Mysteries of the numerical field and errors of natural sciences related to "imaginary numbers"

1. Introduction

Can a composer create a musical composition unknowing musical notes? Of course, he cannot do it that is self-understood. For natural sciences, their notes are numbers. However, as no wonder is it, it is usual to assume that all, or almost all, is known about numbers. They are regarded as a free creation of reason. Unfortunately, it is a greatest fallacy because we are a part of the Universe, which prompts to us how we should perceive its quantitative field.

Nobody will object to the fact that there are objective physics of nature and physics as a science about nature. The objective physics of nature is the first simplest level of qualitative properties of fields of the Universe, whereas objective chemistry is the higher level of them. If we unsettle accounts with reality and use the numbers following the way of a free game of notions, then theories created herein are doubtful and most often are incorrect, at least, in principal.

The first notes-numbers, expressing only an elementary count of things, had no sign. As concerns numbers with the negative sign, these have perceived long time as imaginary quantities unreflecting the real features of nature. Even in the 18th century, some outstanding mathematicians have regarded negative quantities as imaginary ones. Immense efforts of mathematicians were required before positive and negative numbers became full notes of science.

However, mathematics turned out to be unable to solve the problem of taking the square root of negative numbers and introduced the imaginary unit $i = \sqrt{-1}$. Formally, an illusion of solving of the problem was created. However, a complex number, as the sum of "real" and "imaginary" numbers

$$\hat{Z} = a + ib \qquad \text{or} \qquad \hat{Z} = a + bi\,, \tag{1.1}$$

has remained, as before, an "imaginary number" without any objective content.

Throughout the course of development of complex numbers theory, a very important stage began with an appearance of Euler's formula

$$e^{i\varphi} = \cos\varphi + i\sin\varphi\,. \tag{1.2}$$

It allowed presenting the numbers on the complex plane in the form

$$\hat{Z} = a + ib = re^{i\varphi} = r(\cos\varphi + i\sin\varphi)\,, \tag{1.3}$$

where φ is the phase angle on this plane, determined on the basis of the relation $tg\varphi = b/a$, and $r = \sqrt{a^2 + b^2}$ is the module of the number.

2. Two algebras of signs reflecting the opposite relations in nature

The algebra of units-notes of "real quantities" is represented by common algebra of signs, which expresses the definite correlation in nature:

$$(\pm 1)(\pm 1) = +1\,, \quad (\pm 1)(\mp 1) = -1\,. \tag{2.1}$$

We will call it the ***positive algebra of signs***. In the field of numbers belonging to this algebra, it is possible to extract the square root of the positive unit, but impossible for the negative unit.

Let us consider how the algebra of "real units" shows its worth in physical fields of the central (longitudinal) interaction. Electric charges in static conditions demonstrate such an interaction. The identical (in sign) two charges, ± 1 and ± 1, repeal that is possible to express by the relative unit measure of the central repulsion +1. Whereas the charges of opposite signs, ± 1 and ∓ 1, attract, the measure –1 reflects it. Such is the objective algebra of quantitative relations in central (longitudinal) fields of exchange of matter-space-time.

Because the World is a system of interdependent fields and phenomena of nature with *opposite properties*, one should expect an existence in nature of the algebra with the *opposite system of relations*. It is natural to call such algebra the ***negative algebra of signs***. It must have the form

$$(\pm \mathbf{1})(\pm \mathbf{1}) = -1\,, \quad (\pm \mathbf{1})(\mp \mathbf{1}) = +1\,. \tag{2.1a}$$

Here, “real units” are written by the bold type in order to emphasize their relation with the negative algebra of signs. Obviously, in the field of numbers with the negative algebra, it is possible to extract the square root of the negative unit, but impossible for the positive one.

The negative algebra shows its worth under the noncentral (transversal) interaction. For example, two rectilinear electric currents of the same sign (direction), $\pm i$ and $\pm i$, attract through their magnetic (transversal) fields that is possible to present by the relative measure –1. Currents of different signs (directions), $\pm i$ and $\mp i$, repeal, the measure +1 represents it. Thus, the algebra of interaction of currents has the form

$$(\pm i)(\pm i) = -1, \quad (\pm i)(\mp i) = +1. \qquad (2.2)$$

It is obvious, this algebra is identical to the algebra of “imaginary units”. However, nobody can assert that a current, for example of the unit value of one ampere, $i = \mathbf{1}\,A$, is an “imaginary object lying in the complex plane”, but not in the real space, only because it does not follow the algebra of signs firmly established in the 18th century.

For the sake of convenience, let us agree to express the real unit **1** by the letter *i*, then it will be difficulty to confuse the qualitatively different numbers, which are related between themselves by the opposite algebras of signs.

The real numbers, which follow the positive algebra of signs, we will denote by the symbol *a*1 or *a*. The numbers, related with the negative algebra of signs, will be denoted by the symbol *bi* or *ib*, which indicates that the given number consists of *b* real units *i*.

As a rule, *any objects and phenomena of nature have* ***opposite properties****, whose measures follow* ***opposite algebras***. Therefore, such objects and phenomena naturally must be described by ***binary real numbers***, where, for example, the first item follows the positive algebra and the second one the negative algebra of signs. Binary numbers $\hat{S}$ are similar, in form, to complex numbers (1.1) and for every of them the conjugated number $\hat{S}^*$ corresponds:

$$\hat{S} = a + bi, \qquad \hat{S}^* = a - bi. \qquad (2.3)$$

We will write binary numbers also in the following form

$$\hat{S} = a + \tilde{b}, \qquad \hat{S}^* = a - \tilde{b}, \qquad (2.3a)$$

where $\tilde{b}$ is the symbol of a number with the negative algebra of signs.

In the field of *binary real numbers*, Euler’s formula is valid:

$$\hat{S} = a + ib = re^{i\varphi} = r(\cos\varphi + i\sin\varphi), \qquad (2.4)$$

where φ is an *argument of the number*, but not a phase angle of the complex plane.

Binary real numbers are characterized by the module *r* and modus *s*:

$$r = \sqrt{a^2 + b^2} = \sqrt{\hat{S}\hat{S}^*}, \qquad s = a \pm b. \qquad (2.5)$$

The sign “$\pm$” takes the values “+” or “–“ depending on the concrete process described by the binary number.

An argument φ of a binary number is a strongly definite quantity. Therefore, raising to the *n*th power of a binary number or taking the *n*th root of a binary number are the operations having a single meaning. Suppose that a binary number describes an oscillatory process, so that $\varphi = \omega t$, then, for example for relative measures of numbers, we will have

$$\left(\frac{\hat{S}}{r}\right)^n = e^{in\omega t}, \qquad \sqrt[n]{\frac{\hat{S}}{r}} = e^{i\omega t/n}. \qquad (2.6)$$

The exponentiation defines the *n*th overtone and the extraction of the root defines the *n*th undertone.

Between binary numbers $\hat{S}_1 = r_1 e^{i\varphi_1} = a_1 + b_1 i$ and $\hat{S}_2 = r_2 e^{i\varphi_2} = a_2 + b_2 i$, the following quantitative relations take place:

a) on components

$$a_1 < a_2, \quad a_1 = a_2, \quad a_1 > a_2; \qquad b_1 i < b_2 i, \quad b_1 i = b_2 i, \quad b_1 i > b_2 i; \qquad (2.7)$$

b) in modulus

$$r_1 < r_2, \quad r_1 = r_2, \quad r_1 > r_2. \qquad (2.7a)$$

The binary numerical field reflects the symmetry of essentially opposite (polar-opposite) properties of objects and processes in nature, whereas the simply opposite properties of nature are expressed by numbers with the signs "+" and "–". Of course, between the essential opposition and the inessential one, there is a continuous realm of properties with discrete levels of the intermediate opposition. Thus, the numbers *a* and *bi* express the essential opposition and the numbers *a* and +*b* the inessential opposition. The convenience and required precision for the description of opposite properties of studying objects and phenomena of nature dictate the choice of numbers. The binary numbers are most suitable for it. In the general case, they describe effectively not only the polar-opposite properties of nature, but also the simply opposite properties of a different extent of opposition.

The symmetry of opposite properties is the fundamental law of the Universe and binary real numbers reflect this law. The algebra of binary numbers follows the laws of dialectical philosophy and dialectical logic, i.e., dialectics as the science of symmetry of binary judgements about the nature of any object or process. The field of binary numbers is the basis of dialectical mathematics and physics.

In the simplest cases, integer and rational numbers express the interrelation of the whole and a part. They reflect, above all, discrete properties of nature, whereas continuous properties are described, mainly, by irrational numbers. In the general case, continuity is represented by the whole numerical field, like discontinuity (discreteness).

When numbers define a quantitative measure in general, they have no signs. These are signless numbers. The first signless numbers were "natural" numbers, appeared for the counting of arbitrary objects in nature. A set of natural numbers is designated by the symbol *N*. Integer numbers, reflecting opposite discrete properties, are represented by two sets, N_+ and N_-, which are related with natural numbers by the equalities:

$$N_+ = +N = N\cos 0 , \qquad N_- = -N = N\cos\pi , \tag{2.8}$$

where $\cos 0 = +1$ and $\cos\pi = -1$ are the indexes of signs.

Thus, in dialectics, whole numerical sets are related between themselves as

$$N \neq N_+ \neq N_- . \qquad (2.9).$$

Naturally, relations (2.9) are valid for any numbers *Q* (rational and irrational), which can be both signed and signless.

$$Q \neq Q_+ \neq Q_- . \tag{2.9a}$$

Here is the simplest example. A *mutual* distance between two cities, *A* and *B*, is defined by the signless measure *S*, whereas the distances from *A* to *B* and from *B* to *A*, strictly speaking, must be represented by the different, in sign, measures: $S_{AB} = +S$ and $S_{BA} = -S$.

In classical mathematics, an analog of the number *Q*, as a quantitative measure in general, is represented by a "modulus of the number" $|Q|$, which, however, is assumed to be equal to the positive number: $|Q| = +Q$. Thus, in contemporary mathematics, strictly speaking, the modulus of a number is regarded as the number with the positive sign and, consequently, mathematics does not operate with signless numbers. For this reason, among a set of integer numbers of contemporary mathematics, natural (signless) numbers are regarded as integer positive numbers:

$$N = N_+ , \tag{2.10}$$

that is incorrect in principle!

In mathematical expressions, it is usual to write the first (after the equality sign) positive numbers, expressed in the numerical or symbolical form, without a sign. However, these are not signless numbers. Here, tacitly, the presence of the sign "+" is assumed. In such cases, for example, the factor +5 will be presented formally by the number 5 without the sign, but it does not quite mean that $+5 = 5$.

In the field of binary numbers, the correlation between the base of a number and its power has the fundamental character. Indeed, if a physical process requires for its representation a binary number with some base *d*, then its binary measure will have the form

$$\hat{Z} = rd^{i\varphi} = re^{i\ln d\cdot\varphi} = r(\cos(\ln d \cdot \varphi) + i\sin(\ln d \cdot \varphi)) . \tag{2.11}$$

The Universe suggests very often operating with the base $d = 10$, then the binary field (2.11) with the decimal base will be characterized by the period-quantum

$$\Delta = 2\pi / \ln 10 = 2\pi \lg e \approx 2.7288 . \tag{2.12}$$

This quantum is represented in metrology by the ancient Roman ounce of 2.7288-decagram mass. Its measure is demonstrated on the first page of the “Dialectical Physics” web site. A comprehensive theory of this fundamental period-quantum of the numerical field with the decimal base is set forth in other papers of this site and also in the works [1-5].

3. Binary real numbers as measures of real processes

Binary real numbers, being measures of real processes, are essentially distinguished from formal complex numbers. The lasts include “imaginary” components, therefore, physicists and chemists avoid them as far as possible. This had serious effects, in particular, at the creation of atomic structure theory: gave rise to Schrödinger’s equation and called a problem dealing with the interpretation of the wave function [1-3, 6].

Hitherto, following Newton, one assumes that an appearance of imaginary quantities means no-solution condition for a problem. It is not the case that hitherto teachers hammer it home to schoolboys the idea that if a discriminant of a quadratic equation is smaller than zero then there is no (real) solution of the equation. Let us look at this, whether is it true?

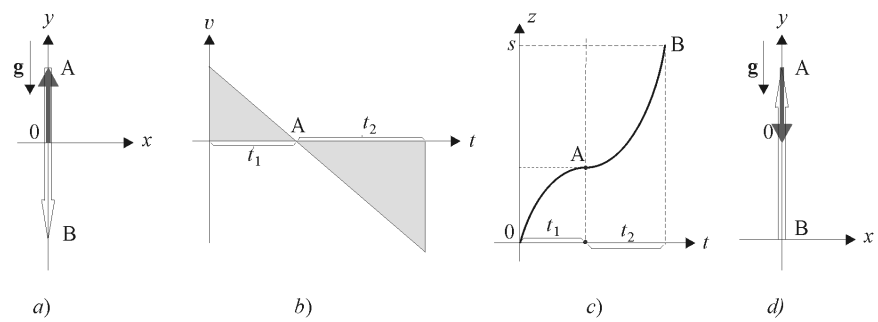

Fig. 3.1. The motion of a body thrown vertically up (*a*); plots of the velocity υ (*b*) and the displacement s (distance) (*c*), z is the axis of displacement; the inverse motion *(d)*.

As the ***first example***, we will consider the simplest problem of determination of the time of motion of a body thrown vertically up with the initial velocity $\upsilon_0 = 30\, m/s$ if the passed distance is $s = 125\, m$ (Fig. 3.1a). Air resistance is not taken into account and it is assumed that the acceleration of free fall $g = 10\, m/s^2$. Two parts of motion, *OA* and *AB*, with the opposite character of motion and two times, t_1 and t_2, relate to each other as the past and the future (Fig. 3.1b), therefore, they must be described by the different algebras of signs. The binary numerical field allows taking into account this peculiarity of motion.

The axis y is directed vertically up, hence, an equation of the uniformly variable motion of a body is expressed by the equation

$$s = \upsilon_0 t - \frac{gt^2}{2} \qquad \text{or} \qquad gt^2 - 2\upsilon_0 t + 2s = 0, \tag{3.1}$$

at that $D = 4\upsilon_0^2 - 8gs < 0$.

The negative discriminant D does not trouble us, because we are able to extract square roots of negative numbers. Solutions of the equation (3.1) have the form:

$$\hat{t} = t_1 \pm it_2 = \frac{2\upsilon_0 \pm \sqrt{4\upsilon_0^2 - 8gs}}{2g} = \frac{\upsilon_0}{g} \pm \frac{i\sqrt{2gs - \upsilon_0^2}}{g} = 3 \pm 4i\ (s)\,. \tag{3.2}$$

The finite velocity is equal to $\upsilon = -\sqrt{2gs - \upsilon_0^2}$ and the time of motion is presented by the binary number as

$$\hat{t}_+ = t_1 + it_2 = \frac{2\upsilon_0 + \sqrt{4\upsilon_0^2 - 8gs}}{2g} = \frac{\upsilon_0}{g} - \frac{i\upsilon}{g} = 3 + 4i\ (s), \tag{3.3}$$

herein, the initial-final velocity is

$$\hat{\upsilon} = \upsilon_0 - i\upsilon = g\hat{t}_+ . \tag{3.4}$$

The solution with the sign "+" expresses the fact that within the limits of the trajectory the direction of motion does not change. It is the absolute, or proper, direction of the trajectory.

On the other hand, the conjugated value of time $\hat{t}_+^* = t_1 - it_2$ shows that the past motion *OA* and the future motion *AB* are opposite, in sign, with respect to the *y*-axis.

The time $t_1 = 3\ s$ is the past time, during which a body goes up. Achieving the apogee, the body falls down. At the end of the fourth "imaginary" second of the future time ($t_2 = 4i\ s$), the body passes, totally, the distance of the length of 125 *m*. The total time of motion is defined by the modus of time: $t_+ = t_1 + t_2 = 7\ s$.

Any trajectory is characterized by the two closely related parameters: (1) the covered distance *s* and (2) the coordinate *y*, which are expressed in the equation (3.1) by the same symbol *s*. Since only the passed distance was given, we have solved the problem in accordance with that value.

If in the equation (3.1), we introduce the value of time equal to $\hat{t}_+ = t_1 + it_2 = 3 + 4i$, we arrive at $s = \upsilon_0 \hat{t}_+ - \frac{g\hat{t}_+^2}{2} = \upsilon_0 t_1 - \frac{gt_1^2}{2} + \frac{gt_2^2}{2} + (\upsilon_0 - gt_1)it_2$, but $(\upsilon_0 - gt_1) = 0$ and $\upsilon_0 t_1 - \frac{gt_1^2}{2} = \frac{gt_1^2}{2}$, hence,

$$s = \frac{g}{2}t_1^2 + \frac{g}{2}t_2^2 = \frac{g}{2}\hat{t}\hat{t}^* = \frac{g}{2}t_m^2 = 125\ m, \tag{3.5}$$

where $t_m^2 = \hat{t}\hat{t}^*$ is the modulus of time squared. We will arrive at the same result with use of the conjugated time $\hat{t}_+^* = t_1 - it_2$.

With respect to the finite point *B*, the past *OA* and the future *AB* together is the past *OB*, therefore, the last will be characterized by the same positive algebra of signs. Now, the total time-modus $t_+ = t_1 + t_2$ defines the coordinate of the body:

$$s = \upsilon_0 t_+ - \frac{gt_+^2}{2} = \upsilon_0(t_1 + t_2) - \frac{gt_1^2}{2} - \frac{gt_2^2}{2} - gt_1 t_2 = \upsilon_0 t_1 - \frac{gt_1^2}{2} - \frac{gt_2^2}{2} + (\upsilon_0 - gt_1)t_2 = \frac{gt_1^2}{2} - \frac{gt_2^2}{2}$$

or

$$s = y = \frac{g}{2}t_1^2 + \frac{g}{2}(it_2)^2 = -35\ m. \tag{3.6}$$

Now, we will consider the inverse motion (Fig. 3.1d). Let the body be reflected from an elastic plane in the point *B*. In this case, the initial velocity υ_{in} and the final velocity υ_{fin} of the inverse motion will be expressed through the velocities of the direct motion by the following way:

$$\upsilon_{in} = -\upsilon = \sqrt{2gs - \upsilon_0^2}, \qquad \upsilon_{fin} = -\upsilon_0. \tag{3.7}$$

In the inverse motion, the future motion *AB* becomes the past one, the past motion *OA* becomes the future one, and the equation of motion takes the form:

$$s = \upsilon_{in} t - \frac{gt^2}{2} \qquad \text{or} \qquad gt^2 - 2\upsilon_{in} t + 2s = 0, \tag{3.8}$$

herein,

$$D = 4\upsilon_{in}^2 - 8gs = -4\upsilon_{fin}^2 < 0. \tag{3.8a}$$

The roots of the equation (3.8) are

$$\hat{t} = t_2 \pm it_1 = \frac{2\upsilon_{in} \pm \sqrt{4\upsilon_{in}^2 - 8gs}}{2g} = \frac{\sqrt{2gs - \upsilon_0^2}}{g} \pm \frac{i\upsilon_{fin}}{g} = 4 \pm 3i\ (s). \tag{3.9}$$

The time of motion

$$\hat{t}_- = t_2 + it_1 = 4 + 3i\ (\text{s}) \tag{3.10}$$

defines the path; the modus of time $t_- = t_2 + t_1$ defines the coordinate:

$$s = \upsilon_{in} t_- - \frac{gt_-^2}{2} = \upsilon_{in}(t_2 + t_1) - \frac{gt_2^2}{2} - \frac{gt_1^2}{2} - gt_2 t_1 = \upsilon_{in} t_2 - \frac{gt_2^2}{2} - \frac{gt_1^2}{2} + (\upsilon_{in} - gt_2)t_1 = \frac{gt_2^2}{2} - \frac{gt_1^2}{2}$$

or

$$s = y = \frac{g}{2}t_2^2 + \frac{g}{2}(it_1)^2 = +35\ m. \tag{3.11}$$

The conjugated time $\hat{t}_-^* = t_2 + it_1$ expresses the external relation between the past and the future motions. The times of direct and inverse motions point out the opposite character of these motions:

$$\hat{t}_- = i(t_1 - it_2) = i\hat{t}_+^*, \qquad \hat{t}_+ = i(t_2 - it_1) = i\hat{t}_-^*. \tag{3.12}$$

The ***next*** *elementary* ***example*** relates to geometry. Let the area of a surface is defined (restricted) by the parabola $y = x^2$. Following the fully formed common concepts, the parabola consists only of one upper branch. However, mathematics of *binary real numbers* and concrete physical conditions "know" nothing about it and give the solution for the whole body of parabola, highlighting our "forgetfulness" and even "ignorance". Namely, solutions of the equation $y = x^2$ give at the *x*-axis, apart from the real values $+x$ and $–x$, the real values $+ix$ and $–ix$. With this, the last pair of values is subjected to the negative algebra of signs, in opposition to the first one with the positive algebra.

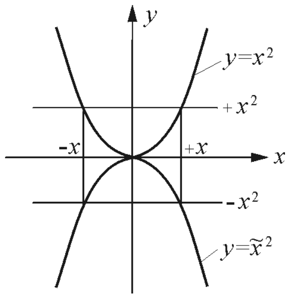

Fig. 3.2. The symmetrical (uncut or whole) parabola with the upper and lower branches.

Besides, any surface has external (positive) and internal (negative) sides, which, strictly speaking, must be characterized by different signs of area. In such a case, two symmetrical branches of parabola

$$y = x^2 \quad \text{and} \quad y = \tilde{x}^2, \tag{3.13}$$

represent (restrict) internal and external areas of the given surface (Fig. 3.2).

The general question arises in this connection: "Why must the parabola be presented in the symmetrical form?" An answer to this question is extremely simple: a frog consists of two parts, left and right, which together just it is a living frog. Any half separately is not a frog, it is only a dead half of her body (a biological mass). Such is the philosophy of the symmetrical world with the different asymmetry of its opposite parts [1-3]. Mathematically, the symmetry is expressed in an existence of the two opposite algebras, which describe both insignificant oppositions and polar oppositions (like rest and motion, material and ideal, etc.).

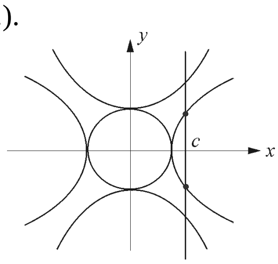

Fig. 3.3. Points of intersection of the straight line $x = c > r$ (*c* are numbers with the positive algebra of signs) with the second order curve $x^2 + y^2 = r^2$; *x* and *y* are coordinate axes neutral with respect to algebra of signs.

At last let us consider ***a problem*** *of intersection* (on a plane) of a straight line $x = c > r$ with the curve

$$x^2 + y^2 = r^2. \tag{3.14}$$

From the formal point of view, this problem has no solution, because this equation defines a "circumference" and the line $x = c > r$ lies beyond the "circumference". However, even on a set of positive numbers, the equation (3.14) defines not a circumference but only its quarter. In the field of *binary real numbers*, the equation (3.14) circumscribes, in the simplest case, a parabolic cross (Fig. 3.3) with a circumference in the center and the straight line $x = c > r$ intersects parabolic branches of this cross.

4. The potential-kinetic field

Any field of mega- and microworld is the potential-kinetic field, the complete description of which is possible only on the basis of *binary real numbers*, because their structure repeats both the structure and algebra of relations in such fields [1-5]. The potential kinetic field is a system of two subfields: kinetic and potential. Contemporary physics describes satisfactorily the kinetic field, but the description of the potential subfield lags behind considerably of the kinetic one. Both subfields (potential and kinetic) are unstable, they mutually transform into each other that *gives rise to the wave process*. Potential-kinetic fields are represented by concrete longitudinal-transversal fields of matter-space-time of the Universe. A spectrum of potential-kinetic fields is infinite and all these fields form the united field of matter-space-time of the Universe.

Newton described in a definite extent the kinetic field. However, the description of the potential field (carried out by Hooke) was realized only in a rudimentary form. Unfortunately, only Hooke has understood all importance of the development of notions of potential mechanics, which obtained its application only in a theory of elasticity and resistance of materials. During subsequent centuries, this theme was not an objective for research. As a result, contemporary physics turned out to be unable to develop a correct theory of the potential-kinetic field of atomic space and gave rise to Schrödinger's equation and other similar equations, containing the gross errors. An analysis of these errors was carried out in the works [1-3,6].

The complete description of kinetic and potential fields must be based on the *symmetrical physical parameters*: kinetic and potential displacements of particles of different levels of these fields. The corresponding velocities present a change of potential and kinetic displacements. The notion *kinetic velocity*, expressing the intensity of the kinetic field, exists, but there is not the notion the *potential velocity*, characterizing the intensity of the potential field. There is the notion the *kinetic momentum*, as the product of the mass and the velocity of the particle, but the notion the *potential momentum* lacks, although we perceive it, compressing a spring. Without symmetrical notions, it is impossible cognition of the World. We will consider some of them briefly below. A detail consideration of these questions can be found in works [1-3].

Let the potential displacement varies in time as cosine, defining the displacement of a particle (of a field) from equilibrium that the particle passes with the maximal velocity. In this sense, the points of the equilibrium are kinetic points of the field. Maxima of the potential displacement define potential points of the field, in which the potential energy is, in value, at its maximum.

The kinetic displacement defines the intensity of the kinetic field. It must attain maximum in kinetic points (points of the equilibrium). Therefore, it is possible to assume that the kinetic displacement varies in time as sine.

If the potential displacement of a particle follows the positive algebra of signs, then the kinetic displacement must satisfy the negative algebra. Hence, the complete potential-kinetic displacement $\hat{\Psi}$ will be presented by the binary number

$$\hat{\Psi} = x + iy = x + \tilde{y} = a(\cos\omega t + i\sin\omega t) = ae^{i\omega t}, \qquad (4.1)$$

where $x = a\cos\omega t$ and $\tilde{y} = iy = ia\sin\omega t$ are the potential and kinetic displacements, respectively.

In the wave field, the potential-kinetic displacement is presented by the harmonic wave

$$\hat{\Psi} = x + iy = a(\cos(\omega t - kr) + i\sin(\omega t - kr)) = ae^{(i\omega t - kr)}, \qquad (4.2)$$

where $k = \omega / c$ is the wave number.

A derivative of the potential-kinetic displacement with respect to time defines the potential-kinetic velocity

$$\hat{\upsilon} = \frac{d\hat{\Psi}}{dt} = i\omega\hat{\Psi} = -\omega y + i\omega x = \upsilon_k + i\upsilon_p = \upsilon_k + \tilde{\upsilon}_p. \qquad (4.3)$$

where $\upsilon_k = \frac{dx}{dt} = -\omega y$ is the kinetic velocity, proportional to the kinetic displacement; $\tilde{\upsilon}_p = \frac{d\tilde{y}}{dt} = i\omega x$ is the potential velocity, proportional to the potential displacement.

The velocity (4.3) defines the potential-kinetic momentum

$$\hat{P} = m\hat{\upsilon} = m\upsilon_k + im\upsilon_p = m\upsilon_k + m\tilde{\upsilon}_p, \qquad (4.4)$$

where $p_k = m\upsilon_k = m\frac{dx}{dt} = -m\omega y$ and $\tilde{p}_p = m\tilde{\upsilon}_p = m\frac{d\tilde{y}}{dt} = im\omega x$ are the kinetic and potential momentum respectively.

The rate of change of the potential-kinetic momentum (or kinema) defines exchange of motion-rest and, in the general case, of mass in the process of interaction:

$$\hat{F} = \frac{d\hat{P}}{dt} = -\omega^2 m\hat{\Psi} = -\kappa\hat{\Psi} = -\kappa(x+iy)\,. \tag{4.5}$$

In contemporary physics, the potential-kinetic kinema is presented by its potential component, called the basic law of dynamics:

$$f_p = \frac{dp_k}{dt}\,. \tag{4.6}$$

This equality is not exceptional among other equalities of a similar kind in anything. Therefore, it is not a law of nature: it is only one of the ways of description (not complete, however) of motion.

The real law of potential-kinetic fields is the *law of universal exchange of matter-space-motion-res*t. It can be described on the basis of different potential-kinetic parameters. In particular, if $\hat{F}$ is a variable quantity, we can use the potential-kinetic parameter $\hat{D}$, expressing the rate of change of $\hat{F}$:

$$\hat{D} = \frac{d\hat{F}}{dt}\,. \tag{4.7}$$

The total potential-kinetic energy has the form

$$\hat{W} = \int_0^{\hat{\upsilon}} \hat{F} d\hat{\Psi} = \frac{m\hat{\upsilon}^2}{2} = \frac{m\upsilon_k^2}{2} + \frac{m\tilde{\upsilon}_p^2}{2} + m\upsilon_k\tilde{\upsilon}_p\,. \tag{4.8}$$

If the kinetic velocity (and the kinetic displacement) is the measure of intensity of motion, then the potential velocity (and the potential displacement) is the measure of intensity of rest. Kinetic and potential velocities define the corresponding energies, having different signs that points to their opposite character:

$$W_p = \frac{m\tilde{\upsilon}_p^2}{2} = -\frac{kx^2}{2}\,, \qquad W_k = \frac{m\upsilon_k^2}{2} = -\frac{k\tilde{y}^2}{2}\,. \tag{4.9}$$

The difference of the energies is equal to the modulus of the total energy, in the classical sense:

$$W = W_k - W_p = \frac{ka^2}{2}\,. \tag{4.10}$$

Symmetrical potential-kinetic binary parameters give the complete description of potential-kinetic fields. That is impossible in classical, quantum, and wave physics, including electrodynamics, which were created on the basis of *notions* of the 19th century undeveloped afterwards.

In the next paper ("*The binary numerical field and potential-kinetic oscillations*"), we will show possibilities of the field of *binary real numbers* for the description of free and forced oscillations in the simplest kinematic circuits.

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