# The binary numerical field and potential-kinetic oscillations

## 1. A phase plane and diagrams of potential-kinetic oscillations

In order to express the relations between components of a binary number, we introduce the notion of the phase plane of binary numbers, where the *X*-axis relates to the positive algebra of signs and the *Y*-axis relates to the negative algebra. On the phase plane, a number $\hat{Z} = a + ib$ is represented by the components *a* and *bi*, modulus *r*, and polar phase angle $\alpha$ (Fig. 1a). Although, actually, *a* and *bi* can have arbitrary directions or be undirected quantities.

The nature of all physical processes has an oscillatory, wave character because the continuous transformation of a kinetic field into the potential field, and vise versa, takes place during these processes. For this reason, the structure of numbers, describing such fields in real physical space, must have the form of potential-kinetic oscillations. For example, if harmonic oscillations occur along the *X*-axis, these numbers have the form (Fig. 1c):

$$\hat{x} = x_p + ix_k = x_m e^{i(\omega t + \alpha)} = a(\cos(\omega t + \alpha) + i\sin(\omega t + \alpha)). \qquad (1.1)$$

If we introduce the binary (complex) amplitude of oscillations $\hat{a} = ae^{i\alpha}$, then

$$\hat{x} = x_p + ix_k = \hat{a}e^{i\omega t} \quad \text{or} \quad \hat{x} = x_p + \tilde{x}_k = \hat{a}e^{i\omega t}. \qquad (1.2)$$

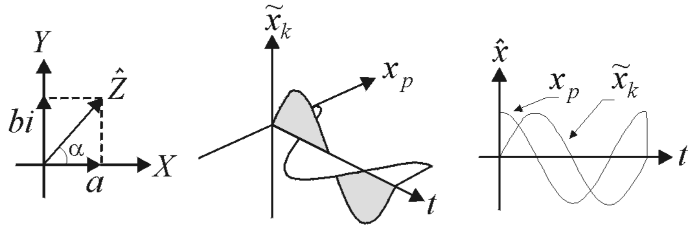


**Fig. 1.1.** A phase plane of a binary number $\hat{Z}$ (*a*), a graph (*b*) and a diagram (*c*) of potential-kinetic oscillations $\hat{x}$ .

A binary graph of potential-kinetic oscillations is presented in Fig. 1.1*b*. This graph is a phase image of potential-kinetic oscillations with mutually perpendicular mathematical axes of rest and motion. A diagram of potential-kinetic oscillations with potential and kinetic displacements along the phase axis *x* is shown in Fig. 1.1c.

For the description of potential-kinetic oscillations of a material point with mass *m*, it makes sense to use the parameters, which give an additional information about the oscillations.

## 1. Harmonic potential-kinetic oscillations

### 2.1. *The gravitational pendulum*

According to the definition of the vector of kinema $\hat{\mathbf{F}}$, as the rate of change of the potential-kinetic momentum $\hat{\mathbf{P}} = m\hat{\upsilon}$, we have (Fig. 2.1):

$$\hat{\mathbf{F}} = m\frac{d\hat{\mathbf{P}}}{dt} \qquad \hat{F}_x = m\frac{d^2\hat{x}}{dt^2}. \qquad (2.1)$$

For small potential-kinetic angles, $\hat{F}_x = -N\sin\hat{\varphi} \approx -N\hat{\varphi} = -G\hat{\varphi} = -mg\hat{\varphi}$, an equation of motion takes the form:

$$\ddot{\hat{\varphi}} + \omega^2\hat{\varphi} = 0, \qquad (2.2)$$

where $\omega^2 = \dfrac{k}{m}$ and $k = \dfrac{G}{a}$.

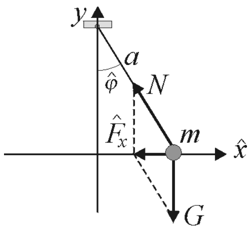


**Fig. 2.1.** A gravitational pendulum: $a$ is its length, $\hat{\varphi}$ is the potential-kinetic angle, and $\hat{x} = \hat{\varphi}a$ is the potential-kinetic displacement.

Let an initial state of the pendulum is defined by the potential-kinetic angle

$$\hat{\varphi}(0) = \varphi_0(\cos\alpha + i\sin\alpha)\,, \tag{2.3}$$

then the solution will take the form

$$\hat{\varphi} = \varphi_p + \tilde{\varphi}_k = \hat{\varphi}_m e^{i\omega t}\,, \tag{2.4}$$

where $\hat{\varphi}_m = \varphi_0 e^{i\alpha}$.

Basic binary measures of oscillations of the pendulum are
a) the potential-kinetic mass, kinematic charge and current:

$$\hat{m} = me^{i(\omega t+\alpha)}\,, \qquad \hat{q} = qe^{i(\omega t+\alpha+\pi/2)}\,, \qquad \hat{I} = \frac{d\hat{q}}{dt}\,; \tag{2.5}$$

b) the potential-kinetic state

$$\hat{S}_\varphi = m\hat{\varphi}\,, \qquad \hat{S} = m\hat{x}\,; \tag{2.6}$$

c) the potential-kinetic momentum

$$\hat{P}_\varphi = m\dot{\hat{\varphi}}\,, \qquad \hat{P} = m\hat{\upsilon}\,; \tag{2.7}$$

d) the potential-kinetic kinema

$$\hat{F}_\varphi = m\frac{d\hat{P}_\varphi}{dt}\,, \quad \hat{F} = m\frac{d\hat{P}}{dt}\,; \tag{2.8}$$

e) the potential-kinetic field of change of kinema

$$\hat{D}_\varphi = m\frac{d\hat{F}_\varphi}{dt}\,, \quad \hat{D} = m\frac{d\hat{F}}{dt}\,; \tag{2.9}$$

etc. (Because the upper limit of the order of a derivative is unlimited, an elementary potential-kinetic field of the pendulum is presented by an infinite series of subfields of the binary field of momentum)
f) the potential-kinetic energy

$$\hat{E}_\varphi = \frac{m\dot{\hat{\varphi}}^2}{2} = \frac{\hat{P}_\varphi^2}{2m}\,, \qquad \hat{E} = \frac{m\hat{\upsilon}^2}{2} = \frac{\hat{P}^2}{2m}\,. \tag{2.10}$$

2.2. *The spring pendulum*

The spring pendulum without damping is described by the equation

$$\hat{\mathbf{F}} = m\frac{d\hat{\mathbf{P}}}{dt}\,. \tag{2.11}$$

For small displacements, the kinema $\hat{\mathbf{F}}$ has the form $\hat{\mathbf{F}} = -k\hat{x}$ and the equation of potential-kinetic oscillations is

$$\ddot{\hat{x}} + \omega^2\hat{x} = 0\,, \tag{2.12}$$

where $\omega^2 = \dfrac{k}{m}$.

If one uses the relative displacement $\hat{\varphi} = \hat{x}/a$, all formulae of potential-kinetic parameters for the gravitational pendulum will also valid for the spring pendulum.

Let an initial state of spring pendulum (Fig. 2.2) is defined by the potential-kinetic displacement

$$\hat{x}(0) = x_p(0) + \tilde{x}(0) = a(\cos\alpha + i\sin\alpha)\,, \tag{2.13}$$

then the solution of the equation (2.12) will take the form

$$\hat{x} = x_p + ix_k = ae^{i(\omega t+\alpha)} . \qquad (2.14)$$

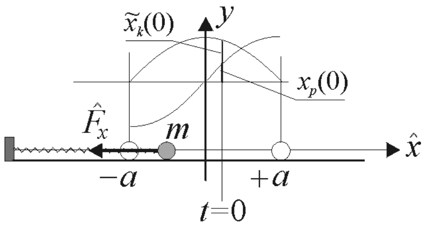


**Fig. 2.2.** A spring pendulum.

At the time, defined from the condition $\omega t + \alpha = n\pi$, gravitational and spring pendulums are in extreme potential states. An extreme position of the spring pendulum is defined by the extreme potential displacements $\pm a$, an extreme position of the gravitational pendulum − by the extreme potential angles $\pm\varphi_0$.

At the time, corresponding to the condition $\omega t + \alpha = \frac{\pi}{2} + n\pi$, the pendulums pass a position of the (static) equilibrium with the maximal in value speed. In this case, kinetic displacements are maximal in value: a position of the spring pendulum is defined by the kinetic displacements $\pm ia$, and a position of the gravitational pendulum is defined by the kinetic angles $\pm i\varphi_0$.

Extreme kinetic angles and displacements are ideal displacements. They are the measures of pure motion “uncolored” by rest. Extreme potential angles and displacements are material displacements: we see and can measure them. The material-ideal essence of the Universe is reflected in these plain potential-kinetic oscillations of pendulums.

Because kinetic angles and displacements are the visually hidden parameters of oscillations, the can be called “potential”, whereas potential angles and displacements, generated by motion, can be called “kinetic”. Thus, there is the direct evidence of the binary character of properties of pure potential (kinetic) angles and displacements: on the one hand, they are potential (kinetic) parameters, on the other hand, they are kinetic (potential) parameters of oscillations.

In the extreme potential positions of masses of pendulums, momenta are only potential; in kinetic positions of equilibrium, momenta are only kinetic:

$$\tilde{P} = \pm m\omega a i , \qquad P = \pm m\omega a = \pm m\upsilon_{k\,\max} . \qquad (2.15)$$

The kinemas, corresponding to the momenta, are also potential in potential positions and kinetic in kinetic positions:

$$F = \pm m\omega^2 a = \pm ka , \qquad \tilde{F} = \pm m\omega^2 ai = \pm kai . \qquad (2.16)$$

In kinetic points, we “see” the momentum $P = \pm m\upsilon_{k\,\max}$ and do not perceive the kinema $\tilde{F} = \pm kai$, because the latter is the measure of proper motion of a body with the mass *m*; i.e., figuratively speaking, the kinema is the “internal force of motion” of the body *m*.

In potential points, the momentum is only potential $\tilde{P} = \pm m\upsilon_p i$; it becomes apparent in the form of the potential kinema, external with respect to the body *m*.

In any intermediate positions, kinetic and potential kinemas, as the external and internal parameters of potential-kinetic oscillations, are unequal to each other and shifted in phase at the angle $90^o$. Hence, the equality in value of “action” and “reaction” is a myth originated from the Newton time. Owing to the inequality (in the general case) of kinetic and potential parameters of binary fields, oscillations and waves take place in nature.

So-called Newton’s third law is, actually, the law of conservation of momentum (motion-rest) at interaction of two bodies and nothing more:

$$\frac{d(\hat{P}_1 + \hat{P}_2)}{dt} = \frac{d\hat{P}_1}{dt} + \frac{d\hat{P}_2}{dt} = 0 \quad \Rightarrow \quad \frac{d\hat{P}_1}{dt} = -\frac{d\hat{P}_2}{dt} \quad \text{or} \quad \hat{F}_1 = -\hat{F}_2 . \qquad (2.17)$$

Indeed, let the quantities of rest-motion of two interacting objects are described by binary parameters $\hat{Z}_1$ and $\hat{Z}_2$. During the time *dt*, these objects interchange by rest-motion with the measures

$d\hat{z}_{12}$ (from the first object to the second one) and $d\hat{z}_{21}$ (from the second object to the first one). As a result of the interchange, the first object gains (loses) and the second object loses (gains), respectively, the quantity of rest-motion:

$$d\hat{Z}_1 = d\hat{z}_{21} - d\hat{z}_{12}, \qquad d\hat{Z}_2 = d\hat{z}_{12} - d\hat{z}_{21}. \tag{2.18}$$

Obviously, resulting rates of exchange of the first object with the second one and the second object with the first one are equal in value and opposite in sign:

$$\hat{F}_1 = \frac{d\hat{Z}_1}{dt} = \frac{d\hat{z}_{21}}{dt} - \frac{d\hat{z}_{12}}{dt}, \quad \hat{F}_2 = \frac{d\hat{Z}_2}{dt} = \frac{d\hat{z}_{12}}{dt} - \frac{d\hat{z}_{21}}{dt} \quad \text{and} \quad \hat{F}_1 = -\hat{F}_2. \tag{2.19}$$

However, actual components of exchange are unequal, in the general case:

$$\frac{d\hat{z}_{21}}{dt} \neq -\frac{d\hat{z}_{12}}{dt}. \tag{2.20}$$

On a boxing ring, a superior boxer by his action $\frac{d\hat{z}_{12}}{dt}$ surpasses the counteraction $\frac{d\hat{z}_{21}}{dt}$ of his opponent, but, following (2.19), their "forces" are equal in value. Evidently, boxers deal with not with these "forces". Thus, Newton's blunder stems from the misunderstanding of the so-called law of "action and reaction".

In harmonic potential-kinetic oscillations of pendulums, amplitudes of state, momentum, kinema, and energy are constant, expressing thus the law of conservation of the enumerated parameters. However, these parameters are changed qualitatively, expressing the mutual transformation of the kinetic field into potential, and vice versa. In particular, amplitude of the potential-kinetic energy has the form:

$$E_m = \frac{m\upsilon_k^2}{2} + \frac{m\upsilon_p^2}{2}. \tag{2.21}$$

2.3. *The conical pendulum*

Let us turn now to oscillations of the conical pendulum of the mass *m* along *X*- and *Y*-axes (Fig. 2.3). Binary oscillations at the rotation of *m* anticlockwise are presented in the following form:

$$\hat{x} = x_p + ix_k = ae^{i\omega t} = a(\cos\omega t + i\sin\omega t), \tag{2.22}$$

$$\hat{y} = y_p + iy_k = ae^{i(\omega t - \pi/2)} = a(\sin\omega t - i\cos\omega t). \tag{2.23}$$

They define potential and kinetic displacements, equal in modulus to the radius of circumference:

$$a_p = a, \qquad \tilde{a}_k = \tilde{a} = ia. \tag{2.24}$$

The displacements-amplitudes (2.24) are mutually perpendicular, whereas, at oscillations along a straight line, potential and kinetic displacements lie on the same axis.

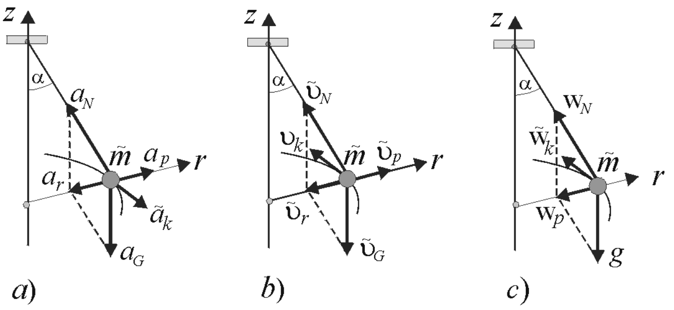


**Fig. 2.3.** The conical pendulum; potential and kinetic displacements-amplitudes (*a*), velocities (*b*), and accelerations (*c*).

Potential-kinetic displacements $\hat{x}$ and $\hat{y}$ describe the circular potential-kinetic motion, which is the motion along a circumference. Displacements $\hat{x}$ and $\hat{y}$ are connected between themselves through the equality $\hat{x} = i\hat{y}$, which shows that during the circular motion they are polar opposite. These displacements define binary velocities and accelerations along axes of coordinates:

$$\dot{\hat{x}} = i\omega(x_p + ix_k) = -\omega x_k + i\omega x_p = \upsilon_{kx} + \tilde{\upsilon}_{px}, \qquad \dot{\hat{y}} = i\omega(y_p + iy_k) = -\omega y_k + i\omega y_p = \upsilon_{ky} + \tilde{\upsilon}_{py}, \quad (2.25)$$

$$\ddot{\hat{x}} = -\omega^2(x_p + ix_k) = w_{px} + \tilde{w}_{kx}, \qquad \ddot{\hat{y}} = -\omega^2(y_p + iy_k) = w_{kp} + \hat{w}_{ky}. \quad (2.26)$$

Hence, resulting velocities and accelerations take the form:

$$\upsilon_k = i\omega ia = i\omega\tilde{a}_k = -\omega a, \qquad \tilde{\upsilon}_p = i\omega a = i\omega a_p; \quad (2.27)$$

$$\tilde{w}_k = -\omega^2 ia = -\omega^2\tilde{a}_k, \qquad w_p = -\omega^2 a = -\omega^2 a_p. \quad (2.28)$$

As follows from these equalities, the potential velocity is directed along the radius of circumference and the kinetic velocity – along the tangent to the circumference. The kinetic acceleration coincides with the direction of the kinetic velocity, the potential acceleration is directed along the radius to the center of circumference (Fig. 2.3).

Thus, the potential-kinetic field of the conical pendulum is the longitudinal-transversal field in which the kinetic field is the circular (longitudinal) field and the potential field is the transversal field.

Potential fields of a light thread and gravitation form the potential acceleration $w_p = -\omega^2 a = -\dfrac{\upsilon^2}{a}$. In the language of kinemas, we have:

$$\mathbf{N} + \mathbf{G} = m\mathbf{w}_p, \quad (2.29)$$

where $\mathbf{N} = m\mathbf{w}_N$, $\mathbf{G} = m\mathbf{g}$; $\mathbf{w}_N$ and $\mathbf{g}$ are the accelerations of rest (potential accelerations).

The following obvious relations bind potential displacements, potential velocities, and potential accelerations:

$$a_N = \frac{a}{\sin\alpha}, \quad a_G = \frac{a}{\tan\alpha}; \quad \tilde{\upsilon}_N = \frac{i\upsilon}{\sin\alpha}, \quad \tilde{\upsilon}_G = \frac{i\upsilon}{\tan\alpha}; \quad w_N = \frac{\omega^2 a}{\sin\alpha}, \quad g = \frac{\omega^2 a}{\tan\alpha}. \quad (2.30)$$

## 3. Free oscillations

Free oscillations in a kinematic circuit *mkr* (Fig. 3.1) arise as a result of an impulse discrete influence upon it.

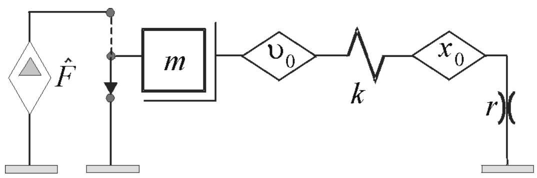


**Fig. 3.1.** A system *mkr* with the initial conditions $x_0$ and $\upsilon_0$, which define the quantity of motion and rest in the system after a short-term kinematic action expressed by the kinema $\hat{F}$.

An equation of free potential-kinetic oscillations has the form

$$m\frac{d^2\hat{x}}{dt^2} + r\frac{d\hat{x}}{dt} + k\hat{x} = 0 \quad (3.1)$$

or $$\frac{d^2\hat{x}}{dt^2} + 2\beta\frac{d\hat{x}}{dt} + \omega_0^2\hat{x} = 0, \qquad \text{where} \quad \beta = \frac{r}{2m}, \qquad \omega_0^2 = \frac{k}{m}. \quad (3.2)$$

We are interested in the solution of the equation (3.2) in the form $\hat{x} = x_0 e^{i\eta t}$, then

$$(-\eta^2 + 2\beta\eta i + \omega_0^2)\hat{x} = 0, \qquad \eta^2 - 2\beta\eta i - \omega_0^2 = 0, \quad (3.3)$$

and $$\hat{\eta} = \pm\sqrt{\omega_0^2 - \beta^2} + i\beta = \pm\omega + i\beta, \qquad \text{where} \quad \omega = \sqrt{\omega_0^2 + \tilde{\beta}^2} = \sqrt{\omega_0^2 - \beta^2}. \quad (3.4)$$

The binary circular (cyclic) frequency of the process is

$$\hat{\eta}_+ = \omega + i\beta. \quad (3.5)$$

If $\omega$ is the frequency of the periodic process, then $\beta$ is the frequency of the aperiodic process, but not the "damping coefficient". The following periods correspond to these polar opposite frequencies:

$$T = \frac{2\pi}{\omega}, \qquad \tilde{T}_\beta = \frac{2\pi}{i\beta} = -iT_\beta, \qquad \text{where} \quad T_\beta = \frac{2\pi}{\beta}. \quad (3.6)$$

The period $T$ is the time of one qualitative change of potential-kinetic oscillation, whereas the period $T_\beta$ expresses the quantitative change of the amplitude of oscillations $e^{-2\pi}$ times. The period $T$ is related with the conservation of motion-rest, and the period $T_\beta$ – with the dissipation of motion-rest, which is transformed into other forms of potential-kinetic oscillations. Thus, both periods are polar opposite ones and define the binary period of quantitative-qualitative changes. By virtue of the fact that processes of conservation and dissipation of energy occur simultaneously, i.e., in a parallel way, the binary period and its components are bound up over the law of parallel processes:

$$\frac{1}{\hat{T}} = \frac{1}{T} + \frac{1}{\tilde{T}_\beta} = \frac{\omega + i\beta}{2\pi} \ . \tag{3.7}$$

Hence, the binary frequency of quantitative-qualitative changes is expressed by the formula

$$\hat{\nu} = \frac{1}{\hat{T}} = \nu + i\nu_\beta = \frac{\omega}{2\pi} + i\frac{\beta}{2\pi}, \tag{3.8}$$

and the circular binary frequency is

$$\hat{\eta}_+ = 2\pi\hat{\nu} = \omega + i\beta \ . \tag{3.9}$$

The following potential-kinetic displacement corresponds to the circular frequency (3.9):

$$\hat{x} = x_0 e^{-\beta t} e^{i\omega t} = x_0 e^{-\beta t}(\cos\omega t + i\sin\omega t) = x_m(\cos\omega t + i\sin\omega t), \tag{3.10}$$

where $x_m = x_0 e^{-\beta t}$, and $x_0$ is the initial amplitude of oscillations.

Logarithmic quanta of the quantitative change of the amplitude $\Delta_\beta$ during the period $T_\beta$ and the qualitative change of the displacement in time during the period $T$ are defined by the fundamental period of the wave binary field:

$$\Delta_\beta = \lg\frac{x_m(t+T_\beta)}{x_m(t)} = -\beta T_\beta \lg e = -2\pi\lg e\ , \tag{3.11}$$

$$\Delta_\omega = \lg\frac{\exp(i\omega(t+T))}{\exp(i\omega t)} = i\omega T \lg e = i2\pi\lg e\ . \tag{3.11a}$$

Logarithmic decrements are equal to

$$\Delta_T = \lg\frac{x_m(t+T)}{x_m(t)} = -2\pi\lg e\cdot\frac{T}{T_\beta}, \tag{3.12}$$

$$\Delta = \ln\frac{x_m(t+T)}{x_m(t)} = -\beta T = -2\pi\cdot\frac{T}{T_\beta}\ . \tag{3.12a}$$

If we multiply the displacement (3.10) by the constant multiplier $e^{i\alpha}$, defining an initial state of oscillations, we obtain the general solution of the equation (3.1):

$$\hat{x} = x_0 e^{-\beta t} e^{i(\omega t+\alpha)} = x_m(\cos(\omega t+\alpha) + i\sin(\omega t+\alpha)) \tag{3.13}$$

or $$\hat{x} = \hat{x}_m e^{i\omega t} = \hat{x}_m(\cos\omega t + i\sin\omega t), \qquad \text{where} \quad \hat{x}_m = x_0 e^{i\alpha} e^{-\beta t} \tag{3.14}$$

is the potential-kinetic (complex) amplitude and $\alpha$ is the initial phase of oscillations.

Under the condition $t = 0$, the complex amplitude defines the initial state of the system

$$\hat{x}(0) = \hat{x}_m = x_0 e^{i\alpha} = x_0\cos\alpha + ix_0\sin\alpha, \tag{3.15}$$

where $x_k(0) = x_0\cos\alpha$ is the initial kinetic displacement and $\tilde{x}_p(0) = ix_0\sin\alpha$ is the initial potential displacement. Thus, the complex amplitude holds the quantitative-qualitative information about the initial potential-kinetic state of the system.

## 4. Forced oscillations

Under the external periodic potential-kinetic action upon the kinematic circuit (Fig. 3.1), forced oscillations with the frequency of the external action $\omega$ arise. In this case, motion-rest in the system is described by the differential equation of the potential-kinetic displacement:

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

We will find the solution of the equation (4.1) in the form $\hat{x} = \hat{x}_m e^{i\omega t}$, where $\hat{x}_m$ is the potential-kinetic amplitude. Assuming that the external potential-kinetic action has the form $\hat{F} = F_m e^{i\omega t}$, we arrive at

$$\hat{F} = m\frac{d^2\hat{x}}{dt^2} + r\frac{d\hat{x}}{dt} + k\hat{x} \quad \Rightarrow \quad \hat{F} = -m\omega^2\hat{x} + ir\omega\hat{x} + k\hat{x}, \tag{4.2}$$

i.e., at the algebraic form of the potential-kinetic exchange of motion-rest:

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

where

$$\hat{k} = (k - m\omega^2) + ir\omega = k_c + ik_r = k_c + \tilde{k}_r \tag{4.3a}$$

is the binary conservative-dissipative parameter (the coefficient of conservation-dissipation) of the system. The conservative coefficient,

$$k_c = k - m\omega^2, \tag{4.3b}$$

defines the capability of the system to conserve motion-rest. Here, $k$ is the coefficient of conservation of rest and $-m\omega^2$ is the coefficient of conservation of motion.

The dissipative coefficient defines the dissipation of rest-motion:

$$\tilde{k}_r = ir\omega. \tag{4.3c}$$

The conservative coefficient $k_c$ expresses the qualitative side of exchange of motion-rest, the dissipative coefficient $\tilde{k}_r$ expresses the quantitative side of exchange of motion-rest with environment.

In the phase plane (Fig. 3.2a), the parameter $\hat{k}$ is represented in the trigonometric form

$$\hat{k} = k_m e^{i\varphi} = k_m \cos\varphi + ik_m \sin\varphi = k_c + ik_r, \tag{4.4}$$

where

$$k_m = \sqrt{(k - m\omega^2)^2 + r^2\omega^2}. \tag{4.4a}$$

The argument $\varphi$ expresses the phase correlation between the capability of the system to conserve and dissipate the potential-kinetic field of oscillations. Simultaneously, the argument $\varphi$ defines the phase shift between the action $\hat{F} = F_m e^{i\omega t}$ and the reaction of the system $\hat{x} = \hat{x}_m e^{i\omega t}$.

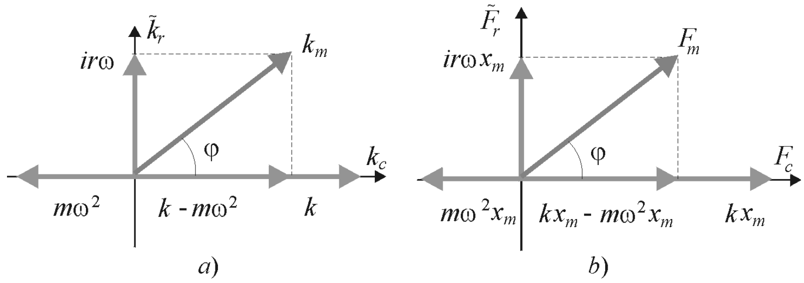


**Fig. 3.2.** A graph of amplitudes of the parameters $\hat{k}$ and $\hat{F}$.

In the phase plane, tangent of the phase shift is defined by the equality

$$tg\varphi = \frac{k_r}{k_c} = \frac{r\omega}{k - m\omega^2} = \frac{2\beta\omega}{\omega_0^2 - \omega^2}. \tag{4.5}$$

Returning back to the equation (4.3), we have

$$\hat{x} = \frac{F_m e^{i\omega t}}{k_m e^{i\varphi}} = \frac{F_m}{k_m} e^{i(\omega t - \varphi)} = x_m e^{i(\omega t - \varphi)}. \tag{4.6}$$

As we see, a reaction of the system $\hat{x} = x_m e^{i(\omega t - \varphi)}$ to the external action $\hat{F} = F_m e^{i\omega t}$ lags behind in phase at the value $\varphi$.

Let us write the equation of exchange (4.3) in the following way:

$$\hat{F} = F_c + \tilde{F}_r = (k - m\omega^2 + ir\omega)\hat{x} = k_c\hat{x} + \tilde{k}_r\hat{x}, \tag{4.7}$$

where

$$F_c = k_c\hat{x} = (k - m\omega^2)\hat{x}, \qquad \tilde{F}_r = \tilde{k}_r = ir\omega\hat{x} \tag{4.7a}$$

The kinema $F_c$ defines the internal potential-kinetic exchange in the system between potential and kinetic fields. The kinema $\tilde{F}_r$ expresses the external exchange of rest-motion, which leads to the dissipation of rest-motion. A graph of amplitudes of the kinema $\hat{F}$ is presented in Fig. 3.2b.

Taking into account that $\hat{P} = \int \hat{F} dt = \frac{1}{i\omega}\hat{F}$, the equation (4.3) can be written in the form of the potential-kinetic momentum of exchange of rest-motion:

$$\hat{P} = (m - \frac{k}{\omega^2} - i\frac{r}{\omega^2})\ \hat{\upsilon} \qquad (4.8)$$

or

$$\hat{P} = p_r + \tilde{p}_c = r\hat{x} + i(m\omega - \frac{k}{\omega})\hat{x} = \hat{r}\hat{x}, \qquad (4.8a)$$

where

$$\hat{r} = r + i(m\omega - \frac{k}{\omega}) = r + \tilde{r}_c \qquad (4.9)$$

is the binary parameter (coefficient) of exchange of potential-kinetic momentum.

The coefficient *r* defines the momentum of dissipation of rest-motion

$$p_r = r\hat{x}, \qquad (4.10)$$

the coefficient $\tilde{r}_c$ defines the internal exchange of potential-kinetic momentum

$$\tilde{p}_c = \tilde{r}_c\hat{x} = i(m\omega - \frac{k}{\omega})\hat{x} = (m - \frac{k}{\omega^2})\hat{\upsilon} = m\hat{\upsilon} + m_p\hat{\upsilon}. \qquad (4.11)$$

The equation of exchange (4.3) can be presented also in the following form:

$$\hat{F} = (m - \frac{k}{\omega^2} - i\frac{r}{\omega^2})\hat{w}, \qquad \text{where} \quad \hat{w} = -\omega^2\hat{x} \qquad (4.12)$$

is the potential-kinetic acceleration.

The binary mass

$$\hat{m} = m - \frac{k}{\omega^2} - i\frac{r}{\omega^2} = m_c + im_r \qquad (4.13)$$

is the conservative-dissipative measure of exchange of rest-motion. Its components are the kinetic mass *m*, the potential mass

$$m_p = -\frac{k}{\omega^2}, \qquad (4.13a)$$

and the mass of dissipation

$$\tilde{m}_r = -i\frac{r}{\omega^2}. \qquad (4.13b)$$

From the expression (4.3), an amplitude relation of the displacement, the external action, and the coefficient of conservation-dissipation of motion-rest follows:

$$F_m = k_m x_m, \qquad x_m = \frac{F_m}{\sqrt{(k - m\omega^2)^2 + r^2\omega^2}} = \frac{F_m}{m\sqrt{(\omega_0^2 - \omega^2)^2 + 4\beta^2\omega^2}}. \qquad (4.14)$$

## 5. Conclusion

The field of binary real numbers exceeds in its possibilities to describe the real physical processes all existent now numerical fields. Its structure takes into account the longitudinal-transversal potential-kinetic character of processes in the Universe. Without usage of this field it is impossible cognition of the Micro- and Megaworld [1-5].

## References


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