Elementary quantum of current	$i_B = \omega Q$	$i_S = \dfrac{\upsilon}{c}\omega Q$
Current	$I_B = nQ\upsilon S$	$I_S = nq\upsilon S$
Density of current	$j_B = \dfrac{dI_B}{dS} = nQ\upsilon$	$j_S = \dfrac{\upsilon}{c} nQv = nq\upsilon$
Circulation	$\Gamma_B = \dfrac{I_B}{c}$	$\Gamma_S = \dfrac{\upsilon}{c}\Gamma_B = \dfrac{\upsilon}{c} I_S$
Density of circulation	$\gamma_B = \dfrac{d\Gamma_B}{dS} = \dfrac{\upsilon}{c} nQ$	$\gamma_S = \dfrac{\upsilon}{c} nq$

It is very difficult to imagine the ***moment of charge*** p_S, within the framework of this spectrum in the form of the measure of the "magnetic" moment equal to $p_S = \frac{1}{2}\frac{\upsilon}{c}Qa$, announced in physics as the "proper magnetic moment of electron".

Thus, however hard we may try to approach from different points, we arrive at the conclusion that the initial conceptions of the Dirac equation are false. Therefore, this equation cannot give us the objective picture of atomic processes. Concerning different concepts of quantum mechanics, they continue the traditions of the thirtieths. Contemporary physics and chemistry still continue to set forth doctrines on the basis of completely exhausted themselves ideas. This is why we devoted much time to Schrödinger's equation. The further development of the aforementioned concepts proceeds via the complication of mathematical constructions, where already no physical sense can be found; and their logic is in the highest degree confused and speculative.

9. WAVES AND CURRENT

9.1. *Basic notions*

The notions, which approximately reflect the real objects and phenomena of nature, are in the basis of physical theories.

Let us agree to call the notions, which quite exactly describe the properties of an object of thought, *objective notions* (*Yes*-notions). In opposite case, the notions will be called *subjective notions* (*No*-notions). In a general case, a clear boundary between objective and subjective notions does not exist.

Therefore, if an objective notion contains elements of subjectivism, we call it the *objective-subjective notion* (*Yes-No*-notion). If a subjective notion contains elements of objectivity, we call it the *subjective-objective notion* (*No-Yes*-notion).

Such a classification of notions more completely corresponds to basic judgements of dialectical logic: *Yes-Yes*, *Yes-No*, *No-Yes*, and *No-No*, which reflect the real picture of intellectual thought. In conformity with these judgements, the absolutely objective *Yes*-notions, strictly speaking, should be called the *objective-objective notions* (the notions *Yes-Yes*) or briefly *Yes*-notions. Analogously, the absolutely non-objective notions should be called the *subjective-subjective notions* (the notions *No-No*) or briefly *No*-notions.

The philosophy of physics of the 19th century has regarded, and continues regarding, notions as only subjective constructions. And many scientists assume that notions have a conditional character of definite covenants. This is a point of view of the philosophy of subjectivism, machism, and pragmatism.

On the contrary, in dialectical philosophy, a notion of the high scientific level must, first of all, be the logical construction, which more exactly adequately reflects the contents and form of an object of nature with this notion. Only then, notions could be regarded as scientific agreements.

Subjective elements of notions lead to misunderstanding of objective properties of objects and phenomena of nature. In order to make theories formally consistent, with experiments, subjective notions generate additional hypotheses and interpretations. The lasts introduce in science nonexistent "physical properties", which are formal mathematical constructions far from reality.

As a rule, at the macrolevel, notions are objective ones on the whole, because their originals (we mean objects to which these notions are ascribed) are visible with the naked eye. Therefore, the objectivity of such notions is verified easily.

At the microlevel, everything is more complicated, because the objectivity of notions is very difficult to verify. By virtue of this, in modern physics, the fully developed practice of the creation of formal hypotheses and interpretations exists. Such formal hypotheses and interpretations only do harm to science, creating an illusion of resolving of a problem.

We will consider the dialectics of objectivity of notions with an example of periodical processes.

Let us assume that a wave of a frequency ν is propagated along a circular trajectory of a radius r. If p waves are placed on the circular orbit, then the linear, λ, and radian (relative), λ_φ, measures of wavelength will be defined by the relations:

$$\lambda = \frac{2\pi r}{p}\ , \qquad \lambda_\varphi = \frac{\lambda}{r} = \frac{2\pi}{p}\,. \tag{9.1}$$

Between the linear velocity υ of the wave front on the circumference and the circular frequency (the angular velocity) of revolution ω_{orb} (or ω_e), the following relations take place:

$$\upsilon = \omega_{orb} r \,, \tag{9.2}$$

$$\omega_{orb} = \frac{2\pi}{T_{orb}} = 2\pi\nu_{orb} , \tag{9.3}$$

where T_{orb} and ν_{orb} are the period and frequency of revolution of the wave front.

In the circular motion, the length of a circumference, C=2πr, is the period-quantum of extension (length); and the period T_{orb} is the time circumference or the period-quantum of time extension (duration).

Obviously, the wave period T is related with the wave-circumference T_e (or T_{orb}) as

$$T = T_e \,/\, p \,. \tag{9.4}$$

The relation between the wave frequency ν and the frequency of revolution ν_e takes the form

$$\nu = \frac{1}{T} = \frac{p}{T_e} = p\nu_e \,. \tag{9.5}$$

The equality (9.5) defines the analogous relation between the circular frequency ω and the circular velocity of rotation ω_e of the wave:

$$\omega = \frac{2\pi}{T} = \frac{2\pi p}{T_e} = p\omega_e \,. \tag{9.6}$$

In the case, when p = 1, i.e., λ = 2πr, the wave will be called the *unit wave* and its length will be denoted as λ_e. For the unit wave, the wave frequency and the frequency of its rotation are equal: $\omega = \omega_e$.

If $p = 1/2$, we deal with the circular frequency of the wave of the fundamental tone

$$\omega = (1/2)\omega_e \,. \tag{9.7}$$

It is convenient to express arbitrary circular frequencies ω_p through the circular frequency of the fundamental tone as

$$\omega_p = p\omega = \frac{p}{2}\omega_e \,, \tag{9.8}$$

where p is the number of half-waves placed on the circumference. Then, elementary potential-kinetic waves of an arbitrary frequency take the form

$$\hat{\Psi} = \hat{a} e^{i\frac{p}{2}(\omega_e t - k_e s)} \,. \tag{9.9}$$

9.2. *The symmetrical definition of current, I*

Classical physics defines the value of a current flowing in a conductor as the "quantity of electricity being conveyed by the motion of electrons or ions through the cross-section area of the conductor per unit time". However, a current is not the flow of an “electric liquid”, it is the complicated wave process. It takes place both on the left and on the right from the cross-section. And the value of current represents by itself the rate of change of this process (Fig. 9.7).

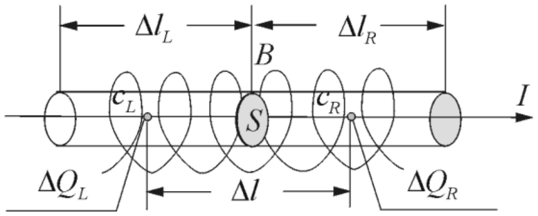

Fig. 9.7. On the definition of the notion a *value of current*; the spiral trajectory B, enveloping a conductor, symbolizes a magnetic field; c_R and c_L are centers of masses of elements of the field, belonging to the intervals Δl_L and Δl_R.

By this reason, one can state that the common definition of the value of current I is related to the objective-subjective notion.

Moreover, the definition of the average value of current takes into account only the “quantity of electricity” displaced on the right side from the cross-section S, $\Delta Q_R = \langle \rho_q \rangle S \Delta l_R$, localized at the part $\Delta l_R = \upsilon \Delta t$:

$$I = \frac{\Delta Q}{\Delta t} = \frac{\Delta Q_R}{\Delta t} = \langle \rho_q \rangle S \upsilon , \tag{9.10}$$

where $\langle \rho_q \rangle$ is the average “density of electricity” and $\Delta Q = \Delta Q_R$.

If we regard the formula (9.10) as the formal convention, there are no problems from the point of view of pragmatism.

In dialectics, this definition has evident subjective features, because it does not take into account the “quantity of electricity” approaching from the left (directly to the cross-section S), $\Delta Q_L = \langle \rho_q \rangle S \Delta l_L$, where $\Delta l_L = \Delta l_R = \Delta l = \upsilon \Delta t$.

This second component of the “quantity of electricity”, unconditionally, takes part in the formation of the wave process in an arbitrary cross-section S. It influences the objective measure, called the “value of electric current”, which is defined by means of physical apparatuses independently of our understanding of its nature. Moreover, as we will show further, the subjectivism of the formula (9.10) gave birth to the spin hypothesis, which does not reflect reality.

In nature, the binary symmetry dominates. And in any cross-section of a conductor, we deal with the symmetry of the process of motion at the microlevel.

Accordingly, the definition (9.10) cannot be recognized as correct, because, in the domain of a cross-section S, the current and the ambient magnetic field, as the wave process, are formed by both the incoming and issuing "quantity of electricity". Their sum defines the "passing quantity of electricity Δ*Q*"

$$\Delta Q = \Delta Q_L + \Delta Q_R \, . \tag{9.11}$$

The following average current (in a conductor, in the domain of a cross-section *S*) corresponds to the quantity (9.11):

$$I = \frac{\Delta Q}{\Delta t} = \frac{\Delta Q_R + \Delta Q_L}{\Delta t} = 2\left\langle \rho_q \right\rangle S\upsilon = 2\left\langle n\right\rangle eS\upsilon \, , \tag{9.12}$$

where $\Delta t = \Delta l / \upsilon$ is the time of the "passing quantity of electricity Δ*Q*"; *e* is the quantum of the "quantity of electricity", which expresses the measure of some wave electric property *E*; $\langle \rho \rangle = \langle n \rangle e$ is the density of the electric property *E*; and $\langle n \rangle$ is the average concentration of carries of the electric property *E*.

The symmetrical definition (9.12) reflects the objective symmetrical structure of the field of a current in the domain of a cross-section. Practically, we are interested only in the value of a current, which does not rest evidently on the real measuring of the "quantity of electricity" Δ*Q*.

Therefore, the one-sided character of the definition of the average value of current (9.10) in no way influences measurements, which are normal in engineering and scientific practice.

However, as soon as a theory analyzes the unit phenomena, the difference of the two formulae, (9.10) and (9.12), influences the objective understanding of a physical process and can lead to the erroneous theoretical conclusions.

The formula of the average value of current (9.12) has a general character and relates to currents of different wave properties, if Δ*Q* is the measure of some wave property.

Let us consider the average value of the current of an orbiting electron, relying on the formula (9.12). The average density of "electricity" $\left\langle \rho_q \right\rangle$ of the electron orbit is

$$\left\langle \rho_q \right\rangle = \frac{e}{2\pi r S_e} = ne \, , \tag{9.14}$$

where

$$n = \frac{1}{2\pi r S_e} \tag{9.15}$$

is the electron concentration and S_e is the cross-section of the electron *physical* orbit (which differs from the *mathematical* orbit with the zero cross-section).

From this, we obtain the average current of the orbiting electron:

$$I = 2neS_e\upsilon = \frac{2e}{2\pi r S_e} S_e \upsilon = \frac{2e}{T_{orb}} \, , \tag{9.16}$$

where $T_{orb} = \dfrac{2\pi r}{\upsilon}$ is the period of electron's revolution.

The formula (9.16) can be also obtained in the other way. Let us consider the average rate of motion along a circumference within the interval from the cross-section S_+ to the polar opposite cross-section S_-, as is shown in Fig. 9.8.

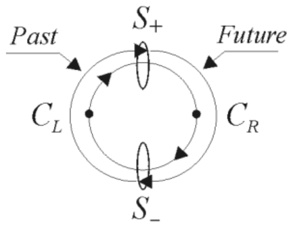

Fig. 9.8. The closed circuit; *Past* and *Future* are, respectively, the limiting past and the limiting future, during the period of revolution T_{orb}; C_R and C_L are, respectively, the right and left "half-circumferences" of the future and the past.

The right and left half-circumferences, C_R and C_L, define maximal displacements from the right and left sides of the cross-section S_+.

The half-space of an orbit, $\Omega_R = C_R \cdot S_e = \pi r S_e$ (where S_e is an arbitrary cross-section), is the half-space of the motion from the section S_+, whereas the half-space $\Omega_L = C_L \cdot S_e = \pi r S_e$ is the half-space of the motion to the section S_+.

The half-spaces, Ω_R and Ω_L, are the spaces of the past and future motions with respect to the cross-section S_+, which in the cross-section S_- are closed on to each other. Both time fields define the time field of passing of the electron through the cross-section S_+.

The half-circumference C_R, as the wave-beam, is circumscribed by the electron, as the wave front, during the half-period of electron's revolution along the orbit. In the half-space of motion from the cross-section S_+, the following relation expresses the average velocity of moving off:

$$I = \upsilon = \frac{e}{\frac{1}{2} T_{orb}} = \frac{2e}{T_{orb}} = \frac{2\pi r}{T_{orb}}, \tag{9.17}$$

where $e = C_R = \pi r$. During the following half-period, the average velocity of approaching to the cross-section S_+ will be the same in value.

The average velocity of moving off and approaching to the section S_+ is, simultaneously, the average velocity of passing through the cross-section S_+.

Since the sections, S_+ and S_-, are arbitrary, the formula (9.17) is valid for any cross-section.

If $e = m$ is the electron's mass, then the average current of mass exchange I_M through the cross-section S_+ will take the form

$$I_M = \frac{m}{\frac{1}{2} T_{orb}} \tag{9.18}$$

or
$$I_M = \frac{2m}{T_{orb}}\,. \qquad (9.19)$$

This is the average current of mass exchange from the section S_+ to the section S_-. During the second half-period, the mass exchange from the section S_- to the section S_+ will take place with the same velocity. The sections, S_+ and S_-, are arbitrary polar opposite sections, therefore, the formulae (9.18) and (9.19) are valid for any cross-sections.

The rate of motion of an electron's electric property e from the cross-section S_+ will be defined by the formula, analogous to (9.17):
$$I = \frac{e}{\frac{1}{2}T_{orb}} = \frac{2e}{T_{orb}}\,. \qquad (9.20)$$

The same will be the rate of motion of an electron's electric property e to the cross-section S_+. Accordingly, this value will be the average velocity of passing of an electron's electric property e through any cross-section. In essence, the current (9.20) represents by itself the "electric" orbital current of the electric exchange and self-exchange.

The average value of current (9.20) is consistent with the other calculations of the average current in wave processes. The asymmetrical formula (9.10) results in the average value of current, which is half as much, i.e.,
$$I = neS_e\upsilon = \frac{e}{2\pi r S_e} S_e\upsilon = \frac{e}{T_{orb}}\,. \qquad (9.21)$$
This value is not in conformity with Einstein's–de Haas's experiments.

9.3. *The circular wave motion and current*

Any particle E, as the wave structure moving along a circumference, represents by itself only one wave node on a circular orbit. Accordingly, only one half-wave of the fundamental tone is placed on an orbit and the wavelength of the fundamental tone is equal to the two circular trajectories–half-waves:
$$\lambda = 4\pi r\,. \qquad (9.22)$$

This conclusion is confirmed by the elementary solution of the wave equation, which is described by the Bessel wave function of the order $\frac{1}{2}$.

Within one ***particular*** *wave* λ, an arbitrary object E twice passes every point of an orbit. The ***particular*** *wave half-period* T_{orb} represents by itself the ***particular*** *period of revolution* of an object E along an orbit. At the same time, during any *period of rotation*, the object turns out to be twice in any point of the circular trajectory.

The motion in inner space of a circular trajectory, along two successive half-circumferences, occurs in one direction (clockwise or anticlockwise). In this sense, they affirm each other. This can be expressed briefly by the logical judgement *Yes*, which affirms the absent of a contradiction (*Yes* = ”no contradiction”).

In the outer space, these motions are mutually opposite in direction. In this sense, they negate each other. This can be expressed by the brief logical judgement *No* (*No* = “a contradiction exists”).

Thus, as inner absolute motions, the motions along two successive half-circumference are one-directed. Simultaneously, the same motions in outer space, as mutually relative ones, are opposite-directed. This also shows the contradictoriness of the circular motion.

If S_p is an arbitrary potential point of a wave of the fundamental tone (i.e., its node), then, the conjugated diametrically opposite point S_k will be the kinetic point of the wave (its loop) (Fig. 9.9). In the longitudinal wave of the fundamental tone, the rectilinear amplitude of displacement is equal to the diameter of a circumference,

$$a_m = 2r. \tag{9.23}$$

The amplitude of the curvilinear displacement along a circumference is equal to half-circumference, i.e., quarter-wave:

$$A_m = \pi r. \tag{9.24}$$

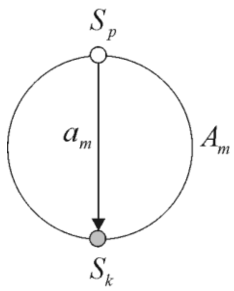

Fig. 9.9. The amplitudes of displacement, a_m and A_m, in a wave of the fundamental tone on a circumference; S_p and S_k are the potential and kinetic points (nodes) of the wave; the kinetic node represents the center of a loop of the wave.

If T_{orb} is the half-period of the wave of the fundamental tone, then, the following expressions are valid: for the wave period

$$T = 2T_{orb}, \tag{9.25}$$

the frequency of the fundamental tone $\nu = 1/T$, (9.26)

the velocity of wave motion $$\upsilon = \frac{\lambda}{T} = \lambda\nu = \frac{2\pi R}{T_{orb}}, \tag{9.27}$$

and for wavelengths of the fundamental tone and the unit wave

$$\lambda = \upsilon T, \qquad \lambda_e = \frac{1}{2}\lambda = \upsilon T_{orb}. \tag{9.28}$$

In the wave of the fundamental tone, the half-period T_{orb} is the time of the wave revolution of an object along a circumference, which defines the frequency of revolution (frequency of half-wave):

$$\nu_{orb} = \frac{1}{T_{orb}} = \frac{2}{T} = 2\nu \,. \qquad (9.29)$$

The center of the wave front of the electron half-wave of the fundamental tone circumscribes one circle. Such motion represent by itself the superposition of two mutually perpendicular potential-kinetic displacements with respect to the center of an orbit (Fig. 9.10):

$$\Psi_x = r \cdot \exp(i\omega_{orb} t)\,, \qquad \Psi_y = ir \cdot \exp(i\omega_{orb} t)\,, \qquad (9.30)$$

where $\omega_{orb} = 2\pi\nu_{orb}$ is the circular frequency. These displacements are the unit potential-kinetic oscillations, describing the electron's motion as the center of the wave front of the *orbital* wave. They form the *frontal waves*, when the orbit moves along the *Z*-axis with the velocity υ_z:

$$\Psi_x = r \cdot \exp(i\omega_{orb} t - k_z z + \alpha)\,, \quad \Psi_y = ir \cdot \exp(i\omega_{orb} t - k_z z + \alpha)\,, \qquad (9.31)$$

where $k_z = \omega_{orb} / \upsilon_z$ is the wave number.

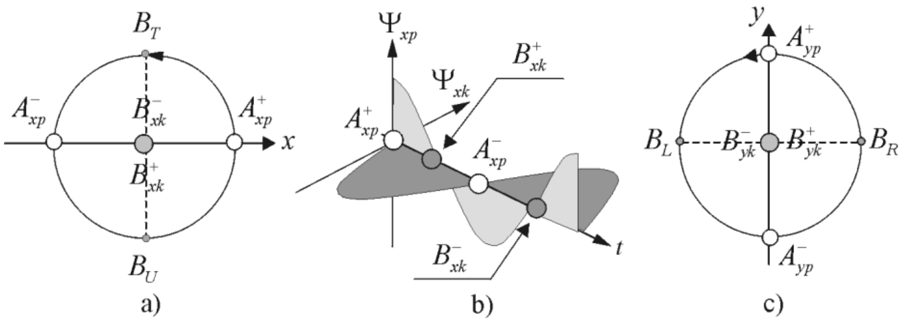

Fig. 9.10. The frontal Ψ_x-oscillation (wave), $A_{xp}^{\pm}$ and $B_{xk}^{\pm}$ are its potential and kinetic nodes (a); a graph of the Ψ_x-wave, Ψ_{xp} and $\Psi_{xk} = i\Psi_{xp}$ are its potential and kinetic components (b); the frontal $\Psi_y = i\Psi_x$-oscillation (wave) with the potential and kinetic nodes (c).

The frontal and orbital waves, as the waves of superstructure over the basis (subatomic) space are related to different levels of the motion on an orbit. The orbital waves are the inner waves of the orbit, whereas the frontal waves are the waves of the front of the orbit. The frontal and orbital waves of superstructure can induce, if a system is open, in the outer space of the basis, the corresponding basis waves. The lasts are propagated with the velocity *c*, i.e., the wave velocity of basis space.

In each of the frontal waves, the average rate of displacement along the axes, *x* and *y*, is defined by the ratio of four amplitudes of displacements a_m to the period of the wave of the fundamental tone:

$$\langle \upsilon \rangle = \frac{4a_m}{T} = \frac{8r}{T} = \frac{4r}{T_{orb}}. \tag{9.32}$$

In such a case, the amplitude frontal rate of displacement is

$$\upsilon = \frac{\pi}{2}\langle \upsilon \rangle = \frac{4\pi r}{T} = \frac{2\pi r}{T_{orb}} \tag{9.33}$$

and
$$\lambda = \upsilon T = 4\pi r. \tag{9.34}$$

If we divide the wave (9.34) by the wave velocity *c* in the field-space outside the circuit, we will obtain the time wave

$$T = 4\pi T_r, \tag{9.35}$$

where
$$T_r = r / c \tag{9.36}$$

is the time radius-period or the radial period.

The time wave of the fundamental tone is defined, in absolute units, by the measure

$$\lambda_T = \frac{T}{T_R} = 4\pi. \tag{9.37}$$

The kinetic points $B_{xk}^{\pm}$ of the Ψ_x-wave are defined by the electron's motion in the points B_T and B_U. The time density *I* of any kinetic wave property *e*, related with the kinetic points, is equal to the product of the number of points and some wave property *e* divided by the corresponding period:

$$I = \frac{2e}{T_{orb}} = \frac{4e}{T}. \tag{9.38}$$

This also concerns such a wave property as the "electric charge".

9.4. *A current in potential-kinetic fields of a circular pendulum and of a string*

Let us turn to the motion of the circular mathematical pendulum. The circular pendulum of mass *m* is connected with an elastic spring, fixed in a point *A* inside of an absolutely smooth horizontal transparent hollow ring of radius *r* (Fig. 9.11). The spring is shown, conditionally, in the form of a thin thread. The point *A* is a point of the unstable states of rest: A_+ and A_- (potential points). The point *B* is a point of the equilibrium state, represented by the two states of motion: B_+ and B_- (kinetic points).

Two circular motions represent the complete swing of the pendulum. The swing starts in the point *A* in the state A_+. In this state, the spring is completely compressed and the displacement from the equilibrium state *B* is equal to the kinetic amplitude of displacement with the positive sign: $+a = +\pi r$. The pendulum passes the point *B* with the positive maximal velocity in the kinetic state B_+. Then, it reaches the point *A* in the potential state A_-. In this state, the displacement is equal to the kinetic amplitude of displacement with the minus sign: $-a = -\pi r$. The half-period of the swing is completed in the state A_-. Along with this, one circular motion is completed. The second half-period begins from the state A_-.. Then, the pendulum passes the point *B* in the kinetic state B_- with the negative maximal velocity and returns in the initial state A_+. The period of the swing is *T* and the half-period $T_e = \frac{1}{2}T$ is the time of revolution along a circle.

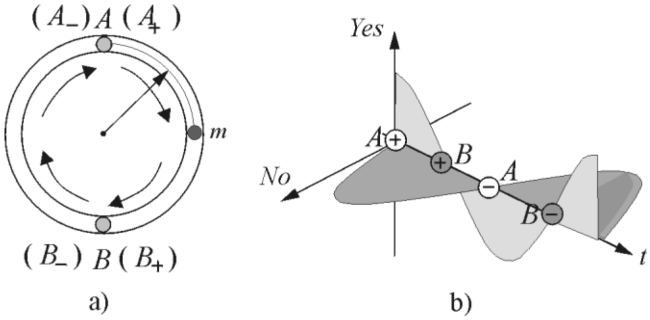

Fig. 9.11. The circular mathematical pendulum (a) and a graph of the potential-kinetic field of its motion (b).

The potential-kinetic displacement of pendulum along a circle is

$$\hat{a} = a_p + ia_k = ae^{i\omega t} = a\cos\omega t + ia\sin\omega t\,, \tag{9.39}$$

where a_p and ia_k are the potential and kinetic displacements, $a = \pi r$ is the amplitude of displacement from the equilibrium state *B* up to the point of rest *A*.

The field of potential-kinetic velocity

$$\hat{\upsilon} = \frac{d\hat{a}}{dt} = i\omega a e^{i\omega t} \tag{9.40}$$

is characterized by the average value of velocity

$$\upsilon = \frac{2}{T}\int_{-T/2}^{0} \hat{\upsilon}dt = \frac{2}{T}ae^{i\omega t}\Big|_{-T/2}^{0} = \frac{2C}{T} = \frac{4}{T}a = \frac{4\pi r}{T} = \frac{2\pi r}{T_e}\,, \tag{9.41}$$

where $C = 2\pi r$ is one half-oscillation and T_e is the half-period of oscillation (the time of revolution along a circle).

If the circular motion is periodic, the form of the function of velocity does not matter, because the average velocity in all cases will be equal to the ratio of the circumference length by the period of revolution. In particular, if the motion is uniform, we have

$$\upsilon = \frac{2}{T}\int_{-T/2}^{0} \upsilon dt = \frac{2C}{T} = \frac{4}{T}a = \frac{4\pi r}{T} = \frac{2\pi r}{T_e}\,. \tag{9.41a}$$

One can say that the uniform motion along a circle is the amplitude wave motion with the two periods, every of which represents by itself one circular motion. Each circular motion represents by itself the synthesis of the two plane polarized unit oscillations-waves along the mutually perpendicular directions.

The potential-kinetic mass of the pendulum, $\hat{m} = me^{i\omega t} = m_p + im_k$, as the mass of superstructure, describes its potential-kinetic state. It represents the mass potential-kinetic wave. And the potential-kinetic field of change of state of the mass is the wave field of the potential-kinetic charge: $\hat{q} = \frac{d\hat{m}}{dt} = i\omega\hat{m}$. In turn, the field of change of the potential-kinetic charge,

$$\hat{I} = \frac{d\hat{q}}{dt} = \frac{d^2\hat{m}}{dt^2} = i\omega\hat{q} = -\omega^2\hat{m}, \tag{9.42}$$

is the field of potential-kinetic (kinematic) current (the field of superstructure).

In the discrete potential points, A_+ and A_-, characteristic wave states of mass and charge are equal, respectively, to

$$A_+: \quad \hat{m}(0) = me^{i\omega t}\Big|_{t=0} = m, \qquad \hat{q} = i\omega\hat{m}(0) = i\omega m. \tag{9.43}$$

$$A_-: \quad \hat{m}(0) = me^{i\omega t}\Big|_{t=T/2} = -m, \qquad \hat{q} = i\omega\hat{m}(0) = -i\omega m. \tag{9.43a}$$

Analogously, in the kinetic points, B_+ and B_-, we have

$$B_+: \quad \hat{m}(\tfrac{1}{4}T) = me^{i\omega t}\Big|_{t=T/4} = im, \qquad \hat{q} = i\omega\hat{m}(\tfrac{1}{4}T) = -\omega m. \tag{9.44}$$

$$B_-: \quad \hat{m}(\tfrac{3}{4}T) = me^{i\omega t}\Big|_{t=3T/4} = -im, \qquad \hat{q} = i\omega\hat{m}(\tfrac{3}{4}T) = +\omega m. \tag{9.44a}$$

Thus, in the potential points, the charges are potential; in the kinetic points, the charges are kinetic.

The average value of the potential current, in any cross-section, is defined by the formula:

$$iI = \frac{2}{T}\int_{-T/2}^{0} \hat{I}dt = -\frac{2}{T}\omega^2\int_{-T/2}^{0}\hat{m}dt = \frac{2}{T}mi\omega e^{i\omega t}\Big|_{-T/2}^{0} = \frac{4qi}{T} = \frac{2qi}{T_e}, \tag{9.45}$$

where $q = m\omega$ is the amplitude of the kinematic charge. Analogously, the average value of the kinematic current, in any cross-section, is

$$I = \frac{4q}{T} = \frac{2q}{T_e}. \tag{9.45a}$$

In the uniform motion along a circumference, as an amplitude wave, the value of current in a cross-section of any point B (Fig. 9.12) has the same value:

$$I = \frac{2}{T}\int_{T/4}^{3T/4} Idt = \frac{2}{T}\int_{T/4}^{3T/4} dq = \frac{2}{T}q\Big|_{T/4}^{3T/4} = \frac{2}{T}\big((\omega m) - (-\omega m)\big) = \frac{4}{T}m\omega = \frac{4q}{T} = \frac{2q}{T_e}. \tag{9.46}$$

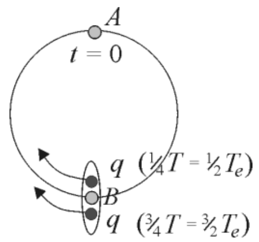

Fig. 9.12. On the calculation of the average current, flowing through a cross-section *B*, if only one charge *q* circulates.

Let us now consider a string in the form of a circle with two ends fixed in one point *A*. In such a string, one can excite the circular polarized transversal wave. Such a string represents by itself an elementary pattern of the wave beam, in which the transversal potential-kinetic wave oscillations take place.

An equation of the potential-kinetic beam-wave has the form:

$$\hat{a} = ae^{i(\omega t \pm ks + \varphi_0)} = aie^{\pm iks + \varphi_0} e^{i\omega t}, \tag{9.47}$$

where
$$\hat{a}_s = ae^{\pm iks} \tag{9.47a}$$

is the potential-kinetic amplitude of transversal displacements. This amplitude is equivalent to the circular motion with the radius $r_s = a|\cos ks|$, where s is the length along the beam, reading off the point *A*, and φ_0 is the initial phase of oscillations. The time component of the wave field of a string is

$$\hat{a}_t = e^{i\omega t}. \tag{9.48}$$

In such a field, the longitudinal mass wave-beam is

$$\hat{m} = me^{i(\omega t \pm ks)} = me^{\pm iks} e^{i\omega t}. \tag{9.49}$$

The mass potential-kinetic wave defines the potential-kinetic longitudinal current

$$\hat{I} = \frac{d\hat{q}}{dt} = -\omega^2 \hat{m} = -\omega^2 me^{\pm iks} e^{i\omega t}. \tag{9.50}$$

Its average value, in time and space, is defined by the integral

$$I = \frac{2}{2\pi i}\int \hat{I} d\varphi = \frac{1}{\pi}\omega e e^{i\varphi}\Big|_{-\pi/2}^{\pi/2} = \frac{2}{\pi}\omega e = \frac{4e}{T} = \frac{2e}{T_e}, \tag{9.51}$$

where $\varphi = \omega t \pm ks + \varphi_0$ is the phase of the wave, $k = \omega / \upsilon_0$ is the wave number corresponding to the wave velocity υ_0, s is the curvilinear length along the beam of current I and of charge $e = \omega M_A$, M_A is the mass of one atom of a string and I is the elementary kinematic current related with one atomic chain along a string.

If the string consists of N atomic chains, the current increases N times, however, the form of the formula does not change. In this case, the charge also will be N times as much: $e = \omega M_A N$. The wave perturbation is transmitted along a string in the form of motion from one to another atom with the average rate υ_0. With that, the integral mass transfer does not take place. The last happens at the level of individual local perturbations along a string.

Since the transversal oscillations also take place, the transversal circular current of individual charges $e = \omega M_A$, flowing along a circle of the radius $r_s = a|\cos ks|$ with the velocity $\upsilon_s = \omega r_s$, takes place as well.

As in the case of the *transversal current*, the same period and charge define the average *longitudinal current*; therefore, *both currents are always equal*.

9.5. *Some parameters of the wave field of gravitation related with the time wave of the fundamental tone*

Let us consider the Earth's motion, which we assume, for simplicity, is circular. The gravitation constant defines the circular frequency

$$\omega_g = \sqrt{4\pi\varepsilon_0 G} = 9.156956336\,10^{-4}\,s^{-1}. \tag{9.52}$$

Here, we accept $G = 6{,}672590000\,10^{-8}\,g^{-1}\cdot cm^3\cdot s^{-2}$. (9.52a)

Using the formula of the time wave of the fundamental tone (9.37), we arrive at the gravitational radial period

$$T_g = \frac{\lambda_T}{\omega_g} = \frac{4\pi}{\omega_g} = 1.372330516\,10^4\,s, \tag{9.53}$$

which expresses the central exchange (central interaction) and defines the azimuth time wave

$$T = 4\pi T_g = 2\cdot 86226.06935\,s = 2\cdot 23.95168593\,h = 2\cdot 23^h 57^m 06^s.069. \tag{9.54}$$

This wave is equal to two Earth's days, which form two circular cycles-half-waves. Each of the cycles-half-waves is equal to one day.

On the basis of (9.54), we find the period of revolution T_e

$$T_e = 2\pi T_g = 86226.06935\,s = 23.95168593\,h \approx 23^h 57^m 06^s, \tag{9.55}$$

It is equal to the Earth's day. The corresponding angular velocity of the Earth's rotation is $\omega_e = 7.292115011\cdot 10^{-5}\,s^{-1}$ and the time day radius is

$$T_R = \frac{1}{\omega_e} = \frac{T_e}{2\pi} = 1.37134425\,10^4\,s. \tag{9.56}$$

The last is equal, practically, to the gravitational radial period that points out the resonance state of Earth's motion in the gravitational field of the Universe.

The period of Earth's revolution around the Sun defines the half-wave of Earth's orbit. In such a case, the time wavelength is equal to two years:

$$\lambda_T = 3.149458919\,10^7\,s. \tag{9.57}$$

Two potential states-winters and two kinetic states-summers represent the Earth's wave. Let us compare the Earth's period with the period of mathematical pendulum. There (see Fig. 9.11), winters are represented by the potential domains with the centers A_+ and $A_–$; summers are represented by the kinetic domains with the centers B_+ and $B_–$.

The domains of Earth's wave (A_+, B_+, $A_–$, and $B_–$) are devided by four transitional climate states – two springs and two falls. The beginning of every year in many countries coincides with the potential center that is quite logical. Thus, the 2000-year is the 1000th wave cycle in the gravitational field.

If we take, as the reference value, the Earth's day in the 2000-year, equal approximately to $23^h56^m04^s$, we should accept the gravitational constant in that year equal to

$$G=\omega_g^2/4\pi\varepsilon_0=6.682160218\cdot 10^{-8}\,g^{-1}\cdot cm^3\cdot s^{-2}. \qquad (9.58)$$

This value is at the level of the fundamental measure:

$$G=\frac{\omega_g^2}{4\pi\varepsilon_0}\approx(6+0.682188177)\cdot 10^{-8}\,g^{-1}\cdot cm^3\cdot s^{-2}=$$

$$=(6+\frac{\pi}{2}\lg e)\cdot 10^{-8}\,g^{-1}\cdot cm^3\cdot s^{-2}.$$

If we accept this value as the "independent (absolute)" standard, we obtain

$$\omega_g=\sqrt{4\pi\varepsilon_0\left(6+\frac{\pi}{2}\lg e\right)\cdot 10^{-8}\,g^{-1}\cdot cm^3\cdot s^{-2}}=\sqrt{4\pi\left(6+\frac{\pi}{2}\lg e\right)\cdot 10^{-8}}\,s^{-1} \qquad (9.59)$$

and

$$\omega_g=9.163561161\cdot 10^{-4}\,s^{-1}. \qquad (9.59a)$$

Further, we have

$$T_g=\frac{\lambda_T}{\omega_g}=\frac{4\pi}{\omega_g}=1.371341381\cdot 10^4\,s \qquad (9.60)$$

and

$$T_e=2\pi T_g=86163.92016\,s=23^h56^m03^s.92, \qquad (9.61)$$

$$T=4\pi T_g=172327.8403\,s=2\cdot 23^h56^m03^s.92. \qquad (9.62)$$

As we see, everywhere, the fundamental measures of the quantitative spectrum on the basis of the fundamental period $\Delta=2\pi\lg e$ show their worth. With that, the number π is the absolute amplitude of the circular wave, if one expresses the amplitude through radii of orbits:

$$a_m=A_m/r=\pi. \qquad (9.63)$$

9.6. *The parameters of a circular electron orbit and Einstein's and de Haas's experiments*

Returning to the electron's circular motion, let us assume that the electron orbits with the frequency ω_e. Then, its circular (rotatory) transversal "magnetic" charge q_e, which defines the kinetic ("magnetic") cylindrical field of the electron orbit, is

$$q_e = m\omega_e . \quad (9.64)$$

The corresponding average transversal ("magnetic") current is

$$I_B = \frac{4q_e}{T} = \frac{2q_e}{T_e} . \quad (9.65)$$

The average current (9.65) defines the orbital transversal kinetic ("magnetic") electron's moment

$$\mu_{orb} = \frac{1}{c} I_B S = \frac{\upsilon_0}{c} q_e r_0 . \quad (9.66)$$

The ratio of the moment (9.66) and the orbital moment of electron's momentum on the Bohr first orbit, $\hbar_{orb} = m\upsilon_0 r_0$, defines the wave number of the subatomic wave field of matter-space (Fig. 9.13):

$$\frac{\mu_{orb}}{\hbar_{orb}} = \frac{\upsilon_0 q_e r_0}{cm\upsilon_0 r_0} = \frac{q_e}{mc} = \frac{\omega_e}{c} = k_e . \quad (9.67)$$

The formula (9.67) is in conformity with the experiment, if we will transform the fictitious "electric" and "magnetic" units into the objective units of nature.

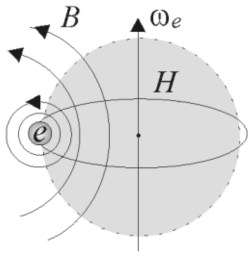

Fig. 9.13. The orbiting electron in the space of the *H*-atom and its transversal kinetic cylindrical *B*-field.

We can now clarify the nature of the electron charge *e*, which enters in the expression for the total energy of the orbiting electron (where it is regarded as the charge of the central field):

$$E = \frac{m\upsilon^2}{2} - \frac{e^2}{4\pi\varepsilon_0 r} = \frac{m\upsilon_0^2}{2} - \frac{e^2}{4\pi\varepsilon_0 r_0} . \quad (9.68)$$

Because $\frac{e^2}{4\pi\varepsilon_0 r_0^2} = \frac{m\upsilon_0^2}{r_0}$ and electron mass is $m = 4\pi\varepsilon_0 r_e^3$, we obtain

$$e^2 = 4\pi\varepsilon_0 m\upsilon_0^2 r_0 = \frac{4\pi\varepsilon_0 r_e^3 m\upsilon_0^2 r_0}{r_e^3} = \frac{m^2\omega_e^2\upsilon_0^2 r_0}{\omega_e^2 r_e^3} = \frac{q_e^2\upsilon_0^2 r_0}{\upsilon_e^2 r_e} .$$

Taking into account that in the cylindrical field $\upsilon_0^2 r_0 = \upsilon_e^2 r_e$, we arrive at

$$e = q_e = m\omega_e . \quad (9.69)$$

Thus, the central "potential" ("electric") charge e and the transversal "kinetic" ("magnetic") charge q_e are equal in value. One can come to the same conclusion on the basis of the following consideration. The orbiting electron forms the cylindrical wave field, which is limited from below by the electron radius r_e,. Along the axis of the trajectory, each electron state corresponds to a part of the orbit, equal to the electron's diameter with the area of the cylindrical surface

$$S = 2\pi r_e d_e = 4\pi r_e^2 . \qquad (9.70)$$

On this surface, the transversal electron flow is defined by the transversal (cylindrical) charge

$$q_e = S\upsilon_e\varepsilon_0 = 4\pi r_e^2\upsilon_e\varepsilon_0 . \qquad (9.71)$$

On the other hand, the central electron flow is defined by the longitudinal (spherical) charge

$$e = 4\pi r_e^2\upsilon_e\varepsilon_0 . \qquad (9.72)$$

Accordingly, we again arrive at the conclusion that $e = q_e$.

In addition, some remarks on the magnetic moment. The electron's magnetic moment and electron's moment of momentum at the orbital motion are the different measures of the same wave process. Indeed, any system, for example, a metallic rod suspended by a thin elastic thread, can be regarded as a closed system (of course, under a definite approximation). Let its initial moment of momentum be equal to zero. This means that its moment of macromomentum, as a solid, and the total moment of micromomenta of all orbital electrons form the total moment of momentum of the system equal to zero:

$$L_S = L_{macro} + L_{micro} = 0 . \qquad (9.73)$$

Under the action of external fields, the ordering of moments of momentum of individual orbital electrons can take place. As a result, the general change of the moments of micromomentum arises. This phenomenon is accompanied with an appearance of the moment of macromomentum of the rod, so that

$$\Delta L_S = \Delta L_{macro} + \Delta L_{micro} = 0 . \qquad (9.74)$$

Let us further introduce the kinetic "magnetic" moment of the orbital electron, as the product of its orbital moment of momentum $\hbar$ by the wave number $k_e = \omega_e / c$ of the field of the subatomic ("electrostatic") level of matter:

$$\mu_{orb} = k_e\hbar = \frac{\omega_e}{c} m\upsilon r = \frac{\upsilon}{c} er . \qquad (9.75)$$

In such a case, the equality (9.74) can be presented as

$$k_e\Delta L_{macro} + (-\sum_n k_e\hbar_n) = 0 \qquad \text{or} \qquad k_e\Delta L_{macro} - \sum_n \mu_{orbn} = 0 . \qquad (9.76)$$

If N is the number of ordered orbits, participating in given process, we arrive at

$$\frac{\sum_n \mu_{orbn}}{k_e\Delta L_{macro}} = \frac{\sum_n \mu_{orbn}}{k_e\sum_n \hbar_{orbn}} = 1 \qquad \text{or} \qquad \frac{\sum_n \mu_{orbn}}{\sum_n \hbar_{orbn}} = \frac{N\mu_{orbn}}{N\hbar_{orbn}} = \frac{\mu_{orbn}}{\hbar_{orbn}} = k_e . \qquad (9.77)$$

Hence, we have
$$\frac{\mu_{orbn}}{\hbar_{orbn}} = k_e. \qquad (9.78)$$

Thus, the "orbital magnetic moment" is, in essence, the other expression of the orbital moment of momentum, which is one of the measures of the orbital motion.

9.7. *The symmetrical formula of current and the Lorentz transversal interaction*

On the basis of Ampère's transversal interaction,

$$\Delta F = B\Gamma\Delta l = B\frac{I}{c}\Delta l, \qquad (9.85)$$

and using the symmetrical formula of current, we arrive at the elementary quantum of the Lorentz interaction, which is a variable quantity:

$$F_L = \frac{\Delta F}{2N} = B\frac{2ne\upsilon S}{2cN}\Delta l = \frac{\upsilon}{c}e\frac{2N}{2N}B = \frac{\upsilon}{c}eB, \qquad (9.86)$$

where $2N$ is the total number of electrons in an element Δl of a conductor (Fig. 9.14).

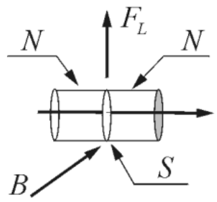

Fig. 9.14. An element Δl of a conductor: N is the number of elementary particles, participating in the formation of current I and localized in its symmetrical parts; S is the central cross-section, dividing the conductor into two symmetrical parts; and B is the magnetic field vector.

Thus, we have
$$F_L = \frac{\upsilon}{c}eB = g_h B, \qquad (9.87)$$

where
$$g_h = \frac{\upsilon}{c}e \qquad (9.88)$$

is the quantum-charge of the transversal magnetic field. Owing to the transversal magnetic charge, the formula of interaction in the magnetic field (9.87) turns out the similar to the formula of interaction in the central (longitudinal) electric field.

9.8. *The symmetrical formula of current and electrolyze*

In conclusion, let us consider (at the elementary level) the process of precipitation of atoms on a cathode under the action of a current (Fig. 9.15).

If we deal with the equilibrium process, then, on average, each half-circuit in Fig. 9.15 corresponds to the half-period $\frac{1}{2}T_K$ of an elementary cycle T_k. The mass of a precipitated substance M is defined through the average value of current I as

$$M = \frac{Am_u}{ne}Q = \frac{Am_u}{ne}I\Delta t\,. \tag{9.90}$$

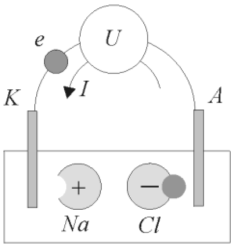

Fig. 9.15. An elementary circuit with two unclosed half-circuits, related with the points of anode *A* and cathode *K*.

In a case of the elementary act of precipitation of N_k natrium atoms, *Na*, on the cathode, the average quantum of current is equal to the ratio of the charge $Q_K = n_V eN_K$ ($n_V = 1$ is the valency of *Na*), flowing in the outer circuit, to the half-period $\frac{1}{2}T_K$:

$$I = \frac{Q_K}{\frac{1}{2}T_K} = \frac{2n_V eN_K}{T_K}\,. \tag{9.91}$$

The time of precipitation of N_k atoms of natrium on the cathode corresponds to half-period. As a result, we have

$$M = \frac{Am_u}{n_V e}I\Delta t = \frac{Am_u}{n_V e}\frac{2n_V eN_K}{T_K}\cdot\frac{1}{2}T_K = N_K Am_u\,. \tag{9.92}$$

If $\Delta t = \frac{1}{2}T_K N_T$, where N_T is the number of half-periods $\frac{1}{2}T_K$ in the time interval Δt, we obtain

$$M = \frac{Am_u}{n_V e}\frac{2n_V eN_K}{T}\cdot\frac{1}{2}T_K N_T = N_K N_T Am_u = NAm_u\,, \tag{9.93}$$

where $N = N_K N_T$ is the number of precipitated *Na*-atoms.

At the level of an elementary quantum of precipitation, the equality $N_K = N_T = 1$ is valid. In this case, we have $M = Am_u$. If one uses the classical formula of current

$$I = e/T_k \tag{9.94}$$

(which does not correspond to the real process), during the time quantum of precipitation of atoms on the cathode $\Delta t = \frac{1}{2}T_K$, the precipitated mass will be equal to $\frac{1}{2}Am_u$. This value is the physical absurdity. In such a situation, one should be invented the lost "spin of mass" of $\frac{1}{2} Am_u$ in order to obtain the whole mass for one *Na*-atom (repeating the sad history of introduction of the electron spin). Of course, the equations obtained approximately describe the process of precipitation of atoms on a cathode, which actually has the wave character (this circumstance was not taken here into account). In spite of this, the above consideration confirms conclusions presented in this section.

10. THE ELECTRON WAVES-CURRENTS AND THE AMBIENT WAVE FIELD OF MATTER-SPACE

10.1. *An electron on the orbit*

Experiments show that, in proportion as dimensions of natural and artificial objects decrease, the definiteness and exactness of their structure and motion increase. The modern electron technologies, in particular, confirm this statement. This is the fundamental law of nature, which should be called ***the law of accuracy***. At the same time, this is ***the law of inaccuracy***, if one considers the higher levels of matter-space, where uncertainty and inaccuracy of structures and motion increase. This binary law can be also called ***the law of accuracy-inaccuracy***. The concepts, which negate the binary law, do not belong to the fundamental scientific theories and can exist only as temporal theoretical fashions.

Resting on the law of accuracy, let us consider the wave motion of electron's satellites in the space of an electron orbit. The wave motion can be presented approximately over the superposition of two transversal potential-kinetic *x*- and *y*-waves-beams, shifted in phase by a quarter of a period:

$$\Psi_x = re^{i(\omega t - k_s s + \alpha)}, \qquad \Psi_y = ire^{i(\omega t - k_s s + \alpha)}. \tag{10.1}$$

where k_s is the wave orbital number and s is the displacement along the orbit.

The waves of *x*- and *y*-beams form the amplitude spiral wave-beam. In every instant, the electron, through its cylindrical field, forms a front of the spiral wave-beam. Simultaneously, the electron, as a microgalaxy, circumscribes the relative circular trajectory with the amplitude velocity $\upsilon = r\omega$, where r is the radius of the spiral line-beam (wave spiral). Circular trajectories, lying in planes in parallel to axes x and y, are relatively closed and, simultaneously, they are absolutely unclosed because presented by the electron spiral (Fig. 9.16).

The orbital motion of electron's satellites in the equatorial plane is the closed circular trajectory, but in the outer space, the satellites move along the spiral trajectory with the pitch (spacing), representing by itself the axial half-wave on the Bohr orbit:

$$l_h = 2\pi r ctg\varphi = 2\pi r\frac{\upsilon_s}{\upsilon}, \tag{10.2}$$

where r is the radius of the circular trajectory of electron's satellite and $\varphi = arctg\dfrac{\upsilon}{\upsilon_s}$ is the inclination of the spiral trajectory to the Bohr orbit. For definiteness, we will consider the motion along the Bohr first orbit of the radius r_0, then, $\upsilon_s = \upsilon_0$ is the Bohr first velocity.

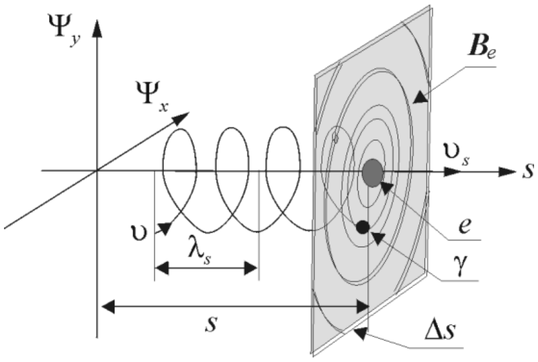

Fig. 9.16. The amplitude electron wave of an elementary part *s* of the orbit, as the superposition of two transversal waves-beams Ψ_x and Ψ_y; Δs is the thickness of the wave front as a four-dimensional physical plane; υ is the azimuth velocity of motion of electron's satellites; λ_s is the axial wavelength; υ_s is the axial velocity of the wave-beam along the orbit; *e* is the electron; γ is the electron's satellite; B_e is the transversal cylindrical ("magnetic") field of the electron – the field of all its satellites with the lower situated fields of matter-space.

In proportion as the distance between the electron and satellites increases, their orbits transform gradually into ellipses with large half-axes *a* and eccentricities ε satisfying the condition

$$a(1-\varepsilon) = r_0 \,. \tag{10.3}$$

This is natural, because the center of the Bohr first orbit represents, at such a motion, the general perihelion of all orbits of satellites.

The simplest forms of wave potential-kinetic fields are the plane, cylindrical, and spherical forms, and also their combinations.

The hydrogen atom is a classical example of the binary spherical-cylindrical field. The *spherical* subfield of possible amplitudes of velocities of microobjects at the subatomic level is defined by the formula

$$\upsilon = \frac{\upsilon_s}{kr}\,, \tag{10.4}$$

where υ_s is the amplitude of velocity of the spherical field, corresponding to the condition $kr = 1$. With that, $k = 2\pi/\lambda = 1/\lambda\!\!\!^{-}$ is the wave number.

The expression (10.4) is the effect of constancy of the energy flow in the elementary spherical field, which is described by the cylindrical functions of the order $\frac{1}{2}$. However, it is approximately valid also for spherical fields, which are described by the spherical functions of higher orders, under the condition $kr >> 1$. If r_0 is the radius of the first stationary shell and υ_0 is the velocity on it, then, at the constant k, we have the following relations for the radii and velocities of stationary shells:

$$r = r_0 n \ , \qquad \upsilon = \upsilon_0 / n \, . \tag{10.5}$$

In the elementary spherical field, n is an integer. This is the homogeneous spherical field. The distance between shells, in such a field, is constant and equal to r_0.

In the homogeneous *cylindrical* subfield of the *H*-atom, the velocity is defined by the formula

$$\upsilon = \upsilon_c / \sqrt{kr} \, . \tag{10.6}$$

When k is the constant, we obtain the following relations for the stationary shells:

$$r = r_0 n \, , \qquad \upsilon = \upsilon_0 / \sqrt{n} \, . \tag{10.7}$$

The formulae (10.6) and (10.7) are approximately valid also for the heterogeneous cylindrical fields under the condition $kr >> 1$.

The *spherical* subfield, as has been mentioned earlier, induces Kepler's second law

$$\upsilon r = \upsilon_0 r_0 = const \, . \tag{10.8}$$

The *cylindrical* subfield induces Kepler's third law for circular fields, which dominate in the atomic world:

$$\upsilon^2 r = \frac{\upsilon_c^2}{k} = const \, . \tag{10.9}$$

If velocities of the spherical and cylindrical fields turns out to be equal, then,

$$\upsilon_c = \upsilon_s / \sqrt{kr} \, . \tag{10.10}$$

In the electron's cylindrical field

$$\upsilon^2 r = \upsilon_0^2 r_0 \, , \tag{10.11}$$

therefore,

$$tg\varphi = \frac{\upsilon}{\upsilon_0} = \sqrt{\frac{r_0}{r}} \, . \tag{10.12}$$

At $r = r_e$, where r_e is the electron's equatorial radius, the angle of the inclination of the spiral trajectory φ is maximal and equal to

$$\varphi = arctg \frac{\upsilon_e}{\upsilon_0} = arctg \sqrt{\frac{r_0}{r_e}} = 74^\circ 19' 13.6'' \, . \tag{10.13}$$

Under the condition $r = r_0$, the angle φ is minimal and equal to 45°. In this case, the pitch defines the axial half-wave, equal to the length of the Bohr first orbit

$$l_h = \frac{\lambda_h}{2} = 2\pi r_0 . \qquad (10.14)$$

The field of motions in the electron's equatorial plane is perceived, at the macrolevel, as a set of "lines of magnetic force", which are detected, by virtue of a small pitch (spacing), as closed lines. They are closed in the electron's space and unclosed in the outer space, related with the electron's motion along the Bohr orbit.

The world of particles-satellites of electrons is many orders as much the electron's size. Accordingly, for them, Earth is in the highest degree the "rarefied" spherical space of the shell structure. These particles pierce the Earth just freely as asteroids pierce the space of the solar system and galaxies. Just this world, called "magnetic field", surrounds a conductor with a current. This is the cylindrical field-space of the subatomic and subelectronic levels.

The amplitude electron wave is ***the wave of superstructure***, ***local wave***, ***oscillatory wave***. Each of the synonyms of the wave of superstructure expresses its definite sides (features). The wave of superstructure of an open microsystem generates in the surrounding field of matter-space-time ***the wave of basis*** (or ***the basis wave***) with ***the velocity of basis c***.

The waves of superstructure and basis consist of separate processes-quanta, bounded in space by the wavelength and period. Such periods-quanta should be called ***wave quanta***, ***wave-beam quanta***, or ***quanta of wave***. The wave process, limited by the length of half-wave, defines the wave ***half-quantum***. One should distinguish ***the wave quanta and half-quanta of superstructure and basis***. The waves of superstructure and basis form the unit ***wave complex of basis-superstructure***. Its complex quantum is ***the wave quantum of basis-superstructure***.

Because the space of the Universe is a system of an infinite series of embedded spaces, each wave of superstructure is simultaneously the wave of basis for the more complicated wave structures. Contemporary physics operates with the atomic level of the field of matter-space-time. It represents by itself the level of superstructure, with a series of sublevels, over the field of matter-space-time, which embraces atomic levels of superstructure. This field is the field of basis with the wave speed *c* (speed of light).

10.2. *An electron in the space of a conductor*

In a general case, an electron in the space of a conductor circumscribes an elementary amplitude wave-beam of the electron current *I*. This wave-beam represents the superposition of two transversal *x*- and *y*-beams of currents:

$$I_x = \omega e \cdot e^{i(\omega t - k_z z + \alpha)}, \qquad I_y = i\omega e \cdot e^{i(\omega t - k_z z + \alpha)}, \qquad (10.15)$$

where
$$\omega e = I_{em} \qquad (10.15a)$$

is the elementary quantum-amplitude of the electron current, k_z is the wave number, z is the displacement along the axis of a conductor and α is the initial phase. In the interatomic space of a conductor (the space of basis), the wave number is defined as

$$k_z = \omega / c. \tag{10.16}$$

If the axial speed of the wave motion is equal to zero, then $k_z = 0$.

The equations (10.15) can be also obtained at the consideration of the transversal plane x- and y-waves-beams of the "electric" charge:

$$Q_x = e \cdot e^{i(\omega t - k_z z + \alpha)}, \qquad Q_y = ie \cdot e^{i(\omega t - k_z z + \alpha)}, \tag{10.17}$$

where e is the amplitude of the electron's charge (Fig. 9.17a).

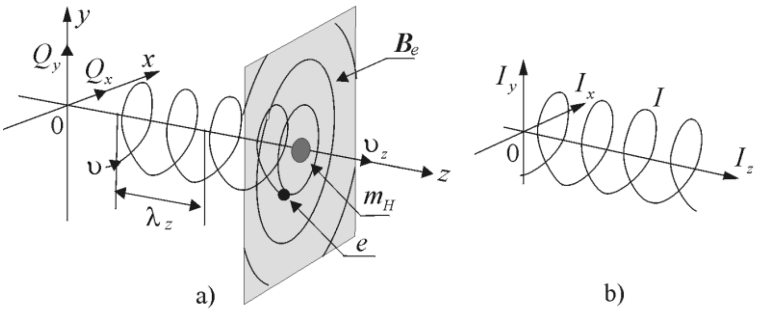

Fig. 9.17. The electron charge waves-beams, Q_x and Q_y, and the H-atom of mass m_H in the cylindrical space of a conductor; υ is the azimuth velocity of electron's motion; λ_z is the axial wavelength; υ_z is the axial velocity of the electron along the z-axis of a conductor; B_e is the wave front (a). A graph of the longitudinal-transversal current-beam: I_x and I_y are the transversal wave beams-currents, I_z is the axial current, and I is the amplitude spiral wave-beam of current (b).

The plane waves-beams, Q_x and Q_y, are related with the electron's wave motion, which is presented by the superposition of two transversal potential-kinetic x- and y-waves-beams, shifted in phase by quarter of a period:

$$\Psi_x = re^{i(\omega t - k_z z + \delta)}, \qquad \Psi_y = ire^{i(\omega t - k_z z + \delta)}, \tag{10.18}$$

where δ is the initial phase of the wave of potential-kinetic displacements.

The waves-beams Ψ_x, Ψ_y, Q_x, and Q_y define the transversal plane waves-beams of current I:

$$I_x = \frac{dQ_x}{dt} = i\omega e \cdot e^{i(\omega t - k_z z + \alpha)}, \qquad I_y = \frac{dQ_y}{dt} = i\omega ie \cdot e^{i(\omega t - k_z z + \alpha)}, \tag{10.19}$$

or
$$I_x = \frac{dQ_x}{dt} = \omega e \cdot e^{i(\omega t - k_z z + \alpha + \pi/2)}, \quad I_y = \frac{dQ_y}{dt} = \omega e \cdot e^{i(\omega t - k_z z + \alpha + \pi)}. \tag{10.20}$$

The plane-polarized waves-beams of current form the amplitude electron wave-beam (Fig. 9.17b). The waves-beams I_x and I_y describe the transversal current, which represents by itself the amplitude spiral wave-beam of electron current. The transversal current is inseparable of the axial current I_z (Fig. 9.17b).

The average current (axial, transversal) is defined by the integral

$$I = \frac{2}{2\pi i}\int \hat{I} d\varphi = \frac{1}{\pi}\omega e e^{i\varphi}\Big|_{-\pi/2}^{\pi/2} = \frac{2}{\pi}\omega e = \frac{4e}{T} = \frac{2e}{T_e}. \tag{10.21}$$

The cylindrical field-space of the longitudinal-transversal wave beam-current is the field of its ***transversal component***, which at the macrolevel is known under the name the "*magnetic*" *field*. ***This is the transversal current***. ***The longitudinal*** (axial) ***component of the current*** is called the "*electric*" *current*.

In a case, when $\upsilon = \upsilon_z$, the angle of a spiral trajectory of the current-beam is equal to $\varphi = 45^\circ$. And the elementary average current of the wave-beam will be presented by the expression

$$I = \frac{2e}{T_e} = \frac{4e}{T} = 4e\nu = \frac{4e\upsilon}{\lambda_\upsilon}, \tag{10.22}$$

where $\lambda_\upsilon = 2T_e\upsilon = 4\pi r$ is the azimuth wavelength of the fundamental tone. The electron current induces, in the ambient space, the basis waves of the same frequency $\nu = c/\lambda$, where λ is the wavelength in the space of basis. Therefore, the formula of current (10.22) can be also presented as

$$I = 4e\nu = 4ec/\lambda. \tag{10.22a}$$

The limiting quantum of the amplitude of current is equal to the fundamental measure

$$I_{e\max} = \omega_e e = e^2/m, \tag{10.23}$$

where *m* is the electron mass. From here, we obtain the limiting value of the quantum of average current, taking into account the objective measure of the ampere, $1A = 1.062736593 10^{10} g/s^2$:

$$I_{\max} = \frac{2}{\pi}\omega_e e = \frac{2e^2}{\pi m} = 2.026111200 10^9 g/s^2 = 0.1906503666 A. \tag{10.24a}$$

The total cylindrical field, formed by all elementary electron fields B_e, is presented around a conductor by the cylindrical "magnetic" field.

During the half-period T_e, an electron accomplishes one revolution in the plane of the wave front, forming the transversal half-wave. Simultaneously, it passes half of the axial wave. Therefore, the transversal and longitudinal (axial) currents turn out to be equal.

At the complete ordering of orbits of atomic *H*-units of average mass m_u (a.m.u.), the specific orbital magnetic moment σ, i.e., the magnetic moment of the unit mass, will be defined by the ratio

$$\sigma = \mu_{orb}/m_u. \tag{10.25}$$

If $\mu_0 = \frac{\upsilon_0}{c} e r_0$ is the magnetic moment of the Bohr first orbit, the relative specific moment of the atomic *H*-unit, expressed in the units μ_0, takes the form:

$$n_{theor} = \frac{m_u \sigma}{\mu_0} = \frac{\mu_{orb}}{\mu_0} = \frac{r\upsilon}{r_0 \upsilon_0}. \tag{10.25a}$$

This relation concerns the total ordering of orbits. Therefore, the measure n_{theor} is the specific moment of magnetic saturation. Under the condition $r\upsilon = r_0\upsilon_0$, the specific moment is equal to $n_{theor} = 1$ (Table. 9.4).

Table. 9.4. The specific atomic moments of saturation of binary alloys of iron.

Addition	Atomic %	n*	$n_{theor} = n/2$
Al	7.1	2.05	1.025
	19.7	1.74	0.87
Au	6.2	2.08	1.04
	10.5	2.02	1.01
Si	8.3	2.00	1.00
	15.9	1.67	0.835
V	5.9	2.09	1.045
	10.6	1.91	0.955
Co	20	2.42	1.21
	80	1.95	0.975
Pd	5.5	2.19	1.095
	40	1.89	0.945
		----	----
		$\langle n \rangle = 2$	$\langle n_{theor} \rangle = 1$

In contemporary physics, the magnetic orbital moment μ_0 is presented by the subjective measure of the Bohr magneton $\mu_B = \frac{1}{2}\mu_{orb}$, which does not have an analogue in nature. Therefore, the specific atomic moment is presented by the erroneous measure *n*, twice exceeding the objective theoretical measure n_{theor}:

$$n = 2n_{theor} = \frac{\mu_{orb}}{\mu_B} = \frac{2r\upsilon}{r_0\upsilon_0}. \tag{10.26}$$

10.3. *The electron wave-beam and its parameters*

The projection of the amplitude electron wave-beam, limited by a small part of the trajectory, on the arbitrary plane *xoz* (Fig. 9.17a) describes its geometry by the electron waves-beams of potential-kinetic displacements, charge, and current:

$$\Psi_x = re^{i(\omega t - k_z z + \delta)}, \quad Q_x = e \cdot e^{i(\omega t - k_z z + \alpha)}, \quad I_x = \omega e \cdot e^{i(\omega t - k_z z + \alpha + \pi/2)}, \tag{10.27}$$

* *American Institute of Physics Handbook*, Ed. by D.E. Gray, N.Y., McGraw-Hill, 1963, p. 5-172.

and by the other parameters. The potential-kinetic structure of any elementary parameter, as the time wave, can be presented by a graph of the wave-beam (Fig. 9.18).

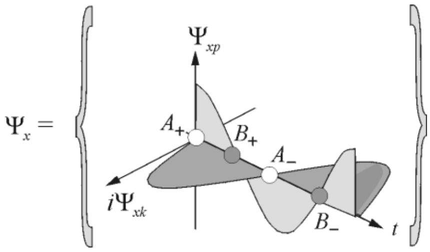

Fig. 9.18. A graph of the potential-kinetic wave-beam; A_+ and A_- are the potential nodes, B_+ and B_- are the kinetic nodes.

The same is the structure of any elementary waves-beams of the subatomic level of the wave field of matter-space-time.

If the azimuth velocity of electron's motion is υ and the axial velocity of the electron wave is $\upsilon_z = c$, then, the length of the axial wave of the fundamental tone will be

$$\lambda_z = 4\pi r ctg\varphi = 4\pi r \frac{c}{\upsilon}. \tag{10.28}$$

The wave action of the electron wave of the fundamental tone takes the form

$$h_\lambda = \lambda_z p = \lambda_z m\upsilon = 4\pi r m\upsilon = 2h, \tag{10.29}$$

where

$$h = 2\pi r m\upsilon \tag{10.29a}$$

is the half-wave action, called the Planck constant. For the sake of simplicity, we usually omit the index z of the wave λ_z.

In the spherical-cylindrical field, the amplitudes of velocities of microobjects of the subatomic level are defined, as shows experiment, rather through the spherical field

$$\upsilon = \frac{\upsilon_s}{kr}, \tag{10.30}$$

where υ_s is the amplitude of velocity corresponding to the condition $kr = 1$, i.e., when only one wave is placed on the circular orbit: $\lambda = 2\pi r$.

As follows from (10.30), the specific elementary wave (and half-wave) actions of particles are the constants of the wave, and the wave field on the whole:

$$\frac{h_\lambda}{m} = 4\pi r\upsilon = \frac{4\pi\upsilon_s}{k} = const, \tag{10.31}$$

$$\frac{h}{m} = 2\pi r\upsilon = \frac{2\pi\upsilon_s}{k} = \lambdabar\upsilon_s = const. \tag{10.32}$$

In the cylindrical field,

$$\upsilon = \frac{\upsilon_c}{\sqrt{kr}} \tag{10.33}$$

and the constant υ_c, similar as the case of the spherical wave, is related with the unit wave through the frequency ω_e; therefore, if $k = \omega_e / \upsilon$, then $\upsilon_c^2 = \upsilon r \omega_e$. Hence, the amplitude energy of any particle of mass m in the unit wave will be defined by the expression

$$m\upsilon_c^2 = m\upsilon r\omega_e = \hbar\omega_e = h\frac{\upsilon}{\lambda_\upsilon} = h\frac{c}{\lambda_e}, \qquad (10.34)$$

where λ_υ is the unit wave of superstructure and λ_e is the wave in the ambient space (the wave of basis), caused by the wave of superstructure.

For the wave of the fundamental tone, $\omega = \frac{1}{2}\omega_e$ and $k = \omega r / \upsilon = \frac{1}{2}$, therefore, the kinetic energy of a particle in such a wave has the form

$$E = \frac{m\upsilon^2}{2} = \frac{m}{2}\frac{\upsilon_c^2}{\frac{1}{2}} = m\upsilon_c^2 = \hbar\omega = h\frac{\upsilon}{\lambda_\upsilon} = h\frac{c}{\lambda}. \qquad (10.35)$$

The frequency of the wave of the fundamental tone is the same both in space of the superstructure and the basis:

$$\nu = \frac{\upsilon}{\lambda_\upsilon} = \frac{c}{\lambda}, \qquad (10.36)$$

where $\lambda_\upsilon = 4\pi r$ is the wave of superstructure and $\lambda = cT$ is the basis wave.

The amplitude electron wave of space-time of superstructure is characterized by ***the wave quantum of superstructure***. The extension of the quantum is defined by the quantum-length of the wave of superstructure λ_υ and, in the time field, by the quantum-length T, called the wave period. The wave quantum of superstructure generates, in the space of basis, ***the wave quantum of basis***. Its extension, in the space of basis, is defined by the quantum-length of the wave of basis λ and its period T. Thus, in the wave time field, the extension of quanta of superstructure and basis is the same.

In the simplest case, all calculations, related with the interaction and transformation of waves, come to the relation between the wave quanta, or half-quanta.

In a case of the electron wave, the wave quantum is defined by the length of the wave of the fundamental tone and by the corresponding wave period (the time length of the wave of the fundamental tone).

The discrete component of the wave electron quantum is an electron. Accordingly, the *wave quantum of the electron wave* can be called ***the wave quantum-electron*** or simply ***the wave quantum-particle***. Such terms (names) reflect the contradictory ***continuous-discontinuous*** character of the wave quantum, in which the continuous component is represented by the wave motion and the discontinuous (discrete) one – by the electron (particle).

The electron quantum of the wave of superstructure is characterized by the electron's kinetic energy, which is presented in the form $E = \frac{m\upsilon^2}{2}$ and in the form of energy of the wave quantum $E = h\dfrac{\upsilon}{\lambda_\upsilon}$. Both forms of energy, as follows from the equalities (10.35), are equal. Of course, these measures of energy do not exhaust completely the potential-kinetic energy of the wave quantum. However, the usage of these measures gives, in a definite extent, an agreement with the experiment.

The energy of the wave quantum of superstructure $E = h(\upsilon/\lambda_\upsilon)$ generates, at the level of basis, the equal energy of the wave quantum of basis $E = h(c/\lambda)$.

The inverse wavelength is the important parameter of the wave quantum. It defines ***the nodal density*** N_n – ***the number of kinetic and potential nodes per unit of length of the basis space***:

$$N_n = \frac{4}{\lambda} = \frac{2}{l_z} = \frac{1}{\pi r}tg\varphi = \frac{1}{\pi r}\frac{\upsilon}{c} = \frac{\upsilon_0}{\pi r_0 c}\frac{1}{n^2} = \frac{2}{T_c c}\frac{1}{n^2} = \frac{4}{\lambda_0 n^2} = 4R_n\,, \qquad (10.37)$$

where

$$R_n = \frac{\upsilon}{4\pi rc} = \frac{1}{\lambda} = \frac{\upsilon_0/n}{4\pi r_0 nc} = \frac{1}{\lambda_0 n^2} \qquad (10.38)$$

is the Rydberg constant of the *n*-shell. The nodal density defines ***the wave density*** $N_{\lambda n}$ – the number of waves per unit of the extension (length) of space,

$$N_{\lambda n} = \frac{N_n}{4} = \frac{1}{\lambda} = R_n = \frac{R}{n^2}\,, \qquad (10.39)$$

and the corresponding ***density of half-waves***

$$N_{\lambda n/2} = \frac{N_n}{2} = \frac{2}{\lambda} = 2R_n = \frac{2R}{n^2}\,. \qquad (10.40)$$

Thus, the wave density $N_{\lambda n}$ and the Rydberg constant R_n are the synonyms of the same property of the wave space.

The nodes of the wave field of space are inseparable of the time nodes of the wave field of time. Therefore, it makes sense to consider the ***density of time nodes***:

$$Z_n = cN_n = \frac{\upsilon}{\pi r} = \frac{\upsilon_0}{\pi r_0}\frac{1}{n^2} = \frac{2}{T_{e0}}\frac{1}{n^2} = 2\nu_{e0}\frac{1}{n^2}\,, \qquad (10.41)$$

and the ***linear density of waves of time*** (***frequency***)

$$Z_{\lambda n} = \frac{c}{\lambda} = \frac{1}{4}cN_{\lambda n} = \frac{\upsilon}{4\pi r} = \frac{cR}{n^2} = \frac{1}{T_0}\frac{1}{n^2} = \nu_0\frac{1}{n^2}\,, \qquad (10.42)$$

where $T_0 = 2T_{e0}$ is the wave period of the fundamental tone of the Bohr first orbit and T_{e0} is the period of revolution on it, representing by itself half-period of the wave of the fundamental tone. The ***density of half-waves of time*** is

$$Z_{\lambda n/2} = \frac{1}{2}cN_{\lambda n} = \frac{\upsilon}{2\pi r} = \frac{2}{T_0}\frac{1}{n^2} = 2\nu_0\frac{1}{n^2}\,. \qquad (10.43)$$

In the light of introduced notions of density, the value of average current

$$I = \frac{2}{\pi}\omega e = \frac{4e}{T} = \frac{2e}{T_e} \qquad (10.44)$$

is the ***nodal density of the wave charge***, related with the waves of space and time. The nodal density of ***charge*** defines its ***wave density***

$$I_\lambda = \frac{1}{4}I = \frac{e}{T} = \frac{e}{2T_e}. \qquad (10.45)$$

The ***half-wave density of charge*** is

$$I_{\lambda/2} = \frac{1}{2}I = \frac{2e}{T} = \frac{e}{T_e}. \qquad (10.46)$$

In classical physics, the last wave measure was erroneously accepted as the average value of the orbital current (regarded as a mechanical flow of "electric liquid" along the orbit).

All above-presented densities are ***parameters-quanta of the electron wave quanta-beam***. They have general character and relate to many wave processes.

10.4. *The wave interaction and the wave current in the field of matter-space*

Let us agree to call an arbitrary particle of the subatomic level δ-particle. The kinetic energy of its wave quantum can be presented in the following form:

$$E_\delta = \frac{1}{2}m_\delta \upsilon^2 = \frac{1}{2}m_\delta \upsilon r\omega_{orb} = \frac{1}{2}m_\delta \upsilon r\frac{2\pi}{T_{orb}} = \frac{1}{2}m_\delta \upsilon r\frac{4\pi}{T} = 2\pi m_\delta \upsilon r\nu = h_\delta \nu = h_\delta \frac{c}{\lambda}, \qquad (10.47)$$

where $h_\delta = 2\pi m_\delta \upsilon r$ is the wave action of δ-particle.

The same in value, but opposite in sign, is the value of potential energy, if we consider the circular amplitude wave quanta:

$$E_{\delta p} = -\frac{1}{2}m_\delta \upsilon^2 = -h_\delta \frac{c}{\lambda}. \qquad (10.47a)$$

The energy E_δ represents the huge world of particles of the subatomic level, which modern physics regard as an abstract field. First of all, these particles are satellites of electrons. According to the equation (10.47), the kinetic and potential field energies of such particles can be presented as

$$E_{\delta mk} = h_\delta \frac{c}{\lambda_{mk}} = h_\delta \nu_0 \frac{1}{m_k^2}, \qquad E_{\delta pmk} = -h_\delta \frac{c}{\lambda_{mk}} = -h_\delta \nu_0 \frac{1}{m_k^2}, \qquad (10.48)$$

where m_k is the relative radius of the azimuth orbit, expressed in radii of the Bohr first orbit.

If the incident wave interacts with an objec*t A* and the potential energy of the wave increases, the properties of the wave change. Such a wave is called the wave of absorption of energy. If after the interaction the potential energy of the wave decreases, an additional wave of radiation, taking away with one the excess energy (Fig. 9.19), arises.

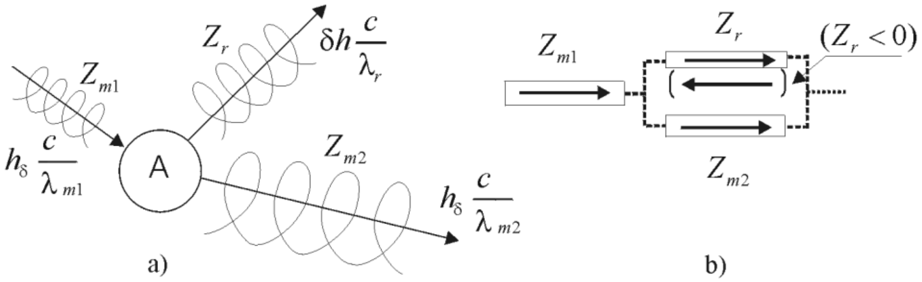

Fig. 9.19. A graph of wave interactions (a): Z_{m1} is the linear density of the initial wave of time, Z_{m2} is the linear density of the wave of time after interaction, and Z_r is the linear density of radiation of the wave of time; an equivalent scheme of the data of wave processes, as waves currents, in which the linear densities are the specific wave conductivities (b).

Such an interaction (at the subatomic level) is expressed over the principle of conservation of energy ***at the level of wave quanta***:

$$E_{\delta pm1} + E_r = E_{\delta pm2}\,, \qquad (10.49)$$

where

$$E_{\delta pm1} = -h_\delta \frac{c}{\lambda_{m1}} = -h_\delta \nu_0 \frac{1}{m_1^2} \qquad (10.49a)$$

is the potential energy of the wave quantum of an incident wave-particle,

$$E_{\delta pm2} = h_\delta \frac{c}{\lambda_{m2}} = -h_\delta \nu_0 \frac{1}{m_2^2} \qquad (10.49b)$$

is the potential energy of the wave quantum of an incident wave-particle after the interaction, and

$$E_{r1} = h_\delta \frac{c}{\lambda} \qquad (10.49c)$$

is the energy of the wave quantum of radiation (absorption).

From the equation (10.49), the law of conservation of frequency or, that is the same, the law of linear density of waves of time, follows:

$$\frac{c}{\lambda_{m1}} = \frac{c}{\lambda_{m2}} + \frac{c}{\lambda}\,, \qquad (10.50)$$

as well as the law of linear density of waves of space,

$$\frac{1}{\lambda_{m1}} = \frac{1}{\lambda_{m2}} + \frac{1}{\lambda}\,. \qquad (10.50a)$$

Both laws represent, simultaneously, the law of conservation of density of the number of wave potential and kinetic nodes, which are related with the states of the wave field of time and space:

$$Z_{m1} = Z_{m2} + Z_r\,, \qquad (10.51)$$

$$N_{m1} = N_{m2} + N_r \,. \tag{10.51a}$$

Thus, resting on any of the laws of conservation for wave quanta, for example, on the law of conservation of energy (10.49), we arrive at

$$E_r = E_{\delta m1} - E_{\delta m2} = h_\delta \frac{c}{\lambda} = h_\delta \nu_0 \left(\frac{1}{m_1^2} - \frac{1}{m_2^2} \right).$$

Hence, the length of the radiated (absorbed) wave is

$$\frac{1}{\lambda} = \frac{\nu_0}{c} \left(\frac{1}{m_1^2} - \frac{1}{m_2^2} \right). \tag{10.52}$$

The above-considered waves are simultaneously the waves of currents. In such a case, the incident wave is the general current. The wave after interaction and the wave of radiation are the two parallel processes-currents, as the parallel elements of the wave chain of exchange of motion-rest (Fig. 19b).

For the wave spherical part of the field, as the field of the spherical current, we obtain, according to the elementary Ohm's law, the following wave quantum of the specific resistance:

$$\rho = \frac{R_{res} S}{l} = \frac{S}{l} \frac{\varphi}{I} = \frac{4\pi r^2}{r} \frac{e}{4\pi\varepsilon_0 r \omega_e e} = \frac{1}{\varepsilon_0 \omega_e} = \frac{m}{\varepsilon_0 e}, \tag{10.53}$$

where m and e are the electron's mass and charge; $\omega_e = e/m$ is the fundamental frequency of the field of electron level.

The specific resistance, at the constant charge, is proportional to mass. And the specific conductivity and the circular frequency are, in essence, the same parameter, presented in the different forms:

$$\sigma = \frac{1}{\rho} = \varepsilon_0 \omega_e = \frac{\varepsilon_0 e}{m}. \tag{10.54}$$

Let us return to the law (10.50). We will present it in the form of the law of conservation of circular frequencies:

$$\omega_{m1} = \omega_{m2} + \omega_r \,. \tag{10.55}$$

According to the formula (10.54), this law can be also presented as

$$\sigma_{m1} = \sigma_{m2} + \sigma_r \tag{10.55a}$$

or

$$\frac{1}{\rho_{m1}} = \frac{1}{\rho_{m2}} + \frac{1}{\rho_r} \,. \tag{10.55b}$$

These are the laws of parallel connection of wave chains-currents. They show that the initial wave-beam bifurcates into two parallel waves-beams, one of which is the wave of radiation and another one is the transformed initial wave (Fig. 19b). If a wave λ_r is radiated, then $Z_{m1} > Z_{m2}$, $\omega_r > 0$, and $\rho_r > 0$. If the same wave is absorbed, we have $Z_{m1} < Z_{m2}$ and, then, $\lambda_r < 0$, $\omega_r < 0$, and $\rho_r < 0$.

Let us now consider the wave interaction at the level of electron waves, when the space of a conductor is treated with waves of δ-particles of a definite frequency. As a result of such action, in the space of a conductor, the relatively intensive electron waves-currents of the same frequency arise. They can leave the space of a conductor. This process is called the *photoelectric effect*. The scheme of interaction for the electron wave quanta-currents, in this case, is analogous to one presented in Fig. 9.19.

The electron wave quantum of current, with the relatively high energy, overcomes the space of a conductor. Losing on its way a part of energy, it excites the wave quanta of δ-particles and leaves the conductor. Outside the space of the conductor, the wave quantum-electron is perceived, in the electron wave, above all, as an individual electron and then, as a wave. The law of conservation of energy for the wave electron quanta has the form

$$E_e = \frac{1}{2}m\upsilon_0^2 = h\frac{c}{\lambda} = \sum_k E_{\delta k} + \frac{1}{2}m\upsilon^2 \qquad (10.56)$$

or briefly

$$h\frac{c}{\lambda} = A + \frac{1}{2}m\upsilon^2, \qquad (10.57)$$

where $E_e = \frac{1}{2}m\upsilon_0^2 = h\frac{c}{\lambda}$ is the kinetic energy of the initial wave quantum, $A = \sum_k E_{\delta k}$ is the energy of the wave quantum of scattered wave in the space of a conductor (which is called the work function), and $\frac{1}{2}m\upsilon^2$ is the kinetic energy of electron outside the space of a conductor.

At last, let us assume that fast electrons are accelerated under the potential difference V up to the energy

$$eV = \frac{1}{2}m\upsilon^2 = h\frac{c}{\lambda_{\min}} \qquad (10.58)$$

and hit an anticathode of a roentgen tube. Then, at braking, their energy is partially scattered on the surface of anticathode. Another part of electrons with the wave energy

$$h\frac{c}{\lambda_\delta} = eV - E_r, \qquad (10.59)$$

where E_r is the electron's energy absorbed by atoms of the anticathode, induces the waves of δ-particles of the subatomic level of the same length λ_δ and of high energy. Such waves are called *X*-rays. Fast electrons, exciting the wave atomic space, cause a discrete series of characteristic waves against the background of bremsstrahlung δ-radiation.

If an elastic interaction of an electron takes place (E_r = 0), then, according to the equality (10.59), the length of the electron wave, and generated waves of δ-particles, will be minimal and equal to

$$\lambda_{\min} = h\frac{c}{eV}, \tag{10.60}$$

which defines the lower boundary of waves of roentgen spectrum.

In conclusion, let us consider the wave dynamics at the level of the axial wave of basis. In the wave process, the change of the extension Δl of the wave element of space (along the wave-beam) takes place. Simultaneously, the change of the field mass, Δm, related with the element of space l, occurs. The following relation approximately expresses this peculiarity:

$$\frac{\Delta l}{l} = \frac{\Delta m}{m}. \tag{10.61}$$

The Δl is the local change, therefore, $\Delta l = \upsilon\Delta t$. But $l = c\Delta t$, hence, we obtain

$$\frac{\Delta l}{l} = \frac{\Delta m}{m} = \frac{\upsilon}{c} = \frac{\omega a}{c} = ka, \tag{10.61a}$$

where a is the amplitude of axial displacement.

The axial element of the mass of "thickening" (the mass of radiation and scattering) along the wave-beam of basis is defined by the equality

$$m_r = \Delta m = \frac{\upsilon}{c}m = mka. \tag{10.62}$$

In the limiting case, when $\upsilon = c$, the field wave mass is equal to $m_r = m$.

This mass takes part both in the wave motion of superstructure and the wave motion of basis. The same measure of scattering of mass (10.62) is obtained from the wave analysis of the central field of exchange (see Chapter 7, sect. 2.2.7). When we speak about the mass of radiation-scattering, one must keep in mind that means the wave perturbation of exchange raised above the equilibrium exchange of matter-space-time.

If m is the electron mass and υ is the Bohr velocity, then, the amplitude mass of radiation is

$$m_{rm} \approx \frac{1}{137}m, \tag{10.63}$$

and its average quantum is

$$m_r = \frac{\upsilon}{2c}m = \frac{1}{274}m. \tag{10.63a}$$

The local momentum (momentum of superstructure) p_r of the quantum of mass of radiation m_r can be presented by Louis de Broglie's formula as

$$p_r = m_r\upsilon = \frac{m\upsilon^2}{2c} = \frac{h}{\lambda}. \tag{10.64}$$

It should be noted that the kinetic energy of the electron, the kinetic energy of the wave quantum of the electron wave of the length λ, and the kinetic energy of superstructure-basis of the particle m_r are equal:

$$\frac{hc}{\lambda} = \frac{m\upsilon^2}{2} = \frac{1}{2}\frac{\upsilon}{c}m\upsilon c = m_r\upsilon c. \tag{10.65}$$

Possibly, this equality is valid for the field mass of the particle m. A question arises. What can measures of masses of radiation-scattering exist? Before the answer to this question, it should be noted once more that the electron's mass is at the level of the fundamental measure:

$$m_{ei} = \frac{2\pi \log e}{3} \cdot 10^{-27} g\ . \qquad (10.66)$$

This measure of mass possibly fairly often appears in wave processes.

One should regard the wave "thickening" m_r as the wave quasiparticle. If its mass turns out to be equal to (10.66), this particle can be regarded as a quasielectron, or a wave electron, participating only in the wave process of radiation and absorption. For the unit wave, the following relation is valid:

$$\frac{m_r}{m_\lambda} = \frac{\upsilon}{c} = \frac{2\pi a}{\lambda} \qquad (10.67)$$

and

$$m_\lambda = \frac{c}{\upsilon} m_r\ , \qquad (10.68)$$

where m_λ is the field mass, related with the quantum of the wave λ.

If υ is the Bohr velocity, corresponding to the amplitude a equal to the Bohr radius, and m_r is the quasielectron, then, the mass of radiation of the unit wave quantum is

$$m_\lambda \approx 137 m_r \qquad (10.69)$$

It is natural to compare this wave quantum with the γ-quantum of the same mass of exchange. Correspondingly, the wave quantum of the fundamental tone has twice as much mass

$$m_\lambda \approx 274 m_r\ , \qquad (10.70)$$

This quantum should be compared with the π-meson mass. In such a case, the wave decay reaction

$$\pi \rightarrow \gamma + \gamma \qquad (10.71)$$

should be treated as decomposition of the wave quantum of the fundamental tone into two half-quanta of this tone or two quanta of the unit wave.

Let roentgen rays (the rays of δ-particles of high energies) interact with free electrons of some space. Then, partial scattering of rays and partial absorption of the energy, by free electrons of the space, take places (Fig. 9.20).

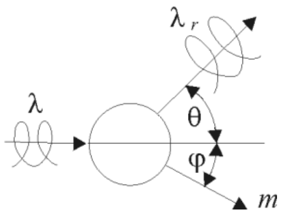

Fig. 9.20. Compton scattering.

In the language of wave quanta, the laws of conservation in such a process take the form

$$\frac{h}{\lambda}\mathbf{n} = \frac{h}{\lambda_r}\mathbf{r} + m\mathbf{v}, \qquad (10.72)$$

$$\frac{hc}{\lambda} = \frac{hc}{\lambda_r} + \frac{m\upsilon^2}{2}, \qquad (10.73)$$

where λ and λ_r are the initial wave and the wave after the interaction, respectively, m is the electron mass.

On the basis of the equalities (10.72) and (10.73), we obtain the Compton difference of scattered and incident waves

$$\Delta\lambda = \lambda_r - \lambda = \frac{\lambda_0}{2m} m_r (1-\cos\theta) = \frac{\lambda_e}{m} m_r (1-\cos\theta), \qquad (10.74)$$

where m_r is the wave mass of δ-particles of X-rays, $\lambda_0 = 4\pi r_0$ is the Bohr wavelength of the fundamental tone, and $\lambda_e = 2\pi r_0$ is the length of the unit wave. In this equality, the ratio $\frac{\lambda_e}{m}$ is the specific density of the wave extension, because one quantum of the electron mass is related with the unit wave. From the expression (10.74), one can estimate the mass of the roentgen quasiparticle:

$$m_r = \frac{\Delta\lambda}{\lambda_e (1-\cos\theta)} m. \qquad (10.75)$$

This formula is approximate, because the fixed electrons also take part in the scattering of X-rays. Therefore, the mass m, entering in the equation (10.75), is some effective mass. It is difficult to define its value precisely.

11. The physical parameters of the man-wave and generality of the laws of dialectics

In connection with the above-presented parameters, having relation to spin, let us consider the wave motion of man (Fig. 9.21). His motion-rest, as a continuous process, is presented by arcs-diagrams of the speed of movement of legs. The formula of man, as an object of the material-ideal World, repeats its structure:

$$\hat{M} = M + iR, \qquad (11.1)$$

where M is the physical body of man and iR is his ideal (spiritual) body or his reason.

An average speed of the mass transfer, i.e., the *charge of man*, is defined (at the length of a half-wave ab) by the relation:

$$\hat{Q} = \left\langle \frac{d\hat{M}}{dt} \right\rangle = \frac{\hat{M}}{(T/2)} = \frac{2\hat{M}}{T}. \quad (11.2)$$

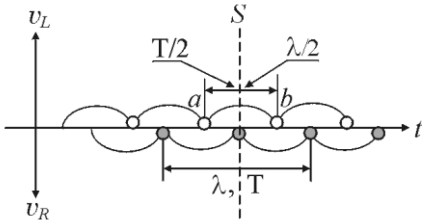

Fig. 9.21. A graph of the wave motion of man: υ_L and υ_R are speeds of the left and right legs, correspondingly; $ab = \lambda/2$ is a step of man (his half-wave of motion-rest); *T* is the wave period; white and dark circles are discrete points-footsteps of the left and right legs, respectively. A dotted line *S* shows a cross section of space through which man passes.

The charge of man is his parameter, connecting in a single whole the mass and time of an elementary half-period of his wave.

Expressing the motion in the language of the charge, we should introduce the *average current*, generated by the man:

$$\hat{I} = \left\langle \frac{d\hat{Q}}{dt} \right\rangle = \frac{\hat{Q}}{(T/2)} = \frac{2\hat{Q}}{T}. \quad (11.3)$$

By analogy with the circular motion, the *wave radius* of longitudinal (axial) trajectory of man is defined as

$$\lambda\!\!\!^{-} = \frac{\lambda}{2\pi}. \quad (11.4)$$

The *average wavelength of many people* is equal to the fundamental period:

$$\lambda \approx 2\pi \lg e\ m = \Delta \cdot 1m = 2.7288\, m. \quad (11.5)$$

From this, the magic *sense of the meter, as the unit of length of the man's fundamental wave,* becomes clear. Accordingly, a half-wave or a step of man is equal to the fundamental half-period:

$$\lambda_{1/2} = \pi \lg e\ m = 1.3644\, m. \quad (11.5a)$$

The wave radius $\lambda\!\!\!^{-}$ has also the magic value:

$$\lambda\!\!\!^{-} = \frac{\lambda}{2\pi} = \lg e\ m \quad \text{and} \quad e^{1/\lambda\!\!\!^{-}} = 10. \quad (11.6)$$

A foot was the fundamental measure in ancient metrology (see sect. 1.4, Chapter 8):

$$1f \approx 2\pi \lg e\ dm = 2.7288\, dm = 27.288\, cm. \quad (11.7)$$

Thus, ten feet constitute the *wave of man*, λ .

The duration of half-wave is approximately equal to a heart cycle, which is equal (for the adult man) about 0.8 *s*. A half-wave of displacement $\lambda_{1/2}$ suits this cycle; so that, we must accept the two cycles as the *wave period of man-wave*:

$$T = 1.6\, s\,. \tag{11.8}$$

It is appropriate to introduce also (in order to complete the picture) the circular frequency

$$\omega = 2\pi / T\,. \tag{11.8a}$$

The *speed of man-wave* represents the rational golden section of the fundamental measure:

$$c = \frac{\lambda}{T} = \frac{5}{8} 2\pi \lg e \; m \cdot s^{-1} = 1.70547\, m \cdot s^{-1}. \tag{11.9}$$

The *linear circulation* $\hat{\Gamma}$, equal to the mass linear density, also characterizes the motion of man. When the left foot is in a state of the maximal movement (at the length of a half-wave *ab*, see Fig. 9.21), the right foot leans on the ground. Therefore, the average linear density of mass in motion must be related to half-wave, because the half-wave is a natural quantum of displacement of man. By virtue of this, we arrive at the following expression for the circulation:

$$\hat{\Gamma} = \frac{\hat{M}}{\lambda_{1/2}} = \frac{2\hat{M}}{\lambda} = \frac{2\hat{M}}{cT} = \frac{\hat{I}}{c}\,. \tag{11.10}$$

We can now define the magnetic moment $\hat{\mu}$ of man-wave. In the capacity of the measure of cross-section *S* of man, we will take (by analogy with the cylindrical wave) a round section of the wave radius, which is equivalent to the transversal area occupying by human body during the motion. The *magnetic moment* $\hat{\mu}$ is

$$\hat{\mu} = \hat{\Gamma} \cdot S = \frac{\hat{I}}{c} \pi ƛ^2 = \frac{2\pi \hat{Q}}{cT} ƛ^2 = \frac{\omega ƛ \hat{Q}}{c} ƛ\,. \tag{11.11}$$

The longitudinal *wave action* of man-wave is

$$h = \hat{M} \upsilon \lambda\,, \tag{11.12}$$

where the speed of motion *c*, for the sake of generality of the expressions, is denoted by the symbol *v*.

The action (11.12) defines the *longitudinal wave moment of momentum*, related to the wave radius:

$$\hbar = \hat{M} \upsilon ƛ\,. \tag{11.12a}$$

The *magnetic moment* (11.11) can be rewritten as

$$\hat{\mu} = \hat{\Gamma} \cdot S = \frac{\upsilon}{c} \hat{Q} ƛ\,. \tag{11.13}$$

Hence, the ratio of the magnetic moment of man-wave, $\hat{\mu}$, to his longitudinal moment of momentum, $\hbar$, will be as follows

$$\frac{\hat{\mu}}{\hbar} = \frac{\hat{Q}}{\hat{M}\upsilon} . \tag{11.14}$$

Thus, here as well, we arrive at the relation equivalent to the one, obtained for the orbiting electron. From here, it does not quite follow that man has no proper spin. On the contrary, a man under rotation during a dance has a "spin", and a figure skater, performing rotation in a point on ice, also has a "spin", but different in value. These assertions are also valid for an electron, all depend on the concrete physical situation. Unfortunately, metaphysics cannot humble with this in no way, it requests only the world constant.

Prothagoras did not suffer the abstract sickness. Therefore, he asserted that ***man is the measure of all measures***. This is true, and the formulae of man-wave confirm his words. Thus, before creating the morbid abstractions (pointing out on a poor level of physical-mathematical education), we must remember the really great sages like Hegel (a genius of human thought). He has stated that the *true professional thinking must be the abstract-concrete* one, but not only abstract. At the beginning of the 21st century, it is necessary to get rid of the rubbish of abstractions, which hampers the right vision of the World.

The motion of man-wave is characterized by the rate of exchange, which has the form

$$\hat{F} = \hat{Q}E , \tag{11.15}$$

where $E = \upsilon$ is the velocity-strength of motion.

On the basis of this expression (if we will treat the rate of exchange formally), it is possible to obtain an equation for the acceleration *w* and velocity *v* of motion:

$$\hat{F} = \hat{Q}E = \hat{M}w , \tag{11.16}$$

$$\upsilon = \int_0^T \frac{\hat{Q}E}{\hat{M}} dt = \frac{\hat{Q}E}{\hat{M}} T = 2E . \tag{11.16a}$$

Hence, the mean velocity of motion is

$$\langle \upsilon \rangle = \frac{0 + 2E}{2} = E = \upsilon . \tag{11.17}$$

As follows from the equality (11.16a), at the upper limit, *NT*, of the integral, the velocity *v* will be equal to $2N \cdot E$ and the mean velocity per *N* periods will be equal to $N \cdot E$:

$$\upsilon = \int_0^{NT} \frac{\hat{Q}E}{\hat{M}} dt = \frac{\hat{Q}E}{\hat{M}} NT = 2NE , \qquad \langle \upsilon \rangle = \frac{0 + 2NE}{2} = NE = N\upsilon . \tag{11.18}$$

This is a *qualitative change of velocity*, which shows how many times the wave process is repeated with the velocity E.

Let us consider the qualitative parameters of a material point in circular motion with a constant, in value, velocity v. In such a case, the centripetal rate of exchange is determined by the expression

$$F = m\frac{\upsilon^2}{r} \tag{11.19}$$

and has the *qualitative character*, because the velocity v is quantitatively constant:

$$V = \int_0^{\varphi} \frac{\upsilon^2}{r} dt = \int_0^{\varphi} \omega^2 r dt = \int_0^{\varphi} \upsilon d\varphi = \upsilon\varphi . \tag{11.20}$$

The result obtained means that the vector of velocity, being unchanged quantitatively, changed qualitatively, rotating about the angle of the φ radian (Fig. 9.22a). Here, a value of the qualitative change of velocity, $v\varphi$, is an arc circumference of the circular speed.

Naturally, a rotation about 2π radian (Fig. 9.22b) should be accepted as a *quantum of the qualitative change of velocity*:

$$d\upsilon = 2\pi\upsilon . \tag{11.21}$$

And, a circumference

$$S = \int_0^{T} \upsilon dt = \int_0^{T} r\omega dt = r\int_0^{2\pi} d\varphi = 2\pi r \tag{11.22}$$

should be regarded as a *quantum of the qualitative displacement*.

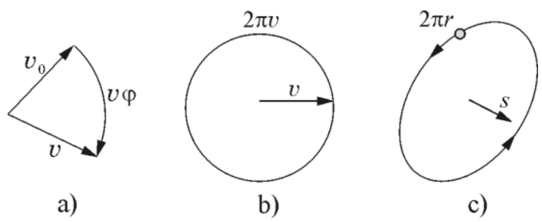

Fig. 9.22. A graph of the qualitative change of velocity.

A displacement, defined by the integral (11.22), is actually the qualitative displacement, because a material point is at the same distance from the center of circumference during the displacement and returns in its initial state. In an arbitrary longitudinal-transversal field of the micro- and megaworld, the qualitative displacement, as the displacement of superstructure, is inseparable from its negation – the quantitative displacement s as the displacement of basis (Fig. 9.22c).

Thus, if in the field of matter-space-time, at the level of basis, a quantitative displacement takes place, then, at the level of the superstructure, the qualitative displacement also occurs. The qualitative displacement is represented, in a simplest case, by the circular motion and, in a general case, by the motion along an ellipse.

A measure of the *rate of qualitative change of orbiting mass* is the kinematic charge $q=\omega m$. Indeed, let us consider an integral of the kinematic change of mass during a period:

$$\Delta m=\int_0^T q dt=q\int_0^T dt=qT=\omega mT=2\pi m. \qquad (11.23)$$

The *quantum of change of mass* during a period $\Delta m=2\pi m$ is the quantum of its qualitative change, which shows that the mass turned about 2π radian per one revolution.

The *power of qualitative change* at motion along a circumference is represented by the expression

$$F=q\upsilon. \qquad (11.24)$$

This expression is an analogue of the *power of quantitative exchange*, at the level of basis (of the central field)

$$F=qE. \qquad (11.24a)$$

If we denote the speed of superstructure in the expression (11.24) by the symbol *B*, then the *power of qualitative exchange* will be presented as

$$F=qB. \qquad (11.25)$$

Let us use this formula for the description of the circular motion of man-wave, which lost his way in a forest and is unable to orient himself by the stars and by some signs in the forest. By virtue of the definite asymmetry of the left and right parts of man, he will move along a circle and sooner or later will return at the former place. For description of this motion, the formula (11.25) can be presented in the following form:

$$\hat{F}=\hat{Q}B=\frac{\Delta\hat{M}}{\Delta t}\upsilon=\frac{2\pi\hat{M}}{T}\frac{\upsilon^2}{\upsilon}=\frac{\hat{M}\upsilon^2}{r}, \qquad (11.26)$$

or

$$\hat{Q}B=\frac{\hat{M}\upsilon^2}{r}. \qquad (11.26a)$$

In the last equality, on the left side, there is the qualitative power of exchange of motion-rest, expressed in the language of the charge $\hat{Q}$ and circular velocity-strength *B*. On the right side of the equality, there is the same power, but presented in the form of a centripetal “force”. It is not necessity to prove that no “force” pulls of man to the center of his circular motion.

By this analysis, we once again emphasize the necessity to consider both the qualitative and quantitative exchanges in longitudinal-transversal fields of matter-space-time. The equality (11.26a) expresses the exchange at the level of basis.

In wave processes, elementary ratios of the parameters of superstructure and basis are determined by the ratio of the speed of superstructure to the speed of basis, $P_S / P_B = \upsilon / c$. Therefore, the equation of basis (11.26a) should be supplemented with the equation of superstructure (“Lorentz force”):

$$\hat{F} = \frac{\upsilon}{c}\hat{Q}B = \frac{\upsilon}{c}\frac{\hat{M}\upsilon^2}{r} = \frac{\hat{m}_\tau \upsilon^2}{r}, \quad (11.27)$$

where

$$\hat{m}_\tau = \frac{\upsilon}{c}\hat{M} \quad (11.28)$$

is the mass of superstructure over the mass of basis, $\hat{M}$.

The basis speed c of man-wave is defined by the formula (11.9). The speed of superstructure υ is essentially less than the speed of basis c. The speed of superstructure υ, i.e., the speed of the transversal motion of all microparticles of human body, is induced by the longitudinal (axial) motion of the man-wave with the speed c.

The transversal field and the mass (11.28), related to this field, are very small ones, so that the detection of them is very problematically at present.

The following “magnetic” moment of the man-wave corresponds to this motion

$$\mu_B = \frac{\upsilon}{c}\hat{Q}r. \quad (11.29)$$

Thus, the above-considered example with the man-wave demonstrated once again the generality of the laws of dialectics.

Newton’s mechanics, one-sidedly reflected reality, is able to see only quantitative changes. Following Aristotle’s laws of “right thinking”, it cannot find qualitative changes

Real processes in nature have the quantitatively qualitative (*Yes*-*No*) character. Accordingly, if there is the quantitative acceleration (*Yes*-acceleration), the qualitative accelerations (*No*-acceleration) must be as well. Usually, both accelerations are inseparable one from another. This statement is based on dialectical logic. Newton did not know this logic. Therefore, still there is no dialectical understanding of motion in the contemporary theoretical mechanics. It stubbornly states that the “force is the reason of acceleration”. Objects of nature can exchange motion (as well as rest), then they are in an active state, or can keep their motion unchanged, being then in a passive state. The passive state, in turn, is accompanied by the qualitative changes that must be taken into account.

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