The Elementary Laws of Transversal Exchange

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Abstract

The development of systems of units led to the sad fact that two parameters, current and circulation, characterizing different subfields (longitudinal and transversal, "electric" and "magnetic") of the unit longitudinal-transversal field have obtained the same name – current, although in principle, in their dimensions and physical meaning, they are different. This fact is reflected, in particular, in the erroneous presentation in modern physics, both in form and contents, the elementary laws of electrodynamics (Ampere's and Biot-Savart). The above faults, inherent also in Maxwell's equations, are uncovered in detail in this work in the framework of dialectical physics. The oldest puzzle in physics concerning magnetic charges (so-called "magnetic monopoles") obtains the natural solution herein.

1. Introduction

The laws of electrodynamics are based on concepts of the 19th century physics. Now at the beginning of the 21st century these laws request reconsideration in the light of the found faults caused by outdated views. A theoretical basis, on which the aforementioned reconsideration becomes possible, is the Dialectical Model of the Universe (DM, the philosophical basis of dialectical physics [1-3]). A series of the discoveries of the DM, started from uncovering the nature of mass and charge of elementary particles [4] makes it possible to perform the corresponding corrections. Physical notions, unknown earlier, as for example, exchange charge at the transversal exchange, the fundamental frequency and fundamental wave radius of atomic and subatomic levels, *etc*., cardinally extended our understanding reality.

We intend here to reconsider on the new basis two elementary laws of electrodynamics, namely Ampere's and Biot-Savart laws, to present them in correct form and contents. These laws deal with the magnetic field caused by a current and the distance from the current. Biot-Savart law is the differential version of Ampere's law. For this goal, we must first of all explain principal notions used in this work and give the corresponding definitions.

Basing on axioms of dialectical physics, related to the wave nature of the World, we begin from the elucidation of basic attributes of longitudinal-transversal (spherical-cylindrical) wave fields and their potential-kinetic structure. Further, we will show how we arrived at such fundamental notions as the associated mass and exchange charge at transversal exchange. The latter is responsible for the transversal, "magnetic" exchange (interaction). One of the principal physical quantities entered in resulting formulas is the circulation Γ. We turn a special attention to elucidation of the physical meaning of this quantity.

An indissoluble bond of longitudinal and transversal, electric and magnetic, fields is reflected in a binary nature of the behavior of electron's charge. The electron shows itself as the spherical electric (scalar) charge and, simultaneously, it is the cylindrical magnetic (vector) charge, or "magnetic monopole". We consider this property at the end of this paper.

2. The principal parameters of wave physical space

According to the DM [5], the spaces of all levels of the Universe are mutually overlapped, embedding in each other. With this, below laying spaces are the basis spaces for upper laying levels. The mass of microobjects of a level is regarded as a particular physical spherical point (like vortices or compressions, *etc*.) pulsing in space.

In view of this we regard the *mass* of physical space *m* as the *amount of the physical space* of the *embeddedness* ε defined by the equality

$$m = \varepsilon V = \varepsilon_0 \varepsilon_r V , \qquad (2.1)$$

where *V* is the volume of the space. The embeddedness $\varepsilon = \varepsilon_0 \varepsilon_r$ is, in other words, the density of the space, where ε_r is the relative density and $\varepsilon_0 = 1\, g \cdot cm^{-3}$ is the absolute unit density of the space.

If we reduce an amount of space *m* to the unit embeddedness, we can write (2.1) as

$$m = \varepsilon_r (\varepsilon_0 V) = \varepsilon_r V_0 , \qquad (2.2)$$

where $V_0 = m$, because in the above mentioned meaning

$$g = cm^3 . \qquad (2.3)$$

For the more accurate description of the wave physical space, we operate with the *kinematic vector-speed E* at the level of the basis wave space. To stress its directed character, one can use the symbol ***E***. The reference dimensionality of the vector-speed *E* is $cm \cdot s^{-1}$.

The dynamic vector, conjugate to the kinematic *E*-vector, is defined as

$$D = \varepsilon E = \varepsilon_r \varepsilon_0 E . \qquad (2.4)$$

We see that the *D*-vector is a vector of the *density of momentum of physical space* with the embeddedness ε; its dimensionality is $(g \cdot cm / s) / cm^3$.

The vectors *D* and *E* are used for the description of *longitudinal* wave field. The analogous pair of the vectors, *H* and *B*, presents the *transversal* wave field:

$$H = \varepsilon B = \varepsilon_r \varepsilon_0 B . \qquad (2.5)$$

The vectors *D* and *E* describe the *spherical* (“electric”) wave field of the basis space; while *H* and *B* describe the *cylindrical* (“magnetic”) wave field of the same basis space.

Along with the “right” embeddedness $\varepsilon = \varepsilon_r \varepsilon_0$, we operate also with the “inverse” embeddedness:

$$\mu_0 = 1/\varepsilon_0 \quad \text{and} \quad \mu_r = 1/\varepsilon_r . \qquad (2.6)$$

Then, the equalities (2.4) and (2.5) take the form

$$E = \mu_r \mu_0 D , \qquad B = \mu_r \mu_0 H . \qquad (2.7)$$

We postulate the validity of the equality $\varepsilon_r = 1$ for the basis space. This is quite natural, because, at this level, the embeddedness, in essence, relates to the space itself, *i.e.*, the *self-embeddedness* of the space takes place.

3. Longitudinal-transversal and potential-kinetic structure of wave fields

In wave field-spaces, the *central field-space* of exchange is inseparable from its *negation*, which is represented by the *transversal field-space* of exchange [6]. The central (longitudinal) field of exchange is described by two vectors, *E* and *D*, the transversal field is described by the analogous vectors, *B* and *H*. Thus, the *B* vector is the *speed-strength vector* and the H vector is a *vector of the density of momentum* of the transversal exchange.

Both fields-spaces (central and transversal) form the unit contradictory *longitudinal-transversal field-space* with the following vectors:

$$\hat{A} = E + iB \qquad \text{and} \qquad \hat{C} = D + iH \, . \tag{3.1}$$

In a general case, each vector of exchange (*E, D, B*, and *H*) has the contradictory *potential-kinetic* character (that is designated by the symbol ^) [26, 27]. Therefore, more correctly, (3.1) must be presented in the following form:

$$\hat{A} = \hat{E} + i\hat{B} \qquad \text{and} \qquad \hat{C} = \hat{D} + i\hat{H} \, , \tag{3.2}$$

where *i* is the *unit of negation* of the central field by the transversal field. Thus, the letter *i* indicates the transversal character of the field of $\hat{B}$ and $\hat{H}$ vectors as against the central field of *E* and *D* vectors. Simultaneously, the letter *i* indicates the *potential* character of the corresponding vectors, as the negation of the kinetic ones, because

$$\hat{E} = E_k + iE_p \, , \qquad \hat{B} = B_k + iB_p \, , \quad \text{and} \quad \hat{D} = \varepsilon_0 \varepsilon_r \hat{E} \, , \qquad \hat{H} = \varepsilon_0 \varepsilon_r \hat{B} \, . \tag{3.3}$$

Obviously,

$$A_k = E_k + iB_k \, , \qquad C_k = D_k + iH_k \tag{3.4}$$

and

$$A_p = E_p + iB_p \, , \qquad C_p = D_p + iH_p \, . \tag{3.5}$$

Each above vector of exchange belongs to the generalized vector of exchange

$$\hat{\Psi} = U + iV \, , \tag{3.6}$$

where $\hat{\Psi} \in (\hat{E}, \hat{B}, \hat{D}, \hat{H}, \hat{A}, \hat{C})$. This vector satisfies the wave equation

$$\Delta\hat{\Psi} - \frac{\partial^2 \hat{\Psi}}{\partial \tau^2} = 0 \, , \tag{3.7}$$

which falls into the three scalar equations

$$\Delta\hat{\Psi}_x - \frac{\partial^2\hat{\Psi}_x}{\partial\tau^2} = 0\,, \qquad \Delta\hat{\Psi}_y - \frac{\partial^2\hat{\Psi}_y}{\partial\tau^2} = 0\,, \qquad \Delta\hat{\Psi}_z - \frac{\partial^2\hat{\Psi}_z}{\partial\tau^2} = 0\,. \tag{3.8}$$

The field-space of the vectors of exchange repeats the structure of fields of matter-space-time, which have the longitudinal-transversal character. The longitudinal-transversal field of exchange $\hat{A} = \hat{E} + i\hat{B}$ is an image of the *longitudinal-transversal structure of the World*. At the subatomic level, it is called the *electromagnetic* field, in which the field of the *transversal* exchange (or more correctly the transversal subfield of the longitudinal-transversal field) is termed the "*magnetic field*" and the longitudinal exchange – the "*electric field*". The *binary field-spaces* are the basis of space of the Universe.

Strictly speaking, the electromagnetic field must be called by only one name: the "electric" (or "magnetic") longitudinal-transversal field with the *longitudinal-transversal charges*. This is a very important question of logical semantics of the field, which inclines to the definite concepts.

The binary fields-spaces are elementary links in a chain of mutually negating longitudinal-transversal spaces-fields, which form the multidimensional spatial structure of matter-space-time of the Universe.

4. Associated mass and exchange charge of transversal exchange

As follows from solutions of the wave equation, the density of oscillatory-wave energy (or pressure) in the cylindrical field-trajectory, at the constant mean power of energy flow in a radial direction, has the form [3]

$$\hat{p} = \frac{p_m}{\sqrt{k_r r}} \exp i(\omega t - k_r r)\,. \tag{4.1}$$

The speed of transversal exchange is defined (like at longitudinal exchange) as

$$\hat{\upsilon} = \upsilon(k_r r) \exp i\omega t\,, \tag{4.2}$$

where $k_r = k = \omega / c$ is the wave number corresponding to the fundamental frequency of the field of exchange ω.

Like for the spherical field-space [5], the following relation is valid for the cylindrical field-space:

$$\hat{\upsilon} = -\frac{k_r}{\varepsilon_0 \varepsilon_r i\omega} \frac{\partial \hat{p}}{\partial (k_r r)}\,. \tag{4.3}$$

On the basis of the above equalities, we get that the density of oscillatory-wave energy at the wave characteristic surface of the radius *a* is defined by the following equality

$$\hat{p} = \frac{2a\varepsilon_0\varepsilon_r}{1 + 4(k_r a)^2} (1 - 2k_r a i) i\omega\hat{\upsilon}\,. \tag{4.4}$$

Hence, the power of *field exchange* at a section of cylindrical surface of the length *l*, $S = 2\pi al$, related to the cylindrical field around a trajectory of the moving proton, in our case (with allowance for $d\hat{\upsilon}/dt = i\omega\hat{\upsilon}$) will be:

$$\hat{p}S = \frac{4\pi a^2 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2}(1-2k_r ai)\frac{d\hat{\upsilon}}{dt}, \tag{4.5}$$

or

$$\hat{p}S = \hat{m}\frac{d\hat{\upsilon}}{dt}, \tag{4.5a}$$

where

$$\hat{m} = \frac{4\pi a^2 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2} - ik_r\frac{8\pi a^3 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2} \tag{4.6}$$

is the *associated field mass* at transversal exchange.

An equation of the transversal exchange in the radial direction has the form

$$m_0\frac{d\hat{\upsilon}}{dt} = \hat{F} - \hat{p}S, \tag{4.7}$$

where m_0 is the *rest mass* of the particle; $\hat{F}$ expresses some additional exchange – the power of exchange with an object in the ambient space.

Replacing $\hat{p}S$ by the equality (4.5), we arrive at the equation of exchange, *i.e.*, in essence, at the common equation of motion accepted in physics from Newton's times in the form

$$\left(m_0 + \frac{4\pi a^2 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2}\right)\frac{d\hat{\upsilon}}{dt} + R\hat{\upsilon} = \hat{F}. \tag{4.8}$$

In this equation,

$$R = 2k_r a\omega\frac{4\pi a^2 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2} \tag{4.9}$$

is the *coefficient of wave resistance*, or the *dispersion* of rest-motion at transversal exchange.

The equation of powers of exchange (4.8) is presented thus in a classical form of Newton's second law, describing the motion in the field-space with the resistance *R*. At such a description, the expression in brackets represents the effective mass *m* of the particle:

$$m = m_0 + \frac{4\pi a^2 l\varepsilon_0\varepsilon_r}{1+4(k_r a)^2}. \tag{4.10}$$

Eq. (4.5a) describes exchange of motion. However, we are interested in the mass exchange, which is defined by exchange charges (4.11). In this case, the field component of mass exchange (4.5a) has to be presented in the following form:

$$\hat{p}S = \frac{d\hat{m}}{dt}\hat{\upsilon} \qquad \text{or} \qquad \hat{p}S = \hat{Q}\hat{\upsilon}, \tag{4.11}$$

where $\hat{Q}$ is the active-reactive charge of exchange. Then, Eq. (4.8) takes the form

$$m_0 \frac{d\hat{\upsilon}}{dt} + \frac{4\pi a l \upsilon \varepsilon_0 \varepsilon_r}{1 + 4(k_r a)^2} i\hat{\upsilon} + R\hat{\upsilon} = \hat{F}\,, \tag{4.12}$$

where $\upsilon = \omega a$ is the speed at the cylindrical surface. The tangential field of exchange, which is negation of the longitudinal field of exchange *E* (see Sect. 3 and Sect. 4), is described by the *speed-strength vector B* (3.7), which is equal therefore to

$$\hat{B} = i\hat{\upsilon}\,, \tag{4.13}$$

where *i* is the unit ("indicator") of negation. Thus, we have

$$m_0 \frac{d\hat{\upsilon}}{dt} + \frac{4\pi a l \upsilon \varepsilon_0 \varepsilon_r}{1 + 4(k_r a)^2} \hat{B} + R\hat{\upsilon} = \hat{F} \tag{4.14}$$

or

$$m_0 \frac{d\hat{\upsilon}}{dt} + q_\tau \hat{B} + R\hat{\upsilon} = \hat{F}\,. \tag{4.15}$$

It should recall again that elementary particles of the DM are pulsing microobjects, so that their masses have *associated* character. Accordingly, the notion of the rest mass is not appropriate for such microobjects of principle Thus, we accept that in the transversal field of exchange, as in the spherical one, the rest mass of a particle m_0 is equal to zero.

Thus, we arrive at the following formula for the *associated transversal mass* m_τ and the *associated transversal charge* q_τ (at $\varepsilon_r = 1$):

$$m_\tau = \frac{4\pi a^2 l \varepsilon_0}{1 + 4(k_r a)^2}\,, \tag{4.16}$$

$$q_\tau = \omega m_\tau = \frac{4\pi a l \upsilon \varepsilon_0}{1 + 4(k_r a)^2}\,. \tag{4.17}$$

Supposing that a part of the cylindrical surface *l*, equal to half of the wave-trajectory, $l = \frac{1}{2}\lambda_Z$, is associated with a particle, we obtain

$$m_\tau = \frac{2\pi a^2 \lambda_Z \varepsilon_0}{1 + 4(k_r a)^2}\,, \tag{4.18}$$

$$q_\tau = \omega m_\tau = \frac{2\pi a \lambda_Z \upsilon \varepsilon_0}{1 + 4(k_r a)^2}\,. \tag{4.19}$$

Hence, *linear densities* of the associated transversal mass m_λ and transversal exchange charge q_λ are equal to

$$m_\lambda = \frac{2\pi a^2 \varepsilon_0}{1 + 4(k_r a)^2}, \tag{4.20}$$

$$q_\lambda = \omega m_\tau = \frac{2\pi a \upsilon \varepsilon_0}{1 + 4(k_r a)^2}. \tag{4.21}$$

At the condition $k_r a << 1$, the above formulas are simplified, and we have

$$m_\tau = 2\pi a^2 \lambda_Z \varepsilon_0, \qquad q_\tau = 2\pi a \lambda_Z \upsilon \varepsilon_0, \qquad m_\lambda = 2\pi a^2 \varepsilon_0, \qquad q_\lambda = 2\pi a \upsilon \varepsilon_0. \tag{4.22}$$

At the equality of *longitudinal* and *transversal* exchanges, the corresponding masses [3],

$$m = \frac{4\pi a^3 \varepsilon_0}{1 + k^2 a^2} \quad \text{and} \quad m_\tau = \frac{2\pi a^2 \lambda_Z \varepsilon_0}{1 + 4k^2 a^2}, \tag{4.23}$$

are equal as well. From this it follows that

$$\lambda_Z = 2a \frac{1 + 4k^2 a^2}{1 + k^2 a^2} \approx 2a. \tag{4.24}$$

5. The notion of circulation, Γ

Under the constant *linear density of the transversal charge* q_λ (4.22), the cylindrical field of tangential speed $\upsilon = B$, at an arbitrary distance r from the axis of the field, is equal to

$$B = \mu_0 \mu_r \frac{\Gamma}{2\pi r}, \tag{5.1}$$

where $\mu_0 = \frac{1}{\varepsilon_0} cm^3 \cdot g^{-1}$ and $\mu_r = \frac{1}{\varepsilon_r}$ are, respectively, the absolute and relative unit volume densities, and

$$\Gamma = 2\pi r \varepsilon_0 \varepsilon_r \upsilon = 2\pi r \varepsilon_0 \varepsilon_r B = 2\pi r H, \tag{5.2}$$

where $H = \varepsilon_r \varepsilon_0 B$, is the *linear density of tangential (transversal) flow of speed* υ, or the *circulation* of the *density of momentum H*. It is obvious that

$$\Gamma = \boldsymbol{q}_\lambda = \frac{d\boldsymbol{q}_\tau}{dz}. \tag{5.3}$$

The *circulation*, or the *linear density of the transversal charge*, points to the longitudinal motion in the cylindrical wave field, and therefore, it is the vector magnitude.

The notion of circulation can be considered from the laws of orbital motion.

In the spherical field at the level of wave oscillations, the following correlation takes place between the oscillatory (circular) speed and radial distance:

$$\upsilon r = const. \tag{5.4}$$

This equality expresses Kepler's second law. Because in this case $\vec{\upsilon}d\vec{r} = \upsilon dr$ (Fig. 1), the law can be rewritten in the following form:

$$\oint \upsilon dr = 2\pi r \upsilon = 2\pi r B = \Gamma_B , \tag{5.5}$$

where Γ_B is the *kinematic action* in the cylindrical field, or *circulation of the speed-strength* $\upsilon = B$.

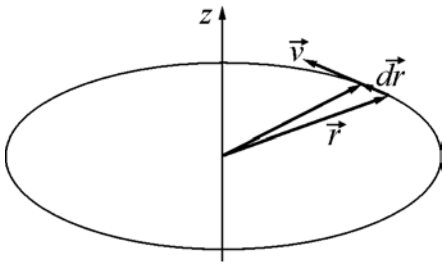

Fig. 1. A graph of the circular motion.

The circulation can be presented through the current flowing along the z-axis of the cylindrical field. Simple manipulations lead us to the following equalities:

$$2\pi r B = \frac{\omega}{c\varepsilon_0} 2\pi r \lambda\!\!\!^{-} \varepsilon_0 B = \frac{\omega q_\tau}{c\varepsilon_0} = \mu_0 \frac{I}{c} \qquad \text{or} \qquad \Gamma = 2\pi r \varepsilon_0 B = \frac{I}{c}, \tag{5.6}$$

where

$$e = q_\tau = 2\pi r \lambda\!\!\!^{-} \varepsilon_0 B \tag{5.7}$$

is the charge of the transversal exchange, and

$$I = \omega e \tag{5.8}$$

is the current of exchange. In this case, circulation Γ is the *dynamic action* in the cylindrical field, or the *circulation of the density of momentum H*.

Let us reveal the correlation between the current of charge exchange $I = \frac{dq}{dt}$ and circulation Γ by another way.

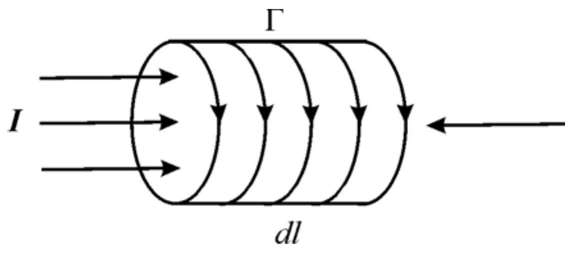

Fig. 2. An element of a vortex cylindrical field.

In a steady-state wave exchange, the total exchange of mass through transversal sections of a cylindrical tube and a lateral surface (see Fig. 2) is balanced.

$$d^2M_\tau - d^2M_S = 0\,. \tag{5.9}$$

After dividing this equality by the time differential dt, we have

$$dq_\tau - dq = 0 \qquad \text{or} \qquad dq_\tau = dq\,, \tag{5.10}$$

where q_τ and q are, respectively, the transversal and longitudinal charges:

$$q_\tau = \frac{dM}{dt} \qquad \text{and} \qquad q = \frac{dM_S}{dt}\,. \tag{5.11}$$

Linear density of the transversal charge is

$$\Gamma = \frac{dq_\tau}{dl}\,, \tag{5.12}$$

hence,

$$\Gamma dl = dq_\tau \tag{5.13}$$

At the basis level, the speed of wave exchange is equal to the speed of light c, and

$$dl = cdt\,. \tag{5.14}$$

As a result, we arrive at the circulational equation of exchange:

$$\Gamma = \frac{1}{c}\frac{dq}{dt} = \frac{1}{c}I\,. \tag{5.15}$$

6. Exchange (interaction) of two cylindrical fields; Ampere's law

We will derive now the "force" of interaction of two cylindrical fields caused by two currents as shown in Fig. 3.

In the plane of symmetry, the lines of exchange pierce the plane at the right angle and the total velocity-strength of the fields of two charges is

$$\mathrm{V} = 2\upsilon\cos\theta\,, \tag{6.1}$$

where $\upsilon = \mu_0\mu_r \dfrac{\Gamma}{2\pi r}$ (5.1). The density of energy of exchange is

$$w = \frac{\varepsilon_0\varepsilon_r \mathrm{V}^2}{2}\,. \tag{6.2}$$

The resulting power ("force") of exchange is determined by integrating the density of the energy w with respect to area S over the whole infinite plane of symmetry:

$$F = \int w dS \, . \tag{6.3}$$

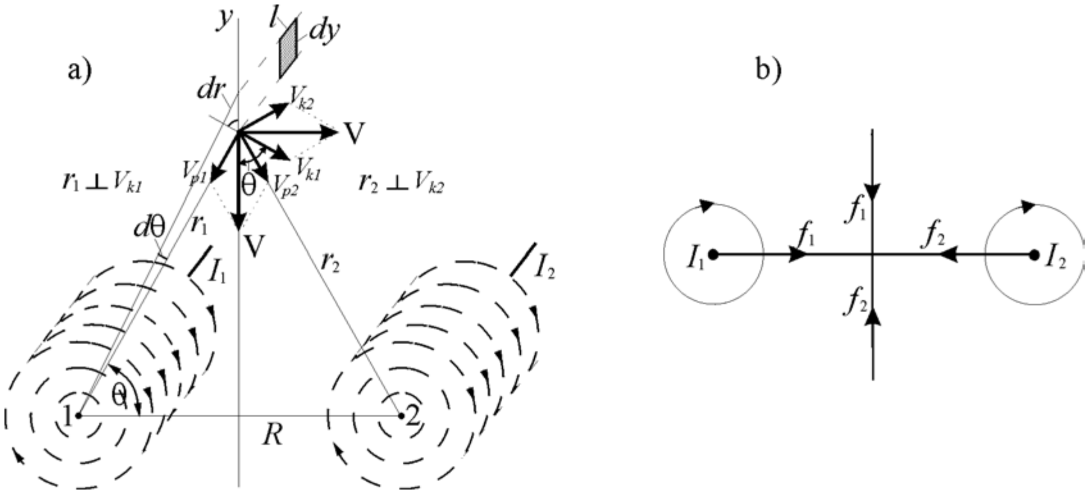

Fig. 3. a) Longitudinal-transversal speeds of the potential-kinetic field of exchange of two rectilinear currents (υ_p and υ_k are potential and kinetic speeds of a mean field of the exchange); b) a graph of longitudinal-transversal power of exchange. Potential and kinetic vectors are mutually perpendicular.

Thus, the power of exchange of two cylindrical surfaces of the length l along the plane of symmetry is

$$F = \int \frac{\varepsilon_0 \varepsilon_r \mathrm{V}^2}{2} dS \, . \tag{6.4}$$

Because (see Fig. 3) $r = \dfrac{R}{2\cos\theta}$, $dr = \dfrac{R\sin\theta}{2\cos^2\theta} d\theta$, the differential dS is

$$dS = l dy = l \frac{dr}{\sin\theta} = \frac{lR d\theta}{2\cos^2\theta} \, . \tag{6.5}$$

Taking into account (5.1), (5.2), (6.1), and (6.5), the differential dF is

$$dF = \frac{\varepsilon_0 \varepsilon_r \mathrm{V}^2}{2} dS = \frac{\mu_0 \mu_r \Gamma^2 \sin^2\theta l d\theta}{\pi^2 R} \, . \tag{6.6}$$

Hence, transversal exchange (interaction) of two wave cylindrical fields caused by two rectilinear currents is described by the formula

$$F = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{\mu_0 \mu_r \Gamma^2 l \sin^2\theta d\theta}{\pi^2 R} = \frac{\mu_0 \mu_r \Gamma^2 l}{2\pi r} \, . \tag{6.7}$$

Because

$$B = \mu_0 \mu_r \frac{\Gamma}{2\pi r},$$

(see (5.1)), the formula of the exchange (6.7) takes the form:

$$F = B\Gamma l. \quad (6.8)$$

Denoting the circulation Γ by the symbol I_m, we obtain

$$\mathrm{I}_m = \frac{1}{c}\mathrm{I}. \quad (6.9)$$

If now to multiply this equality by *dt*, we arrive at the following formal equality

$$dq_m = \frac{1}{c}dq, \quad (6.10)$$

where $dq_m = \mathrm{I}_m dt = \Gamma dt$ is the *circulation charge*.

The physical quantities, I_m and dq_m, are regarded in physics as the current and charge in the magnetic system of units.

We see that there are two kinds of physical charges, "electric" and "circulation". Both charges are related to themselves through the basis wave speed *c* as

$$q_m = \frac{1}{c}q. \quad (6.11)$$

The charges, q_m and q, describe different properties of exchange and cannot be regarded as the same physical quantities expressed in the different systems of units.

Thus, the correct form of the laws, (6.7) and (6.8), in the theory of transversal (magnetic) fields must be the following:

$$F = \frac{\mu_0 \mu_r \Gamma^2 l}{2\pi r}, \qquad F = B\Gamma l, \quad (6.12)$$

or, because $\Gamma = \frac{1}{c}I$ (5.10),

$$F = \frac{\mu_0 \mu_r}{c^2}\frac{\mathrm{I}^2 l}{2\pi r}, \qquad F = \frac{1}{c}B\mathrm{I}l. \quad (6.13)$$

where $\mu_0 = \frac{1}{\varepsilon_0} = 1\,cm^3 \cdot g^{-1}$ and $\mu_r = \frac{1}{\varepsilon_r}$ are, correspondingly, the unit *absolute* and *relative volume densities*; herein $\varepsilon_0 = 1\,g \cdot cm^{-3}$ is the *absolute unit density* and ε_r is the *relative density* of the space; the dimensionality of the current I is $g \cdot s^{-2}$, and the dimensionality of circulation Γ (as the *linear density of the charge*) is $g \cdot s^{-1} \cdot cm^{-1}$.

Equations (6.12) and (6.13) express an elementary law of electrodynamics discovered first by Ampere. However, their resulting presentation differs both in form and contents from the modern presentation accepted in physics in SI units. The use of true dimensionalities for all physical magnitudes in the above equations, expressed through integer powers of basic units of matter-space-time (g, cm, and s), is one of the characteristic features of the present work. True dimensionalities originate from the true meaning of the quantities uncovered in the framework of the DM. Although equations (6.13) do not differ in form from analogous equations presented in Gausian units, but in contents, they are essentially different; in particular, because the Gausian system operates with physical measures (*e.g.*, of current I, $g^{1/2} \cdot cm^{3/2} \cdot s^{-2}$) expressed by fractional powers of basic units of matter-space-time; $\mu_0 = 1$ is the dimensionless unit, *etc*.

Thus, the vector power of exchange, or the "force of interaction", has the form (6.12). Strictly speaking, the vector F, as the power of interchange of two currents, is the bipolar vector. Actually, F is the summarized power of exchange: $F = f_2 - f_1$, where f_1 is the power transmitted by the current I_1, and f_2 is the power absorbed by the same current (see Fig. 3b).

Because of the symmetry of the fields of exchange, we can state that $f_2 = -f_1 = f$; therefore, $F = 2f$, *i.e.*, half of the total power is related to one current I, or to one element of the interaction:

$$f = \frac{1}{2}F = \frac{\mu_0\mu_r\Gamma^2 l}{4\pi R}. \tag{6.14}$$

Eq. (6.14) defines both the central, or longitudinal, power of exchange generated by the kinetic ("magnetic") field and not central, or transversal, power of exchange (Fig. 3b), because in this and other formulas $\Gamma_k = \Gamma_p = \Gamma$ ($|\upsilon_k| = |\upsilon_p|$ and $|V_k| = |V_p| = |V|$).

7. The differential form of the speed-strength *B*; Biot-Savart law

Let us to elucidate now the relation between the local cylindrical field of tangential speed-strength B (at an arbitrary distance r from the axis of the field, Fig. 4) and the circulation Γ.

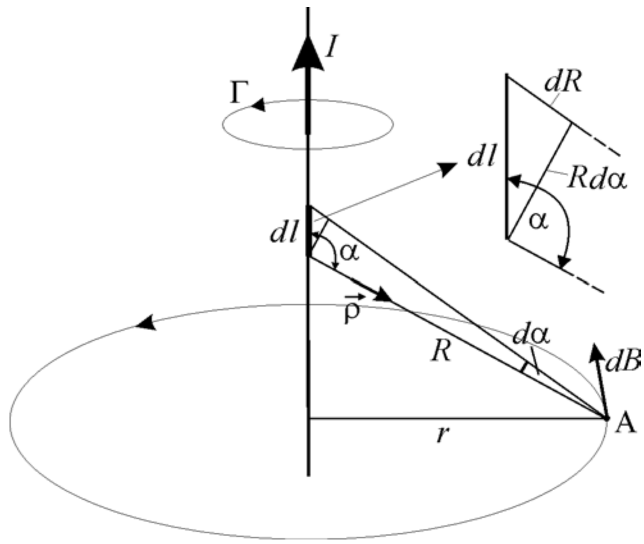

Fig. 4. The speed-strength of the transversal field B in the point A.

Differential presentation of the formula $B = \mu_0\mu_r \dfrac{\Gamma}{2\pi r}$ (5.1) leads to the Biot-Savart Law:

$$dB = \frac{\mu_0\mu_r \Gamma dl \sin\alpha}{4\pi R^2} = \frac{\mu_0\mu_r dq_\tau \sin\alpha}{4\pi R^2} = \frac{\left|(d\vec{q}_\tau \times \vec{\rho})\right|}{4\pi\varepsilon_0\varepsilon_r R^2}, \tag{7.1}$$

where Γdl is the differential of transversal power of exchange (the transversal charge dq_τ); dB is the differential of speed-strength; $\vec{\rho}$ is the unit vector of radius-vector R.

Thus, in the vector presentation, the law (7.1) has the form

$$d\vec{B} = \frac{d\vec{q}_\tau \times \vec{\rho}}{4\pi\varepsilon_0\varepsilon_r R^2}. \tag{7.2}$$

The formula (7.2) is analogous to the differential form of the law of longitudinal exchange

$$d\vec{E} = \frac{dq \cdot \vec{\rho}}{4\pi\varepsilon_0\varepsilon_r R^2}. \tag{7.3}$$

Thus, in longitudinal-transversal fields of matter-space-time at longitudinal-transversal exchange, we must operate both the *scalar longitudinal* (“electric”) exchange charges and *vector transversal* (“magnetic”) exchange charges.

In the point A (Fig. 4), the total speed-strength is equal to the integral of dB (7.1):

$$B = \int_{-\infty}^{+\infty} \frac{\mu_0\mu_r \Gamma \sin\alpha}{4\pi R^2} dl = \int_0^{\pi} \frac{\mu_0\mu_r \Gamma \sin\alpha}{4\pi r} d\alpha = \mu_0\mu_r \frac{\Gamma}{2\pi r}, \tag{7.4}$$

(where $dl = \dfrac{Rd\alpha}{\sin\alpha}$ and $R = \dfrac{r}{\sin\alpha}$) that corresponds to (5.1).

8. The moment of circulation; magnetic moment and magnetic charge

Let us consider the exchange process in a cylindrical space of a round cross-section, *e.g.*, in a copper wire. A wave field of current of exchange of azimuthal symmetry is presented in the form [3]

$$\hat{I} = I_0(k_r r)e^{-ikz}e^{-i\omega t}. \tag{8.1}$$

Elementary relations originated from this equation: the axial gradient, $\dfrac{d\hat{I}}{dz}$, and the rate of change of current, $\dfrac{d\hat{I}}{dt}$, are equal to

$$\hat{I}_\lambda = \frac{d\hat{I}}{dz} = -ik\hat{I} = -i\omega\frac{I}{c} = -i\omega\hat{\Gamma}, \qquad \frac{d\hat{I}}{dt} = -i\omega\hat{I}, \tag{8.2}$$

where

$$\hat{\Gamma} = \frac{\hat{I}}{c} \tag{8.3}$$

is the *axial* (longitudinal) *circulation*, equal to the transversal circulation, because the transversal circulation is related to current by the same equality. The transversal current always surrounds the longitudinal (axial) current. Because the longitudinal and transversal masses of exchange are equal, the longitudinal and transversal currents are equal as well.

If the axial current is closed, and a circuit of the current is circular, then the moment of current $\hat{P}_I$ and moment of circulation $\hat{P}_\Gamma$ are determined by the following formulas:

$$\hat{P}_I = \hat{I} \cdot S = \hat{I} \cdot \pi a^2, \tag{8.4}$$

$$\hat{P}_\Gamma = \hat{\Gamma} \cdot S = \hat{\Gamma} \cdot \pi a^2. \tag{8.5}$$

From this it follows that

$$\hat{P}_\Gamma = \frac{\hat{I}}{c} \cdot S = \frac{\hat{P}_I}{c}. \tag{8.6}$$

An elementary quantum of the circulation is equal to

$$\hat{\Gamma} = \frac{\hat{I}}{c} = \frac{i\omega\hat{e}}{c} = ik\hat{e}. \tag{8.7}$$

Hence, the amplitude value of the moment of circulation $P_{\Gamma,m}$, that is the amplitude measure of the orbital magnetic moment μ_m, is

$$P_{\Gamma,m} = \mu_m = \frac{I}{c} S = \frac{\omega e}{c} \pi a^2. \tag{8.8}$$

Because only half-wave of the fundamental tone is placed on the cylindrical wave shell (like on the spherical wave shell, at the equator), its length is twice of the circumference of the cylinder, so that $2\omega a = \upsilon$. Accordingly, the following relation takes place:

$$\mu_m = \frac{I}{c} S = \frac{\pi}{2} \frac{\upsilon e}{c} a. \tag{8.9}$$

Hence, the mean magnetic moment is

$$\mu = \frac{2}{\pi} \mu_m = \frac{\upsilon}{c} ea = \frac{\upsilon}{c} P_e, \tag{8.10}$$

where $P_e = ea$ is the moment of electron's charge.

At the electromagnetic field level, the "threshold" speed of oscillations is equal to the first Bohr speed, $\upsilon = \upsilon_0$; and the amplitude a of the wave is equal to the Bohr radius r_0, hence, we have

$$\mu = \frac{\upsilon_0}{c} er_0, \quad \text{or} \quad \mu = \alpha er_0 \tag{8.11}$$

where

$$\alpha = \frac{\upsilon_0}{c} = \frac{e^2}{4\pi\varepsilon_0 \hbar c} \tag{8.12}$$

is called in modern physics the "fine-structure constant". As shown in [7], the latter expresses the scale correlation of threshold states of conjugated oscillatory-wave processes at different levels of the Universe, including electromagnetic. (Note that in (8.12), ε_0 is the "electric constant" of the dimensionality $F \cdot m^{-1}$, and *e* is the electron charge in coulomb, *C* [8, 9])

Presenting the *magnetic moment* μ (8.11), in the same form as the *electric moment*, $P_e = ea$, we arrive at the following expression,

$$\mu = e_H a\,, \tag{8.13}$$

where

$$e_H = \frac{\upsilon_0}{c} e \tag{8.14}$$

is the *magnetic* (transversal) *charge* of the electron.

The latter equality expresses an indissoluble bond of longitudinal and transversal, electric and magnetic, fields. The electron is the *spherical electric* (scalar) *charge* and, simultaneously, it is the *cylindrical magnetic* (vector) *charge*, or "monopole". In other words, the electron is the *quantum of longitudinal-transversal, spherical-cylindrical* ("electromagnetic") *field* of the subatomic level of matter-space-time, presenting the indissoluble pair of e - e_H, source ─ vortex. The source *e* is the quantum of the spherical subfield, and the vortex e_H is the quantum of the cylindrical subfield of the unified spherical-cylindrical field.

Conclusion

The physical quantity $\Gamma = 2\pi r \varepsilon_0 \varepsilon_r B = \frac{1}{c}\mathrm{I}$ of the dimensionality $g \cdot cm^{-1} \cdot s^{-1}$, being the parameter of the *transversal* ("magnetic") subfield, is the circulation of the *vector of density of momentum* $H = \varepsilon_0 \varepsilon_r B = \dfrac{B}{\mu_0 \mu_r}$; whereas the current I (of the dimensionality $g \cdot s^{-2}$) is the parameter of the *longitudinal* ("electric") subfield. Thus circulation Γ is the parameter, which bonds in a single whole the electric and magnetic (longitudinal and transversal) features of the united field.

Since the circulation Γ is inseparable from the current I, we can conditionally call Γ the *current circulation*, *i.e.*, the circulation related to the given current. Just this inseparable relation of the circulation and current led, unfortunately, to the erroneous name of circulation as current. The circulation Γ was first termed as the "current in the magnetic system of units" and denoted by the symbol I_m, but further, simply by the letter I, accepting herein in fact the dimensionality of the circulation in ampere. This confusion remains in electrodynamics up to present that is convincingly shown in Table 1. The above-indicated faults concern all relevant formulas, including Maxwell's equations.

Thus the development of systems of units led to the sad fact that two parameters, current and circulation, characterizing different subfields (longitudinal and transversal, "electric" and "magnetic") of the unit longitudinal-transversal field have obtained the same name - current, although in principle, in their dimensions and physical meaning, they are different. This fact is reflected, in particular, in the erroneous presentation in modern physics, both in form and contents, the elementary laws of electrodynamics, Ampere's and Biot-Savart. The right form of the laws was derived and presented here.

An important feature of the approach used here, which is based on the Dialectical Model of the Universe [10], is that all physical quantities are characterized by dimensionalities expressed by only integer powers of basic units: the *centimeter* as unit of length, the *gram* as unit of mass, and the *second* as unit of time.

Along with the circulation, the problem of magnetic charges (former "magnetic monopoles") has obtained the natural solution here as well. The electron, as the quantum of longitudinal-transversal, spherical-cylindrical ("electromagnetic") field of the subatomic level of matter-space-time, is the quantum of the spherical subfield, and simultaneously it is the quantum of the cylindrical subfield, "magnetic monopole" or the vortex of the unified spherical-cylindrical field.

Note at the end that Ampere's and Biot-Savart laws describe not only wave cylindrical fields of "electric" currents and their interchange (interaction), but also the wave fields of pulsing and rotating cylinders (and moving pulsing or rotating spheres) and their interactions in different media (that was not considered here).

Table 1. Two presentations of the elementary laws of electrodynamics: correct (left) obtained in the framework of dialectical physics and incorrect (right) accepted in modern physics.

Correct (both in form and contents) [3]	**Incorrect**$^{*)}$ (both in form and contents) [modern physics, SI]
$d\mathbf{B} = \frac{\mu_0\mu_r}{4\pi}\frac{\Gamma[d\boldsymbol{l},\rho]}{R^2}$, $\quad F = \mu_0\mu\frac{\Gamma^2 l}{2\pi r}$	$d\mathbf{B} = \frac{\mu_0\mu_r}{4\pi}\frac{\mathrm{I}[d\boldsymbol{l},\rho]}{R^2}$ $\quad F = \mu_0\mu\frac{\mathrm{I}^2 l}{2\pi r}$
B is the *speed-strength* vector, $cm\cdot s^{-1}$	**B** is the *magnetic induction* vector, T ($1T = 10^4\ Gs = 10^4\ g^{1/2}\cdot cm^{-1/2}\cdot s^{-1}$)
$\Gamma = \frac{1}{c}\mathrm{I}$ is the *circulation*, $g\cdot cm^{-1}\cdot s^{-1}$ (The dimensionality of electric current I is $g\cdot s^{-2}$; the speed of light c, $cm\cdot s^{-1}$)	I is the *electric current*, A ($1A = \frac{c_r}{10}g^{1/2}\cdot cm^{3/2}\cdot s^{-2}$, where $c_r = \frac{c}{cm\cdot s^{-1}} = 2.99792458\cdot 10^{10}$)
$\mu_0 = \frac{1}{\varepsilon_0} = 1\,cm^3\cdot g^{-1}$ and $\mu_r = \frac{1}{\varepsilon_r}$ are, correspondingly, the unit *absolute* and *relative volume densities*; herein $\varepsilon_0 = 1\ g\cdot cm^{-3}$ is the *absolute unit density* and ε_r is the *relative density* of the space.	$\mu_0 = 4\pi\cdot 10^{-7}\ H\cdot m^{-1}$ is the *magnetic constant*. Actually, because $1H = 10^7\ m$, $\mu_0 = 4\pi$. --- According to "2006 CODATA" [11, page 4], $\mu_0 = 4\pi\cdot 10^{-7}\ N\cdot A^{-2}$. Hence, because $N\cdot A^{-2} = \frac{10^7}{c^2}$, $\mu_0 = \frac{4\pi}{c^2}cm^{-2}\cdot s^2$ (see *)

*) Below are parts of the Tables I and XLIX posted in [11]. We show the latter here to convince the scientific community of the scientific value of our discoveries.

"TABLE I. Some exact quantities relevant to the 2006 adjustment" [11, page 7].

Quantity	Symbol	Value
magnetic constant electric constant	μ_0 ε_0	$4\pi\times10^{-7}\ N\cdot A^{-2}=12.566370614...\times10^{-7}\ N\cdot A^{-2}$ $(\mu_0 c^2)^{-1}=8.854187817...\times10^{-12}\ F\cdot m^{-1}$

"TABLE XLIX. An abbreviated list of the CODATA recommended values of the fundamental constants of physics and chemistry based on the 2006 adjustment" [11, page 94].

Quantity	Symbol	Numerical value	Unit	Relative std. uncert. u_r
magnetic constant	μ_0	$4\pi\times10^{-7}$ $=12.566370614...\times10^{-7}$	$N\cdot A^{-2}$ $N\cdot A^{-2}$	(exact)
electric constant $1/\mu_0 c^2$	ε_0	$8.854187817...\times10^{-12}$	$F\cdot m^{-1}$	(exact)

Comments: The unit

$$\frac{N}{A^2}=\frac{10^5}{\left(\frac{c_r}{10}\right)^2}\frac{dyn}{(CGSE_I)^2}=\frac{10^5}{\left(\frac{c_r}{10}\right)^2}\frac{g\cdot cm\cdot s^{-2}}{(g^{1/2}\cdot cm^{3/2}\cdot s^{-2})^2}=\frac{10^7}{c^2}cm^{-2}\cdot s^2,$$

where $c_r=\frac{c}{1\,cm\cdot s^{-1}}$ is the dimensionless magnitude (the relative speed of light), is senseless. In this case

$$\mu_0=4\pi\cdot10^{-7}\ N\cdot A^{-2}=\frac{4\pi}{c^2}cm^{-2}\cdot s^2.$$

Accordingly, resting upon the definition of ε_0 presented in the above Tables, we have

$$\varepsilon_0=\frac{1}{\mu_0 c^2}=\frac{1}{4\pi}.$$

We leave the resulting data without further comments, because the absurdity of an introduction in physics of the quantities, ε_0 and μ_0, of the aforementioned dimensionalities and values in a series of the "*fundamental physical constants of physics and chemistry*" is obvious. All details concerning this matter one can find in [3] (see also [8]).

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