereinafter, the  $i, j$  and  $k$  symbols will be used instead of  $\Delta_i, \Delta_j$  and  $\Delta_k$ .

The separately taken  $\Delta$ -element consisting of sixteen  $\varepsilon$  particles is characterized by the amplitude of oscillation

$$H_{\Delta} = \frac{16!}{8 \cdot \alpha_0}, \quad (1)$$

a pair of  $\Delta$  elements is characterized by

$$H_{00} = \alpha_0 \cdot H_{\Delta}^2 = \alpha_0 \cdot H_c \quad (2)$$

$\varepsilon$  intervals, that is,  $\alpha_0$  multiple repetition of value

$$H_{\Delta}^2 = H_c, \quad (3)$$

where  $\alpha_0$  is the constant, determined by the following equation

$$\alpha_0 = \sum_{n=1}^7 n^2 = \sum_{n=1}^7 \sum_{\ell=0}^{n-1} (2\ell + 1) = 140 \quad (4)$$

which shows the number of possible variants of interrelations in the group of eight elements (from eight  $\varepsilon$ -pairs); one is chosen from the very beginning and seven others are the partners,  $n$  and  $l$  are the analogs of the principal and azimuthal quantum numbers for given hierarchy level.

It is supposed that the circumference formed by the trajectory of motion of  $\Delta$ -pairs with the mutually perpendicular directions of oscillations and the phase  $\pm\pi/2$  (e.g.,  $2i$ - and  $2k$ -pairs) is defined by the equation

$$\frac{H_c \xi_d}{\chi_c} = \frac{2\pi r_c}{\chi_c}, \quad (5)$$

or subject to condition of  $\alpha_0$  - fold repetition of the quantity  $H_c$  (2), and the resulting path length is given by the following equation

$$\alpha_c H_c \xi_d = \alpha_c 2\pi r_c = H_0 \xi_d, \quad (6)$$

where:

$$\alpha_c = \frac{\alpha_0}{\chi_c} = \frac{140}{\chi_c}, \quad (7)$$

$$\alpha_c \cdot H_c = H_0, \quad (8)$$

and  $\chi_c$  is the constant depending on the expenditure of some part of  $\varepsilon$  intervals for the formation of closed curved trajectories.

From six  $\Delta$ - elements one is modeling the  $\gamma$ -particles which are the basis of known particles forming both the microworld (electron, positron, photons, neutrino, etc.) and  $\gamma_{0i}$ -particles of general content

$2i2j;2k$  (or  $2i2j2k_i$ ), by the presence of which the generality of quantitative laws of their motion is explained in all physical bodies.

The subscript “ $i$ ” in the  $2j$ -pair means that the given pair arise as a part of the  $\gamma_{0i}$ -particle due to interaction (e.g., of an electrostatic interaction) with the other bodies. As a rule, the interaction with the ST is reduced to the exchange of  $\Delta$ -by  $\Delta$  pairs, and the  $2j_i$  pair being appeared as a result of interaction is characterized by the  $H_i \varepsilon$  intervals of displacement, after which the particle moves backward. The quantity  $H_i$  may be defined by the ratio  $\chi_i H_i = H_c$ , where  $\chi_i$  is any positive number greater than unity; however, it is more rational to use the integer values  $\chi_i$  (that is,  $\chi_i = n = 1, 2, 3, \dots$ ) and the equality

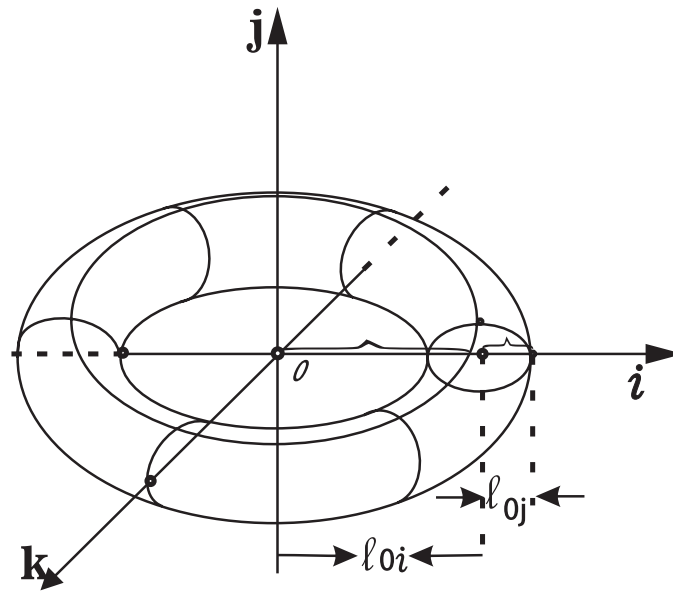
$$nH_i = H_c, \tag{9}$$

or subject to (8):

$$n\alpha_c H_i = H_0, \tag{10}$$

because the periodical  $n$ -tuple duplication of  $H_i$  in relation to  $H_c$  may serve as a criterion of the stationarity of system.

The quantities  $H_{00}$ ,  $H_0$  and  $H_i$  are called the potentials of  $\Delta$ -pairs. The mechanism of motion of  $\gamma_{0i}$ -particles is represented as a sequential periodic modification of the given organization consisting of  $\varepsilon$ -particles, the resulting trajectory of which is formed by the motion along the three mutually perpendicular directions corresponding to the torus (Fig. 1).



**Figure 1.** The final trajectory of particles formed by the composition of oscillations along three mutually perpendicular directions represents the torus.

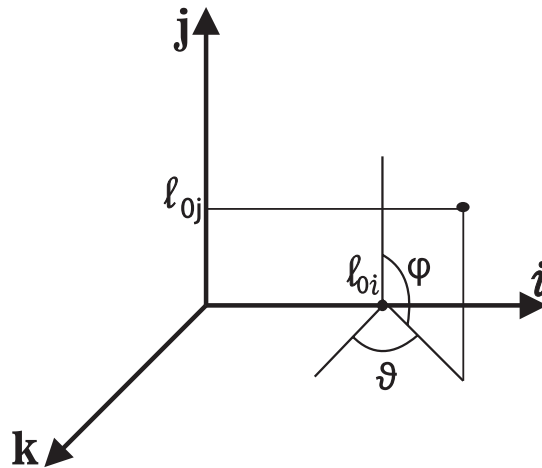
The torus is described by the following parametric equations

$$l_i = (l_0 + l_{0j} \cos \varphi) \cos \vartheta, \tag{11}$$

$$l_k = (l_0 + l_{0j} \cos \varphi) \sin \vartheta, \tag{12}$$

$$l_j = l_{0j} \sin \varphi, \tag{13}$$

which show the behaviour of each  $\Delta$ -pair individually. The content of basic parameters which are given in equations (11) - (13) follows from Fig. 2.



**Figure 2.** The basic parameters of equations (11) - (13)

The volume of given torus (Fig.1) is defined by integrals

$$\oint_L H_{is}^2 dl = \oint_S \text{curl} H_{is}^2 dS, \quad (14)$$

where the axial vectors  $H_{is}^2$  and  $H_{0s}^2$  are defined by the sum of vector products of the corresponding potentials:

$$H_{is}^2 = H_{ii} \times H_{ij} + H_{ik} \times H_{ii}, \quad (15)$$

$$H_{0s}^2 = H_{0k} \times H_{0i} \quad (16)$$

The given torus does not exist as an integral figure. It is formed by the temporal trails of motion of  $\gamma_{0i}$ - particles, therefore, the volume (14) is called the trajectorial volume and it has a temporal nature. Integrating the equation (14), and taking the equalities of modules  $|H_{0i}| = |H_{0k}|$ ,  $|H_{ii}| = |H_{ij}| = |H_{ik}|$  we obtain in the limits  $\ell = 0 \div \lambda$ ,  $\ell = 0 \div 2\pi r$ ,  $\ell = 0 \div \alpha_c 2\pi r$  for the left-hand side and  $S = 0 \div H_{0s}^2$  for the right-hand side,

$$\lambda_i \cdot H_{is}^2 = H_i \cdot H_{0s}^2, \quad (17)$$

$$2\pi r \cdot H_{is}^2 = H_c \cdot H_{0s}^2, \quad (18)$$

$$\alpha_c 2\pi r \cdot H_{is}^2 = \alpha_c \cdot H_c \cdot H_{0s}^2 = H_0 \cdot H_{0s}^2, \quad (19)$$

along with the equation (14) they represent the basic equations of motion of the ST.

The equation (14) differs from the Stokes equation by the fact that it describes the motion of one  $\gamma_{0i}$ -particle with the help of which the volume is calculated: by the circulation of the axial vector  $H_{is}^2$  over the closed path  $L$  (the left-hand side of the equation) or by the mixed product of three vectors one of which is the  $\text{curl} H_{is}^2$  (the right-hand side of the equation). On the basis of the given principles for the formation of the trajectorial volume, the motion mechanism of  $\gamma_{0i}$ -particles is represented by the transverse component with the curvilinear closed trajectory (the circulation path) with the perpendicular surface  $H_{is}^2$  and the longitudinal component with the perpendicular surface  $H_{0s}^2$  (the right-hand side of the equation of motion). Thus, it follows from the equation (17), the transverse path  $\lambda$  with the perpendicular surface  $H_{is}^2$  corresponds to the longitudinal path  $H_i \xi_d$  with the perpendicular surface  $H_{0s}^2$ .

If due to some influence on the  $\gamma_{0i}$ -particle the new  $\gamma_{0i}$ -particles are attached and additional exchanges with the  $\Delta$ - pairs ( $2\Delta_{ji}$  or  $2\Delta_{ki}$ ) with the potentials  $H_i$  take place, then there is an additional trajectorial volume, and the total volume is defined as the sum of equations (17) and (19):

$$(\alpha_c 2\pi r + \lambda) H_{is}^2 = (H_0 + H_i) H_{0s}^2, \quad (20)$$

where  $\lambda$  is the transverse path determined by an additional influence.

It follows from the equations (6) and (19) that the self-interaction (the absence of other  $\Delta$ - pairs) corresponds to the trajectorial volume

$$\alpha_c 2\pi r_c H_{0s}^2 = \alpha_c \cdot H_c \cdot H_{0s}^2 = H_0^3, \quad (21)$$

which implies also the relations

$$\alpha_c 2\pi r \cdot H_{is}^2 = \alpha_c 2\pi r_c \cdot H_{0s}^2 = H_0^3, \quad (22)$$

that is, with the increase of the major radius of the torus, the perpendicular surface of the transverse component is decreasing, however, the volume of the torus remains the same.

As a rule, the behavior of  $\gamma_{0i}$ -particles is defined by their  $\Delta$ -contents, which is given by the corresponding choice of the parametric equations in the case when all three equations are being periodic, the  $\gamma_{0i}$ -particle remains in a limited part of space. If the conditions have been created such that any of parametric equations is not periodic (that is, if  $\ell = v \cdot t$ , where  $v$  is the velocity and  $t$  is time), the given particle will be in the state of rectilinear motion along the direction of interaction; in the presence of two non-periodic equations the  $\gamma_{0i}$ -particle itself will be unstable.

Therefore, the  $\gamma_{0i}$ -particles are characterized minimally by two periodic equations; by virtue of mutually perpendicular directions of motion of  $\Delta$ - pairs the following condition is always met

$$H_i \perp H_0. \quad (23)$$

On the whole, the nature of parametric equations becomes the criterion to find the particles in a limited part of space or in the state of motion along the prescribed directions. In the latter case, the preferred direction of motion of the many particle system is defined by the sum of the *curl* $H_{is}^2$  projections of each individual particle.

### 3 The Intrinsic Metric Characterizations and the Velocity of Motion of Physical Bodies

In equations (17) - (21), the results of interactions reveal itself by the passage of the minimal longitudinal paths

$$\ell_i = H_i \xi_d, \quad \ell_c = H_c \xi_d, \quad \ell_0 = H_0 \xi_d, \quad \ell_{0i} = (H_0 + H_i) \xi_d, \quad (24)$$

to which correspond the minimal transverse paths defined by the following ratios

$$\begin{aligned} \lambda &= \frac{H_i \cdot H_0^2 \xi_d}{H_{is}^2} = \frac{H_0^2 \xi_d}{H_2}, & \lambda_c &= \frac{H_0^2 \xi_d}{H_c} = \alpha_c^2 H_c \xi_d, \\ \lambda_0 &= \frac{H_0^2 \xi_d}{H_0} = H_0 \xi_d, & \lambda_{0i} &= \frac{(H_0 + H_{ii}) H_0^2 \xi_d}{H_{is}^2}. \end{aligned} \quad (25)$$

Because the longitudinal component of motion is realized by the “netting” of perpendicular surface  $H_{0s}^2$ , the paths (24) being overcome for the time intervals

$$t_i = H_i \xi_\tau, \quad t_c = H_c \xi_\tau, \quad t_0 = H_0 \xi_\tau, \quad t_{0i} = (H_0 + H_i) \xi_\tau, \quad (26)$$

respectively, where for each variant the time is determined by the value of the  $\varepsilon$ -interval of displacement and a new coefficient of dimensionality of time is introduced as

$$\xi_\tau = H_0^2 \xi_t. \quad (27)$$

It is obvious that the dimensionless parts of time (26) represent the corresponding dimensionless trajectorial volume. Because one and the same volume is determined by the both sides of the equations (17) - (21), the corresponding time intervals of passage (24) and (25) should be equal as well.

When searching for matches between the structural and kinematic conventional parameters of motion, the necessity is arising to use the longitudinal paths equal to the quantities of the transverse motion (25).

In this case, relating the time interval  $\xi_\tau$  with each  $\varepsilon$ -interval of displacement, we obtain the new range of characteristic times:

$$\tau = \frac{H_i \cdot H_0^2 \xi_\tau}{H_i^2} = \frac{H_0^2 \xi_\tau}{H_i}; \quad \tau_c = \frac{H_0^2 \xi_\tau}{H_c};$$

$$\tau_0 = H_0 \xi_\tau; \quad \tau_{0i} = \frac{(H_0 + H_i) H_0^2 \xi_\tau}{H_i^2}.$$
(28)

It is obvious that the frequencies of revealing of paths can be determined (25) by means of the inverse time values of the interval (28):

$$v = \frac{H_i \cdot \xi_\nu}{H_0^2}; \quad \nu_c = \frac{H_c \xi_\nu}{H_0^2};$$

$$\nu_0 = \frac{\xi_\nu}{H_0}; \quad \nu_{0i} = \frac{H_i^2}{(H_0 + H_i) \cdot H_0^2},$$
(29)

where the coefficient of dimensionality of frequency is denoted by  $\xi_\nu$ :

$$\xi_\nu = \xi_\tau^{-1}.$$
(30)

The revealing of the interaction potential  $H_i$  is related to the realization of minimal paths  $\ell_i$ ,  $\lambda$  and time intervals  $t_i$ ; the formation of closed trajectories is finished by the passing of paths  $2\pi r$  and  $\lambda_c$  per one time interval  $t_c$ ; the potential of intrinsic interaction  $H_0$  is shown by means of the  $\alpha_0$ -fold repetition of closed trajectory  $2\pi r_c$  per time  $t_0$ . The minimal parameters of the joint revealing of potentials  $H_i$  and  $H_0$  are the paths  $\ell_{0i}$ ,  $\lambda_{0i}$  and time interval  $t_{0i}$ . The set of parameters (24), (25), (26), (28) and (29) is called the intrinsic metric characteristics of  $\gamma_{0i}$ -particles; they are related to the minimal values of time and paths necessary for potential revealing of the external and intrinsic interactions.

By proper selection of characteristic parameters of the paths and time, depending on the type of the raised problem, one can define the velocity of  $\gamma_{0i}$ -particles by various variants. In particular, by means of metric characteristics (24) and (26) the velocity of longitudinal motion  $v_i$  is defined by the ratio

$$v_i = \frac{H_i \xi_d}{H_i \xi_\tau} = \frac{H_c \xi_d}{H_c \xi_\tau} = \frac{H_0 \xi_d}{H_0 \xi_\tau} = \frac{(H_0 + H_i) \xi_d}{(H_0 + H_i) \xi_\tau} = c,$$
(31)

where the counting of time has been carried out by the numbers of  $\varepsilon$ -intervals along the displacement and  $c$  is denoted by

$$c = \frac{\xi_d}{\xi_\tau}.$$
(32)

Owing to this, the minimal temporal interval of revealing of intrinsic and external interaction is determined by the last formula of the set (26). During this time the particle passes the transverse path  $\lambda$  (25) and the longitudinal path  $\lambda_0$  (25), respectively. Subject to the formula (32), the velocities of transversal  $v_{nn}$  and longitudinal  $v$  motions are given by the following equations.

$$v_{nn} = \frac{\lambda}{\tau_{0i}} = \frac{H_0^2}{H_i(H_0 + H_i)} c,$$
(33)

$$v = \frac{\ell_i}{\tau_{0i}} = \frac{H_i}{H_0 + H_i} c$$
(34)

Because the trajectory of transverse motion is circular, the resulting observed motion at the small values of transverse path will be caused only by the longitudinal motion; therefore, the velocity is calculated with the use of (34). Just this velocity corresponds to the conventional definition of velocity of motion of physical bodies.

As the generalizing parameter of longitudinal and transverse motions, the general path  $\lambda_\Sigma$  is introduced, represented by the ratio

$$\begin{aligned}\lambda_\Sigma &= \frac{(H_0 + H_i) \cdot H_{0s}^2 \xi_d}{H_0^2 + H_i^2} = \\ &= \frac{(H_0 + H_i) \cdot H_{0s}^2 \xi_d}{(H_0 + H_i)^2} = \frac{H_{0s}^2 \xi_d}{H_0 + H_i},\end{aligned}\quad (35)$$

where an equation is introduced  $\mathbf{H}_i \cdot \mathbf{H}_0 = 0$  due to the condition  $H_i \perp H_0$  (23)

It follows from definitions (25), (34) and (35) that  $\lambda$  and  $\lambda_\Sigma$  are related by

$$\lambda v = c \lambda_\Sigma. \quad (36)$$

#### 4 On the Concept of “Mass”. The Unity of Mass and Energy

Composing the following identities with the use of the equalities  $c\lambda = c\lambda$ ,  $c\lambda_0 = c\lambda_0$ ,  $c\lambda_{0i} = c\lambda_{0i}$ ,  $c\lambda_\Sigma = c\lambda_\Sigma$ , representing the right-hand sides of these identities as the product of dimensionless and dimensional components, after elementary transformations and with the aid of equations (25), (35) and the notation (32), we obtain

$$\begin{aligned}c\lambda \frac{H_i}{H_0^2} &= \frac{\xi_d^2}{\xi_\tau}; \quad c\lambda_0 \frac{1}{H_0} = \frac{\xi_d^2}{\xi_\tau}; \\ c\lambda_{0i} \frac{H_i^2}{(H_0 + H_i)H_0^2} &= \frac{\xi_d^2}{\xi_\tau}; \quad c\lambda \frac{H_0 + H_i}{H_0^2} = \frac{\xi_d^2}{\xi_\tau}.\end{aligned}\quad (37)$$

Multiplying both sides of these equations by the constant  $\xi_m$  with the dimension of mass, we obtain

$$m_i c \lambda = h; \quad m_0 c \lambda_0 = h; \quad m_{0i} c \lambda_{0i} = h; \quad m c \lambda = h, \quad (38)$$

where  $m_i$  the mass of interaction, the mass of the intrinsic interaction  $m_0$ , the mass of the general interaction  $m_{0i}$  and the total mass  $m$  are defined as follows

$$\begin{aligned}m_i &= \frac{\xi_m H_i^2}{H_i \cdot H_0^2} = \frac{\xi_m H_i}{H_0^2}; \\ m_0 &= \frac{\xi_m H_0^2}{H_0 \cdot H_0^2} = \frac{\xi_m}{H_0}; \\ m_{0i} &= \frac{\xi_m H_i^2}{(H_0 + H_i)H_0^2}; \\ m &= \frac{\xi_m (H_0 + H_i)^2}{(H_0 + H_i)H_0^2} = \frac{\xi_m (H_0 + H_i)}{H_0^2};\end{aligned}\quad (39)$$

the constant  $h$  is composed of  $\xi_d$ ,  $\xi_t$  and  $\xi_m$

$$h = \frac{\xi_m \xi_d^2}{\xi_\tau}. \quad (40)$$

It follows from the equation (39) that the total mass can be represented by the following sum

$$m = m_0 + m_i. \quad (41)$$

The resulting trajectory of  $\gamma_0$ -particles which participate only in the intrinsic interaction is always closed. Therefore, in the process of observing the particles during  $\tau_0$ -intervals (or during the  $\tau_0$ -folds intervals) the state of the “rest” is fixed; hence,  $m_0$  is also called the rest mass.

Taking into consideration the equation (36), the last of the equations (39) can be represented in the following form

$$mv\lambda = h, \quad (42)$$

and comparing it with the first of the equations (38), we obtain the equality of momentums

$$m_i c = mv = (m_0 + m_i)v, \quad (43)$$

where the sum (41) is used.

Both equations (43) and (34) show that in the absence of the rest mass  $v = c$ . Taking into account that from the known particles the photons do not possess the rest mass, one can conclude that the numerical value of  $c$ , which is defined by (32), is equal to the velocity of light in vacuum. Hence, considering the equations (38) and (42) as the different variants of the de Broglie equation, the constant  $h$ , which is the combination of dimensional coefficients (40), is possible to identify with the Planck constant.

Thus, as follows from the definitions (39), the mass of one  $\gamma_{0i}$ -particle is defined by the ratio of the perpendicular surface of given component of motion ( $H_{is}^2$  and  $H_{0s}^2$ ) or their sum ( $H_{is}^2 + H_{0s}^2$ ) to the corresponding trajectorial volume:  $H_i \cdot H_{0s}^2$ ,  $H_0 \cdot H_{0s}^2$  and  $(H_0 + H_i) \cdot H_{0s}^2$ . The mass  $m$  is an analog of the mass used in mechanics. Assuming that some physical body consists of  $N_m$   $\gamma_{0i}$ -particles, its mass of interaction  $M_i$  can be represented by the following relation

$$M_i = \frac{N_m \xi_m H_i}{H_0^2}, \quad (44)$$

and the total mass is equal to

$$M = \frac{N_m (H_0 + H_i)}{H_0^2}. \quad (45)$$

Worth noting that the use of some average value of the potential  $H_i$  was supposed when the total mass was determined by the equation (45); to compute the masses of specific particles, one should have more data on their structure. Nevertheless, it is always possible to select some average potential  $H_1$  (that is, on the basis of the atomic mass unit), and the value  $M_1$  can be defined by the following equation

$$M_1 = \frac{N_{m1} \xi_m (H_1 + H_i)}{H_0^2}, \quad (46)$$

where  $N_{m1}$  is the number of structural units with the potential  $H_1$ .

It follows from the equation (43) that the momentum of  $\gamma_{0i}$ -particles is defined by the mass of interaction. Differentiating the given equation with respect to time, we obtain the basic law of mechanics:

$$F = c \frac{dm_i}{dt} = \frac{dmv}{dt}, \quad (47)$$

where the force  $F$  is defined by the changes of the mass of interaction.

At the transfer from the mass of  $\gamma_{0i}$ -particles to the masses (44), (45) or (46), neither the form nor the content of equations (43) and (47) changes at all. Just when differentiating the momentums it must be emphasized that the quantities  $N_m$  (or  $N_{m1}$ ) remain the same, that is, the given body retains its integrity.

The greater are the values of parameters  $N_m (H_{0s}^2 + H_{is}^2)$  or  $N_m \cdot H_{0s}^2$  that determine the mass of a specific body, the more it will reveal the inertness to the external influences, which is characterized by the parameter  $\Delta H_{is}^2$ , or by the total parameter  $N_m (H_{0s}^2 + H_{2s}^2) + \Delta H_{2s}^2$  and  $N_m H_{0s}^2 + \Delta H_{is}^2$ .

Introducing the coefficient with the dimension of energy

$$\xi_\varepsilon = \frac{\xi_m \xi_d^2}{\xi_\tau^2} = \xi_m c^2, \quad (48)$$

and multiplying it by the dimensionless components of (39), we obtain

$$\varepsilon_i = m_i c^2, \quad \varepsilon_0 = m_0 c^2, \quad \varepsilon_{0i} = m_{0i} c^2, \quad \varepsilon_m = m c^2, \quad (49)$$



where the energies of the corresponding variants of interaction are denoted as

$$\varepsilon_i = \frac{\xi_i H_i}{H_0^2}, \quad \varepsilon_0 = \frac{\xi_\varepsilon}{H_0}, \quad (50)$$

$$\varepsilon_{0i} = \frac{\xi_\varepsilon H_i^2}{(H_0 + H_i)H_0^2}, \quad \varepsilon_m = \frac{\xi_\varepsilon (H_0 + H_i)}{H_0^2}.$$

Multiplying the quantity  $\xi_v$  in (30) by the constant  $h$  (40), we obtain the coefficient with the dimension of energy

$$\frac{\xi_m \xi_d^2}{\xi_\tau} \cdot \frac{1}{\xi_\tau} = \frac{\xi_m \xi_d^2}{\xi_\tau^2} = \xi_m c^2 = \xi_\varepsilon, \quad (51)$$

in the same manner, multiplying all the relations (29) by  $h$ , we obtain the equalities

$$h\nu_i = m_i c^2, \quad h\nu_0 = m_0 c^2, \quad h\nu_{0i} = m_{0i} c^2, \quad h\nu = m c^2. \quad (52)$$

Let us establish a relation between the general mass  $m$  and the mass of general interaction  $m_{0i}$  using (34) and (39)

$$mv^2 = m_{0i} c^2. \quad (53)$$

It follows from the equations (39), (50) and (52) that the unity of mass, the frequency revealing the integrity and the energy defined in various forms are caused by the identity of their dimensionless components. From the mathematical point of view, the equations (38) and (42) are identical with the de Broglie equation but they have a completely different interpretation. According to the ST, the dual nature of physical bodies does not follow from these equations. In this case, the quantities  $\lambda$ ,  $\lambda_0$  and  $\lambda_{0i}$  are not the wavelengths, but they represent the real individual paths of the particles which are localized in the limited part of space, that is, they are the particles with their own real sizes passing for specified time intervals. In the same manner, the parameters  $\nu_i$ ,  $\nu_0$ ,  $\nu_{0i}$  and  $\nu$  in equation (52) are not the frequencies of waves but the frequencies of the passage of paths  $\lambda$ ,  $\lambda_0$ ,  $\lambda_{0i}$  (25) and  $\lambda$  (35).

It should be noted also that writing the equation (42) in the form  $v\lambda = hm^{-1}$ , one can conclude that the product of kinematic parameters  $v\lambda$  and the dynamic parameter  $m^{-1}$  have the same physical meaning, the coefficient of proportionality  $h$  (40) provides the equality of dimensionalities in both sides of the relations mentioned above.

## 5 The Transformation of Motion Parameters

In the description of motion of  $\gamma_{0i}$ -particles, the problems related to the choice of reference systems practically have not been considered. The methodology of the ST is such that to describe the motion one can choose the most convenient reference frame, including the modeled reference systems, which are in an absolute rest, because at the modeling of the world around us the initially modeled particles move in the absolutely empty continuum. The reference system which is at rest can be placed in any part of this continuum and the behavior of any modeled particle can be described with respect to this system. However, the most rational is to use the structural system of reference (SSR), because, due to its  $\Delta$ -content, the behavior of  $\gamma_{0i}$ -particles is determined by the summation of displacements along the three mutually perpendicular directions. These directions are used as the coordinate system. The distance traveled and the displacement time are determined by the counting of the  $\varepsilon$ -acts along the each direction. It goes without saying that the results obtained in such a way are related exclusively to the given particle. However, there is always a possibility to consider the parameters of motion of modeled particles relative to each other.

Let be given two particles with the following masses and velocities  $m_1$ ,  $m_{i1}$ ,  $v_1$ , and  $m_2$ ,  $m_{i2}$ ,  $v_2$ , respectively. According to the definition of mass (41), momentum (43) and owing to the condition  $H_i \perp H_0$  (23), we obtain

$$\begin{aligned} m_1^2 c^2 &= m_0^2 c^2 + m_{i1}^2 c^2 = m_0^2 c^2 + m_1^2 v_1^2, \\ m_2^2 c^2 &= m_0^2 c^2 + m_{i2}^2 c^2 = m_0^2 c^2 + m_2^2 v_2^2, \end{aligned} \quad (54)$$

which result in

$$\begin{aligned} m_1 \sqrt{1 - \beta_1^2} &= m_0, \\ m_2 \sqrt{1 - \beta_2^2} &= m_0, \end{aligned} \quad (55)$$

$$m_1 \sqrt{1 - \beta_1^2} = m_2 \sqrt{1 - \beta_2^2}, \quad (56)$$

where  $\beta_1 = v_1/c$  and  $\beta_2 = v_2/c$ .

If

$$v_1 \ll c, \quad v_1 \ll v_2, \quad v = v_2 - v_1 \quad (57)$$

where  $v$  is the velocity of the second particle relative to the velocity of the first along a given direction and denoting  $\beta = v/c$ , from the equation (56) we obtain the transformation of mass proposed in the Special Theory of Relativity (STR):

$$m_2 = \frac{m_1}{\sqrt{1 - \beta^2}}, \quad (58)$$

According to the equation (58), the mass  $m_1$  can be considered as the rest mass for the second particle. This statement has its justification: from the first formula (55) and conditions (57) the approximate equality  $m_1 \approx m_0$  follows immediately.

Comparing the coordinates and time of given particles [9, § 13], we obtain

$$x_2 \sqrt{1 - \beta_2^2} = (x_1 - vt_1) \sqrt{1 - \beta_1^2}, \quad (59)$$

$$t_2 \sqrt{1 - \beta_2^2} = \left(t_1 - \frac{vx_1}{c^2}\right) \sqrt{1 - \beta_1^2}, \quad (60)$$

and taking into account the condition (57), it turns into the transformations of the STR:

$$x_2 = \frac{x_1 - vt_1}{\sqrt{1 - \beta^2}}, \quad t_2 = \frac{t_1 - \frac{vx_1}{c^2}}{\sqrt{1 - \beta^2}}. \quad (61)$$

To derive the quantitative relations for the description of the motion of  $\gamma_{0i}$ -particles, the particles themselves are used both the system of coordinate and the tools for measurements of length and time, thereby, all the obtained results are determined by the  $\Delta$ -content of  $\gamma_{0i}$ -particles and they cannot depend on the choice of the exterior reference frames, as they do not affect the behavior of given particles nor the procedure of their description. The equations of the ST satisfy to the invariance requirements of the STR namely by this circumstance.

## 6 The Mass and Spin of Electron

The electron is one of the most important particles of physical world and its mass and charge are related to the fundamental most important properties of matter. According to the ST, electron consists of two  $\gamma$ -particles in two inter-transient structural states  $S_1$  and  $S_2$  given below in the left and right sides of the scheme, respectively:

$$4j(\bar{i}k) + 2\bar{i}2\bar{k}(\bar{i}\bar{k}) \xleftrightarrow{\quad} 4\bar{j}(\bar{i}\bar{k}) + 2\bar{i}2k(\bar{i}k), \quad (62)$$

or at the level of  $\gamma$ -transformations:

$$\gamma_{eE1} + \gamma_{e01} \xleftrightarrow{\quad} \gamma_{eE2} + \gamma_{e02}, \quad (63)$$

where

$$\gamma_{eE1} = 4j(\bar{i}k), \gamma_{e01} = 2\bar{i}2\bar{k}(\bar{i}\bar{k}); \gamma_{eE2} = 4\bar{j}(\bar{i}\bar{k}), \gamma_{e02} = 2\bar{i}2k(\bar{i}k),$$

the line above the symbol of  $\Delta$ -element shows that at the given time instant the particle moves in the opposite direction; the symbol  $\xleftrightarrow{\quad}$  implies that the interaction is invertible; index "e" at the  $\gamma$ -particles implies the belonging of this particle to electron; indexes "1" and "2" qualify the structural state of a

particle; the initial state is highlighted by index “0” of  $\gamma_0$ -base; the index “E” shows those particles with the participation of which the electrostatic interaction is realized.

Periodically interacting with its  $\gamma_{e0}$ -base, the  $\gamma_e$ -particles perform the shuttle motions, make the distance between them bigger and form a spherical temporal nimbus around its base. According to that, the  $\gamma_e$ -particles are also called the nimbi. As a result of interaction of  $\gamma_e$ - nimbi with their own  $\gamma_{e0}$ -base (the intrinsic interaction), the intermediate complexes are formed

$$[2j\bar{2i}\bar{2k}, 2j\bar{2i}(k\bar{k})] \quad \text{and} \quad [2j\bar{2i}2k, 2j\bar{2i}(\bar{k}k)], \quad (64)$$

which decay later to  $\gamma_{e1-}$ ,  $\gamma_{e01-}$  and  $\gamma_{eE2-}$ ,  $\gamma_{e02-}$ -particles, respectively.

Because in the state of its intrinsic interaction the electron consists of two  $\gamma_{0i}$ -particles (64), its mass  $m_e$  is doubled according to (45):

$$m_e = \frac{2\xi_m}{H_0} = 2m_0, \quad (65)$$

the radius of transverse circle  $r_e$  caused by the quartet  $2i\bar{2k}$  or  $2i\bar{2}k$  is reduced two times, correspondingly:

$$r_e = \frac{r_c}{2}. \quad (66)$$

In view of the above circumstances, transforming the equation (21) as applied to electron in the form

$$\frac{2\alpha_c 2\pi r_e}{H_0} = \xi_d \quad (67)$$

and multiplying both sides by the coefficient of dimensionality of momentum  $\xi_{mc} = \xi_m \xi_d / \xi_\tau$ , we obtain

$$m_e c \alpha_c r_e = \hbar, \quad (68)$$

where it is denoted

$$\frac{c \xi_m \xi_d}{2\pi} = \frac{\hbar}{2\pi} = \hbar. \quad (69)$$

However, if to determine the mechanical moment in (64) only for the base of electron with the mass  $m_0$  (39), we write the conventional value of spin of electron:

$$m_0 c \alpha_c r_e = \frac{1}{2} \hbar. \quad (70)$$

Because the transversal motion is defined by  $2i\bar{2k}$ - or  $2i\bar{2}k$ -quartets, the projection of spin in an arbitrary direction is equal to  $\frac{1}{2}\hbar$  for  $\gamma_{e01}$ -base ( $S_1$ -state) and  $-\frac{1}{2}\hbar$  for  $\gamma_{e02}$ -base ( $S_2$ -state).

## 7 Electrostatic Interaction. “Charge” as a Property of Matter

The necessary condition for electrostatic interaction of charges is their being in the structural states  $S_1$  and  $S_2$  which allows the motion of  $\gamma_E$ -particles towards the base of partners. The interaction of electron with electron as in the case of intrinsic interaction is carried out through the stage of formation of complexes with the participation of the base and the partners of  $\gamma_E$ - particles:

$$4j(\bar{i}k) + 2i\bar{2}k(\bar{i}k) \xleftrightarrow{\leftarrow} [2j\bar{2i}2k, 2j\bar{2i}(2\bar{k})] \xleftrightarrow{\leftarrow} \xleftrightarrow{\leftarrow} 4j(\bar{i}k) + 2i\bar{2}k(\bar{i}k), \quad (71)$$

$$4j(\bar{i}\bar{k}) + 2i\bar{2}k(\bar{i}\bar{k}) \xleftrightarrow{\leftarrow} [2j\bar{2i}2\bar{k}, 2j\bar{2i}(2\bar{k})] \xleftrightarrow{\leftarrow} \xleftrightarrow{\leftarrow} 4j(\bar{i}\bar{k}) + 2i\bar{2}k(\bar{i}\bar{k}), \quad (72)$$

which after the longitudinal displacement by the value of the potential interaction  $H_{ij}$  along  $\gamma_{eE_1}$ - and  $\gamma_{eE_2}$ -nimbi decay into the original particles.

The initial stage of interaction between the electron and positron which by analogy with the electron is represented in the structural states  $S_1$  and  $S_2$

$$4j(i\bar{k}) + 2i2k(ik) \xleftrightarrow{\leftarrow} 4\bar{j}(ik) + 2i2\bar{k}(i\bar{k}) \quad (73)$$

or at the level of  $\gamma$ -transformations

$$\gamma_{pE1} + \gamma_{p01} \xleftrightarrow{\leftarrow} \gamma_{pE2} + \gamma_{p02} \quad (74)$$

takes place according to the schemes

$$\begin{aligned} \frac{\gamma_{eE1}}{\gamma_{p02}} \xleftrightarrow{\leftarrow} \frac{\gamma_{e\mu1}}{\gamma_{pi2}} \quad \text{or} \quad \frac{4j(i\bar{k})}{2i2\bar{k}(i\bar{k})} \xleftrightarrow{\leftarrow} \frac{2j2i2\bar{k}}{2\bar{j}2i2\bar{k}}, \\ \frac{\gamma_{e01}}{\gamma_{pE2}} \xleftrightarrow{\leftarrow} \frac{\gamma_{ei1}}{\gamma_{p\mu2}} \quad \text{or} \quad \frac{2i2\bar{k}(i\bar{k})}{4\bar{j}(ik)} \xleftrightarrow{\leftarrow} \frac{2j2i2\bar{k}}{2\bar{j}2i2k} \end{aligned} \quad (75)$$

where the indexes “ $e$ ” and “ $p$ ” imply the belonging to electron and positron; the  $\gamma$ -particles from the electron and positron are located in the numerator and the denominator, correspondingly; the symbol  $\xleftrightarrow{\leftarrow}$  shows that the interaction is revertible at the initial stage; the bases of electron and positron in the state of interaction are marked by an additional index “ $i$ ”; the derivative of  $\gamma_E$ -particles is marked by the index “ $\mu$ ”; the numbers 1 and 2 in the indexes denote the structural state of particles:

$$\gamma_{ei1} = 2j2i2\bar{k}, \quad \gamma_{pi2} = 2\bar{j}2i2\bar{k}, \quad \gamma_{e\mu1} = 2j2i2\bar{k}, \quad \gamma_{p\mu2} = 2\bar{j}2i2k.$$

It is seen from the given schemes that as a result of interaction between  $\gamma_E$ -particles with the base of partners, they exchange  $2j$ - and  $(i\bar{k})$ -pairs; and  $2j$ - pairs transit from the numerator (“the world of electron”) to the denominator (“the world of positron”) changing the direction of their motion. In cases when  $2j$ -pairs passed from  $\gamma_E$ -particles into the content of the base of partner are changing their direction to the opposite (the scheme(75)), the bases of charges move toward each other and it is perceived as a mutual attraction of particles. In those cases when  $2j$ -pairs from  $\gamma_E$ -nimbi, being in the content of the base do not change their direction ((71) and (72) schemes) the motion of charges in the opposite directions is observed, which is considered as the mutual repulsion. It should be noted additionally that in the case of attraction of charges, the helicity of their bases (the projection of spin on the direction motion) is positive, and in case of the repulsion, the bases are characterized by the negative helicity.

In the process of interaction of electron and positron, a complex of four  $\gamma$ -particles (positronium) is formed, which decays subsequently into two photons ( $f_{\bar{k}i}$  and  $f_{k\mu}$ ) with the opposite directions of motions:

$$\frac{\gamma_{5i}}{\gamma_{pi}} \cdot \frac{\gamma_{e\mu}}{\gamma_{p\mu}} \rightarrow \frac{\gamma_{5i}}{\gamma_{pi}} + \frac{\gamma_{e\mu}}{\gamma_{p\mu}},$$

where

$$f_{\bar{k}i} = \frac{\gamma_{5i}}{\gamma_{pi}} = \frac{2j2\bar{j}2\bar{k}}{2\bar{j}2i2\bar{k}}; \quad f_{k\mu} = \frac{\gamma_{5\mu}}{\gamma_{p\mu}} = \frac{2j2\bar{j}2k}{2\bar{j}2i2k}, \quad (76)$$

the indexes “ $k$ ” and “ $\bar{k}$ ” with  $f$  (the symbol of photon) show the motion direction of the photon; index “ $i$ ” shows that the photon is formed from the  $\gamma$ -bases of electron and positron; index “ $\mu$ ” denotes the photons formed from the derivatives of  $\gamma_{eE}$ - and  $\gamma_{pE}$ -nimbi, that is, from  $\gamma_{e\mu}$ - and  $\gamma_{p\mu}$ -particles. It is accepted in general that photons are formed from  $\gamma_{ef}$ - and  $\gamma_{pf}$ -particles, that is, from the derivatives of electron and positron.

From the given interactions (71), (72) and (75) it follows that due to its  $\Delta$ -structure it is possible to present the motion of  $\gamma_{5i}$ - and  $\gamma_{pi}$ -base with the equations (17)-(19). Using the equation (19), we will obtain:

$$\frac{H_{is}^2}{H_0 \cdot H_{0s}^2} = \frac{\xi_d}{\alpha_c 2\pi r}. \quad (77)$$

As long as the left side of the equation has the meaning of energy (49), the right side should also have the same meaning. Therefore, if we multiply and divide both sides by the coefficient of dimensionality

$\xi_\varepsilon$  (48), and take into account the definition (49), we obtain the energy of general interaction for unit charges:

$$\varepsilon_{0i} = m_{0i}c^2 = \frac{ch}{\alpha_c 2\pi r}, \tag{78}$$

where  $r$  is denoted with regard to definitions (32) and (40)

$$\xi_\varepsilon \xi_d = ch, \tag{79}$$

and  $r$  is the radius of the circle of the transverse motion of  $\gamma_{e2^-}$  and  $\gamma_{p2^-}$  -bases.

There is the value  $r$  of the transversal pathway length  $\ell$  between the base of charges

$$\ell = \alpha_c 2\pi r \tag{80}$$

it is considered to be the distance of interaction between charges, therefore, by means of (78), the energy of interaction of electron with the electron or electron with the positron (depending on the distance between the bases) is identified.

Because the electrostatic interaction at a distance is caused by the property of matter which is called the “charge” and the interaction itself is realized by the participation of  $\gamma_E$ -particles it is assumed that the charge is caused by the presence of  $\gamma_E$ -particles in physical body, the number of  $\gamma_E$ -particles being emitted per  $t_{0i}$ -intervals becomes the quantitative characteristic of the magnitude of charge. Hence, introducing a new dimensional coefficient  $\xi_q$ , let us estimate the magnitude of charge  $q$  with  $N_q$   $\gamma_E$ -nimbi by the product

$$q = \xi_q N_q, \tag{81}$$

and for the unit charge ( $N_q = 1$ )

$$q = e = \xi_q. \tag{82}$$

If the interacting charges per  $t_{0i}$ -interval emit  $N_q$ - and  $N_{qn}$ -nimbi, respectively, they all interact with the base of partners by turns; thus, let us define the total interaction energy  $\varepsilon_{0i}$  based of the equation (78) by the following equation

$$\varepsilon_{0i} = \frac{N_q N_{qn} ch}{\alpha_c 2\pi r}. \tag{83}$$

Dividing and multiplying the resulting equation by the square of the dimension of charge  $\xi_q^2$ , with the notation (81) we obtain the Coulomb’s law equation:

$$\varepsilon_{0i} = \frac{q \cdot q_n ch}{\alpha_c 2\pi r \xi_q^2} = \frac{q \cdot q_n}{r}, \tag{84}$$

where it is denoted

$$\alpha_c \xi_q^2 = c\hbar, \tag{85}$$

or taking into account the equation (82)

$$\alpha_c e^2 = c\hbar. \tag{86}$$

From this it follows that the constant  $\alpha_c$  obtained from the sum (4) and the notation (7) is equal to the inverse value of fine structure constant  $\alpha$  [10,11] that is

$$\alpha_c = \alpha^{-1}. \tag{87}$$

It should be noted that by writing the interaction energy in the form (84), the constant  $\alpha_c 2\pi$  is included into the value of the conventional charge dimension.

It is generally assumed that the charge interaction at a distance is realized by the electrostatic field which is characterized by the scalar potential  $\varphi_q$  and vector characteristics  $E_q$ . In the ST, no properties ascribed to the space, as analog of the charge field the previously discussed temporal nimbus formed by the shuttling motion of  $\gamma_E$ -particles relative to their bases is taken. Using the equations (77) and (83), the energy of charge interaction  $N_q$  and  $N_{qn}$  is given by equality

$$\frac{N_q N_{qn} H_{ij}^2}{H_0^3} = \frac{N_q N_{qn} \xi_d}{\alpha_c 2\pi r}, \tag{88}$$

and dividing both sides by  $N_{qn}$ , we will obtain the potential of charge field  $N_q$  :

$$\varphi_q = \frac{N_q \cdot H_{ij}^2}{H_0^3} = \frac{N_q \xi_d}{\alpha_c 2\pi r}, \quad (89)$$

where the value of scalar parameter  $H_{ij}^2$  is taken to be equal to the module of vector  $H_{is}^2$ .

Differentiating the equation (89) and taking by turns  $r = const$  and  $N_q = const$ , two vector characteristics of electrostatic field  $E_{qr}$  and  $E_{qs}$  are put forward

$$E_{qr} = \left( \frac{\partial \varphi_q}{\partial \ell} \right)_r = \frac{dN_q}{dS}, \quad (90)$$

where  $dS = 2\pi\alpha r dl$  and  $dl \perp dr$ ;

$$E_{qs} = \left( \frac{\partial \varphi_q}{\partial r} \right)_{N_q} = -\frac{N_q}{2\pi\alpha r^2}. \quad (91)$$

The intensity  $E_{qr}$  is characterized by the  $\gamma_E$ -nimbi flux over the surface covered by the system of charges. The law of conservation of charge is reduced to the conservation of the amount of  $\gamma_E$ -nimbi. If from the volume  $V$  covered with the surface  $S$  the  $N_q \gamma_E$ -nimbi are emitted, then taking into account the equation (90) we will write the Gauss equation

$$\oint_S E_{qr} dS = \oint_V div E_{qr} dV = N_q, \quad (92)$$

from which it follows that the density of  $\gamma$ -bases  $n_q = N_q/V$  emitting the  $\gamma_E$ -nimbi in the given part of the space is defined as

$$div E_{qr} = n_q. \quad (93)$$

If to integrate from 0 to  $4\pi r^2$  the equation (90) in the left side, that is, over the surface of a sphere with the radius  $r$ , we obtain

$$E_{qr} = \frac{N_q}{4\pi r^2}. \quad (94)$$

The intensity  $E_{qs}$  characterizes the change of the potential  $\varphi_q$  depending on the remoteness of  $\gamma_E$ -nimbi from its base. It follows from the equations (91) and (94) that the intensities  $E_{qs}$  and  $E_{qr}$  are the functions of an inverse-square; however, the intensities in equations (90) and (91) have different content.

To summarize, one could conclude that the quantitative criterion of the self-interactions and interactions at a distance with the participation of  $\gamma_E$ -particles is the energy which can be represented as

- the property of matter the "mass", which is defined by various interaction potentials and the corresponding extensivity coefficients  $N_m$ , etc.;

- the property of matter the "charge" as an ability to interact at a distance, which is defined by the corresponding coefficients of extensivity ( $N_q$ ,  $N_{qn}$ , and so on).

These parameters of both variants for the definition of energy are related by the motion equations (17) - (21). Let us show this on an example of the self-interacting electron. By transforming and multiplying both sides of the equation (67) by the coefficient with the dimension of energy (48), in view of formulas (65), (68) and (86), we obtain

$$m_e c^2 = e^2 / r_e \quad (95)$$

where the energy of self-interaction of electron in the left side of the equation is expressed by its mass, and in the right side it is expressed by its charge.

## 8 The Numerical Values of Dimensional Coefficients

By means of fundamental properties of electron, its mass and charge, let us define the numerical values of dimensional coefficients. The value of  $\alpha_c$  is defined by the equation (86). In view of (1), (2), (3) and (8), let us calculate the numerical value of the constant

$$H_0 = \alpha_c \cdot H_c = 4,78 \cdot 10^{22}, \quad (96)$$

with the use of which the numerical value of the dimension coefficient of the mass using the equation (65) is possible to obtain:

$$\xi_m = \frac{m_e H_0}{2} = 2,176 \cdot 10^{-5} gr \quad (97)$$

Starting from equation (32) and representing the Plank constant as

$$h = \frac{\xi_m \xi_d^2}{\xi_\tau} = \xi_m c \xi_d, \quad (98)$$

let us determine the dimensional coefficients of length and time:

$$\xi_d = \frac{h}{\xi_m c} = \frac{2h}{H_0 m_e c} = 1,015 \cdot 10^{-32} cm, \quad (99)$$

$$\xi_\tau = \frac{h}{\xi_m c^2} = \frac{2h}{H_0 m_e c^2} = 3,387 \cdot 10^{-43} s. \quad (100)$$

And, taking into account (27), we obtain

$$\xi_t = \frac{\xi_\tau}{H_0^2} = 1,4827 \cdot 10^{-88} s. \quad (101)$$

From these numerical values it follows that the magnitude  $\xi_m$  coincides with the Plank mass, and the coefficients  $\xi_d$  and  $\xi_\tau$  somewhat different from the Planck length and time values [12]. Recall that the Plank quantities of length, time and mass were introduced on the basis of dimensionalities of constants  $c$ ,  $h$  and gravitation  $G$ ; in our examples the numerical values of dimensional coefficients were introduced by means of the quantities  $c$ ,  $h$ , mass and charge of electron, and also the ST constant  $H_c$ . With their help, the known physical parameters can be calculated with the high accuracy. Thus, using numerical values of  $H_c$ ,  $\xi_d$  (99) and the formula (67) let us calculate the value of  $r_e$ , which is called the classical radius of electron

$$r_e = \frac{H_c \xi_d}{4\pi} = 2,82 \cdot 10^{-13} cm. \quad (102)$$

## 9 The de Broglie Hypothesis and the Heisenberg Uncertainty Principle

Suppose that as a result of any interaction, the  $\gamma_{0i}$ -particle with the potential  $H_i$  is formed. This potential will be revealed by the transversal path  $\lambda$ , and the lesser is the value of the path than  $\lambda$ , the higher is the indeterminacy of revealing the  $H_i$  potential. Dividing the transversal path  $\lambda$  by  $\chi$  and multiplying the momentum  $mv = m_i c = P$  by the same quantity, from the equation (42) we obtain

$$\Delta l \cdot \Delta P = h, \quad (103)$$

where  $\Delta l = \lambda/\chi$ ,  $\Delta P = \chi P$ ;  $\chi$  takes the values from zero to one.

If the experimental criteria of the realization of  $H_i$  potential is the value of the traveled distance  $\Delta l$ , based on the equation (103) the following can be stated: the lesser is the value of the realized path  $\Delta l$ , the greater is the uncertainty of the revealing of momentum, and, therefore, the higher is the uncertainty of identification of particle with the given momentum.

The travelled path  $\lambda$  and the complete identification of particle with the momentum  $P$  corresponds to the condition  $\chi = 1$ . Therefore, the value  $\lambda$  is characterized as the identification path or the revealing of particle consistency.

In the first of the equation (38), replacing  $\lambda$  by  $c\tau_i$ , we obtain  $m_i c^2 \tau_i = \varepsilon_i \tau_i = h$ , and by means of  $\Delta t = \tau_i/\chi$  and  $\Delta \varepsilon = \chi \varepsilon_i$ , we obtain

$$\Delta t \cdot \Delta \varepsilon = h, \quad (104)$$

from which it follows that to identify the particle with the energy  $\varepsilon_i$  there is a need to realize the motion during time  $\tau_i$ . The lower is the value  $\Delta t$  than  $\tau_i$ , the higher is the uncertainty of identification of particle

with the energy  $\varepsilon_i$ . It should be emphasized that it does not follow from the equation (104) that some material bodies may have the very high values of energy during very small time intervals.

The fact of realization of  $\lambda$  path is possible to determine with the use of the principle of least action:

$$\delta \int P dl = \delta \int m v dl = 0. \quad (105)$$

Integrating the equation (105) from 0 to  $\lambda$ , and taking into account the equation (42), we obtain

$$\delta(mv\lambda) = \delta h = 0, \quad (106)$$

that is, the variation of constants is equal to zero.

The same result is obtained from

$$\delta \int \varepsilon dt = 0, \quad (107)$$

when picking up the limits of integration in the interval  $0 - \tau_i$ .

From the equations (105) and (107) it follows that the minimum path and time intervals should be equal to  $\lambda$  and  $\tau_i$  or their multiples for the deterministic description of phenomena in the terms of classical mechanics

## 10 The Quantization of Parameters of Motion. Quantum Numbers

With use of notion (9), and replacing the variable  $H_i$  by  $H_c/n$  in the equations (17), (18), (34), (42) and (53) and carrying out some transformations, we obtain

$$\lambda = \frac{1}{2}n \cdot \alpha_c^2 H_c \xi_d, \quad (108)$$

$$2\pi r_n = \frac{1}{2}n^2 \cdot \alpha_c^2 H_c \xi_d, \quad (109)$$

$$2\pi r_n = n\lambda, \quad (110)$$

$$v_n = \frac{c}{n\alpha_c + 1} \approx \frac{c}{n\alpha_c}, \quad (111)$$

$$mvr_n = n\hbar, \quad (112)$$

$$\varepsilon_n = \frac{m_e c^2}{2n\alpha_c(n\alpha_c + 1)} \approx \frac{m_e c^2}{2n^2\alpha_c^2} = \frac{m_e e^4}{2n^2\hbar^2}, \quad (113)$$

where the relations (65), (66) and (86) are used; the quantum parameters are marked by the index “ $n$ ”; in the equations (111) and (113) an additional condition  $n\alpha_c \gg 1$  is met.

Based on the fact that the electrostatic interactions of proton with electrons, as well as positron with the electron is carried out according to the (75) with the participation of the same  $\gamma_{pE}$ -particles one may conclude that the given equations with the principal quantum number  $n$  coincide with the equations of quantum mechanics for the description of electron in the atom of hydrogen. From the above, it follows the most important that the Bohr orbits (109) are the trajectories of the transversal component of electron.

Thus, quantum mechanics, penetrating deep into the structure of matter operates by the quantities of the path and time comparable or multiple of the intrinsic metric parameters of particles (25) and (26), and the parameter  $\lambda$  being not the wavelength but the real path of the transversal component of motion of electron.

In case of the absorption of photons by the hydrogen atom, a new partners appear with which the electron exchanges the  $\Delta$ -pairs, thus, the orbit of electron is formed not only by its own  $2i$ - and  $2k$ -pairs, but also by the foreign  $\Delta_{kf}$ - and  $\Delta_j$ -pairs ( $f$  with the index  $\Delta$  denotes the foreign origin of  $\Delta_k$ -pair) whereby the transversal path for identification  $\lambda$  is determined by the sum

$$\lambda = \lambda_i + \lambda_k + \lambda_{kf} + \lambda_j, \quad (114)$$



and the length of the closed transverse path  $L_n$  is represented as

$$L_n = n\lambda = n(\lambda_i + \lambda_k + \lambda_{kf} + \lambda_j), \quad (115)$$

or, considering the formulas (9), (17) and (66)

$$L_n = \frac{1}{2}n(n_i + n_k + n_{kf} + n_j) \cdot \alpha_c^2 H_c \xi_d, \quad (116)$$

where:

$$n = n_i + n_k + n_{kf} + n_j, \quad (117)$$

$$\lambda_i = \frac{1}{2}n_i\alpha_c^2 H_c \xi_d, \quad \lambda_k = \frac{1}{2}n_k\alpha_c^2 H_c \xi_d, \quad (118)$$

$$\lambda_{kf} = \frac{1}{2}n_{kf}\alpha_c^2 H_c \xi_d, \quad \lambda_j = \frac{1}{2}n_j\alpha_c^2 H_c \xi_d.$$

As the paths  $\lambda_i$  and  $\lambda_k$  are formed by means of their intrinsic 2i- and 2k-pairs,  $\lambda_{kf}$  and  $\lambda_j$  are formed by means of foreign pairs, the  $n_i$  and  $n_k$  are called the proper quantum numbers, the  $n_{kf}$  and  $n_j$  are called the foreign quantum numbers. Based on the equality of the magnitudes of initial potentials  $H_{0i}$  and  $H_{0k}$ , the following condition is always met

$$n_i = n_k, \quad (119)$$

For any orbit the presence of minimal values, or

$$n_i + n_k = 1 \quad (120)$$

is the mandatory requirement because this condition is the criteria of the identity for the considered  $e^- - p^+$  pair with its own partner.

From the equations (117) and (120) it follows that the sum of foreign quantum numbers

$$\ell = n_{kf} + n_j \quad (121)$$

is an integer from zero to  $n - 1$ , and indicates the amount of foreign partners with the participation of which the trajectory of transversal path is formed.

According to the definition (121), the given value  $\ell$  can be reached by the following set of  $n_{kf}$  and  $n_j$

$$n_{kf} = \ell, (\ell - 0, 5), \dots, \ell/2, \dots, 0, 5, \quad 0 \quad (122)$$

$$n_j = 0, \quad 0, 5, \quad \dots, \ell/2, \dots, (\ell - 0, 5), \ell, \quad (123)$$

$$m_\ell = \ell, (\ell - 1), \quad \dots, \quad 0, \dots, -(\ell - 1), -\ell, \quad (124)$$

where the value  $m_\ell$  is defined by the difference

$$m_\ell = n_{kf} - n_j \quad (125)$$

and according to (122) and (123) it takes the following values:  $0, \pm 1, \pm 2, \dots, \pm \ell$ .

It is obvious that  $\ell$  and  $m_\ell$  defined by the formulas (121) and (125) correspond to the azimuthal and magnetic quantum numbers. The difference (125) determines the orientation of orbits of electron in space: in the case of  $n_j = 0$  and  $n_{kf} = 0$  we have the circles; in the case of  $n_j = 0, n_{kf} > 0$  - ellipses, and in the case of  $n_{kf} > 0$  and  $n_j > 0$  we have the precessing orbits.

The quantum numbers  $n_i, n_k, n_{kf}$  and  $n_j$  are related to the interaction potentials along three mutually orthogonal directions, that is, with the potentials 2i-, 2k-, 2kf- and 2j-pairs, and with the equality (119) they may not only substitute the quantum numbers  $n, \ell$  and  $m_\ell$  but give them an additional content. In the group with the principal quantum number  $n$ , the sum of intrinsic and foreign quantum

numbers (117) determines the maximal possible amount of interaction partners. The sum of foreign quantum numbers (121) determines the amount of foreign partners in the subgroup with the azimuthal quantum number; and the minimum value of  $\ell$ , that is, the condition  $\ell=0$ , indicates that this group is formed with then-fold participation of intrinsic interaction partners; the maximal value of  $\ell$ , that is, the condition  $\ell = n - 1$  corresponds to the single participation of intrinsic partners in the process of formation of given group.

With the use of equation (125), the magnetic quantum number  $m_e$  is defined, which, according to (124), takes  $2l + 1$  values that correspond to the number of variants for filling the subgroup with the given numbers  $m_\ell$ , thus, the group with the quantum number  $n$  can be realized by

$$\sum_{\ell=0}^{n-1} (2\ell + 1) = n^2 \quad (126)$$

variants. The total number of ways to fill all the groups may be defined with the following sum

$$\sum_{n=1}^n n^2 = \sum_{n=1}^n \sum_{l=0}^{n-1} (2l + 1) \quad (127)$$

It is well known that the quantum numbers are used not only for the classification of the spectrum of hydrogen atoms, but also for the description of many-electron atoms and atomic nucleus (the shell core theory). After summing of (127) in the range from 1 to 7, we obtain the number 140 which is the key parameter for modeling of  $\Delta$ -elements and  $\Delta$ -pairs from the  $\varepsilon$ -particles. According to (7) and (87), the same number is the basis to obtain the fine structure constant.

It follows from the foregoing that the quantum numbers become the universal regulators for structure formation of systems with the various hierarchy levels. Moreover, the interpretation, given above, has the generality and can be applied to any system of macro- and microcosm.

## 11 The Free Energy Pairs and the Magnetic Interaction

According to the scheme (76), two photons with the opposite directions of motion are formed as a result of annihilation of slow electron and positron. Each photon consists of two  $\gamma_{0i}$ -particles; in the numerator and the denominator there are the  $\Delta$ -pairs with the same motion direction which determine the longitudinal direction of motion of photon. The binary  $\gamma_{0i}$ -particles of  $\Delta$ -structure are called the  $\gamma$ -energy pairs or  $\gamma_\varepsilon$ -pairs, and this is indicated by the index “ $\varepsilon$ ”. The  $\gamma_\varepsilon$ -pairs are formed not only as a result of annihilation but also due to the many other processes. Practically, all chemical and nuclear transformations and phase transitions occur with the participation of  $\gamma_\varepsilon$ -pairs; and the  $\gamma_\varepsilon$ -pairs being both absorbed and radiated as photons (the emission) and exchanged between the various systems by the direct contact. In many processes, the essence of energy exchange is reduced to the exchange of  $\gamma_\varepsilon$ -energy pairs; the exchange of energy pairs is carried out by means of mechanical work, the supply or removal of heat, photon absorption or emission, etc. In such cases, the energy conservation law, as a rule, is reduced to the conservation of the quantity and the potential of  $\gamma_\varepsilon$ -pairs.

Frequently, the physical base for the formation  $\gamma_\varepsilon$ -pairs is the principle of generalization, the essence of which we will consider on an example of the synthesis of hydrogen molecule  $H_2$  from the separate atoms of  $H$ . At the modeling of the bound systems in the ST, the  $\gamma$ -particles in two  $t_I$  and  $t_{II}$  temporal states are used and they are differing in that their  $\Delta$ -elements have the opposite directions of motion at one and same time. Besides, in the  $t_I$  state the beginning of the  $\gamma_{eE}$ - and  $\gamma_{pE}$ -nimbi in the  $t_{II}$  state corresponds to the beginning of the return of these nimbi from their maximal distance to their bases. Depending on the temporal state, the  $\gamma$ -particles are additionally supplied by the indexes “ $I$ ” or “ $II$ ”:  $e_I^-$ ,  $e_{II}^-$ ,  $\gamma_{eEI}$ ,  $\gamma_{eEII}$ ,  $e_I^+$ ,  $e_{II}^+$ ,  $\gamma_{pEI}$ ,  $\gamma_{pEII}$ , and so on.

Let us represent the interaction of hydrogen atoms in states  $t_I$  and  $t_{II}$  in the following way

$$\begin{aligned} & \left( \frac{e_{iI}}{\gamma_{p\mu I}}, \frac{\bar{\gamma}_{e\mu I}}{P_{iI}} \right) + \left( \frac{e_{iII}}{\gamma_{p\mu II}} + \frac{\bar{\gamma}_{e\mu II}}{P_{iII}} \right) = \\ & = (e_{iI}, P_{iI}) + (P_{0II}, \bar{\gamma}_{eEII} + P_{0II}, \bar{\gamma}_{p\mu II}) + \frac{\gamma_{ef}}{\gamma_{pf}}, \end{aligned} \quad (128)$$

where the line over the symbol  $\gamma_\mu$  means that the particle moves in the opposite direction; the  $e_0$  and  $e_i$ ,  $P_0$  and  $P_i$  are the bases for  $e^-$  and  $p^+$  in the states of “rest” and interaction.

According to the definition of temporal state, the  $\gamma_{p\mu I^-}$  and  $\bar{\gamma}_{p\mu II}$ -particles move simultaneously towards the  $e_{iII}$  base being the incoming for it, the  $\gamma_{e\mu I}$  and  $\bar{\gamma}_{e\mu II}$  just as like are the incoming for the  $P_{iII}$ . The resulting excess of particles is released by the system in the form of the free energy pair:

$$\frac{\gamma_{ef}}{\gamma_{pf}} = \frac{2j\bar{2}i2k}{2\bar{j}2\bar{i}2k}, \quad (129)$$

$e^-$  and  $p^-$ -bases of  $H_I$  and  $H_{II}$  atoms being bound by the same  $\gamma_{eE^-}$  and  $\gamma_{pE^-}$ -particles and are characterized by the mutually transforming states

$$\begin{aligned} & (e_{0II}, \gamma_{eEII} + P_{0II}, \gamma_{pEII}) + (e_{iI}, P_{iI}) \Leftrightarrow \\ & \Leftrightarrow (e_{0I}, \gamma_{eEI}, P_{0I}, \gamma_{pEI}) + (e_{iII}, P_{iII}), \end{aligned} \quad (130)$$

Thus, the mechanism of origination of bound systems (nuclei, molecules, liquids, solid states, etc.) is that due to the removal of the own  $\gamma_{E\mu^-}$ -particles from the initial system in the form of a free  $\gamma$ -energy pair, the bases  $e_I^-$  and  $e_{II}^-$  have one mutual  $\gamma_{eE^-}$ -particle, just as like the bases  $P_I^+$  and  $P_{II}^+$  have the mutual  $\gamma_{pE^-}$  particle. Hence the name the “principle of generalization”, the creation of a bound system with use of the common bonding  $\gamma_{E^-}$ -particles. Free  $\gamma_\varepsilon$ -pairs interact with the  $[\gamma_{e\mu}(p^+ - e^-)\gamma_{pM}]$  elements of atoms and molecules according to the scheme

$$\frac{e_i}{\gamma_{p\mu}} + \frac{\gamma_{e\mu}}{p_i} + \frac{\gamma_{ef}}{\gamma_{pf}} \rightleftharpoons \beta_{0\mu} + \beta_\mu, \quad (131)$$

where the following pairs

$$\beta_{0\mu} = \frac{e_0}{P_0} \quad (132)$$

consist of the bases  $e^-$  and  $p^+$  at rest,

$$\beta_\mu = \frac{\gamma_{eE}}{\gamma_{pE}} \quad (133)$$

are doublets from the bases  $\gamma_e$  and  $\gamma_p$ -particles, executing the shuttle motion relative to the  $\beta_{0\mu}$ -centers.

It is supposed that just with the participation of  $\beta_\mu$ -particles the magnetic interaction with  $\beta_{0\mu}$ -centers of partners is realized.

Because of the binarity of  $\beta_\mu$ -particles, the strength of the magnetic interaction is doubled also, and in the equations of motion the potential  $H_i$  of  $\gamma_\varepsilon$ -pairs is taken as a base and not the potential  $H_0$  as in the case of electrostatic interaction, because just  $\gamma_{ef}$  - and  $\gamma_{pf}$ -particles are the base for formation of  $\beta_\mu$ -particles. In view of the noted above, the equation (17) can be rewritten in the form

$$\lambda_{i\mu} \cdot H_{i\mu}^2 = H_{i\mu} \cdot H_{is}^2 \xi_d, \quad (134)$$

where by the use of an additional index “ $\mu$ ” we emphasize that the magnetic interaction is considered. By multiplying the both sides of the given equation by  $n\alpha_c$  and dividing it by  $r \cdot H_0^2$ , and taking into account equations (10), (17) and (19), we obtain

$$\frac{H_{i\mu}^2}{rH_0^2} = \frac{H_0 H_{is}^2 \xi_d}{\alpha_c 2\pi r^2 \cdot H_0^2}, \quad (135)$$

where after elementary transformations follows the well-known equation for the strength  $F_\mu$  of the magnetic interaction between the moving charges:

$$F_\mu = \frac{2m_0 v_\mu^2}{r} = \frac{\xi_\varepsilon \xi_d v^2}{\alpha_c 2\pi r^2 c^2} = \frac{2e^2 v^2}{c^2 r^2}, \quad (136)$$

where according to (34), (39), (79) and (86) are designated

$$v_\mu = \frac{H_{i\mu}}{H_0} c; \quad v = \frac{H_i}{H_c} c; \quad m_0 = \frac{\xi_m}{H_0}; \quad e^2 = \frac{c\hbar}{\alpha_c} = \frac{\xi_\varepsilon \xi_d}{2\pi\alpha_c}.$$

Thus, between the particles the magnetic interaction is carried out with the participation of  $\beta_\mu$ -particles which are formed as a result of interaction of bases of charges in the state of interaction with the foreign  $\gamma_\varepsilon$ -pairs. In general, many of the properties of physical bodies (optical, thermal, magnetic, etc.) are also defined by the specifics of its interaction with the  $\gamma_\varepsilon$ -pairs from the outside.

## 12 The Electric Current and the Properties of Magnetic Field

The electric current, as a rule, is associated with the regular motion of charges in the given direction. However, despite the fact how these free charges were obtained, they are always represented as complexes with the free  $\gamma$ -energy pairs; thus, the electric current is also based on the organized motion of  $\gamma_\varepsilon$ -pairs. Such a characterization of the electric current is mostly interesting in cases when the conductors are the solid states in which it is impossible to imagine the regular motion of charged particles, all the more, in opposite directions.

The formation of solid state is determined by the spatial generalization (§ 10) with the participation of  $\gamma'_{p\mu}(e_i - p_i)\gamma'_{5\mu}$  -elements (which will be called the s-groups) a number of which will remain not generalized. The transfer of  $\gamma_\varepsilon$ -pairs in solid medium is realized through the stage of interaction with the not generalized s-groups like in the scheme (131), therefore, the greater is the number of s-groups in solid state, the higher is the conductivity. Thus, the atoms of the majority of metals have several s-groups with the participation of valent electron from  $s-$ ,  $p-$ ,  $d-$  and  $f-$  subgroups; after transition into the solid state, most of the s-groups remain not generalized, which explains the high conductivity of metals. The dielectrics, which practically do not have the s-groups have a vanishing conductivity. On the whole, the conductivity of solid states is characterized by a coefficient  $\chi_T$  which is defined in the following way

$$\Delta N_\mu = \chi_T N_\mu, \quad (137)$$

where  $N_\mu$  is an amount of carried  $\gamma_\varepsilon$ -pairs through a particular volume of the conductor with the length  $\Delta\ell$  and the cross section  $S$ ; the  $\Delta N_\mu$  is the difference of quantity of  $\gamma_\varepsilon$ -pairs relative to the length  $\Delta\ell$ .

From the equation (137) it follows that the system does not possess the conductivity at  $\chi_T=0$ , and at  $\chi_T=1$  the system becomes the ideal conductor.

If we divide both sides of the equation (137) by the length of conductor element  $\Delta\ell$ , then multiplying and dividing its right side by  $\Delta t$ , that is, by the time interval of traveled path  $\Delta\ell$ , we obtain

$$\frac{\Delta N_\mu}{\Delta\ell} = \frac{\chi_T \Delta t N_\mu}{\Delta\ell \Delta t}, \quad (138)$$

from which, assuming the correspondences

$$U = \frac{\Delta N_\mu}{\Delta\ell}; \quad R = \frac{\chi_T \Delta t}{\Delta\ell} \quad \text{and} \quad I = \frac{N_\mu}{\Delta t} \quad (139)$$

the Ohm's law equation is following, which relates the voltage  $U$  with the resistance  $R$  and current  $I$ :

$$U = RI. \quad (140)$$

Dividing the both sides of the equation (138) by  $\Delta\ell$ , and multiplying and dividing the right side by the cross section  $S$  of the conductor, we relate the electric field intensity  $E$  with the current density  $j$ , and the specific conductance  $\rho$  and resistance  $R$  with the geometrical parameters of the conductor:

$$E = \frac{\Delta N_\mu}{\Delta\ell^2} = \frac{\chi_T \Delta t \cdot N_\mu \cdot S}{\Delta\ell^2 \Delta t \cdot S} = \rho \cdot j, \quad (141)$$

where taking into account the formulas (139) and (140), we obtain

$$E = \frac{U}{\Delta\ell}; \quad j = \frac{N_\mu}{\Delta t \cdot S}; \quad \rho = \frac{\chi_T \cdot \Delta t \cdot S}{\Delta\ell^2}; \quad R = \frac{\rho \Delta\ell}{S}. \quad (142)$$

Defining the density of  $\gamma$ -energy pairs by the relation

$$n_\mu = \frac{N_\mu}{S \Delta\ell}, \quad (143)$$

using the notation  $j$  (142) and suggesting the conductivity  $\sigma$  equal to the reciprocal value of specific conductance, from (141) it follows

$$j = \sigma E = n_\mu \cdot v, \quad (144)$$

where  $v = \Delta\ell/\Delta t$  is the velocity of motion of  $\gamma_{0i}$ -elements in the conductor.

Therefore, accepting the current in conductors as a stream of  $\gamma$ -energy pairs, we obtain all characteristic equations of this phenomenon; moreover, the principal parameters have more simple dimensionalities, and a clear content.

At a distance, the magnetic interaction originates according to the following scheme

$$\left(\frac{\gamma_0}{P_0}\right)_\mu + \left(\frac{\gamma_{eE}}{\gamma_{pE}}\right)_\mu \longleftrightarrow \left(\frac{e_i}{P_i}\right)_\mu + \left(\frac{\gamma_{e\mu}}{\gamma_{p\mu}}\right)_\mu, \quad (145)$$

from which it follows that the binary  $\beta_\mu$ -particles (133) interacting with the  $\beta_{0\mu}$ -centers (132) of their partners are exchanging the  $\Delta$ -pairs, and depending on the  $\Delta$ -content of newly originated particles, their trajectories are formed. In cases when the magnetic field is formed by the electric current, that is, by the regular transfer of  $\gamma_\varepsilon$ -pairs, the concomitant shuttling motion of  $\beta_\mu$ -particles is also organized, which interacting with the test bodies reproduce the rate of orderliness of its source. In particular, the change of the  $\beta_\mu$ -particle stream in a probe circuit induces the same organized transfer of  $\gamma_\varepsilon$ -pairs, that is, the electric current.

As in the case of electrostatic interaction, no properties are attributed to the space to describe the magnetic interaction. Because the magnetic interaction is realized by the participation of  $\beta_\mu$ -nimbi, the part of space accessible to the  $\beta_\mu$ -nimbi is called the magnetic field, the particles of the magnetic field being the  $\beta_\mu$ -nimbi themselves. By definition of characteristics of magnetic field one starts with the regularities of motion of the test bodies that are described by the equation (14). Thus, the equation (14) may become the key for definition of magnetic field properties. As the equation (14) corresponds to the volume, by multiplying both sides by the density of conductive centers  $n_\mu$ , we obtain the amount of conductive centers  $N_\mu$  in the trajectorial volume  $V_t$ :

$$\oint_L \varphi_\mu dl = \oint_{dS} \text{curl} \varphi_\mu dS = N_\mu, \quad (146)$$

where

$$\varphi_\mu = n_\mu \cdot H_{i\mu}^2 = \frac{N_\mu}{V_t} \cdot H_{i\mu}^2. \quad (147)$$

The volume of the trajectory

$$V_t = L_r \cdot H_{i\mu}^2 \quad (148)$$

is defined by the circulation of the axial vector  $H_{i\mu}^2$  along the transverse path:

$$L_r = \beta^{-1} \alpha_c 2\pi r, \quad (149)$$

The appearance of the coefficient

$$\beta = \frac{H_{iS}^2}{H_{0S}^2} c^2 = \frac{v^2}{c^2}, \quad (150)$$

as it has been shown in the equations (134)-(136), is based on the fact that the formation of  $\beta_\mu$ -particles and  $\beta_{0\mu}$ -centers is carried out with the participation of  $\gamma_\varepsilon$ -pairs with the potential  $H_{iS}^2$ , i.e., as a result of transformation of equation (19) into the following equation

$$\alpha_c 2\pi r H_{i\mu}^2 = H_0 \cdot H_{iS}^2 = \beta H_0^3 \quad (151)$$

Let the electric current induced in the test contour is characterized by the transfer of  $\gamma_\varepsilon$ -pairs of  $\Delta$ -content  $f_{k\mu}$  (76), that is, the transfer is caused by the  $2\Delta_k$ -pairs. In this case, in view of the method to determine the transversal displacement (15), we obtain

$$\text{curl} H_{i\mu}^2 = H_{ik} \xi_d = \ell_{ik} = \Delta \ell_k \quad (152)$$

According to the first formula of the equation (31), the longitudinal path  $\ell_{ik}$  is defined by equality

$$\ell_{ik} = ct_i \quad \text{or} \quad d\ell_k = cdt_{1i}, \quad (153)$$

and, in the process of motion, the  $\gamma_\varepsilon$ -pairs intersect the surface

$$S_k = L_r \times \Delta r_{ij}, \quad (154)$$

the trajectorial volume is given by the mixed product of three vectors

$$V_t = \Delta \ell_k \cdot [L_r \times \Delta r_{ij}] = \Delta \ell_k \cdot S_k \quad (155)$$

Therefore, the density  $n_\mu$  is defined by the formula

$$n_\mu = \frac{N_\mu}{L_r \Delta \ell_k \Delta r_{ij}}, \quad (156)$$

where

$$\begin{aligned} r &= r_i + r_j, \quad \Delta r_{ij} = \Delta r_i + \Delta r_j, \\ \Delta r_{ij} &\perp \Delta \ell_k, \quad |\Delta r_{ij}| = |\Delta \ell_k|. \end{aligned} \quad (157)$$

The index “ $k$ ” denotes the direction of the surface orientation  $S_k$ , symbol “ $\times$ ” implies the vector product of vectors.

With regard to the formulas (147), (148), (151) and (152), let us present axial vector  $\varphi_\mu$  and vector  $\text{curl} \varphi_\mu$  as the following relation

$$\varphi_\mu = \frac{N_\mu}{L_r} = \frac{N_\mu \cdot H_{i\mu}^2}{H_0^3}, \quad (158)$$

$$\text{curl} \varphi_\mu = \frac{N_\mu}{L_r \Delta r_{ij}} = \frac{N_\mu}{S_k} \quad (159)$$

Denoting

$$B_k = \text{curl} \varphi_\mu, \quad (160)$$

the equation (146) is represented as

$$\int \varphi_\mu d\ell = \int B_k dS_k = N_\mu, \quad (161)$$

from which it also follows

$$B_k dS_k = dN_\mu, \quad (162)$$

where index “ $k$ ” near  $B$  means the direction of the vector.

Because the axial vector  $\varphi_\mu$  has the base of definition of energy (77), (78), it, as well as the vector  $B_k$ , may be used as a potential and the vector characteristics of magnetic field. From the definition (158) it follows that the module of the potential  $\varphi_\mu$  is the linear density of the quantity  $N_\mu$  relative to the transversal path  $L_r$ , the module of the vector  $B_k$  (159) and (160) is the surface density of  $N_\mu$  relative to the surface  $S_k$ .

As follows from equation (158), any change of magnetic field, independently of the way how it was made, results in the changes of the principal variables  $\varphi_\mu$ : the distance  $L_r$  and the amount  $N_\mu$  of  $\beta_\mu$ -particles. Thus, assuming the change of the number of  $\beta_\mu$ -particles equal to the changes of the magnetic field flux  $\Phi$ , with regard to the equation (162), the electromotive force  $\mathcal{E}$  can be represented in the following way

$$\begin{aligned} \mathcal{E} &= -\frac{1}{c} \frac{d\Phi}{dt} = -\frac{1}{c} \frac{dN_\mu}{dt} = \\ &= -\frac{1}{c} \frac{\partial}{\partial t} \int B_k dS = -\int \frac{1}{c} \frac{\partial B_k}{\partial t} dS. \end{aligned} \quad (163)$$

Based on the equations (139), (141), (153) and the Stokes equation, we obtain

$$U = \frac{dN_\mu}{d\ell} = \frac{dN_\mu}{c dt} = \int_{L_2} E_{\mu k} d\ell = \oint_{S_k} \text{curl} E_{\mu k} dS \quad (164)$$

By comparing equations (163) and (164), we obtain the equation as follows

$$\text{curl} E_{\mu k} = -\frac{1}{c} \frac{\partial B_k}{\partial t} \quad (165)$$

and the equivalence of the parameters  $\mathcal{E}$  and  $U$  as well.

From the definition of potential (158), it follows that the change of  $\varphi_{i\mu}$  on  $H_{i\mu}^2$  is adequate to the change of  $\varphi_\mu$  on length  $L_r$  thus, it is necessary to take into account that the parameter  $H_{i\mu}^2$  of separately taken  $\gamma_\varepsilon$ -pairs depends not only on the length  $L_r$  (that is, on  $r$ ), but also on the value of the traveled part  $\ell_k$  along the displacement. With this in mind, and taking conditions (157), twice differentiating successively  $\varphi_\mu$  (158), we obtain.

$$B = \text{curl} \varphi_\mu = \frac{dN_\mu}{L_r dr_{ij}} - \frac{N_\mu}{\beta^{-1} \alpha_c 2\pi r^2} = B_k + B_r, \quad (166)$$

$$\text{curl} B = \frac{dN_\mu}{L_r dr_{ij} d\ell_k} - \frac{N_\mu}{\beta^{-1} \alpha_c 2\pi r^2 d\ell_k} \quad (167)$$

Considering the formula (139), (142), (153), (154) and denoting

$$B_k = \frac{dN_\mu}{L_r dr_{ij}} = \frac{1}{c} \frac{dN_\mu}{L_r dt} = \frac{I}{c L_r}, \quad (168)$$

$$B_k = \frac{dN_\mu}{dS_k} = E_{\mu k}, \quad (169)$$

$$B_r = -\frac{N_\mu}{\beta^{-1} \alpha_c 2\pi r^2} = E_{\mu r} \quad (170)$$

$$\frac{dN_\mu}{L_r dr_{ij} d\ell_k} = \frac{1}{c} \frac{dN_\mu}{dS_k dt} = \frac{1}{c} j \quad (171)$$

the equation (167) may be represented as

$$\text{curl} B = \frac{1}{c} \frac{dE_{\mu r}}{dt} + \frac{1}{c} j \quad (172)$$

and at  $j = 0$ , it follows

$$\text{curl} B = \frac{1}{c} \frac{dE_{\mu r}}{dt} \quad (173)$$

The vector  $B_k$  (168)-(169) in the right side of the equation (166) is related to the changes of the amount of  $\gamma_\varepsilon$ -pairs, the vector  $B_r$  is related to the change of the potential  $H_{i\mu}^2$ , and in the equation (167) the mentioned changes being considered depending on the parameters of both the transversal ( $dr$ ) and the longitudinal ( $d\ell_k$ ) motions. In case of two wires interacting with the current, each  $\beta_\mu$ -particle interacts with the all  $\beta_{0\mu}$ -centers of partners, therefore, the interaction force of the wires  $F_{\mu r}$  at the distance  $L_r$  we define by the product

$$F_{\mu r} = B_k N_{\mu n} = \frac{I \cdot N_{\mu n}}{c L_r}, \quad (174)$$

where  $N_{\mu n}$  is the amount of  $B_{0\mu}$ -centers in trajectorial volume of the probe conductor;  $B_k$  is the field strength (168).

By dividing and multiplying the numerator and denominator of the equation (174) by the velocity  $c$ , we obtain the Ampere equation, that is, the interaction force per unit length of the conductor:

$$F_{eq} = \frac{2I \cdot I_n}{c^2 L_r}, \quad (175)$$

where the formulas (139) are used and

$$N_{\mu n} \cdot c = I_n \Delta \ell_k.$$

It follows from the comparing (89), (90), (91), (158), (168) and (170) that the main parameters of description of electrostatic interaction ( $\varphi_q$ ,  $E_{qr}$ ,  $E_{qs}$ ) are differing from the parameters of magnetic field ( $\varphi_\mu$ ,  $B_r$ ,  $B_K$ ) as the parameters of magnetic field have the coefficient  $\beta = v^2/c^2$ ; therefore at  $\beta = 0$ , that is, in the absence of interaction of  $s$ -group of the medium with the foreign  $\gamma_\varepsilon$ -pairs, there is no magnetic field.

The mathematical criteria of the distinction of mentioned fields are the conditions

$$\text{curl} E_{qr} = 0, \quad \text{and} \quad \text{div} E_{\mu k} = 0 \quad (176)$$

which are followed by representing the given formulas with use of the nabla operator:

$$\nabla = \frac{\partial}{\partial x} e_x + \frac{\partial}{\partial y} e_y + \frac{\partial}{\partial z} e_z,$$

$$\text{div} E_{\mu k} = \nabla \cdot \nabla \times E_{\mu k} = \nabla \cdot \nabla \cdot \nabla \times \varphi_\mu = 0, \quad (177)$$

$$\text{curl} E_{qr} = \nabla \times \nabla \cdot \varphi_q = 0, \quad (178)$$

because  $\nabla \times \nabla = 0$ ,

It is supposed that according to the condition  $\text{div} E_{\mu K} = 0$ , the magnetic field lines are curved and closed with no beginning and no end. Obviously, these lines are the demonstrations of the closed curved trajectories of the transverse component of motion.

The equations (165), (172), (173) and (176) represent the group of Maxwell's equations describing the main regularities of electrodynamics. It should be noted that in this work the denoted equations are obtained by means of potentials  $\varphi_q$  and  $\varphi_\mu$  which are the derivatives of the characteristic variables of motion equations (19) and (151). Thereby, the scalar and vector characteristics of electrostatic and magnet fields put forward from the empiric equations (such as the Coulomb or Ampere equations), cease to be the essence of mathematical research tools and they obtain the clear physical contents related to the mechanisms of phenomena under consideration.

It should be emphasized that if the electron and positron are modeled as the formation of a single of  $\gamma_0$ - and  $\gamma_E$ - particles (that is, the particles of electrostatic field are prescribed from the very beginning), then the  $\beta_\mu$ -particles of magnetic field have the derivative origins, there is no physical body with the initially prescribed particles of magnetic field, that is, there is no Dirac monopoles in the Nature.

### 13 The Basic Concepts and Laws of Thermodynamics

In the case of absence of regular transfer of foreign  $\gamma$ -energy pairs in the form of electric current, the magnetic interaction leads to the repulsion of particles of the medium by the force described by the formula (136). It is supposed that the heat motion is based on the forces of magnetic repulsion, and the process is identified with the input or the removal of foreign  $\gamma$ -energy pairs. The balance of heat energy of a particular system is estimated by the amount  $N_T$  of input  $\gamma$ -energy pairs and their potential  $H_T^2$ , respectively, thus, the change in the energy balance is represented by the equation

$$d(N_T H_T^2) = N_T dH_T^2 + H_T^2 dN_T \quad (179)$$

from which the basic equation of heat phenomena is derived when the equality (151) is taken into account

$$\frac{dN_T H_T^2}{N_T H_T^2} = \frac{dH_{i\mu}^2}{H_{i\mu}^2} + \frac{dr_{T\mu}}{r_{T\mu}} + \frac{dN_T}{N_T} \quad (180)$$

which is often expedient to represent as:

$$H_{T\mu}^2 \frac{d(N_T H_T^2)}{H_T^2} = N_T dH_{T\mu}^2 + N_T H_{T\mu}^2 \frac{dr_{T\mu}}{r_{T\mu}} + H_{T\mu}^2 dN_T \quad (181)$$



where the parameters are replaced,  $H_{i\mu}^2$  by  $H_{T\mu}^2$ ,  $H_{iS}^2$  by  $H_T^2$ , and  $r$  by  $r_{T\mu}$ , in order to underline the origins of heat energy with the use of index "T": it is the energy of repulsion of electromagnetic interaction.

Using the relationship between the volume and the linear coefficients of heat expansion for isotropic medium

$$\frac{1}{r} \frac{dr}{dT} = \frac{1}{3V} \frac{dV}{dT},$$

assuming  $N_T = const$  and multiplying all terms of (181) by the combination of dimensional coefficients  $\xi_T \xi_\varepsilon / \xi_T H_0^3$ , we obtain the equation which unifies the first and second laws of thermodynamics:

$$TdS = dE + P_T dV, \quad (182)$$

where the temperature  $T$ , differentials of the entropy  $dS$  and internal energy  $dE$ , the pressure or the density of the repulsion energy  $P_T$  are defined by the correspondences:

$$T = \frac{N_T \xi_T H_{T\mu}^2}{3N \cdot H_0^3}, \quad dS = k \frac{d(N_T H_T^2)}{H_T^2}, \quad (183)$$

$$dE = \frac{N_T \xi_\varepsilon dH_{T\mu}^2}{H_0^3}, \quad P_T = \frac{N_T H_{T\mu}^2 dr_{T\mu}}{r_{T\mu}}.$$

where  $N$  is the number of particles,  $\xi_T$  is the dimensional coefficient of temperature, and

$$k = \frac{\xi_\varepsilon}{\xi_T} = \frac{\xi_m \xi_d^2}{\xi_T^2 \xi_T} \quad (184)$$

is the Boltzmann constant.

The coefficient 1/3 in the first formula of (183) is related to the fact that the temperature is the characteristic of a repulsion realized only in one direction, therefore, only by one  $\Delta$ -pair, that is, by the third part of the existing in one  $\gamma$ -base  $\Delta$ -pairs.

Multiplying both sides of the first formula (183) by the dimensional coefficient  $k$  (184) and with regard to the definitions of velocity  $v$  at  $H_i \ll H_0$  (34) and mass (39), we obtain

$$m_0 v^2 = 3kT \quad \text{or} \quad v = \left( \frac{3kT}{m_0} \right)^{1/2}. \quad (185)$$

Just as like on the assumption of definitions  $T, P_T$  (183) and (184), we obtain

$$P_T = \frac{NkT}{V}. \quad (186)$$

In fact, the formulas (185) and (186) represent the characteristic equation of ideal gases (the dimensionalities of the density of energy and pressure are equal). Thus, it is necessary somewhat to improve the definition of the ideal gas by characterizing it not as the system where the intermolecular interaction is practically absent but as the gas with the predominant forces of repulsion.

It is not difficult to make sure that with the help of equation (180) or (181) which do not contain any individual properties of individual particles, one can derive all the basic equations of thermodynamics.

## 14 To the Content of the Universal Constants of Physics and Relations Between Them

In the physical world, surrounding us, there are the sizes, however, the dimensionalities do not exist. The dimensionalities have been invented by the researches, especially during the formation of classical physics, the development of each conceptual direction was related to the invention of the new properties of matter to which, in its turn, were given the corresponding dimensionalities. The choice of the dimensionality has been based on the specific revealing of the newly discovered properties of matter by selection the

reference samples with the relevant measures and scales. Such an approach allows one to describe the natural phenomena with a high precision, although, the contents of the properties remained unrevealed.

At the beginning of the last century, Planck, based on the outcome of the unification of universal constants  $c$ ,  $\hbar$ , gravity  $G$  and the Boltzmann constant  $k$ , suggested a new base for the units of measurement, which does not depend on the particular properties of matter [12]:

$$\begin{aligned} \ell_p &= \left(\frac{G\hbar}{c^3}\right)^{1/2} ; t_p = \left(\frac{G\hbar}{c^5}\right)^{1/2} ; \\ m_p &= \left(\frac{c\hbar}{G}\right)^{1/2} ; T_p = \left(\frac{c^5\hbar}{Gk^2}\right)^{1/2} \end{aligned} \quad (187)$$

Nowadays, the Planck quantities of mass  $m_p$  and length  $\ell_p$  are the characteristic parameters of the Superstring theory and M-theory [13,14] the Planck time  $t_p$  also plays equally important role in the Quantum Astrophysics [15,16]. At the same time, the equations (187) were derived starting from the dimensionalities of the universal constants, and the content itself of the Planck quantities remains unclear.

In the ST, in the process of modeling of world, the dimensionalities are not used at the initial stage. The distance and duration of interaction between two  $\varepsilon$ -particles ( $\varepsilon$ -act) are used as the minimum intervals of length and time, the constancy of which is taken axiomatically. Hence, the measurement of length and time is carried out by the computation of the amount of  $\varepsilon$ -acts. However, to set the correspondences between modeled and generally accepted worlds, a need arises to prescribe the dimensionalities to particular parameters; to do this, the length and the duration of  $\varepsilon$ -acts are taken equal to  $\xi_d$  cm and  $\xi_t$  c. Because it is accepted from the beginning that all physical bodies consist of  $\varepsilon$ -particles, the intervals  $\xi_d$  and  $\xi_t$  are common for all the bodies. If we present the product of transverse path  $\lambda$  (25) and velocity of transversal motion  $v$  (34) in the form of  $\lambda v \equiv \lambda v$ , and then divide its right side by dimensionless and dimensional components, we obtain

$$v\lambda = \frac{\xi_d^2 H_0^2}{\xi_\tau (H_0 + H_i)} \quad (188)$$

Multiplying and dividing the right side of the given equation by a new dimension coefficient of mass  $\xi_m$ , we prescribe a new property to the product  $v\lambda$  – the mass:

$$m = \frac{\xi_m (H_0 + H_i)}{H_0^2}, \quad (189)$$

thus, the equation (188) takes the form

$$v\lambda = hm^{-1}, \quad (190)$$

where the combination of  $\xi_d$ ,  $\xi_\tau$  and  $\xi_m$  (40), that is, the Planck constant  $h$  is introduced to give the same dimension to both sides of the equation (190).

As a result, three coefficients of dimensionalities are introduced:  $\xi_d$ ,  $\xi_\tau$  and  $\xi_m$  with use of these, is possible to represent any other dimensionalities.

With regard to the equations (65), (78) and (86), the ratio of energies of electrostatic and gravitational interactions of two electrons at the same distance (the numerical value of which Eddington called the Constant of the Universe) will be written as

$$\frac{e^2}{Gm_e^2} = \frac{H_0^2 \xi_m \xi_d^3}{4G\alpha_c 2\pi \xi_m^2 \xi_\tau^2} = \frac{H_0^2}{4\alpha_c} = 4,168 \cdot 10^{42}, \quad (191)$$

from which the gravity constant  $G$  will be represented by the formula

$$G = \frac{\xi_d^3}{2\pi \xi_m \xi_\tau^2}. \quad (192)$$

Thus, with use of the equations (32), (40), (184) and (192), the world constants  $c$ ,  $\hbar$ , and  $G$  and the Boltzmann constant  $k$  can be represented by the combination of the coefficients of dimensionalities  $\xi_d$ ,  $\xi_\tau$ ,

$\xi_m$  and  $\xi_T$ , from which the relations immediately follow

$$\begin{aligned}\xi_d &= \left(\frac{2\pi hG}{c^3}\right)^{1/2} = 1,015 \cdot 10^{-32} \text{ cm}; \\ \xi_\tau &= \left(\frac{2\pi hG}{c^5}\right)^{1/2} = 3,38 \cdot 10^{-43} \text{ s}; \\ \xi_m &= \left(\frac{ch}{2\pi G}\right)^{1/2} = 2,1767 \cdot 10^{-5} \text{ g}; \\ \xi_T &= \left(\frac{c^5 h}{2\pi G k^2}\right)^{1/2} = 1,4185 \cdot 10^{32} \text{ K}.\end{aligned}\tag{193}$$

Comparing (187) and (193), one can conclude that the quantities  $\xi_m$  and  $m_p$ , as well as  $\xi_T$  and  $T_n$ , coincide completely. The only difference is in  $\xi_d$  and  $\xi_\tau$ . However, the preference should be given to the quantities  $\xi_d$  and  $\xi_\tau$  in the formulas (99) and (100), because the parameters calculated with their aid, such as the classical radius of electron (102), the radii of the Bohr orbits  $r_n = \frac{n^2 \alpha_c^2 H_c \xi_d}{4\pi}$ , coincide with the known values. It is also possible to write the results of computations of second constants of the radiation  $c_2$  [17]

$$c_2 = \frac{ch}{k} = \xi_d \xi_T = 1,4396 \text{ cm} \cdot \text{K},\tag{194}$$

and make sure that the values  $\xi_d$  and  $\xi_\tau$  are more suitable for theoretical calculations. Thus, in order to describe the physical phenomena instead of constants  $c$ ,  $h$ ,  $G$ ,  $k$  and the fundamental properties of matter as the mass and charge of electron, it is possible to use the dimensionless constants  $H_c$ ,  $\alpha_c$  and a set of the coefficients of dimensionalities  $\xi_d$ ,  $\xi_t$  (or  $\xi_t = H_0^2 \xi_t$ )  $\xi_m$ ,  $\xi_T$ . The  $H_c$  being computed theoretically, most likely that the value of the constant  $\chi_c = 140/\alpha_c$  also can be computed theoretically, thereby will arise new opportunities of dimensionless description of the natural phenomena.

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