# The binary numerical field and longitudinal-transversal motion

## 1. The unit vector of rotation

Binary numbers effectively describe longitudinal-transversal properties of different fields of matter-space-time. They and their components with different algebras of signs express both scalar and vector properties of objects and processes of nature. Therefore, they can be numbers-scalars, numbers-vectors, and scalar-vector numbers.

By virtue of their structure, there is no necessity to print in bold type binary numbers-vectors, except of cases when particular features of a mathematical sentence dictate it.

If we will present longitudinal and transversal components by only positive algebra of signs, then, for example, the rotating unit vector will be defined by the vector sum:

$$\mathbf{1} = \cos(\omega t + \alpha)\cdot \mathbf{i} + \sin(\omega t + \alpha)\cdot \mathbf{j}, \qquad (1.1)$$

where $\alpha$ is the phase of a state of the unit vector, giving its initial coordinates $x_0 = \cos\alpha$ and $y_0 = \sin\alpha$ (Fig.1.1).

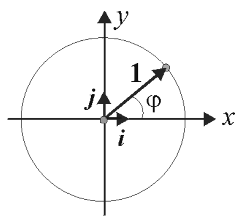


**Fig. 1.1.** The rotating unit-vector **1** with the constant angular velocity $\varphi = \omega t$ .

Rotation of the unit vector is also described by the equalities:

$$x = \cos(\omega t + \alpha) = \cos\omega t \cdot x_0 - \sin\omega t \cdot y_0, \qquad (1.2)$$
$$y = \sin(\omega t + \alpha) = \sin\omega t \cdot x_0 + \cos\omega t \cdot y_0 .$$

The matrix form of expressions (1.2) is

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} \cos\omega t & -\sin\omega t \\ \sin\omega t & \cos\omega t \end{pmatrix} \cdot \begin{pmatrix} x_0 \\ y_0 \end{pmatrix} \quad \text{or} \quad e = A\cdot e_0 , \qquad (1.2a)$$

where $e = \begin{pmatrix} x \\ y \end{pmatrix}$ and $e_0 = \begin{pmatrix} x_0 \\ y_0 \end{pmatrix}$ are the matrix representation of the unit number-vector

and
$$A = \begin{pmatrix} \cos\omega t & -\sin\omega t \\ \sin\omega t & \cos\omega t \end{pmatrix} \qquad (1.3)$$

is the matrix of rotation.

It is more simply to present the matrix of rotation in the diagonal form then we will have

$$e = \begin{pmatrix} \lambda & 0 \\ 0 & \lambda \end{pmatrix} e_0 . \qquad (1.4)$$

The elements $\lambda$ of the diagonal matrix coincide with the roots of the algebraic equation

$$\begin{vmatrix} \cos\omega t - \lambda & -\sin\omega t \\ \sin\omega t & \cos\omega t - \lambda \end{vmatrix} = 0 \quad \text{or} \quad \lambda^2 - 2\cos\omega t \cdot \lambda + 1 = 0 . \qquad (1.5)$$

In the general case, $\lambda$ is the binary number:

$$\hat{\lambda} = e^{\pm j\omega t} . \qquad (1.5a)$$

In order to clear up a sense of the obtained solution, we will turn to the vector form of the rotating vector (1.1). This form does not distinguish the qualitative distinction between the longitudinal and transversal motions, although they are different and these differences can be considerable.

It is more correctly to describe a scalar product of the unit vector **i** on the basis of the positive algebra of signs, $\mathbf{i} \cdot \mathbf{i} = i \cdot i = +1$, and a scalar product of the unit vector **j** on the basis of the negative algebra of signs, $\mathbf{j} \cdot \mathbf{j} = j \cdot j = -1$.

For the sake of simplicity, let us agree to turn down the vector **i**, then the rotating unit number-vector will be presented by the binary number

$$\hat{1} = \cos(\omega t + \alpha) + j\sin(\omega t + \alpha) = e^{j(\omega t + \alpha)} = e^{j\omega t} e^{j\alpha} = e^{j\omega t}\hat{1}_0, \qquad (1.6)$$

where

$$\hat{1}_0 = e^{j\alpha} \qquad (1.6a)$$

is the initial state of the rotating unit.

If $\alpha = 0$, we have the rotating unit in the form

$$\hat{1} = \cos\omega t + j\sin\omega t = e^{j\omega t} \quad \text{or} \quad \hat{1}_\omega = e^{j\omega t}, \qquad (1.6b)$$

where the subscript $\omega$ shows the circular frequency of rotation. Longitudinal and transversal components of the unit number-vector are equal, respectively, to

$$1_x = \cos\omega t \quad \text{and} \quad \tilde{1}_y = j\sin\omega t. \qquad (1.7)$$

An arbitrary power *n* of the rotating unit defines the rotating unit with the circular frequency of the *n*-multiple power:

$$\hat{1}_\omega^n = e^{jn\omega t} = \hat{1}_{n\omega}. \qquad (1.8)$$

Let us turn again to the equation (1.5). Its solutions (1.5a) define two rotating numbers, which define two possible directions of rotation: anticlockwise (a positive rotation) and clockwise (a negative rotation). Thus, the matrix transformation $e = A \cdot e_0$ is represented by two possible rotations in the algebraic form:

$$\hat{1} = \hat{\lambda}_+ \hat{1}_0 = e^{j\omega t}\hat{1}_0, \qquad \hat{1} = \hat{\lambda}_- \hat{1}_0 = e^{-j\omega t}\hat{1}_0, \qquad (1.9)$$

where

$$\hat{\lambda}_+ = e^{j\omega t} \quad \text{and} \quad \hat{\lambda}_- = e^{-j\omega t} \qquad (1.9a)$$

are the unit multipliers of rotation. For the rotating vector of the length *a*, we have

$$\hat{a} = \hat{\lambda}_+ \hat{1}_0 a = ae^{j\omega t}\hat{1}_0, \qquad \hat{a} = \hat{\lambda}_- \hat{1}_0 a = ae^{-j\omega t}\hat{1}_0. \qquad (1.9b)$$

## 2. The longitudinal-transversal potential-kinetic field in circular motion

As was mentioned in the preceding paper, two mutually perpendicular potential-kinetic fields of displacements present the circular motion:

$$\hat{x} = x_p + ix_k = ae^{i\omega t} = a(\cos\omega t + i\sin\omega t), \qquad (2.1)$$

$$\hat{y} = y_p + iy_k = ae^{i(\omega t - \pi/2)} = a(\sin\omega t - i\cos\omega t). \qquad (2.1a)$$

They define the potential-kinetic circular displacement

$$\hat{a} = a \pm ia. \qquad (2.2)$$

The displacement $\hat{a}$ is the potential-kinetic radius, the conjugated signs "$\pm$" express the direction of circular motion.

The kinetic radius $r_k = \pm ia$ characterizes the kinetic field, the potential radius $r_p = a$ - the potential field of a circular process. These radii are mutually perpendicular, therefore, here the unit *i* with the negative algebra expresses not only the kinetic field but also its direction. The unit with the positive algebra 1 characterizes the potential field and its direction. Kinetic and potential fields of the circular process balance dynamically each other.

The potential-kinetic radius defines the potential-kinetic velocity of circular motion

$$\hat{\upsilon} = i\omega\hat{a} = \mu\omega a + i\omega a = \upsilon_k + i\upsilon_p \quad \text{or} \quad \hat{\upsilon} = \upsilon_k + \tilde{\upsilon}_p. \qquad (2.3)$$

The unit with the negative algebra *i* expresses now the potential field. It is natural, because the field of velocity is the negation of the field of displacements. Mathematically, it is expressed through a change of the quality of units. In the field of displacements, 1 is the potential unit and *i* is the kinetic unit; and vice versa, in the field of velocities, 1 is the kinetic unit and *i* is the potential unit.

The potential-kinetic velocity defines the total energy in circular motion

$$\hat{E} = \frac{m\hat{\upsilon}^2}{2} . \quad (2.4)$$

The sum of kinetic and potential energies is equal to zero

$$E_{kp} = \frac{m\upsilon_k^2}{2} + \frac{m\tilde{\upsilon}_p^2}{2} = 0 . \quad (2.5)$$

It is natural: potential and kinetic fields mutually balance each other. The modulus of total energy, equal to the difference of kinetic and potential energies, is characterized by the measure

$$E_m = \left|\hat{E}\right| = \frac{m\upsilon_k^2}{2} - \frac{m\tilde{\upsilon}_p^2}{2} = \frac{m\upsilon_k^2}{2} + \frac{m\upsilon_p^2}{2} = m\upsilon^2 , \quad (2.6)$$

where $\upsilon = \omega a$ .

In particular, at the level of wave processes with the basis speed *c* for a wave object of the mass $\Delta m$, we have

$$E_m = \Delta m \cdot c^2 . \quad (2.7)$$

In Einstein's formal theory, this measure has appeared, to some extent, by chance and began to be interpreted as the equivalence of mass and energy that is, generally speaking, incorrectly.

In the circular potential-kinetic field, binary numbers-measures rotate, therefore, the binary velocity can be presented, according to (1.9a), as

$$\hat{\text{v}} = \hat{\upsilon}\hat{\lambda} = (\upsilon_k + i\upsilon_p)e^{\pm j\omega t} . \quad (2.8)$$

The vector of velocity defines the potential-kinetic acceleration and, correspondingly, the potential-kinetic kinema:

$$\hat{w} = i\omega\hat{\upsilon} = -\omega\upsilon_p + i\omega\upsilon_k = w_p + iw_k , \qquad \hat{F} = m\hat{w} = mw_p + imw_k , \quad (2.9)$$

where $f_p = mw_p$ is the longitudinal potential kinema and $\tilde{f}_k = imw_k$ is the transversal kinetic kinema.

The field of circular motion, as the longitudinal-transversal potential-kinetic field, is analogous to the electromagnetic field, which is the longitudinal-transversal potential-kinetic field of the subatomic level of matter-space-time.

The gravitational field of any moving megaobject of mass *M* represents by itself also the longitudinal-transversal potential-kinetic field with two velocities-"strengths":

$$\tilde{\upsilon}_p = \frac{w_p}{i\omega} = i\frac{\gamma M}{r^2\omega} , \qquad \upsilon_k = \frac{\tilde{w}_k}{i\omega} = \frac{\gamma M}{r^2\omega} . \quad (2.10)$$

Potential and kinetic velocities describe the cylindrical potential-kinetic field of a moving object (star, planet). Taking into account the formula of the gravitational constant [1-3], expressions for the vectors of the gravitational field can be also presented in the following form:

$$\tilde{\upsilon}_p = \frac{w_p}{i\omega} = i\frac{Q_g}{4\pi\varepsilon_0 r^2} \cdot \frac{\omega_g}{\omega} , \qquad \upsilon_k = \frac{\tilde{w}_k}{i\omega} = \frac{Q_g}{4\pi\varepsilon_0 r^2} \cdot \frac{\omega_g}{\omega} , \quad (2.11)$$

where $Q_g = \omega_g M$ is the central gravitational charge of exchange of matter-space-time and $\omega_g$ is the fundamental frequency of the gravitational field. Such a representation of vectors of the gravitational longitudinal-transversal field stresses the relation of the cylindrical component of the field with its central component.

## References

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October 04, 2001