Description of Physical Processes by the Dialectical Field of Binumbers

(L.G. Kreidik and G.P. Shpenkov, *Foundation of Physics*: 13.644…*Collected Papers*, **The paper No 3**, pp. 37-52, Bydgoszcz, 1998)

Abstract. A dialectical binumerical field reflecting the bipolar symmetry in nature is considered. A wave character of physical processes is presented by the wave binumerical field of real numbers repeating the geometry of these processes in three dimensional space, which is impossible to express by the conventional field of complex numbers localized in the plane of real and "imaginary" components. An essential distinction between an application of the dialectical binumerical field of real numbers and the conventional field of complex numbers is shown in the simplest examples. In particular, the advantage and completeness of nonconventional description by the dialectical field of binumbers is demonstrated by an analysis of harmonic oscillations. It is stated that the field of complex numbers is a particular case of this dialectical field.
PACS Numbers: 01.70.+w, 02.10.-v, 01.55.+b

1. Introduction: formal logic and dialectics

Formal logic was established by Aristotle (384 BC − 322 BC). The basic rules of the logic − the law of identity, the law of noncontradiction, and the law of the excluded middle − were described in his principle philosophical work, "Metaphysics".

At present, it usual to call these rules the laws of right thinking, although they are, in essence, the logical rules of metaphysics. These rules were in discordance with the contributions of antique dialecticists, and Hegel in Germany and Plekhanov in Russia revealed their limitations.

The *law of identity* claims: any judgement about a subject of thought must be definite and invariable in the course of reasoning, i.e. "*a* is *a*", where *a* is any judgement. This rule is expressed by the formula

$$a = a \quad \text{(the law of identity).} \qquad (1.1)$$

Thus, *Yes* is only *Yes*, and *No* is only *No*:

$$Yes = Yes, \qquad No = No \qquad (1.1a)$$

Of course, if a book is on the table then it seems only natural to state that only the book is on the table. So, in this sense, the law of identity is valid, but only for some time because, for example, the book can disappear, even in the process of judgement about it, and another subject, for example, a folder, can appear on the table in place of the book. It is an everyday situation. But, when we study physical processes, our thoughts and judgements must reflect a changing picture and be variable functional judgements *Yes*(*t*), *No*(*t*), so that a question about identity must not arise in such situations..

The *law of noncontradiction* states: a judgement about a subject of thought must not be simultaneously affirmative a and nagative $\overline{a}$ − both of these cannot be true together. This rule is the first metaphysical support of the law of identity that is expressed by the following formula

$$a \cap \overline{a} = \varnothing \qquad \text{(the law of noncontradiction)} \qquad (1.2)$$

Thus, "*Yes* and *No*" is an empty set:

$$Yes \cap No = \varnothing . \qquad (1.2a)$$

The *law of the excluded middle* states: at least, one of the two opposite judgements, a or $\bar{a}$, is the true one and the third is not given. This rule forms the second metaphysical support of the law of identity, expressed by

$$a \cup \bar{a} = I \qquad \text{(the law of the excluded middle)}, \qquad (1.3)$$

where I is the universal set represented in metaphysics by only *Yes* and *No* elements.

Thus, “*Yes* and *No*” exhaust all judgements:

$$Yes \cup No = I \qquad (1.3a)$$

The algebra of judgements by Aristotle is valid, within definite bounds, as the algebra of contact elements in devices similar to robot systems, computers, etc., but not more.

In contrast with metaphysics, *dialectics states*: the World is objective dialectics, which is effectively described on the basis of subjective dialectics (dialectical philosophy and its logic) by basic notes-judgements of dialectics

Yes, *No*, *Yes*-*Yes*, *No*-*No*, *Yes*-*No*

and more complicated accords as

Yes-*Yes*-*No*, etc.

Dialectical judgements are variable ones. They are changed in accordance with the change of a subject of thought, i.e. in a general case, any judgement a must satisfy the *law of motion* which can be presented, in terms of sets, by the antinomy

$$(a = a) \wedge (a \neq a), \qquad (1.4)$$

which states that a judgement must be variable, reflecting variable processes in nature, i.e. being equal itself it must not be equal itself.

For instance, Smith as a child, schoolboy, student, man is the same Smith so that, in this sense, all they enumerated are equal themselves, but simultaneously they are not equal because the child is not equal to the schoolboy, especially not to the student or man. At that, the process of Smith’s change is a comparatively slow one, but when physical processes are analyzed, which runs its course sufficiently quickly, Aristotle’s rules turn into fetters of thought essentially decreasing possibilities of intellect.

2. A dialectical field of binary numbers

According to dialectics, a number Z is the system of its basis B and superstructure $\{S\}$:

$$Z = B^{\{S\}}. \qquad (2.1)$$

If it is necessary to note that B is the basis of the number Z, we write $B = bas(Z)$. The superstructure (or adbasis by the Greek-Latin) $\{S\}$ represents any qualitative, quantitative, or quantitative-qualitative, symbols and/or signs characterizing the number Z with this basis.

Symbols and signs of superstructure can be settled before, after, above, and under its basis. The main signs of superstructure to basis are plus-minus signs, exponents, indexes, etc. We present any symbol or sign of superstructure $\{S\}$ of number Z by the following equality

$$\{S\} = \mathrm{ad}_B(Z) \quad \text{or} \qquad \{S\} = \sup_B(Z). \qquad (2.2)$$

Equalities (2.2) mean that "$\{S\}$ is adbasis (superstructure) to basis *B* of number Z".

If *S* is the power *m* of number Z with basis *B*, i.e. $Z = B^m$, then

$$m = ad_B(Z). \qquad (2.3)$$

Since a degree of a number is defined by logarithm, therefore, $\log_B Z$ is as well the adbasis (superstructure) to base *B* of number Z.

In the simplest case, the basis of number Z can be presented by measures *Yes* or *No*. In dialectics [4], algebra of such basis is expressed by the following equalities

Yes · *Yes* = *Yes*, *No* · *No* = *Yes*, *Yes* · *No* = *No*, *No* · *Yes* = *No*. (2.4)

Algebra of superstructure of signs "+" and "–", expressed by the equalities

$$(\pm)\cdot(\pm) = +, \quad (\pm)\cdot(\mp) = -, \qquad (2.5)$$

we will call the positive algebra of superstructure (superstructure *Yes*). Signs of superstructure *Yes*, "+" and "–", are signs of the affirmative feature.

According to dialectical logic, if algebra of signs of superstructure *Yes* (2.5) is, then there must exist algebra of superstructure *No*, opposite to (2.5):

$$(\mp)\cdot(\mp) = -, \quad (\mp)\cdot(\pm) = + . \qquad (2.6)$$

Algebra of superstructure *Yes* (algebra of affirmation) is inherent in electric interactions: the product of charges of the same sign defines repulsion and the opposite signs – attraction that is expressed by the corresponding signs "+" or "–" in the right side of the equation (2.5).

On the contrary, algebra of superstructure *No* (algebra of negation) describes magnetic interactions of currents: the product of currents of the same sign defines attraction and the opposite currents – repulsion. Of course, a choice of signs of results of interaction is relative, to some extent, but the diametric opposition of algebras of charges and currents interactions is absolute.

Numbers pertaining to algebra of superstructure *Yes*, we call the *numbers of affirmation*, at that the unit of affirmation is denoted by the symbol of unit 1.

Any quantity of affirmation *Yes* is characterized by a number-measure Z of the kind:

$$Z = a \cdot 1 \qquad \text{or briefly} \qquad Z = a, \qquad (2.7)$$

where a is an arbitrary real number of units of affirmation.

Numbers with algebra of superstructure *No*, we call the *numbers of negation*. The unit of negation is denoted by one of the symbols *i*, *j*, or *n*.

Any quantity of negation *No* is defined by the number-measure Z of the kind:

$$Z = b \cdot i \qquad \text{or briefly} \qquad Z = ib, \qquad (2.8)$$

where b is an arbitrary real number of units of negation.

Thus, dialectical numbers-judgements *Yes*-*No* can be presented by a binary structure $\hat{Z}$ of the following kind

$$\hat{Z} = a + ib. \qquad (2.9)$$

In order that the unit of negation *i* would not be associated with the imaginary unit of complex numbers *i*, number *ib* in (2.9) can also be presented by underlining *b* (without *i*): $\underline{b}$.

The sign $\wedge$ above the number $\hat{Z}$ indicates its contradictory *Yes-No* character. We will omit this sign, not infrequently, for simplicity. Obviously, both numbers a and ib are real numbers but with diametrically opposite algebras of their signs. In this sense, the factor i is the *indicator of the algebra* (2.6).

Binary numbers of affirmation-negation $\hat{Z}$ reflect the contrasting symmetry inherent in nature. They form the field of binary real numbers, i.e. the field of real numbers with polar opposed algebras of signs. Let us call such binary numbers *binumbers*, and the physical parameters described by them – *biparameters*.

We introduce the *quantitative module* r of the binumber $\hat{Z}$, defining it by the equality

$$r = \left|\hat{Z}\right| = \sqrt{a^2 + b^2}\ , \qquad (2.10)$$

and the *norm* (from the Latin, norma=quantity) $No(\hat{Z})$ of $\hat{Z}$, equal to the sum of a and b numbers,

$$No(\hat{Z}) = a + b\ . \qquad (2.11)$$

If we introduce the parameter φ, satisfying the equalities, $\cos\varphi = a / r$ and $\sin\varphi = b / r$, then $\hat{Z}$ (2.9) can be presented by the trigonometrical functions:

$$\hat{Z} = r\cos\varphi + ir\sin\varphi\ . \qquad (2.12)$$

Both components of $\hat{Z}$ can have arbitrary directions or be undirected quantities; therefore, *it is impossible, generally, to consider* φ-parameter *as an angle similarly as it takes place in the theory of complex numbers* [1].

As known, an analytical function in the vicinity of a point x_0 can be presented by Taylor series on the basis of which the number $Z = e^{i\varphi}$, where e is the base of natural logarithms, can be presented in the form of the sum

$$e^{i\varphi} = \cos\varphi + i\sin\varphi\ . \qquad (2.13)$$

This equality, analogical to Euler's formula in the theory of complex numbers, makes it possible to express any binumber $\hat{Z} = a + ib$ in the following way

$$\hat{Z} = a + ib = re^{i\varphi} = r(\cos\varphi + i\sin\varphi) \qquad (2.14)$$

Hence, φ-parameter is the real number of units of negation of superstructure, a phase of the binumber, expressing a variable character of the number and the bond of affirmation and negation components. Obviously,

$$tg\varphi = \frac{b}{a}, \qquad \varphi = arctg\left(\frac{b}{a}\right) \qquad (2.15)$$

If $\mathrm{ad}_B(Z) = \vartheta$ is a number of affirmation then $Z = B^{\vartheta}$ expresses the quantitative changes.

If $\mathrm{ad}_B(Z) = i\varphi$ is a number of negation then $Z = B^{i\varphi}$ describes the qualitative changes.

In a general case, a number of the kind $\hat{Z} = B^{\vartheta + i\varphi}$ represents quantitative-qualitative processes, and in this sense, *binumbers are quantitative-qualitative numbers.*

In variable processes, $ad_B(\hat{Z}) = \vartheta + i\varphi$ represents a parameter proportional to time $ad_B(\hat{Z}) = (\eta + i\omega)t$. A binumber corresponding to it is

$$\hat{Z} = B^{(\eta + i\omega)t}. \qquad (2.16)$$

The binumber is an elementary object-image of nature, being in unceasing development as is any object of nature, because instantaneous parameters of the object-image (of an elementary process) just define an instantaneous quantitative-qualitative value of the binumber.

In a case where $bas(B) = \alpha + i\beta = B_m e^{i\sigma}$, the structure of the binumber is reduced to the quantitative-qualitative binumber as well:

$$\hat{Z} = B_m^{(-\omega\sigma + i\eta\sigma)t} \quad \text{or} \quad \hat{Z} = B_m^{(-\mu + i\Omega)t}. \qquad (2.17)$$

The algebra of binumbers coincides, formally, with the algebra of complex numbers [2]; however, the first one is, actually, a quite different numerical field [3] and not all aspects of complex numbers are valid here. Moreover, components of the binumber reflect bipolar symmetry in nature and have a quite definite sense.

If there is the notion defined by the component of affirmation a and there is not the notion corresponding to the component of negation $\underline{b}$, then it is necessary to introduce the lack complementary notion. As a result, we will arrive at the complete description of the phenomenon under study.

Thus, if we operate only by the numerical monofield, i.e. by the usual field of real numbers or, in a best case, formally, by the conventional field of complex numbers, it indicates the incompleteness of our ideas about a process under study.

Below is a simple ***example*** which shows a distinction between the dialectical field of binary real numbers and the field of complex numbers. Let us determine the time of motion of a body thrown vertically up with the initial speed $v_0 = 30\, m/s$ if the passed distance is $s = 125m$ (Fig. 2.1a). Air resistance is not taken into account and it is assumed that $g = 10\, m/s^2$.

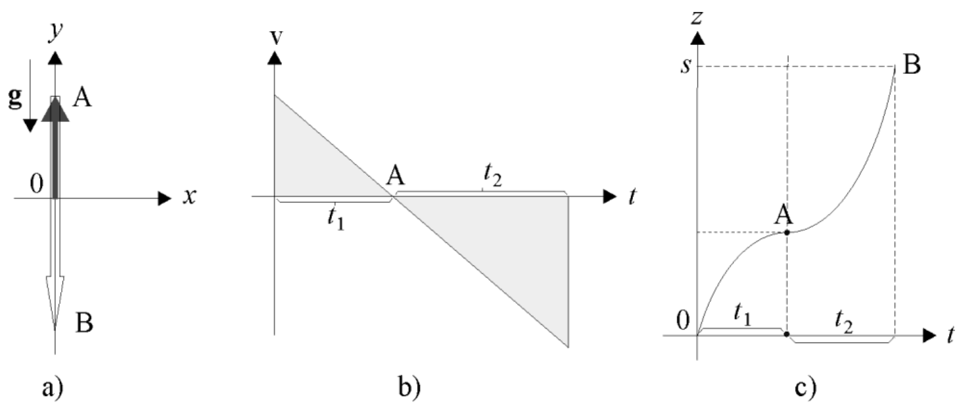

Fig. 2.1. The motion of a body thrown vertically up (a); plots of the velocity *v* (b) and the displacement *s* (distance) (c); *z* is the axis of displacement (distance).

Parts of the total covered distance OA and AB are sections with opposite characters of motion. The time intervals t_1 and t_2 are related as the past and the future; therefore, they belong to the different algebras of signs (Fig. 2.1b); the binumerical field takes this singularity of motion into account in the following way.

Relying on the equation of motion $s = v_0 t - \frac{gt^2}{2}$, we obtain the solution in the form of the single binary answer:

$$\hat{t} = \frac{v_0}{g} + i\frac{\sqrt{2gs - v_0^2}}{g} = t_1 + it_2 = (3 + i4)s \ ,$$

where $\hat{t} = t_1 + it_2 = (3 + i4)s$ is the compound time interval of the past-future. However, with respect to the future of two sections of motion, t_1 and t_2 are the past times. So that the norm (2.11) of the compound time determines the total time of motion $No(\hat{t}) = t_1 + t_2 = 7s$, and the module squared of the past-future time $|\hat{t}|^2 = t_1^2 + t_2^2$ determines the covered distance

$$s = \frac{g(t_1^2 + t_2^2)}{2} .$$

From the viewpoint of conventional formalism, the above equation of motion contains displacement s but not the distance s. However, it is an elementary artificial method to avoid “complex” solutions, when “imaginary solutions have not a physical sense”.

In the binumerical field, *there are not imaginary solutions*: all solutions are right because in reality displacement and distance represent different facets of the same process, that explicitly expresses the above described binumerical field. At the section OA (Fig. 2.1c), the distance and the coordinate (displacement) are equal; this section is related to the lower branch of the parabola, described by the algebra of affirmation, whereas the upper branch of the parabola is described by the algebra of negation – it determines the covered distance AB.

Another example. Let us consider an equation of the kind $x^2 + y^2 = r^2$. According to classical statements, it is the equation of a circumference. In dialectics, a graph of the equation depends on the structure of the equation $()^2 + ()^2 = r^2$ and on algebra of signs (Fig. 2.2).

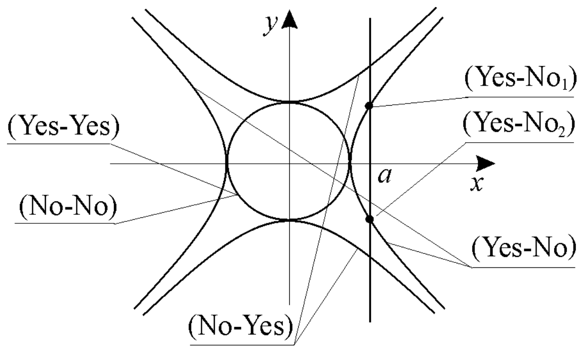

Fig. 2.2. Points *Yes-No*$_1$ and *Yes-No*$_2$ of intersection of the straight line $x = a > r$, where a are *Yes* numbers, with the second order curve $x^2 + y^2 = r^2$; x and y are coordinate axes neutral with respect to algebra of signs.

If x and y are numbers of affirmation, then this equation describes the branch *Yes-Yes* of the graph. When x are numbers of affirmation and y are numbers of negation, we obtain the branch *Yes-No*. If x are numbers of negation and y are numbers of affirmation, the branch *No-Yes* is formed. In a case when the structure of the equation has the more general form $()^2 + ()^2 = ()^2$, the branch *No-No* takes place.

Evidently, in the binumerical field, the straight line $x = a > r$ intersects the second order curve $x^2 + y^2 = r^2$ at four points, whereas according to classical statements, there are no intersections.

When analyzing the relations between the numbers *Yes* (a) and *No* (ib), the notion of a phase plane of affirmation-negation numbers, where x-axis is the axis of affirmation and y-axis is the axis of negation, is useful to introduce. On this plane, a binumber is presented by a and ib components and also by the quantitative module r and polar phase angle α (Fig. 2.3a), although in reality, a and ib can have arbitrary directions or be undirected magnitudes.

Because the nature of physical processes has the wave bipolar character, the structure of physical biwaves must be presented by the wave binumerical field. If the phase plane coincides with the physical plane of oscillations and the direction of propagation of waves is perpendicular to the plane of oscillations, then the geometry of the bifield with $\mathrm{ad}_e(\hat{Z}) = i\omega t$ coincides with the real oscillatory wave (Fig. 2.3b) in the physical space:

$$\hat{Z} = a + bi = re^{i\omega t} = r(\cos\omega t + i\sin\omega t)\,. \qquad (3.1)$$

The oscillatory wave (3.1) is inseparable from the wave propagated in physical space. In particular, the simplest biwave-beam has the following form

$$\hat{Z} = a + bi = re^{i(\omega t - ks)} = r(\cos(\omega t - ks) + i\sin(\omega t - ks))\,, \qquad (3.2)$$

where $k = \dfrac{2\pi}{\lambda}$ is the wave number of the beam s.

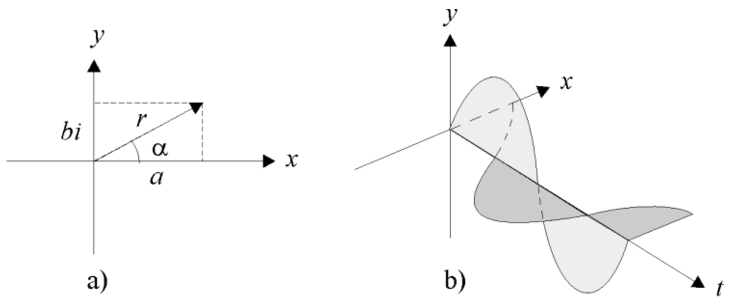

Fig. 2.3. (a) A phase plane of a binumber, and (b) the wave of affirmation-negation of bifield.

Thus, the essential difference between the binumerical field of affirmation-negation and the field of complex numbers takes place. The geometry of binumbers repeats the geometry of real processes that is realized in three-dimensional space. Whereas the field of complex numbers is localized only on the complex plane, at that of the "imaginary" component, it is still an "imaginary" magnitude at solving of many fundamental problems of physics when complex-valued functions are used.

In particular, harmonic oscillations of motion-rest represent the physical bifield of motion-rest (kinetic-potential field); therefore, harmonic oscillations should be described by the binumerical field.

3. Harmonic kinetic-potential oscillations and the binumerical field

Harmonic oscillations of motion-rest in terms of the above introduced binumbers are presented by kinetic-potential displacements:

$$\hat{x} = x_k + x_p i = x_m e^{i(\omega t + \alpha)} = x_m(\cos(\omega t + \alpha) + i\sin(\omega t + \alpha)) \qquad (3.3)$$

or

$$\hat{x} = x_k - x_p i = x_m e^{-i(\omega t + \alpha)} = x_m(\cos(\omega t + \alpha) - i\sin(\omega t + \alpha))\,. \qquad (3.3a)$$

The kinetic displacement is the displacement of motion from an equilibrium state, whereas the potential displacement is the displacement of rest from its state of nonequilibrium.

If we introduce the biamplitude of oscillations

$$\hat{x}_m = x_m e^{i\alpha}, \qquad (3.4)$$

then the harmonic oscillsation (3.3) can also be presented in the following way

$$\hat{x} = x_k + x_p i = \hat{x}_m e^{i\omega t}. \qquad (3.5)$$

Using for description of oscillations the equation (3.3) with the zero initial phase, we arrive at the following row of kinetic and potential parameters of the bifield of motion-rest:

TABLE 3.1
The kinetic and potential parameters of the bifield of motion-rest

	<u>kinetic</u> (*Yes*)	<u>potential</u> (*No*)
1) *displacement*	$x_k = x_m \cos\omega t$,	$x_p = -ix_m \sin\omega t$
2) *speed of displacement*	$v_k = \dot{x}_k = -\omega x_m \sin\omega t = -i\omega x_p$,	$v_p = \dot{x}_p = -i\omega x_m \cos\omega t = -i\omega x_k$
3) *acceleration of displacement*	$w_k = \ddot{x}_k = -\omega^2 x_k$,	$w_p = \ddot{x}_p = -\omega^2 x_p$
4) *momentum*	$p_k = mv_k = m\dot{x}_k$,	$p_p = mv_p = m\dot{x}_p$
5) *the rate of change of momentum (power of exchange by motion-rest, when its measure is momentum)*	$F_k = m\frac{dv_k}{dt} = m\ddot{x}_k = -kx_k$,	$F_p = m\frac{dv_p}{dt} = m\ddot{x}_p = -kx_p$
6) *energy*	$E_k = \frac{mv_k^2}{2} = -\frac{kx_p^2}{2}$,	$E_p = \frac{kx_k^2}{2} = -\frac{mv_p^2}{2}$
7) *the rate of change of energy (power of exchange by motion-rest, when its measure is energy)*	$N_k = \frac{dE_k}{dt} = F_k v_k$,	$N_p = \frac{dE_p}{dt} = -F_p v_p$

The equation of free kinetic-potential oscillations of the simplest system (Fig. 3.1a) in the binumerical field has the following form

$$\frac{d^2\hat{x}}{dt^2} + 2\beta\frac{d\hat{x}}{dt} + \omega_0^2\hat{x} = 0, \qquad (3.6)$$

where $\beta = \frac{r}{2m}$ is the damping factor, $\omega_0^2 = \frac{k}{m}$ is the free frequency.

The search for a solution to the equation (3.6) in the form $\hat{x} = \hat{x}_m e^{\eta t}$, where $\hat{x}_m = x_m e^{i\alpha}$ is the biamplitude, leads to the quadratic equation $\eta^2 + 2\beta\eta + \omega_0^2 = 0$, the positive root of which

$\eta = -\beta + i\sqrt{\omega_0^2 - \beta^2} = -\beta + i\omega$, where $\omega = \sqrt{\omega_0^2 - \beta^2}$, determines the damped kinetic-potential displacement

$$\hat{x} = \hat{x}_m e^{i\omega t} = \hat{x}_m(\cos\omega t + i\sin\omega t). \tag{3.7}$$

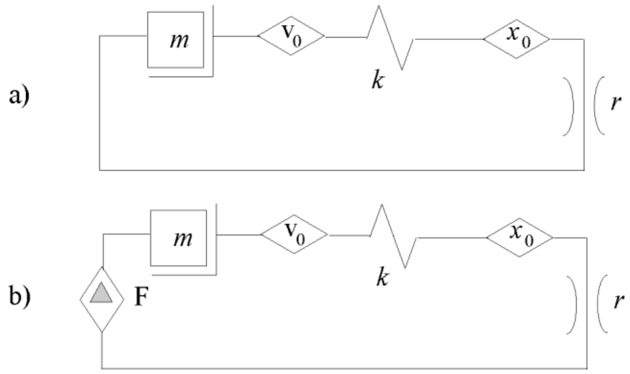

Fig. 3.1. Elementary kinematic systems with mass *m*, elasticity *k*, and resistance *r* without (a) and with (b) an external source *F* of motion-rest; v_0 is the initial speed, x_0 is the initial displacement.

Here,

$$\hat{x}_m = x_m e^{i\alpha} e^{-\beta t} \tag{3.8}$$

is the kinetic-potential biamplitude. At $t = 0$, the biamplitude (3.8) determines the initial state of the system:

$$\hat{x}(0) = \hat{x}_m = x_m e^{i\alpha} = x_m \cos\alpha + i x_m \sin\alpha, \tag{3.9}$$

where $x_k(0) = x_m \cos\alpha$ is the initial kinetic displacement and $\tilde{x}_p(0) = i x_m \sin\alpha$ is the initial potential displacement.

4. Forced oscillations

When analyzing the influence of an external periodic kinetic-potential action $\hat{F} = F_m e^{i\omega t}$ on the elementary system (Fig. 3.1b), forced oscillations of the kind $\hat{Z} = \hat{Z}_m e^{i\omega t}$ arise.

Motion-rest in such a case will be described by the following differential equations of the kinetic-potential displacement $\hat{x} = \hat{x}_m e^{i\omega t}$, speed $\hat{v} = \hat{v}_m e^{i\omega t}$, and acceleration $\hat{w} = \hat{w}_m e^{i\omega t}$, correspondingly:

$$m\frac{d^2\hat{x}}{dt^2} + r\frac{d\hat{x}}{dt} + k\hat{x} = \hat{F}; \tag{4.1}$$

$$m\frac{d\hat{v}}{dt} + r\hat{v} + k\int \hat{v}dt = \hat{F}; \tag{4.1a}$$

$$m\hat{w} + r\int \hat{w}dt + k\int dt\int \hat{w}dt = \hat{F} \tag{4.1b}$$

These equations lead to the following three equations of motion-rest in the binumerical field

$$\hat{F} = \hat{k}\hat{x}, \tag{4.2}$$

$$\hat{F} = \hat{r}\hat{v}\,, \qquad (4.2a)$$

$$\hat{F} = \hat{m}\hat{w}\,, \qquad (4.2b)$$

where

$$\hat{k} = (k - m\omega^2) + ir\omega\,, \qquad (4.3)$$

$$\hat{r} = r + i(m\omega - \frac{k}{\omega}), \qquad (4.4)$$

and

$$\hat{m} = (m - \frac{k}{\omega^2}) - i\frac{r}{\omega} \qquad (4.5)$$

are *bielasticity*, *biresistance*, and *bimass*, correspondingly.

The component $(k - m\omega^2)$ of bielasticity (4.3) defines the conservatism of the system, i.e. its ability to save rest and motion. In this equation, k is the coefficient of conservation of rest and $-m\omega^2$ is the coefficient of conservation of motion; whereas the component $ir\omega$ defines the nonconservatism (dissipation) of the system, i.e. its ability to disperse rest-motion.

Hence, if the component $(k - m\omega^2)$ states the conservatism of the system, expressing its *Yes* quality, then the component $ir\omega$ is the negation of conservatism, expressing the *No* quality of the system.

Thus, the bicoefficient $\hat{k}$ (4.3) characterizes the conservative-dissipative system; therefore, in this sense, it can be called the conservative-dissipative coefficient of the system. The conservative coefficient $(k - m\omega^2)$ expresses the qualitative side of exchange by motion-rest, the dissipative coefficient $ir\omega$ – its quantitative facet.

In the phase plane of binumbers (Fig. 4.1a), $\hat{k}$ is represented in the trigonometric form $\hat{k} = k_m e^{i\varphi}$ with parameters

$$k_m = \sqrt{(k - m\omega^2)^2 + r^2\omega^2}\,, \qquad (4.6)$$

$$tg\varphi = \frac{r\omega}{k - m\omega^2} = \frac{2\beta\omega}{\omega_0^2 - \omega^2}\,, \qquad (4.7)$$

where k_m is the quantitative module and φ is the superstructure of the bielasticity $\hat{k}$. Since $\hat{F} = F_m e^{i\omega t}$ and $\hat{x}_m = x_m e^{i\alpha}$, then in accordance with (4.2) $\alpha = -\varphi$; therefore,

$$\hat{x}_m = \frac{F_m}{(k - m\omega^2) + ir\omega} \quad \text{and} \quad x_m = \frac{F_m}{\sqrt{(k - m\omega^2)^2 + r^2\omega^2}} \qquad (4.8)$$

The relation between the amplitudes (4.8) can be depicted by the graph of amplitudes (Fig. 4.1b).

Let us pass now to the second equation $\hat{F} = \hat{r}\hat{v}$ of (4.2) and consider the structure of biresistance $\hat{r}$ (4.4). The first component of biresistance, r is the active coefficient of dispersion – the coefficient of quantitative dispersion. The second component of (4.4),

$$i(m\omega - \frac{k}{\omega})\,,$$

is the reactive coefficient of dispersion – the coefficient of qualitative exchange by motion-rest, the first constituent of which $im\omega$ is the coefficient of exchange by motion and the second of their

$$-i\frac{k}{\omega},$$

is the coefficient of exchange by rest.

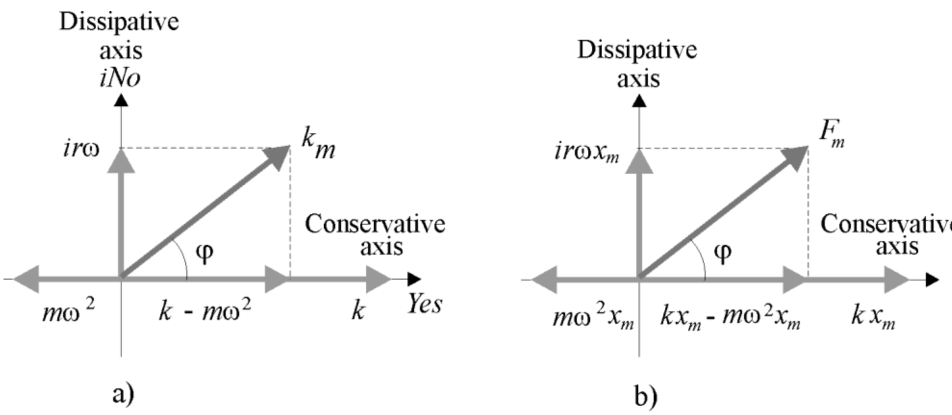

Fig. 4.1. Graphs of bielasticity $\hat{k}$ (a) and amplitudes (b).

In the trigonometric form, the coefficient of biresistance $\hat{r}$ can be presented as

$$\hat{r} = r_m e^{i\psi}, \tag{4.9}$$

$$r_m = \sqrt{r^2 + (m\omega - k/\omega)^2}, \tag{4.9a}$$

$$tg\psi = \frac{m\omega^2 - k}{r\omega} = \frac{\omega^2 - \omega_0^2}{2\beta\omega}. \tag{4.9b}$$

If $\hat{v}_m = v_m e^{i\alpha}$, then $\alpha = -\psi$ and

$$\hat{v}_m = \frac{F_m}{r + i(m\omega - k/\omega)}, \tag{4.10}$$

$$v_m = \frac{F_m}{\sqrt{r^2 + (m\omega - k/\omega)^2}}. \tag{4.10a}$$

Finally, the last equation $\hat{F} = \hat{m}\hat{w}$ of (4.2) includes bimass (4.5). Here: m is the positive kinetic mass, absorbing motion; $-\frac{k}{\omega^2}$ is the negative potential mass of the system, absorbing rest; $-i\frac{k}{\omega}$ is the mass of dispersion of motion-rest. In the trigonometric form, the bimass (4.5) is presented as

$$\hat{m} = m_m e^{i\vartheta}, \tag{4.11}$$

$$m_m = \sqrt{(m - k/\omega^2)^2 + r^2/\omega^2}, \tag{4.11a}$$

$$tg\vartheta = \frac{-r/\omega}{m - k/\omega^2} = -\frac{2\beta\omega}{\omega^2 - \omega_0^2}, \tag{4.11b}$$

hence,

$$\hat{w}_m = \frac{F_m}{(m - k/\omega^2) - ir/\omega} \tag{4.12}$$

and

$$w_m = \frac{F_m}{\sqrt{(m - k/\omega^2)^2 + r^2/\omega^2}} \tag{4.12a}$$

5. Final conclusion

Basic rules of formal logic have been analyzed in comparison with dialectical logic and its law of motion. The latter have been, formally, presented by the binary structure of real numbers reflecting the bipolar symmetry in nature. A binumber, as an elementary object-image of nature, defines some its instantaneous quantitative-qualitative meaning, which, as any object of nature, is in unceasing development. By asserting the principles of dialectical logical thinking, the corresponding algebra of the dialectical binumerical field has been developed.

A wave bipolar character of physical processes has presented by the corresponding wave binumerical field of real numbers repeating geometry of real wave processes in three dimensional space, which is impossible to express by the conventional field of complex numbers localized in the complex plane of real and "imaginary" components.

An essential distinction between the possibilities of the dialectical binumerical field of real numbers and the conventional field of complex numbers has been shown by simple examples. Analysis of harmonic oscillations of motion-rest, considered here additionally, confirms the advantage and completeness of nonconventional description in studying phenomena by the dialectical field of binumbers.

The description of physical processes on the basis of the dialectical binumerical field allows for a more exact and complete clarification of the processes under investigation, their kinetic-potential character [4]. In particular, symmetrical notions of motion-rest fields give a complete picture of real periodic (oscillatory and wave) processes, where mutual transformation of motion into rest and of rest into motion occurs.

All the above described allows us to state that the complex numbers are a particular case of the more general dialectical field of binumbers. It means that we are now approaching the discovery of the nature of complex numbers with their "imaginary" unit.

Note finally that the misunderstanding of the deep nature of complex numbers has forced quantum mechanics to drop "an imaginary part" of the wave function, which "does not have a physical meaning" as it is believed conventionally, and to operate only with a squared modulus of the wave function.

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