# Conjugate Fields and Symmetries

George P. Shpenkov Institute of Mathematics & Physics, UTA, Kaliskiego 7, 85-796 Bydgoszcz, Poland
shpenkov@janmax.com

The symmetry of opposite properties is the fundamental law of the Universe and the binary field of conjugate real numbers (parameters), related to opposite properties, reflects this law. The opposite algebras of signs for components of the binary numbers follow the laws of symmetry of binary judgments about the nature of any object or process. The notion of imaginary numbers does not exist here. The period of binary numbers with the decimal base is equal to $\Delta=2\pi\lg e\approx2.7288$. The complex wave function consistent of two real components, reflecting potential-kinetic structure of rest-motion, sheds light on symmetry of atomic spaces.

*Keywords*: complex numbers, imaginary number, symmetry

Received February 02, 2003, Communicated by V. Simulik

## 1. Introduction

We recall G. Leibniz's (Leibniz, G. Wilhelm, 1646-1716) well-known words: "*Complex numbers are a fine and wonderful refuge of the divine spirit, as if it were an amphibian of existence and nonexistence*".

And L. Euler, in his "*Algebra*" (1770), has asserted: "*Square roots of negative numbers are not equal to zero, are not less than zero, and are not greater than zero. From this it is clear that the square roots of negative numbers cannot be among the possible (actual, real) numbers. Hence, we have no another way except to acknowledge these numbers as impossible ones. This leads us to the notion of numbers,* ***impossible in essence****, which are usually called* ***imaginary (fictitious) numbers****, because they exist only in our imagination*."

Hitherto the situation with complex numbers in science did not change and is on the same level of non-understanding of their deep sense. This fact led to serious consequences, in particular, for the development of physics being now dominated through quantum mechanics. Actually, in order to get rid of the imaginary part, Born in 1926 proposed the well-known probabilistic interpretation of Schrödinger's complex wave Ψ-function. He confesses in his book [1] (page 147) that "*The reason for taking the square of the modulus is that the wave function itself (because of the imaginary coefficient of the time derivative in the differential equation) is a complex quantity, while* ***quantities susceptible of physical interpretation must of course be real***". Since then, quantum mechanics (QM) loudly asserts that the physical sense has only the modulus squared of Schrödinger's wave function

$$\psi_{n,l,m}\psi^{*}_{n,l,m} = R^{2}_{n,l}(r)\Theta^{2}_{l,m}(\theta)\,. \tag{1.1}$$

This step caused a series of problems at the description of energetic structure (spectra) of atoms and gave rise to quantum electrodynamics (QED), which all time struggles against infinities; although the majority (grown up on the university courses on QM) is still fully convinced of that the hydrogen atom is quite well described by Schrödinger's wave function.

Impossibility in the framework of QM to describe the spatial (bulk) intra-atomic structure, *i.e.*, the geometry of disposition of nucleons in a nucleus, is also a consequence of misunderstanding the sense of the imaginary component of complex wave Ψ-function.

The absurd contradictions inherent in QM [2] (on which many have already paid attention) are as well a result of acceptance of the contradictory probabilistic approach. However, it is not emphasized in the literature and textbooks on QM as if it were all okay in the theory. Therefore, throughout an existence of quantum mechanics (QM), the three-dimensional distribution of extremes of Schrödinger's Ψ-functions has never been presented.

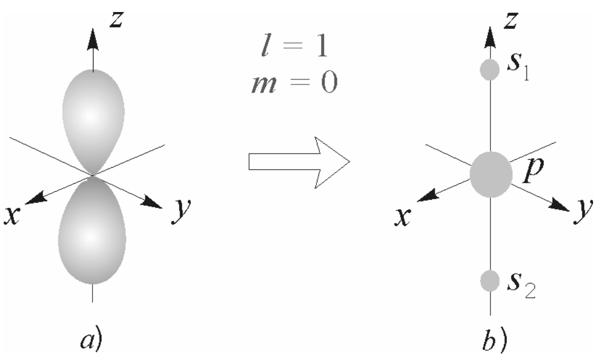



**Fig. 1.1**. The surface (a) and corresponding to it two polar extremes $s_1$ and $s_2$ (b) of $|\Psi|^2$ on the radial sphere $R_1(r)$; *p* is the proton.

Actually, following QM, the density of probability of the presence of a single electron in the hydrogen atom, at every point and at every instant, is proportional to $|\Psi|^2$. Therefore, *e.g.*, at $l = 1$ and $m = 0$, extremes of $|\Psi|^2 = R_1^2(r)\Theta_{1,0}^2(\theta)|\Phi_0(\varphi)|^2$ are in two polar points $s_1$ and $s_2$, *i.e.*, on the extreme radial sphere determined by the solutions of the radial equation for the radial function $R_1(r)$ (Fig. 1.1).

We arrive at the fact that with the equal probability the electron can be either in $s_1$ or $s_2$. It means that the electron (being in the state determined by the quantum numbers $l = 1$ and $m = 0$) "hangs" above the "north" or "south" poles of the proton surface, forming together with the proton an electric dipole directed along the polar z-axis, and its orbital (magnetic and mechanical) moments are equal to zero.

Obviously, such a structure of the hydrogen atom, originated from the QM interpretation, is inconsistent with experiment. The similar inconsistency is inherent in all other functions with different quantum numbers $l$ and $m$ that has been convincingly shown in works of the present author with L. Kreidik (see References), in particular, in [2, 3].

According to the Postulate of Existence of dialectical philosophy and logic [4], the World is material-ideal. Symbolically the material-ideal essence of the World can be briefly presented by the logical binominal

$$\hat{M} = M + iR ,$$

where $M$ and $iR$ are, correspondingly, material and ideal components of the World; the sign “+” expresses their mutual bond, the sign “^” denotes the complexity and contradictoriness (duality).

Cognition of the World proceeds on the basis of comparison and through comparison. In the first approximation, any element of a state or a phenomenon of nature has at least two sides of comparison. It requests to describe them by the dialectical *symmetrically asymmetric judgments* of the kind *Yes* – *No*. What does it mean? In dialectical logic and philosophy, consequently, in physics as well, the judgment *Yes* is the qualitative measure of affirmation, as such, about an object or process. Concerning its quantitative measure, the judgment *Yes* is defined by the measures of studying processes and objects. Thus, the implicit dialectical symbol *Yes* is represented by the symbol of the physical quantity, which the symbol *Yes* expresses logically. The judgment *Yes* − *No* presents the *symmetrical* pair of judgments *Yes* and *No*, which are in essence the *opposite* judgments, so that in this sense both these judgments are *asymmetric* ones [4].

Since properties of the processes and objects, expressed by the judgment *Yes*, in a general case are variable ones, the dialectical judgment *Yes* is a variable quantity, represented by a function of its arguments. For example, if *Yes* expresses kinetic energy of a material point, then the value *Yes* is equal to the value of the kinetic energy itself.

In a general case, *Yes* and *No* are natural judgments about an object of thought. These judgments express both quantitative and qualitative notions about the object. Here are some examples of polar-opposite notions: rest-motion, potential-kinetic, continuous-discontinuous, absolute-relative, existence-nonexistence, material-ideal, form-contents, basis-superstructure, qualitative-quantitative, cause-effect, objective-subjective, past-future, necessary-casual, finite-infinite, real-imaginary, wave-quantum, particle-antiparticle, electric-magnetic, *etc*.

For the description of the *opposite* properties of objective reality, it is convenient to use binary numbers, similar in form to common *complex numbers*, but consisting of only two real numbers which have, moreover, the polar opposite algebraic properties, that we intend to elucidate in this paper.

Then, the transformation of the kinetic field into the potential one, or the "*electric*" field into the "*magnetic*" one, means (in the language of complex numbers) the transformation of the *material* ("*real*") numerical field into the *ideal* ("*imaginary*") one and *vice versa* although both fields are real. As it turned out, similarly as the kinetic (*electric*) and potential (*magnetic*) fields are the real fields [5], the "*real*" and "*imaginary*" units, 1 and *i*, are the real units as well. Thus, actually we deal with the real numbers in both polar (conjugate) cases [6, 7]. We will show it below and will answer to the question what does the "*imaginary*" unit *i* represent in this case.

## 2. Two algebras of signs

It is natural to express the measures of real (material) states by the field of *real* (*material*) *numbers*, whereas the measures of possible (ideal) states – by the field of *possible* (*ideal*) *numbers*. In this connection, the necessity to introduce the field of *ideal numbers* for the description of measures of possibility, future, rest, and ideal states of processes and phenomena arises. Because the possibility, future, rest, and ideal states are polar-opposite to the reality, past, motion, and material states, *two algebras* of fields of real and ideal numbers *must be qualitatively different* [5].

If the logical judgment *Yes* expresses *reality* and *No* – *possibility*, then measures *Yes* must be expressed on the basis of the *field of real numbers* and measures *No* – on the basis of the *field of ideal numbers*. This gives the accurate dialectical description of different conjugate processes (possible and real, potential and kinetic, past and future, material and ideal, *etc*.).

Let us denote the "*real*" unit by the symbol 1 and the "*ideal*" unit by the symbol $\dot{1}$. In the *longitudinal* (*e.g*., *electric*) *fields*, the algebra of signs of two opposite charges is conditionally as follows:

$$(\pm 1)(\pm 1) = +1, \qquad (\pm 1)(\mp 1) = -1. \tag{2.1}$$

In the language of interaction, this algebra means that the identical in sign two charges repel (the sign "+" in the first equality shows it) and the opposite charges attract (the sign "–" in the second equality reflects it). In essence, the two equalities in (2.1) represent the "initial conditions" of the character of interaction of longitudinal fields, expressed at the level of the units.

The algebra of interaction of *transversal (e.g., magnetic) fields*, which are the opposite fields (in their properties) with respect to the longitudinal fields, should be expressed by the opposite algebra of signs:

$$(\pm\dot{1})(\pm\dot{1}) = -1, \qquad (\pm\dot{1})(\mp\dot{1}) = +1. \tag{2.2}$$

These conditions show that the two cylindrical fields, for example, magnetic vortices of parallel rectilinear currents, of the same direction (that is equivalent to the same sign) attract. The negative unit of the longitudinal field (the attraction, as the repulsion, is the longitudinal process) reflects it. Correspondingly, the two opposite cylindrical fields of the opposite direction repel that is expressed by the positive unit of the longitudinal field.

In the longitudinal field, it is possible to extract the square root of "+1", but impossible for "–1". On the contrary, in the transversal field, it is impossible to extract the square root of "+1", but possible for "–1". Such are the nature of the opposite fields. In essence, in both cases, (2.1) and (2.2), we deal with the complex *longitudinal-transversal* (electro-magnetic) field. In fact, its measure is expressed by the two real units, 1 and $\dot{1}$, but belonging to the opposite algebras of signs: $\hat{\Psi} = a \cdot 1 + b \cdot \dot{1}$ or $\hat{\Psi} = a \cdot 1 + \dot{1} \cdot b$. In the brief form, these expressions can be presented as

$$\hat{\Psi} = a + b\dot{1} \quad \text{or} \quad \hat{\Psi} = a + \dot{1}b \tag{2.3}$$

By virtue of the fact that both units, 1 and $\dot{1}$, are real ones, they present in real space the real processes, reflecting at the same time the opposite properties of them.

# 3. Relativity of the notions, "real" and "imaginary"

The world is a *material-ideal* (quantitative-qualitative) *system*; hence, the numbers 1 and i are the *real units of material and ideal* (quantitative and qualitative). Let us show the definite relativity of the notions, "real" and "imaginary", with the example of the structure of the parabola (Fig. 3.1).

An analysis of the equation of parabola $y = x^2$ reveals the possibilities of the practical use of both algebras [3]. There are no problems with the finding of the value of the argument $x$ if $y = +b^2$. There is no problem so long as $+b^2 > 0$. The square root gives the true values $x$: $x = \sqrt{+b^2} = \pm b$.

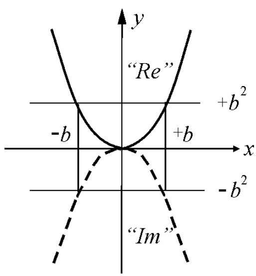



**Fig. 3.1.** The symmetrical, "real" and "imaginary", branches of parabola.

Now, let us imagine a situation when, because of some conditions, we arrive at the equality $y = -b^2$. In this case, we have

$$x = \sqrt{-b^2} = \pm ib. \tag{3.1}$$

In the framework of common notions, it is impossible to show the values of the argument $x$ (3.1) in a diagram, because $i$ is the "imaginary" unit.

Following the aforementioned binary structure of fields, we obtain

$$x = \sqrt{-b^2} = \pm\dot{1}b\,. \tag{3.2}$$

This solution means that we obtained the two real values of the argument *x*, $+\dot{1}b$ and $-\dot{1}b$, which define the missing part of the parabola (the dash line in Fig. 3.1, denoted conditionally as "*Im*"). It is conjugate and symmetrical to the part of the parabola denoted by the symbol "*Re*".

Following the fully formed common concepts, the parabola consists only of one upper branch. However, mathematics based on dialectical logic and concrete physical conditions "know" nothing about it and give the solutions for the whole body of parabola, highlighting our "forgetfulness" and even "ignorance". Thus, solutions of the equation $y = x^2$ give at the *x*-axis, apart from the real values $+b$ and $-b$, the real values $+\dot{1}b$ and $-\dot{1}b$. However, the last pair of values is subjected to the algebra of signs (2.2) in opposition to the first one with the algebra (2.1). If we change the positive direction of the *y*-axis, then the "real" branch of parabola is turned out to be "imaginary" and "imaginary" – "real".

The world is a system of contradictions *Yes* and *No*, which always coexist. It is the principal axiom of dialectical philosophy – the philosophy of the symmetrical world with the definite asymmetry of its opposite parts. In this connection, it is to the point to cite here, for example, the outstanding Chinese philosopher Chuang Tzu (c. 369-286 B.C.) who has written [8] (p.215): ): "In the World, everything *denies* itself through the other thing, which is its opposition. Every thing states itself through itself. It is impossible to discern (in the one separately taken thing) its opposition, because it is possible to perceive a thing only immediately. This is why, they say: '*Negation* issues from *affirmation* and affirmation exist only owing to negation'.

Such is the doctrine on the conditional character of negation and affirmation. If this is so, then all dies already being born and all is born already dying; all is possible already being impossible and all is impossible already being possible. Truth is only insomuch as, inasmuch as lie exists, and lie is only insomuch as, inasmuch as truth exists. The above stated is not an invention of a sage, but it is the fact that is observed in nature…"

Mathematically, the symmetry is expressed in an existence of the *two algebras*: *Yes*-algebra, presented by the equalities (2.1), and *No*-algebra, expressed by the equalities (2.2). Thus, the complete description of the potential-kinetic field is built on the basis of the two real (in the equal degree) units.

The power of a number $ae^{1\omega t}$, based on the real unit 1, defines the *quantitative* ("radial" or "longitudinal") change of the magnitude *a*. On the contrary, the power of the same number $ae^{\dot{1}\omega t}$, on the basis of the real unit $\dot{1}$, defines the *qualitative* ("transversal") change of the magnitude, which is represented, in the simplest case, by the rotation of the quantity *a* in space. The transverse changes of this number are represented, using Euler's formula, as $ae^{\dot{1}\omega t} = a(\cos\omega t + \dot{1}\sin\omega t)$ or, if $\dot{1} \equiv i$, as $ae^{i\omega t} = a(\cos\omega t + i\sin\omega t)$. In this equation, both its opposite terms are *real* as well.

The *longitudinal* (radial) *quantitative* ("real") motion, for example, of the Sun, is accompanied by the *transversal qualitative* ("ideal") motion of its planets. Moreover, with respect to the center of our Galaxy, the motion of the Sun is "ideal". Such is the Universe. The same relation occurs in the microworld, where the "electric" field-space, as the longitudinal one, is quantitative ("real"); the "magnetic" field-space, as the transversal one, is qualitative ("ideal").

The quantitative-qualitative presentation should be used in the description of all phenomena and objects, in question. Here is a simple school *example*. Let us determine the time of motion of a body thrown vertically up from the point 0 with the initial speed $\upsilon_0 = 30\, m/s$ if the passed distance is $l = 125\, m$ (Fig. 3.2a). Air resistance is not taken into account and it is assumed that $g = 10\, m/s^2$.

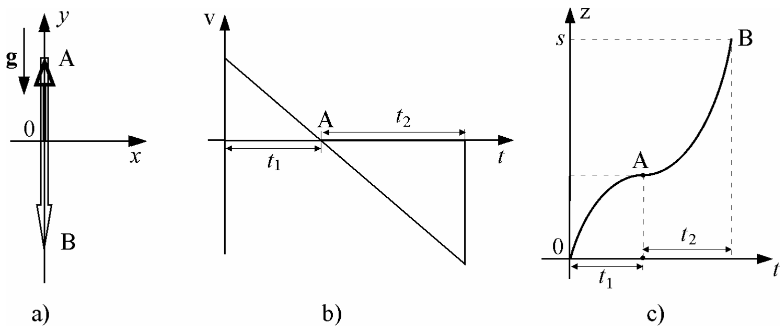



**Fig. 3.2**. The motion of a body thrown vertically up (a); plots of the velocity *u* (b) and the displacement *l* (distance) (c); *z* is the axis of displacement (distance).

The parts of trajectory of motion OA and AB with *opposite* characters of motion and the time intervals $t_1$ and $t_2$ relate as the past and the future; therefore, they belong to the different algebras of signs (Fig. 3.2b). The binumerical field takes this singularity of motion into account.

The corresponding equation of uniformly variable motion of a body takes the form

$$l = \upsilon_0 t - gt^2/2 \quad \text{or} \quad gt^2 - 2\upsilon_0 t + 2l = 0 . \qquad (3.1)$$

The negative discriminant of this equation, $D = 4\upsilon_0^2 - 8gl < 0$, must not embarrass us because we do not operate with complex numbers. We can extract the square roots from negative numbers. Solutions of Eq. (3.1) in the field of binary numbers are real and have the form

$$\hat{t} = t_1 \pm it_2 = \upsilon_0 / g \pm i\sqrt{2gl - \upsilon_0^2} / g = 3 \pm 4i \ (s) .$$

The final speed is $\upsilon = -\sqrt{2gl - \upsilon_0^2}$, hence, the time of motion is represented by the binary number

$$\hat{t}_+ = t_1 + it_2 = \upsilon_0 / g + \sqrt{\upsilon_0^2 - 2gl} / g = \upsilon_0 / g - i\upsilon / g = 3 + 4i \ (s) .$$

The solution with the *positive sign* expresses the fact that the *direction of motion* is strictly along the trajectory and does not change. This is the absolute (proper) direction of trajectory.

On the other hand, the conjugated value of time $\hat{t}_+^* = t_1 - it_2$ indicates that the *past displacement* OA and the *future displacement* AB are opposite in sign with respect to the y-axis.

With respect to the future of two sections of motion, the times $t_1$ and $t_2$ are the past times. So that the norm [3] of the compound time determines the total time of motion $t_+ = t_1 + t_2 = 7 \ (s)$, and the modulus squared of the past-future time $|\hat{t}|^2 = t_1^2 + t_2^2$ determines the covered distance $l = g(t_1^2 + t_2^2)/2$.

Any trajectory is characterized by two closely related parameters: the distance *l* and the coordinate *y* of a body. It means that any point of space is not only a coordinate, but also the final point of a traversed path of motion, which it represents. These parameters are expressed in Eq. (3.1) by one symbol *l* in accordance with the initial conditions (the passed distance *l*) of the problem.

Let us to introduce $\hat{t}_+ = t_1 + it_2 = 3 + 4i$ in Eq. (3.1), we obtain

$$l = \upsilon_0 \hat{t}_+ - g\hat{t}_+^2 / 2 = \upsilon_0 t_1 - gt_1^2 / 2 + gt_2^2 / 2 + (\upsilon_0 - gt_1)it_2 ,$$

but $(\upsilon_0 - gt_1) = 0$ and $\upsilon_0 t_1 - gt_1^2 / 2 = gt_1^2 / 2$, hence,

$$l = gt_1^2/2 + gt_2^2/2 = g\hat{t}\hat{t}^*/2 = gt_m^2 = 125\ m,$$

where $t_m^2 = \hat{t}_+\hat{t}_+^*$ is the square modulus of time. If we will take the time $\hat{t}_+^* = t_1 - it_2$, we will arrive at the same result.

In the binumerical field, *there are no imaginary solutions*: all solutions are right because in reality displacement and distance represent different facets of the same process that explicitly expresses the binumerical field [3]. At the section OA (Fig. 3.2c), the distance and the displacement are equal; this section is related to the lower branch of the parabola, described by the *algebra of affirmation*, whereas the upper branch of the parabola is described by the *algebra of negation* – it determines the covered distance AB.

With respect to the final point B, the past OA and the future AB are the past OB. Therefore, they will be characterized by the same positive algebra of signs. In this case, the general time $t_+ = t_1 + t_2$ defines the final *coordinate* of a body:

$$l = \upsilon_0 t_+ - gt_+^2/2 = \upsilon_0(t_1 + t_2) - gt_1^2/2 - gt_2^2/2 - gt_1t_2 =$$

$$= \upsilon_0 t_1 - gt_1^2/2 - gt_2^2/2 - (\upsilon_0 - gt_1)t_2 = gt_1^2/2 - gt_2^2/2$$

or

$$l = y = gt_1^2/2 + g(it_2)^2/2 = -35\ m.$$

# 4. Fundamental period-quantum of binary numbers with the decimal base

In the field of binary numbers, the correlation between the base of a binumber and its power has the fundamental meaning. Indeed, if a physical process requires for its presentation a binary number $\hat{Z}$ with some base $d$, then its binary measure will have the form

$$\hat{Z} = rd^{i\varphi} = r\exp(i\ln d\cdot\varphi) = r(\cos(\ln d\cdot\varphi) + i\sin(\ln d\cdot\varphi)). \qquad (4.1)$$

The binary field with the *decimal base* $d = 10$ is characterized by the period-quantum

$$\Delta = 2\pi / \ln 10 = 2\pi \lg e \approx 2.7288 . \quad (4.2)$$

It follows from the comprehensive analysis [9], fundamental constants of physics and the reference units (gram, centimetre, and second) correlate with the fundamental period-quantum (4.2).

## 5. Symmetry and quasiperiodicity of atomic structures

After their introduction in science, imaginary numbers were and still are the great mystery. Let us show how with regard to the aforementioned binary structure of properties one can arrive at symmetry of atomic structures.

Because the *wave exchange* of matter-space and motion-rest (*matter-space-time* for brevity) is in the nature of all physical phenomena, the *probability* of possible states at wave exchange must also have the *wave character* and reflect the states of *rest* and *motion*. The *possibility* of rest and motion gives birth to the potential-kinetic field of *reality*, where rest (*potential* field) and motion (*kinetic* field) are inseparably linked between themselves in the unit *potential-kinetic field* [7]. The notion *exchange* reflects *wave behaviour* of microobjects in their dynamic equilibrium with the ambient field, at rest and motion, and interactions with other objects [5].

The *probability potential* (as the *measure of possibility* and *reality*), introduced first in [3], describes any wave events, including probability of concentration of substance in specific points of wave spaces, in which its amplitude achieves extreme and zero values. Following the requirement of the symmetry, conditioned by the dialectical logic, the probability potential has the binary *potential-*

*kinetic* structure $\hat{\Psi} = \Psi_p + i\Psi_k$ [10] and is determined by the product of *spatial* and *time* probability functions:

$$\hat{\Psi} = \hat{R}(\rho)\Theta(\theta)\hat{\Phi}(\varphi)\hat{\Xi}(t) = \hat{\psi}(\rho,\theta,\varphi)\hat{\Xi}(t), \quad (5.1)$$

Their amplitudes are described by the equations

$$\Delta\hat{\psi} + k^2\hat{\psi} = 0 \quad (5.2)$$

and $d^2\hat{\Xi}/dt^2 = -\omega^2\hat{\Xi}$, where $k = 2\pi/\lambda = \omega/c$ is the wave number, the *constant quantity*. After the conventional separation of variables, Eq. (5.2) falls into the equations of radial $\hat{R}_l(\rho)$, polar $\Theta_{l,m}(\theta)$, and azimuth $\hat{\Phi}(\varphi)$ components. For any model of an object of study, the radial solutions define the characteristic spheres of extremes (domains of more intensive radial displacements) and zeroes (where radial displacements are absent) of the radial function [5].

Polar components $\Theta_{l,m}(\theta)$ of $\hat{\psi}$ define characteristic parallels of extremes (primary and secondary) and zeroes on radial spheres (shells). Azimuth components $\Phi_m(\varphi)$ define characteristic meridians of extremes and zeroes. Potential and kinetic polar-azimuth probabilities select together the distinctive coordinates (points) of extremes and zeroes on the radial shells. Graphs of these functions (see Fig. 5.1 and Table 5.1) show that there are *primary* and *secondary* extremes (called also *nodes*), which determine, correspondingly, stable and metastable states of probabilistic events. The *quasiperiodicity*, or *quasisimilarity*, of shells responding to different quantum numbers $l$ at the same $m = l - 1$ is clearly observed in Table 5.1 as well.

The completely realized polar-azimuth $n$-th shell of the *potential* nodes is defined, in accordance with the wave probabilistic equation (5.2), by the function

$$\Psi_{l,m}(\rho_{l,n},\theta,\varphi)_p = C_\Psi R_l(\rho_{l,n})\Theta_{l,m}(\theta)\cos(m\varphi+\alpha)\,, \tag{5.3}$$

where $\rho_{l,n}$ is the radius of *n*-th extremal radial shell of the function $R_l(\rho)$. We will call such shells the *whole shells*. The geometry of shells is determined by the polar-azimuth functions.

The "*fractional*" (uncompleted) *shells* are defined by the half-integer solutions of the form

$$\Psi_{l,l}(\rho_{l,n},\theta,\varphi)_p = C_\Psi R_l(\rho_{l,n})\sin^l\theta\cos(l\varphi+\alpha)\,, \tag{5.4}$$

where $l$ is a real number, with extremes lying in the equatorial plane.

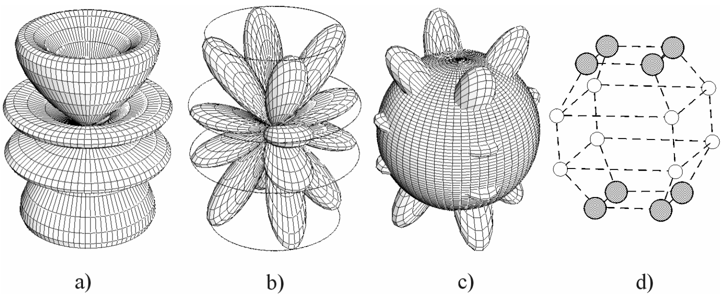
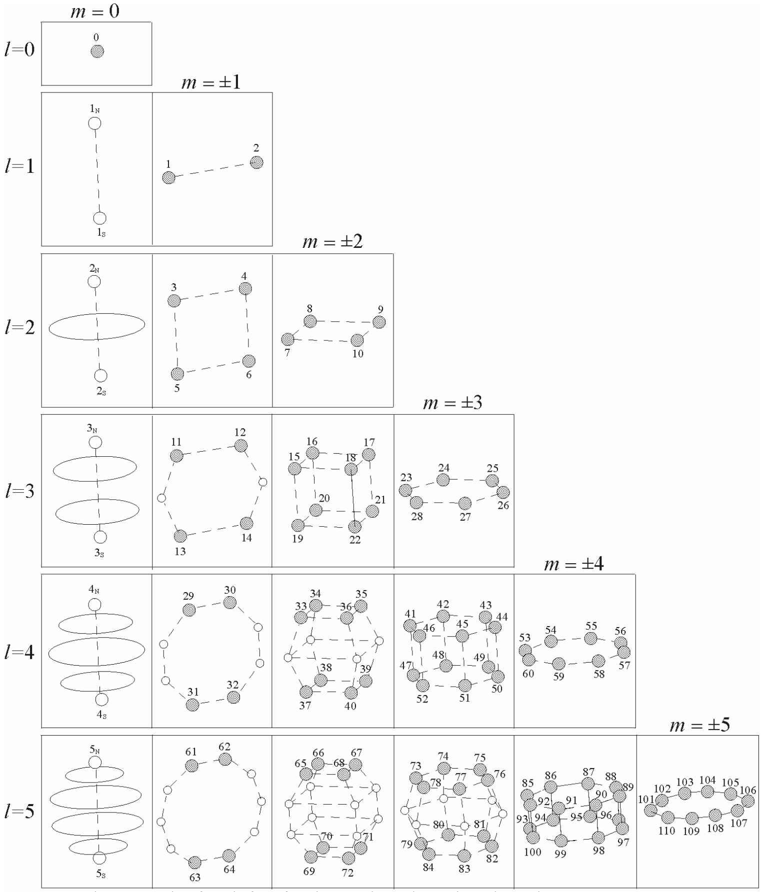



**Fig. 5.1.** The graphs of (a) $\Theta_{5,2}(\theta)$, (b) $Y_{5,2}(\theta, \varphi)$, (c) $Y_{5,2}(\theta, \varphi)$ together with $R_5(r)$, indicating (d) the disposition of *primary* and *secondary* potential extremes (designated conditionally by shaded and blank spheres) of $\psi_{5,2}(\rho,\theta,\varphi)_p$ in the spherical field of probability [5, 10].

In a general case, the complete structure of *any probabilistic object* (called an *abstract atom* [5]) with the ordinal number $Z$ is defined by the two sums:

$$\Psi_Z = \sum C_\psi R_l(\rho_{l,n})\Theta_{l,m}(\theta)\cos(m\varphi+\alpha_m)\oplus \\ \oplus\sum C_s R_s(\rho_{s,j})\sin^{s/2}\theta\cos\left(s/2\,\varphi+\beta_s\right), \tag{5.5}$$

**Table 5.1.** Solutions of the equation (5.2) presented in the form of the spatial distribution of *potential* extremes-nodes; numbers 1, 2, 3, … , 110 are the ordinal numbers $Z$ of the primary polar-azimuth nodes and, simultaneously, the ordinal numbers of the last primary node of a probabilistic object [5, 10].




“N” and “S” are subscripts designating the “north” and “south” polar nodes (at $m = 0$).

where the subscript $Z$ indicates the number of primary nodes and, simultaneously, the ordinal number of the last primary node of a *probabilistic object*; $s = 0, 1, 2, 3, \ldots$; $\alpha_m$ and $\beta_s$ are the initial phases. The first sum in (5.5) consists of embedded whole shells (recalling a set of nesting dols); the second sum consists of embedded half-integer subshells. The ordinal numbers $Z$ correspond to the atomic numbers of Mendeleev's Table [5].

The extremes and zeros of the phase probability are significant in an equal degree. Zero values of the wave spherical field of probability define the radial shells of zero probability of radial displacements (oscillations). Naturally, they are the shells of stationary states. On the contrary, shells of extremal values of the wave field of probability define domains of more intensive radial displacements and, accordingly, these shells describe nonstationary (unstable) states.

Thus, the extremes of the wave field of probability do not quite mean that they are domains of the most probable localization of microparticles. (The *QM* formalism, accentuating the attention to *extremes* of the wave function squared, is unable to describe the qualitative peculiarities of probabilistic processes).

## 6. Conjugate fields of displacements

The dialectical numerical field of reality-possibility is characterized by algebra, which coincides, in form, with the algebra of the field of complex numbers. For example, let a kinetic displacement of a material point *Yes* is its displacement from the state of equilibrium and defined as

$$Yes = a\cos\omega t\ . \tag{6.1}$$

Following the requirement of the symmetry, conditioned by the dialectical logic, one should introduce the notion, which will be opposite to the notion the *kinetic displacement*, *Yes*. It is natural to term it the *potential displacement*, *No*. The displacement *No*, as *negation* of the kinetic displacement *Yes*, can be described by the sine function, since *sine is negation of cosine*, just as *cosine* in turn *is negation of sine*. It is natural to accept amplitude of the potential displacement equal to the amplitude of the kinetic displacement. Apart from this, we present the potential displacement, as the negation of the kinetic one, by the ideal number. Thus, in the capacity of the potential displacement, we accept the following measure:

$$No = ia\sin\omega t\ . \qquad 6.2)$$

Both displacements, reflecting the indissoluble bond of rest and motion, constitute the *potential-kinetic displacement* $\hat{\Psi}$, which we present in the following form:

$$\hat{\Psi} = Yes + No\ . \qquad (6.3)$$

If we will denote the kinetic displacement *Yes* as $x_k$ and the potential displacement *No* as $ix_p$, we will obtain the following dialectical expression for the potential-kinetic displacement (Fig. 6.1):

$$\hat{\Psi} = x_k + ix_p \quad \text{or} \quad \hat{\Psi} = a\cos\omega t + ia\sin\omega t\ . \qquad (6.4)$$

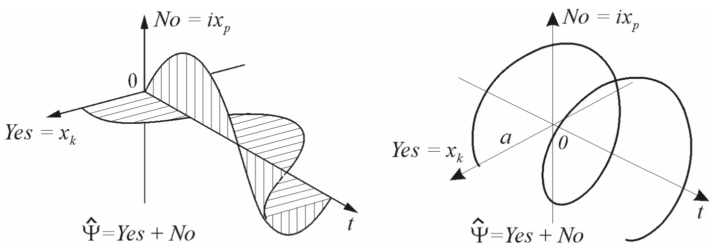



**Fig. 6.1**. A graph of the potential-kinetic displacement *Yes* – *No*.

The kinetic displacement is the possibility of the potential displacement and *vice versa*, the potential displacement is the possibility of the kinetic displacement. When a material point passes through the equilibrium state, its motion is more intensive (takes place the maximum of motion). After passing the equilibrium, the intensity of motion falls and, simultaneously, it increases the extent of rest, expressed through the growing value of the potential displacement. Using Euler's equations, we present the potential-kinetic harmonic displacement as

$$\hat{\Psi} = ae^{i\omega t}. \tag{6.5}$$

The constant component of the potential-kinetic displacement is expressed by the amplitude *a*, the variable component – by the ideal exponential function. The ideal exponential function $e^{i\omega t}$ is also the relative measure of displacement and its fundamental quantum of qualitative changes is

$$e^{i\omega t} = \hat{\Psi} / a. \tag{6.6}$$

And because the relation (6.6) is valid for all harmonic potential-kinetic measures, all these measures have (in the capacity of a relative measure) the ideal exponential function. In this sense, their relative measures are turned out to be equal between themselves.

The field of complex numbers is localized only in the *complex plane*. While images of reality and possibility manifest themselves in the *real space of events* and all these are, in this sense, real.

Thus, the dialectical image of the judgment $\hat{\Psi}$ reproduces mathematically the real image and character of the original. In physics, in the overwhelming majority of cases, the imaginary unit *i* is regarded as something that "*has no physical sense*". This misunderstanding gave rise to the aforementioned nothing-grounded interpretation in QM of the wave Ψ-function, according to which the real physical sense has only its modulus squared [2].

# 7. Conclusion

1. All the above described allows us to state that we are approaching to the understanding of the nature of complex numbers with their "imaginary" unit. The "imaginary" unit *i* is merely the indicator of negative algebra of signs to which the conjugated real number (called in complex numbers theory as "imaginary") subjects. The reason of appearance of complex numbers in the contradictory material-ideal nature of the World is not casual. The Material-Ideal World *imposed these numbers to mathematics in the hope that sooner or later the mystery of the imaginary unit i will be revealed by humankind*.

2. The binary wave functions, reflecting the *symmetry-asymmetry* of polar opposite (potential and kinetic) properties of spaces [11], contain information about morphology (and *symmetry*) crystals. Half-integer solutions (5.5), having in the equatorial domain *any-fold symmetry*, reveal the origin of the symmetries (five- [12], seven-, eight-fold, *etc*.) "*strictly forbidden by the mathematical laws of crystallography*" [13], which attracts last time the world-wide attention.

3. The data obtained indicates also that the *law of constancy of angles between edges* (and facets) for all crystals of the same substance has the wave nature. This statement is based on the fact that, as it turned out, the characteristic angles of crystals are the characteristic angles of wave functions (5.6) [3-5]; *i.e*., they repeat at the macrolevel the angles of disposition of corresponding nodes, presented in Table 5.1, and define the shape of crystals [14].

4. The comprehensive analysis, conducted in [5], confirms also that the directions of chemical bonds in ordered structures are determined by the superposition of elementary solutions of Eq. (5.3) for the wave probabilistic field [15]. These solutions can be used for the prediction of the molecular and crystalline structures. Moreover,

they reveal from the other point of view the nature of Mendeleev's Periodic Law [16, 17] and lead to other of principle results not discussed here.

## References

[1] Max Born, *Atomic Physics*, Hafner Publishing Company, New York, Seventh Edition, 1962 (First published in 1935, Great Britain).

[2] L. Kreidik and G. Shpenkov, *Important Results of Analyzing Foundations of Quantum Mechanics*, Galilean Electrodynamics & GED-East, Special Issues 2, **13**, 23-30, (2002).

[3] L. Kreidik and G. Shpenkov, *Foundations of Physics; 13.644… Collected Papers*, Geo. S., Bydgoszcz, 1998, 272 p.

[4] L. Kreidik and G. Shpenkov, *Alternative Picture of the World*, Geo. S., Bydgoszcz, 1996, Vol. 1-3; pp. 148, 156, and 178.

[5] L. Kreidik and G. Shpenkov, *Atomic Structure of Matter-Space*, Geo. S., Bydgoszcz, 2001, 584 p.

[6] L. Kreidik and G. Shpenkov, *Material-Ideal Numerical Field*, in Contact'95, Proceedings of the General Scientific-Technological Session Contact'95, Vol.II (Bulgaria, Sofia, 1995), pp. 34-39.

[7] L. Kreidik and G. Shpenkov, *Philosophy and the Language of Dialectics and the Algebra of Dialectical Judgements*, Proceedings of The Twentieth World Congress of Philosophy, Copley Place, Boston, Massachusetts, USA, 10-16 August, 1998; http://www.bu.edu/wcp/Papers/Logi/LogiShpe.htm

[8] *Anthology of the World Philosophy*, V.1, Part 1, "Mysl", Moscow, 1969.

[9] L. Kreidik and G. Shpenkov, *Interrelation of Values of Base Units and Fundamental Constants with the Fundamental Quantum of Measures*, http://shpenkov.janmax.com/Metrology.pdf

[10] G. Shpenkov and L. Kreidik, *Discrete Configuration of Probability of Occurrence of Events in Wave Spaces*, Apeiron, Vol. 9, No. 4, 91-102 (2002).

[11] G. Shpenkov and L. Kreidik, *Potential-Kinetic Parameters of Oscillations*, Hadronic Journal, Vol. 26, No 2, 217-230, (2003).

[12] D. Shechtman, *et al.*, *Metallic Phase with Long-Range Orientation Order and no Translation Symmetry*, Phys. Rev. Lett., 53, No.20, 1984, pp. 1951-1953.

[13] P.J. Steinhardt and H.C. Jeong, Nature, Vol. 382, pp. 433-435 (1996); *New Rules for Constructing Penrose Tilings May Shed Light on How Quasicrystals Form*,

http://dept.physics.upenn.edu/~www/astro-cosmo/walker/walker.html

[14] L. Kreidik and G. Shpenkov, *A Wave Field of Probability and the Form of Crystals*, Abstracts, p. 258, 18th IUCr Congress & General Assembly, 4th-13th August, 1999, Glasgow, Scotland.

[15] L. Kreidik and G. Shpenkov, *Nucleon Shells of the Atom and the Structure of Molecules* (*Chemistry of Nucleon Bonds*), Proceedings of The 5th Int. Conf. on Intermolecular Interactions in Matter, pp. 61-66, Politechnika Lubelska, 2-4 September, Lublin, Poland, 1999.

[16] L. Kreidik and G. Shpenkov, *The Wave Equation Reveals Atomic Structure, Periodicity and Symmetry*, Kemija u Industriji, **51**, 9, 375-384, (2002).

[17] G. Shpenkov, *Generalized Table of the Elements*,

http://shpenkov.janmax.com/periodictable.asp