Parameters of circular motion-rest

George P. Shpenkov

This is a corrected version of several paragraphs of the book "Atomic Structure of Matter-Space" by L. Kreidik and G. Shpenkov, published in 2001 [1], in which a few technical editorial and author's mistakes were made, due to confusion with signs in mathematical expressions when describing circular motion-rest. This did not affect the general concept, but influenced in some extent on correctness of the corresponding particular conclusions concerning mainly of the direction of some of the constituent parameters that characterise such a motion.

I. The circular kinematic field of motion-rest

1.1. The potential-kinetic radius-vector of motion-rest. Vector and scalar forms of potential-kinetic parameters.

The complete description of motion of a material point along a circumference is first presented here. Let us begin with the uniform motion.

The uniform motion along a circumference is complicated, consisting of two mutually perpendicular potential-kinetic harmonic oscillations.

For the definiteness, we assume that the motion along the axes, *x* and *y*, is defined by the potential-kinetic displacements $\hat{\Psi}_x = ae^{i\omega t}$ and $\hat{\Psi}_y = -i\hat{\Psi}_x = -iae^{i\omega t}$. A displacement along *y*-axis is the negation of a displacement along *x*-axis with the negative sign, defining the clockwise motion. If $\hat{\Psi}_y = i\hat{\Psi}_x = iae^{i\omega t}$, the anticlockwise motion takes place.

To describe the kinematics of motion, we use the four unit vectors: the unit tangent vector $\boldsymbol{\tau}$, directed along motion; the unit vector $\mathbf{n}$, defining the direction of the radius-vector $\boldsymbol{a}$; the unit vectors of the *x* and *y* axes, correspondingly, $\mathbf{k}$ and $\mathbf{l}$ (Fig. 1a).

Thus, the structure of motion clockwise along a circumference is defined by the potential-kinetic displacements:

$$\hat{\Psi}_x = \psi_{xp} + \psi_{xk} = a\cos\omega t + ia\sin\omega t \ ,$$
$$\hat{\Psi}_y = \psi_{yp} + i\psi_{yk} = a\sin\omega t - ia\cos\omega t \ . \qquad (1.1)$$

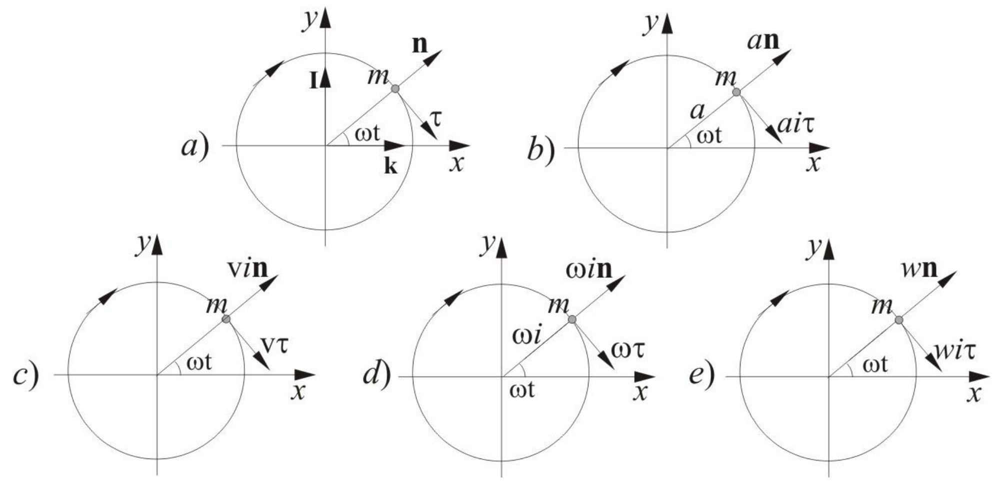

Fig. 1. The kinematics of motion-rest along a circumference: a) the four units vectors; b) $\mathbf{r}_p = a\mathbf{n}$ is the potential vector of motion, $\mathbf{r}_k = ia\boldsymbol{\tau}$ is the kinetic vector of motion; c) $\mathbf{v}_p = i\omega a\mathbf{n} = i\mathrm{v}\mathbf{n}$ is the potential velocity, $\mathbf{v}_k = \omega a\boldsymbol{\tau} = \upsilon\boldsymbol{\tau}$ is the kinetic velocity; d) $\boldsymbol{\omega}_p = i\omega\mathbf{n}$ is the potential angular velocity, $\boldsymbol{\omega}_k = \omega\boldsymbol{\tau}$ is the kinetic angular velocity; e) $\mathbf{w}_p = \omega^2\mathbf{r}_p = \omega^2 a\mathbf{n} = w\mathbf{n}$ is the potential acceleration, $\mathbf{w}_k = \omega^2\mathbf{r}_k = i\omega^2 a\boldsymbol{\tau} = iw\boldsymbol{\tau}$ is the kinetic acceleration.

The unit vectors, **n** and **τ**, of the mobile basis are expressed through the unit vectors, **k** and **l**, of the motionless basis in the following way:

$$\mathbf{n} = \cos\omega t \cdot \mathbf{k} + \sin\omega t \cdot \mathbf{l}\ , \qquad \boldsymbol{\tau} = \sin\omega t \cdot \mathbf{k} - \cos\omega t \cdot \mathbf{l} \tag{1.2}$$

Because **l**-vector is the space negation of **k**-vector, we can write

$$\mathbf{l} = j\mathbf{k} \qquad \text{or} \qquad \mathbf{k} = -j\mathbf{l}\ , \tag{1.3}$$

where j is the *unit of space negation*, pointing out the mutual orthogonality of properties.

A sense of the unit negation j is the anticlockwise turning about 90 degrees of the vector, which is negated.

On the basis of (1.3), we arrive at the new representation of the vectors **n** and **τ**:

$$\mathbf{n} = \mathbf{k}e^{j\omega t}\ , \qquad \boldsymbol{\tau} = -\mathbf{l}e^{j\omega t}\ . \tag{1.4}$$

It is obvious that the units, i and j, as the units of negation, are equal because they follow the same algebra of negation, but qualitatively they are different, since they express different negations.

This dialectical assertion can be presented by the following dialectical antinomy

$$(i = j)_q \wedge (i \neq j)_k\ ,$$

where the index q indicates the quantitative equality of both vectors, and the index k – their qualitative inequality.

The displacements, $\hat{\Psi}_x$ and $\hat{\Psi}_y$, define the potential-kinetic vector $\hat{\mathbf{r}}$ of motion along a circumference (Fig.1b):

$$\hat{\mathbf{r}} = \hat{\Psi}_x\mathbf{k} + \hat{\Psi}_y\mathbf{l} = ae^{i\omega t}\cdot\mathbf{k} + (-iae^{i\omega t})\cdot\mathbf{l} = \mathbf{r}_p + \mathbf{r}_k \tag{1.5}$$

or

$$\hat{\mathbf{r}} = (a\cdot\mathbf{k} - ia\cdot\mathbf{l})e^{i\omega t} = \mathbf{r}_p + \mathbf{r}_k\,. \tag{1.6}$$

Here,

$$\mathbf{r}_p = \psi_{xp}\mathbf{k} + \psi_{yp}\mathbf{l} = a\cos\omega t\cdot\mathbf{k} + a\sin\omega t\cdot\mathbf{l} = a\mathbf{k}e^{j\omega t} = a\mathbf{n} \tag{1.7}$$

is the potential radius, characterizing the constant (potential) side of revolving motion, directed along the radius-vector of a moving point;

$$\mathbf{r}_k = \psi_{xk}\mathbf{k} + \psi_{yk}\mathbf{l} = i(a\sin\omega t\cdot\mathbf{k} - a\cos\omega t\cdot\mathbf{l}) = -ia\cdot\mathbf{l}e^{j\omega t} = ia\boldsymbol{\tau} \tag{1.8}$$

is the kinetic radius, characterizing the variable (kinetic) side of revolving motion, directed along the motion of the point.

Thus, the potential-kinetic vector $\hat{\mathbf{r}}$, which we will denote also as $\hat{\mathbf{a}}$, takes the form (Fig. 1b):

$$\hat{\mathbf{a}} = (a\mathbf{k} - ia\mathbf{l})e^{j\omega t} = \hat{\mathbf{a}}_0 e^{j\omega t} = a\mathbf{n} + ia\boldsymbol{\tau}\,, \tag{1.9}$$

where $\hat{\mathbf{a}}_0 = a\mathbf{k} - ia\mathbf{l}$ and

$$\hat{\mathbf{a}}_p = a\mathbf{n}\,,\qquad \hat{\mathbf{a}}_k = ia\boldsymbol{\tau}\,. \tag{1.10}$$

Removing the unit vectors, $\mathbf{n}$ and $\boldsymbol{\tau}$, of the mobile basis, we will obtain the scalar form of the vector $\hat{\mathbf{a}}$ in the mobile basis

$$\hat{a} = a + ia\,. \tag{1.11}$$

The potential radius expresses the degree of stay, and the kinetic radius – the degree of non-stay, of a material point in every point of the circular trajectory. The potential-kinetic radius defines, simultaneously, the stay and non-stay of the material point in every point of the circular trajectory.

Removing vectors $\mathbf{k}$ and $\mathbf{l}$ of the motionless basis in the expression (1.4) or 1.9), we will obtain the scalar form $\hat{R}$ of presentation of the potential-kinetic vector $\hat{\mathbf{r}}$ in the motionless basis:

$$\hat{R} = \hat{\Psi}_x + \hat{\Psi}_y = \hat{a}e^{j\omega t} \quad \text{or} \quad \hat{R} = \hat{a}e^{j\omega t} = (a+ia)e^{j\omega t}\,. \tag{1.12}$$

Because any process in nature has a contradictory directed-undirected character, we present all physical parameters of fields and objects in vector and scalar forms.

Thus, we see that the circular field of matter-space-rest-motion represents the longitudinal-transversal (or radial-tangential) field, where the field of rest (the potential field) and the field of motion (the kinetic field) are mutually perpendicular.

The radial field is the potential field and the tangential field is the kinetic field that is expressed by the structure of the radius-vector (1.9).

2. The kinetic-potential velocity of motion along a circumference

The linear and angular velocities characterize the motion along a circumference:

$$\mathbf{v} = \frac{d\mathbf{s}}{dt} = \frac{ds\boldsymbol{\tau}}{dt} = \upsilon\boldsymbol{\tau} \quad , \qquad \boldsymbol{\omega} = \frac{d\varphi}{dt} = \frac{d\mathbf{s}/a}{dt} = \frac{(ds/a)\boldsymbol{\tau}}{dt} = \frac{d\varphi\boldsymbol{\tau}}{dt} = \omega\boldsymbol{\tau}\,, \qquad (1.13)$$

where $d\varphi$ is the vector differential of the arc displacement $d\mathbf{s}/a$ and a is the radius of circumference.

The derivative of the radius-vector $\hat{\mathbf{a}}$ (1.9) determines the kinetic-potential velocity of motion along the circumference (Fig. 1c)

$$\hat{\mathbf{v}} = \frac{d\hat{\mathbf{a}}}{dt} = \frac{d}{dt}(a\mathbf{n} + ia\boldsymbol{\tau}) = \omega a\boldsymbol{\tau} + \imath\omega a\mathbf{n}$$

or

$$\hat{\mathbf{v}} = \frac{d\hat{\mathbf{a}}}{dt} = \hat{\mathbf{v}}_k + \hat{\mathbf{v}}_p = \upsilon\boldsymbol{\tau} + \imath\upsilon\mathbf{n}\,, \qquad (1.14)$$

where $\upsilon = \omega a$ and

$$\hat{\mathbf{v}}_k = \frac{d\hat{\mathbf{a}}_p}{dt} = \upsilon\boldsymbol{\tau} \qquad (1.15)$$

is the kinetic tangential velocity,

$$\hat{\mathbf{v}}_p = \frac{d\hat{\mathbf{a}}_k}{dt} = i\upsilon\mathbf{n} \qquad (1.16)$$

is the potential normal velocity.

The corresponding angular velocities have the following form:

$$\hat{\boldsymbol{\omega}} = \frac{1}{a}\frac{d\hat{\mathbf{a}}}{dt} = \hat{\boldsymbol{\omega}}_k + \hat{\boldsymbol{\omega}}_p = \omega\boldsymbol{\tau} + \imath\omega\mathbf{n}\,, \qquad (1.17)$$

$$\hat{\boldsymbol{\omega}}_k = \frac{1}{a}\frac{d\hat{\mathbf{a}}_p}{dt} = \frac{d\mathbf{n}}{dt} = \omega\boldsymbol{\tau}\,, \qquad (1.18)$$

$$\hat{\boldsymbol{\omega}}_p = \frac{1}{a}\frac{d\hat{\mathbf{a}}_k}{dt} = \frac{d(i\boldsymbol{\tau})}{dt} = i\omega\mathbf{n}\,. \qquad (1.19)$$

A scalar form of the velocity (Fig. 1c) in the motionless basis is

$$\hat{\upsilon} = \frac{d\hat{R}}{dt} = \upsilon_k + \upsilon_p = i\omega\hat{a}e^{i\omega t} = (\omega a + i\omega a)e^{i\omega t}\,, \qquad (1.20)$$

where

$$\upsilon_k = \omega a e^{i\omega t}\,, \qquad \upsilon_p = i\omega a e^{i\omega t}\,. \qquad (1.21)$$

In the mobile basis, it is

$$\hat{\upsilon} = \upsilon_k + \upsilon_p = \omega a + i\omega a\,. \qquad (1.22)$$

Analogous forms of the specific velocity $\hat{\omega}$ (Fig. 1d) correspond to the above-presented scalar forms of the linear velocity:

$$\hat{\omega} = \frac{1}{a}\frac{d\hat{R}}{dt} = \omega_k + \omega_p = (\omega + i\omega)e^{i\omega t}\,, \tag{1.23}$$

where
$$\omega_k = \omega e^{i\omega t}\,, \qquad \omega_p = i\omega e^{i\omega t}\,. \tag{1.24}$$

In the mobile basis, it is

$$\hat{\omega} = \omega_k + \omega_p = \omega + i\omega\ . \tag{1.25}$$

The kinetic tangential velocity is directed along the motion and the potential normal velocity – along the radius-vector of the circumference.

The potential velocity is the centrifugal velocity of rest, which (under definite conditions) can be transformed into the centrifugal velocity of motion.

The kinetic velocity characterizes both the quantitative side of motion and the qualitative side of rest, whereas the potential velocity – the quantitative side of rest and the qualitative side of motion.

3. Accelerations

The derivative of the potential-kinetic velocity determines the potential-kinetic acceleration:

$$\hat{\mathbf{w}} = \mathbf{w}_p + \mathbf{w}_k = \omega^2(a\mathbf{n} + ia\boldsymbol{\tau})\,, \tag{1.26}$$

where
$$\mathbf{w}_p = \omega^2 a\mathbf{n} = w\mathbf{n} = \frac{\upsilon^2}{a}\mathbf{n} \tag{1.27}$$

is the potential centrifugal acceleration;

$$\mathbf{w}_k = i\omega^2 a\boldsymbol{\tau} = iw\boldsymbol{\tau} = i\frac{\upsilon^2}{a}\boldsymbol{\tau} \tag{1.28}$$

is the kinetic non-centrifugal acceleration.

The corresponding specific potential-kinetic accelerations have the form

$$\hat{\boldsymbol{\varepsilon}} = \frac{\hat{\mathbf{w}}}{a} = \boldsymbol{\varepsilon}_p + \boldsymbol{\varepsilon}_k = \omega^2(\mathbf{n} + i\boldsymbol{\tau})\,, \tag{1.29}$$

where
$$\boldsymbol{\varepsilon}_p = \omega^2\mathbf{n}\,, \qquad \boldsymbol{\varepsilon}_k = i\omega^2\boldsymbol{\tau}\,. \tag{1.30}$$

The scalar forms of the accelerations in the motionless and mobile bases are, correspondingly, equal to

$$\hat{w} = \omega^2\hat{a}\,, \qquad \hat{w} = \omega^2\hat{a}\,e^{i\omega t}\,, \tag{1.31}$$

$$\hat{\varepsilon} = \omega^2(1+i)\,, \qquad \hat{w} = \omega^2(1+i)\,e^{i\omega t}\,. \tag{1.32}$$

The potential normal, or centrifugal, acceleration is directed along a radius-vector of the circumference and the kinetic tangential, or rotational, acceleration is directed along the motion.

All types of the above-considered accelerations, which describe uniform circular motion, are the qualitative accelerations. They characterize the change of the field of motion-rest only along the direction. Besides, the relation of quantity and quality connects the potential and kinetic accelerations between themselves.

II. The circular dynamic field of motion-rest

1. The vector of potential-kinetic state in the circular motion

Under the motion along a circle, the state vector $\hat{\mathbf{S}}$ (see (1.5)) has the form

$$\hat{\mathbf{S}} = m\hat{\mathbf{r}} = m(\hat{\Psi}_x\mathbf{k} + \hat{\Psi}_y\mathbf{l}) = m\mathbf{r}_p + m\mathbf{r}_k = \mathbf{S}_p + \mathbf{S}_k \,, \tag{2.1}$$

where

$$\mathbf{S}_p = m\mathbf{r}_p = ma\mathbf{k}e^{j\omega t} = ma\mathbf{n} \tag{2.2}$$

is the vector of the potential state,

$$\mathbf{S}_k = m\mathbf{r}_k = -mia\mathbf{l}e^{j\omega t} = mia\boldsymbol{\tau} \tag{2.3}$$

is the vector of the kinetic state.

Their scalar forms in the fixed and mobile bases are, correspondingly:

$$S_p = mr_p = mae^{j\omega t}\,, \qquad S_p = mr_p = ma \tag{2.4}$$

$$S_k = mr_k = miae^{j\omega t}\,, \qquad S_k = mr_k = mia\,. \tag{2.5}$$

2. The kinetic-potential momentum

The kinetic-potential (or kinematic) momentum of a point on the circumference, according to the equation (3.5), is

$$\hat{\mathbf{P}} = m\hat{\mathbf{v}} = m\upsilon\boldsymbol{\tau} + im\upsilon\mathbf{n}\,.$$

This formula can be obtained also by the following way:

$$\hat{\mathbf{P}} = \frac{d\hat{\mathbf{S}}}{dt} = \frac{d\mathbf{S}_p}{dt} + \frac{d\mathbf{S}_k}{dt} = \mathbf{p}_k + \mathbf{p}_p = m\upsilon\boldsymbol{\tau} + im\upsilon\mathbf{n}\,, \tag{2.6}$$

where

$$\mathbf{p}_k = \frac{d\mathbf{S}_p}{dt} = ma\omega\boldsymbol{\tau} = m\upsilon\boldsymbol{\tau} \tag{2.7}$$

is the tangential kinetic momentum and

$$\mathbf{p}_p = \frac{d\mathbf{S}_k}{dt} = -j\omega mia\mathbf{l}e^{j\omega t} = mi\omega a\mathbf{n} = mi\upsilon\mathbf{n} \tag{2.8}$$

is the normal (or centrifugal) potential momentum.

Thus, the momenta of motion and rest represent the kinetic-potential momentum. These momenta are mutually perpendicular, which reflects the mutual orthogonality of fields of motion and rest.

In the motionless and mobile bases, scalar forms of the momenta are

$$\hat{P} = \frac{dm\hat{A}}{dt} = m\hat{\upsilon} = m\upsilon_k + m\upsilon_p = m(\upsilon + i\upsilon)e^{j\omega t}, \tag{2.9}$$

$$\hat{P} = m\hat{\upsilon} = m\upsilon + mi\upsilon. \tag{2.10}$$

The potential-kinetic momentum (2.6) can be also expressed as

$$\hat{\mathbf{P}} = m\hat{\mathbf{v}} = j\omega m e^{j\omega t}(a\mathbf{k} - ia\mathbf{l}) = j\omega\hat{m}(a\mathbf{k} - ia\mathbf{l}) = \hat{q}\hat{\mathbf{a}}_0 \tag{2.11}$$

or

$$\hat{\mathbf{P}} = m\hat{\mathbf{v}} = \hat{q}a\mathbf{k} - \hat{q}ia\mathbf{l}, \tag{2.12}$$

where

$$\hat{m} = me^{j\omega t} = m\cos\omega t + jm\sin\omega t \tag{2.13}$$

is the longitudinal-transversal mass of the oscillator, defining the corresponding longitudinal-transversal charge

$$\hat{q} = \frac{d\hat{m}}{dt} = j\omega m e^{J\omega t} = q\cos\omega t + jq\sin\omega t. \tag{2.14}$$

Thus, in the motionless basis, the kinetic-potential momentum (2.12) represents by itself the two polarized oscillatory waves of moments of charge, correspondingly, in the planes *ZOX* and *ZOY*:

$$\hat{\mathbf{P}} = \hat{\mathbf{P}}_q = \hat{\mathbf{p}}_{qp} + \hat{\mathbf{p}}_{qk} = \hat{q}a\mathbf{k} - \hat{q}ia\mathbf{l}, \tag{2.15}$$

where

$$\hat{\mathbf{p}}_{qp} = \hat{q}a\mathbf{k} \tag{2.16}$$

is the potential kinematic moment of charge,

$$\hat{\mathbf{p}}_{qk} = -\hat{q}ia\mathbf{l} \tag{2.17}$$

is the kinetic kinematic moment of charge.

In the mobile basis, the kinetic momentum

$$\mathbf{p}_k = m\upsilon\boldsymbol{\tau} = \mathbf{p}_{q\tau} = qa\boldsymbol{\tau} = iq(ia\boldsymbol{\tau}) = iq\hat{\mathbf{a}}_k \tag{2.18}$$

is the tangential moment of the kinetic charge $q = \omega m$ and the potential momentum

$$\mathbf{p}_p = mi\upsilon\mathbf{n} = \mathbf{p}_{qn} = iqa\mathbf{n} = iq\hat{\mathbf{a}}_p \tag{2.19}$$

is the radial moment of the potential charge $iq = i\omega m$.

Their scalar forms in the motionless and mobile bases are as follows:

$$\hat{P}_q = (qa + iqa)e^{j\omega t}, \qquad \hat{P}_{qp} = qae^{j\omega t}, \qquad \hat{P}_{qk} = iqae^{j\omega t}$$

$$\hat{P}_{qp} = \hat{q}a\,, \qquad \hat{P}_{qk} = \hat{q}ia\,, \tag{2.20}$$

where $\hat{q}$ is the potential-kinetic charge defined by the formula

$$\hat{q} = \frac{d\hat{m}}{dt} = i\omega\hat{m} = qe^{i(\omega t + \frac{1}{2}\pi)} \tag{2.21}$$

q=ωm is the modulus of the charge.

3. The kinetic-potential charge

The specific momentum defines the vector kinetic-potential charge:

$$\hat{\mathbf{Q}} = \hat{\mathbf{P}}/a = \hat{\mathbf{q}}_k + \hat{\mathbf{q}}_p = q\boldsymbol{\tau} + qi\mathbf{n}\,. \tag{2.22}$$

Its scalar form is: in the motionless basis

$$\hat{Q} = \hat{P}/a = (q + iq)e^{j\omega t} \tag{2.23}$$

and in the mobile basis

$$\hat{q} = q + iq\,. \tag{2.24}$$

The kinematic charge is related with the rotor-divergence of velocity and momentum:

$$rodiv\hat{\mathbf{v}} = rot\hat{\mathbf{v}} + div\hat{\mathbf{v}} = 2\frac{\hat{\mathbf{Q}}}{m}\,, \tag{2.25}$$

$$rodiv\hat{\mathbf{P}} = rot\hat{\mathbf{P}} + div\hat{\mathbf{P}} = 2\hat{\mathbf{Q}}\,; \tag{2.26}$$

at that,

$$rot(\hat{\mathbf{P}}) = \hat{\mathbf{Q}}_k\,, \qquad rot\hat{\mathbf{v}} = 2\frac{\hat{\mathbf{Q}}_k}{m} = 2\hat{\boldsymbol{\rho}}_k\,, \tag{2.27}$$

$$rot\hat{\mathbf{P}} = \hat{\mathbf{Q}}_p\,, \qquad rot\hat{\mathbf{v}} = 2\frac{\hat{\mathbf{Q}}_p}{m} = 2\hat{\boldsymbol{\rho}}_p\,, \tag{2.28}$$

where $\hat{\rho}_k$ is the vector of mass density of the transversal kinetic charge and $\hat{\rho}_p$ is the vector of density of the longitudinal potential charge.

4. The basic parameters of kinematic exchange

The rate (of the field) of change of momentum (or the power of exchange) describes the exchange of rest-motion

$$\hat{\mathbf{F}} = \frac{d\hat{\mathbf{P}}}{dt} = m\hat{\mathbf{w}} = \hat{\mathbf{F}}_p + \hat{\mathbf{F}}_k = m\omega^2 a\mathbf{n} + m\omega^2 ia\boldsymbol{\tau} = I\hat{\mathbf{a}}\,. \tag{2.29}$$

The potential and kinetic powers of exchange are, correspondingly, equal to

$$\hat{\mathbf{F}}_p = m\hat{\mathbf{w}}_p = m\omega^2 a\mathbf{n} = \frac{m\upsilon^2}{a}\mathbf{n} = I\hat{\mathbf{a}}_p\,, \tag{2.30}$$

$$\hat{\mathbf{F}}_k = m\hat{\mathbf{w}}_k = m\omega^2 ia\boldsymbol{\tau} = i\frac{m\upsilon^2}{a}\boldsymbol{\tau} = I\hat{\mathbf{a}}_k\,, \tag{2.31}$$

and $I \equiv k = m\omega^2 = q\omega$ is the amplitude of the kinematic current.

The scalar form of the power of exchange in the mobile basis is

$$\hat{F} = m\hat{w} = \hat{F}_p + \hat{F}_k = m\omega^2 a + m\omega^2 ia = I\hat{a}\,. \tag{2.32}$$

The specific power of exchange of momentum $\hat{\mathbf{I}} = \hat{\mathbf{F}}/a$ is the kinematic current

$$\hat{\mathbf{I}} = \frac{d\hat{\mathbf{P}}}{adt} = \frac{d\hat{q}}{dt} = \hat{\mathbf{I}}_p + \hat{\mathbf{I}}_k = -m\omega^2\mathbf{n} + m\omega^2 i\boldsymbol{\tau} = I(\mathbf{n} + i\boldsymbol{\tau})\,, \tag{2.33}$$

where

$$\hat{\mathbf{I}}_p = I\mathbf{n} \tag{2.34}$$

is the potential (or centripetal) current, and

$$\hat{\mathbf{I}}_k = iI\boldsymbol{\tau} \tag{2.35}$$

is the kinetic (tangential) current.

The scalar form of the kinetic current in the mobile basis is

$$\hat{I} = \hat{I}_p + \hat{I}_k = m\omega^2 + m\omega^2 i = I + iI\,. \tag{2.36}$$

The rate of exchange of momentum is perceived physiologically, at the level of sensations, as “force”. This word is very unsuccessful. We should leave it for sport and physiology, but in physics, it is necessary to use a different term. We call the rate of exchange of momentum the “*kinema*”.

The rotor-divergence of kinema defines the kinematic current:

$$rodiv\hat{\mathbf{F}} = rot\hat{\mathbf{F}} + div\hat{\mathbf{F}} = 2\hat{\mathbf{I}}\,. \tag{2.37}$$

According to the definition, there is the following correlation between the kinema and current

$$\hat{\mathbf{F}} = a\hat{\mathbf{I}}\,. \tag{2.38}$$

In its turn, the kinema, as the state of motion-rest, demands operating by the rate of its change, which we will call the vector of mobility or *mobilite* (from the Latin, *mobilitas* = mobility) $\hat{\mathbf{D}}$:

$$\hat{\mathbf{D}} = \frac{d\hat{\mathbf{F}}}{dt} = a\frac{d\hat{\mathbf{I}}}{dt} = \hat{\mathbf{D}}_k + \hat{\mathbf{D}}_p = I\upsilon(\boldsymbol{\tau} + i\mathbf{n}) = k\hat{\mathbf{v}}\,. \tag{2.39}$$

Thus,

$$\hat{\mathbf{D}} = \hat{\mathbf{D}}_p + \hat{\mathbf{D}}_k = k\hat{\mathbf{v}}\,, \tag{2.40}$$

where

$$\hat{\mathbf{D}}_p = iI\upsilon\mathbf{n} \qquad \text{and} \qquad \hat{\mathbf{D}}_k = I\upsilon\boldsymbol{\tau}\,. \tag{2.41}$$

5. The moments of momentum and of kinema

The following potential-kinetic moments, by the definition, are related with the momentum and kinema:

$$\hat{\mathbf{L}} = \hat{\mathbf{P}}a = \hat{\mathbf{L}}_k + \hat{\mathbf{L}}_p = ma^2\hat{\omega} = J\hat{\boldsymbol{\omega}} = J\omega\boldsymbol{\tau} + J\omega i\mathbf{n}\,, \tag{2.42}$$

$$\hat{\mathbf{M}} = \hat{\mathbf{F}}a = \hat{\mathbf{M}}_p + \hat{\mathbf{M}}_k = J\hat{\boldsymbol{\varepsilon}} = J\boldsymbol{\varepsilon}_p + J\boldsymbol{\varepsilon}_k\,, \tag{2.43}$$

where

$$\hat{\mathbf{M}}_p = J\boldsymbol{\varepsilon}_p = J\omega^2\mathbf{n} \tag{2.44}$$

is the centripetal potential moment and

$$\hat{\mathbf{M}}_k = J\boldsymbol{\varepsilon}_k = J\omega^2 i\boldsymbol{\tau} \tag{2.45}$$

is the tangential kinetic moment.

A scalar ratio of the moment of kinematic charge

$$\hat{\mathbf{P}} = \hat{\mathbf{Q}}a = (\hat{\mathbf{q}}_k + \hat{\mathbf{q}}_p)a = qa\boldsymbol{\tau} + iqa\mathbf{n} \tag{2.46}$$

to the moment of momentum

$$\hat{\mathbf{L}} = m\hat{\mathbf{v}}a = m(\upsilon\boldsymbol{\tau} + i\upsilon\mathbf{n})a \tag{2.47}$$

has the form

$$\frac{\hat{\mathbf{P}}}{\hat{\mathbf{L}}} = \frac{\hat{\mathbf{Q}}a}{m\hat{\mathbf{v}}a} = \frac{\hat{\mathbf{Q}}}{m\hat{\mathbf{v}}} = \frac{qa(\boldsymbol{\tau} + i\mathbf{n})}{m\upsilon a(\boldsymbol{\tau} + i\mathbf{n})} = \frac{q}{m\upsilon}\,. \tag{2.48}$$

6. The energetic measures of circular motion-rest

The circular motion-rest has a many-sided character. It is described by a series of energetic measures. The ***first energetic scalar measure*** of motion-rest along a circumference of a material point is defined by the following integral

$$\hat{E} = \int \hat{F}d\hat{a} = \int m\hat{\upsilon}d\hat{\upsilon} = -\int I\hat{a}d\hat{a} = -\frac{k\hat{a}^2}{2} = \frac{m\hat{\upsilon}^2}{2} \tag{2.49}$$

The ***second energetic measure*** of the motion-rest on the basis of *vector* measures, is

$$\hat{E} = \int \hat{\mathbf{F}}d\hat{\mathbf{a}} = \int m\hat{\mathbf{v}}d\hat{\mathbf{v}} = -\int I\hat{\mathbf{a}}d\hat{\mathbf{a}} = -\frac{k\hat{\mathbf{a}}^2}{2} = \frac{m\hat{\mathbf{v}}^2}{2}\,,$$

or

$$\hat{E} = \frac{m\mathbf{v}_k^2}{2} + \frac{m\mathbf{v}_p^2}{2} + \frac{2m\mathbf{v}_k\mathbf{v}_p\cos\alpha}{2} = \frac{m\upsilon^2}{2} + \frac{m(i\upsilon)^2}{2} + \frac{2m\mathbf{v}_k\mathbf{v}_p\cos(\pi/2)}{2}\,,$$

and

$$\hat{E} = \frac{m\upsilon_k^2}{2} + \frac{m\upsilon_p^2}{2} = \left(\frac{m\upsilon^2}{2}\right)_k + \left(-\frac{m\upsilon^2}{2}\right)_p = 0$$

or

$$E = \frac{m\upsilon_k^2}{2} + \frac{m\upsilon_p^2}{2} = \frac{p_k^2}{2m} + \frac{p_p^2}{2m} = 0\,, \quad E = \frac{\hbar_k\omega}{2} + \frac{\hbar_p\omega i}{2} = 0\ , \qquad (2.50)$$

where $\hbar_k = m\upsilon_k a$ is the kinetic moment of momentum and $\hbar_k = mi\upsilon_p a$ is the potential moment of momentum.

Thus, under the motion along a circumference (as in particular it takes place with the electron in H-atom), the potential-kinetic vector energy of a material point is equal to zero. By virtue of this, the circular motion is the optimal (equilibrium) state of the field of rest-motion, where "attraction" and "repulsion" are mutually balanced, which, in turn, provide for the steadiness of orbital motion in the micro- and macroworld.

The quantitative equality of "attraction" and "repulsion" is accompanied, simultaneously, by the qualitative inequality of the directions of fields of rest and motion, which generates the eternal circular wave motion. In order to break such a motion, it is necessary to destroy this system entirely. However, in this case, a vast number of new circular wave motions of more disperse levels will appear as a result.

The ***third energetic measure*** of motion-rest is defined on the basis of the fact that the motion along a circumference is the sum of two potential-kinetic oscillations.

Therefore, the total *scalar measure* of energy of motion-rest along a circumference is equal to the sum of potential-kinetic energies, E_x and E_y, of such oscillations:

$$E = E_x + E_y = E_k + E_p = \frac{m\upsilon^2}{2} + \frac{m\upsilon^2}{2} = m\upsilon^2 = \hbar\omega = h\nu\,, \qquad (2.51)$$

where

$$E_k = \left(\frac{m\upsilon_k^2}{2}\right)_x + \left(\frac{m\upsilon_k^2}{2}\right)_y = \frac{m\upsilon^2}{2}$$

and

$$E_p = \left(\frac{m\upsilon_p^2}{2}\right)_x + \left(\frac{m\upsilon_p^2}{2}\right)_y = \frac{m\upsilon^2}{2} \qquad (2.52)$$

are, accordingly, the total kinetic and potential energies of a material point in a circular motion.

As follows from the formulae (2.52), the total kinetic and potential energies are equal.

Every energetic measure, of the above-presented energetic measures, expresses the definite side of a many-sided process of motion-rest. If a radius of a circumference moves towards infinity, then any part of this circumference can be regarded as a part of the rectilinear motion-rest with the total energy

$$E = E_k + E_p = m\upsilon^2 , \qquad (2.53)$$

where

$$E_k = E_p = \frac{m\upsilon^2}{2} .$$

[1] L. G. Kreidik and G. P. Shpenkov, *Atomic Structure of Matter-Space*, Geo. S., Bydgoszcz, 2001, 584 p.; shpenkov.com/pdf/atom.html

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George P. Shpenkov
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