

Schrödinger's Errors of Principle

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In this paper we analyze Schrödinger's wave equation in comparison to the ordinary wave equation describing arbitrary periodic processes running in space and time. Schrödinger's approach gave birth to abstract phenomenological constructions, which do not reflect the real picture of the micro-world; it has by now exhausted itself completely. So a comprehensive re-analysis of foundations of quantum mechanics is urgently needed; first of all, interpretation of Schrödinger's equation and complex Ψ -functions. Here, we emphasize unknown (or un-discussed) features of Schrödinger's equation.

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1. Introduction

The Schrödinger wave equation (SE) is commonly regarded as one of the postulates of quantum mechanics (QM). However, the time is ripe for clarifying the meaning of the SE, in order to understand the origin of numerous contradictions and faults inherent in QM. In this paper, continuing the analysis of the basis of QM started in [1], we emphasize unknown (or un-discussed) features of Schrödinger's wave equation.

Schrödinger's equation appeared in the years of a wild blooming of formalism, which was represented, first of all, by positivism, machism, pragmatism, and other philosophical trends, denying the objective world [2]. Arbitrary mathematical constructions (in the spirit of a free play on notions) were the characteristic result in physics from these philosophical currents. By virtue of this, a reasonable logic was absent or insignificant in such constructions. Schrödinger, a representative of those years, designed his equation following the spirit of aforementioned ideological trends in physics. Nevertheless, we should give Schrödinger his due, because the positivistic style did not satisfy him. He had a propensity for actual realism, and was restrained in regarded to new fashion trends. But he was under the influence of that time. Schrödinger's mathematical model is currently represented in the form of generalized and extended equations, including the relativistic invariant of them, *etc.*

In the 1920's, the SE began to be regarded as a major achievement of scientific thought. It became the basis for lectures on atomic physics in universities. The common opinion is that the SE (in view of its modifications considered in modern QM and QED) proved its validity by the conformity of its solutions with vast amounts of experimental data and the co-ordination with general physical notions.

Now, at the beginning of the 21st century, let us look at the events of those years once more and give an objective estimate of the past. For clearness and simplicity, we will not use the operator formalism as far as possible. In the initial variant, the SE had the following form:

$$\Delta\Psi + \frac{2m}{\hbar^2} \left(W + e^2 / 4\pi\epsilon_0 r \right) \Psi = 0 \quad (1.1)$$

Its structure had a quite artificial character, and rested upon the operator and variational methods.

The wave function Ψ satisfying the wave equation (1.1) is represented as

$$\Psi = R(r)\Theta(\theta)\Phi(\varphi)T(t) = \psi(r, \theta, \varphi)T(t) \quad (1.2)$$

where $\psi(r, \theta, \varphi) = R(r)\Theta(\theta)\Phi(\varphi)$ is the complex amplitude of the wave function, because

$$\Phi_m(\varphi) = C_m e^{\pm im\varphi}$$

The multiplicative form of the amplitude ψ -function allows separation of Schrödinger's equation (1.1) into equations for the radial $R(r)$, polar $\Theta_{lm}(\theta)$, and azimuth $\Phi_m(\varphi)$ functions:

$$\begin{aligned} \frac{d^2 R}{dr^2} + \frac{2}{r} \frac{dR}{dr} + \left[\frac{2m}{\hbar^2} \left(W + Ze^2 / 4\pi\epsilon_0 r \right) - l(l+1) / r^2 \right] R &= 0 \\ \frac{d^2 \Theta_{l,m}}{d\theta^2} + \text{ctg}\theta \frac{d\Theta_{l,m}}{d\theta} + \left[l(l+1) - m^2 / \sin^2 \theta \right] \Theta_{l,m} &= 0 \\ d^2 \Phi_m / d\varphi^2 = -m^2 \Phi_m & \end{aligned} \quad (1.3)$$

An equation for the time component of Ψ is $d^2 T / dt^2 = -\omega^2 T$; its simplest solution is $T = e^{\pm i\omega t}$.

The Θ , Φ , and T equations were known in the theory of wave fields. Hence, these equations presented nothing new. Only the R was new. Its solution turned out to be divergent. However, Schrödinger together with H. Weyl (1885-1955, German mathematician), contrary to the logic and all experience of theoretical physics, artificially cut off the divergent power series of the radial function $R(r)$ at a κ -th term. This allowed them to obtain the radial solutions, which, as a result of the cut off operation, actually were the fictitious solutions. For hydrogen-like atoms, the radial function has the following form

$$R_{\kappa l} = N_{\kappa l} \exp \left[\frac{-\rho}{\kappa + l + 1} \right] \times \left(\frac{2\rho}{\kappa + l + 1} \right)^l L_{\kappa}^{2l+1} \left(\frac{2\rho}{\kappa + l + 1} \right) \quad (1.4)$$

where $\rho = r / a$, $a = a_0 / Z$, a_0 is the Bohr radius; $L_{\kappa}^{2l+1} [2\rho / (\kappa + l + 1)]$ is the Laguerre polynomial of the power κ

that power being simultaneously the parameter for cutting off the divergent series; and

$$N_{\kappa l} = \frac{2}{(\kappa + l + 1)^2} \sqrt{\frac{\kappa!}{(\kappa + 1 + 2l)!}} \cdot \left(\frac{1}{a}\right)^{3/2} \quad (1.5)$$

is a normalizing multiplier.

Since the radial equation in (1.3) contained the energy of interaction of the electron with the nucleus, $-Ze^2/4\pi\epsilon_0 r$, it was natural to expect that Eq. (1.3) would 'give out' this energy as a result of the solution under the definite conditions. Indeed, the formal cutting off leads to the discrete series of values of the total electron energy:

$$W = -Ze^2/8\pi\epsilon_0 a_0(\kappa + l + 1)^2 = -Ze^2/8\pi\epsilon_0 a_0 n^2 \quad (1.6)$$

where the sum $n = \kappa + l + 1$ (equal to 1, 2, 3, ...) was called the *main quantum number*.

The formula (1.6) creates the illusion of a solution to the problem. Actually, in a strictly scientific sense, we deal here with the plain mathematical adjustment to Bohr postulates. The radial solution (1.4) for the hydrogen-like atom, after replacing $\kappa + l + 1$ with n , takes the form

$$R_{nl} = N_{nl} \exp(-\rho/n) \left(\frac{2\rho}{n}\right)^l L_{n-l-1}^{2l+1} \left(\frac{2\rho}{n}\right)$$

where

$$N_{nl} = \frac{2}{n^2} \sqrt{\frac{(n-l-1)!}{(n+l)!}} \cdot \left(\frac{1}{a}\right)^{3/2} \quad (1.7)$$

and $L_{n-l-1}^{2l+1} \left(\frac{2\rho}{n}\right) =$

$$\frac{\exp(2\rho/n) \left(\frac{2\rho}{n}\right)^{-(2l+1)}}{(n-l-1)! \left(\frac{2\rho}{n}\right)^{-(2l+1)}} \frac{d^{n-l-1}}{d(2\rho/n)^{n-l-1}} \left\{ \exp(-2\rho/n) \left(\frac{2\rho}{n}\right)^{l+n} \right\}$$

With use of the accepted designations, Schrödinger's Ψ -function (1.2) is presented as

$$\Psi = R_{nl}(r)\Theta_{lm}(\theta)\Phi_m(\varphi)T(t) = \psi_{nl}(r, \theta, \varphi)T(t) \quad (1.8)$$

where $\psi_{nl}(r, \theta, \varphi) = R_{nl}(r)\Theta_{lm}(\theta)\Phi_m(\varphi)$. Let us begin an analysis of Schrödinger's equation from the aforementioned radial solution.

2. Radial solution

Schrödinger's radial equation (1.3) contains only the wave number l . The number κ has an auxiliary character. Accordingly, the radial function should be presented in the form $R_l(\rho, \kappa)$. Taking into consideration these remarks, Schrödinger's elementary Ψ -function (1.8) can be rewritten as

$$\Psi_{lm,\kappa} = \psi_{lm,\kappa}(\rho, \theta, \varphi; \kappa)T(t) = R_l(\rho; \kappa)\Theta_{lm}(\theta)\Phi_m(\varphi)T(t) \quad (2.1)$$

where $\psi_{lm,\kappa}(\rho, \theta, \varphi; \kappa) = R_l(\rho; \kappa)\Theta_{lm}(\theta)\Phi_m(\varphi)$ is the spatial $\Psi_{lm,\kappa}$ -function.

According to the QM conception, the extremes of the radial functions R_{nl} define the radii of shells of the most probable states: $r = a\rho_{nl, \max i}$, where i is the number of the root of the extremum. However, for the overwhelming number of cases, **these roots are not equal to integers squared; i.e., $\rho_{nl, \max i} \neq n^2$** (where $n = 1, 2, 3, \dots$), and hence, **they deny the cut-off condition** (1.6). Such roots define energetic levels that do not exist in Nature:

$$W = -e^2/8\pi\epsilon_0 a\rho_{nl, \max i}. \quad (2.2)$$

For example, the radial function $R_{3,0}$, corresponding to the numbers $\kappa = 2$ and $l = 0$ ($n = 3$) is

$$R_{3,0} = \frac{2}{81\sqrt{3}} \exp(-\rho/3)(27 - 18\rho + 2\rho^2) \quad (2.3)$$

One-dimensional and two-dimensional graphs of the radial component of density of probability $R_{3,0}^2$, as a function of the distance along the radius ρ , are presented in Fig. 2.1.

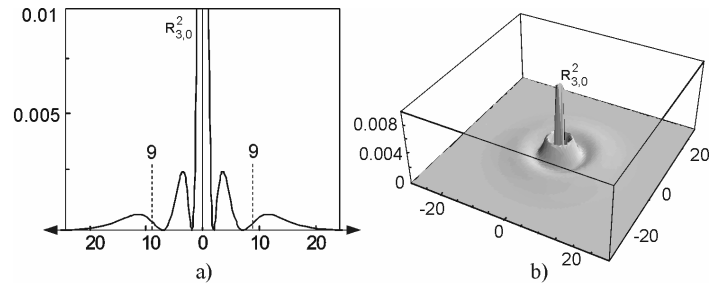


Figure 2.1. The density of hypothetical probability of s -state, $R_{3,0}^2$, for Schrödinger's Ψ -function with the parameters, $n = 3$ and $l = 0$; (a) one-dimensional, (b) two-dimensional.

The radial function squared, $R_{3,0}^2$, has the maximum in the origin of coordinates. There are also two smaller maxima, defining the two shells of the most probable localization of the electron (if we will strictly follow the QM interpretation of Ψ -function). Extremes of the radial function are as follows:

$$\rho_{3,0, \max 1} = 0$$

$$\rho_{3,0, \max 2} = 3.531370333, \quad \rho_{3,0, \max 3} = 11.46862697$$

At the same time, according to the cut-off condition, only the radius $\rho = 3^2 = 9$ defines the stationary shell of the electron corresponding to this function. Two vertical lines in Fig 2.1a, at the distance equal to 9 from the coordinate origin, indicate its location. As we see, there is no maximum (shell) of such radius among extremes of $R_{3,0}^2$! It is no wonder that the radial function $R_{3,0}$ is 'ignorant'. It does not 'know' that it represents by itself the reduced function (obtained as a result of the cut-off operation) and, therefore, it cannot define anything here, including "the most probable localization of the electron".

Thus, according to the condition (1.6), energetic 'levels' (states) (2.2) must not exist. If we suppose that they exist, then these *levels must formally transform the radial function into a divergent functional series* because Eq. (2.2), where $\rho \neq n^2$ ($n = 1, 2, 3, \dots$), does not satisfy the cut-off condition (1.6) where $\rho = n^2$. Such an absurdity appeared because of the artificial and invalid cutting off of the power series.

The quantum numbers of the SE are usually compared with the quantum numbers in Bohr-Sommerfeld's generalized theory of the hydrogen atom. Between 1913 and 1926, the Bohr-Sommerfeld's theory took root in minds; as a result, the superficial resemblance of its quantum numbers to those of the SE was groundlessly used by founders of QM. As an analog of the azimuth number m , the magnetic number m of Bohr-Sommerfeld's theory was accepted. The number l plays the role of the azimuth number n_ϕ , which defines (along with the main quantum number n) the smaller half-axis of the elliptical electron orbit $b = a_0 n n_\phi$. The larger half-axis of the orbit a , defining the electron's total energy on the orbit, in Bohr's-Sommerfeld's theory, depends only on the main quantum number n : $a = a_0 n^2$. Such a formal juxtaposition must mean that the wave function in the SE (1.1) contains elliptical orbits in the form of 'electron clouds'. All these definitions are the fruit of fantasy. In fact, the SE describes only the *circular* orbits, but not mystic clouds-orbitals that convincingly were shown in [1]. If we assume that the electron's motion can be the elliptic one, then such orbits must pierce the shells of the stationary states. Accordingly, when an electron recedes from H -atom, moving along a stationary elliptic orbit, it must absorb energy, at the transition from one shell to another, and, at the approaching to H -atom, it must emit energy of the same value. The energetic transitions within the orbit will be determined by irrational numbers that are not observed in reality. Apart from this, such strange orbits cannot be regarded as stationary.

3. The Wave Number k

We can assume that, at the initial stage of his work, Schrödinger could not do without the ordinary wave equation, describing arbitrary periodic processes running in space and time:

$$\Delta\Psi = \frac{1}{v_0^2} \partial^2\Psi / \partial t^2 \quad (3.1)$$

Presenting the Ψ -function in the form $\Psi = \psi(x, y, z)e^{i\omega t}$, where $\psi(x, y, z)$ is its amplitude (a complex magnitude, in a general case), we obtain

$$\Delta\Psi = \frac{1}{v_0^2} \partial^2\Psi = -\frac{\omega^2}{v_0^2} \Psi = -k^2\Psi$$

Hence, the wave equation (3.1) can also be presented as

$$\Delta\Psi + k^2\Psi = 0 \quad (3.2)$$

where $k = \omega / v_0 = 2\pi / \lambda = 1 / \lambda$ is the wave number of the field. Comparing Eqs. (3.2) and (1.1), we find what the wave number k in the SE is:

$$k = \sqrt{\frac{2m}{\hbar^2} \left(W + \frac{e^2}{4\pi\epsilon_0 r} \right)}. \quad (3.3)$$

This means that the *wave number* in Schrödinger's radial equation is a *quantity that varies continuously in the radial direction*. Is it possible to imagine a field where the wave number, and hence the frequency, change from one point to another in the space of the field? Of course, it is not possible. ***Such wave objects do not exist in Nature!***

The wave number k is a constant parameter of wave objects. It can take a definite series of discrete values depending only on the boundary conditions. According to the cut-off condition (1.6), the wave number (3.3) is defined by the following formula:

$$k = e \sqrt{\frac{Zm}{2\pi\epsilon_0\hbar^2} \left(\frac{1}{r} - \frac{1}{2an^2} \right)} \quad (3.4)$$

From this it follows that the wave number k is a real number only under the condition $r < 2an^2$. Therefore, one should mention the limiting sphere of wave processes in the atom. The radius of the sphere is equal to the doubled radius of n -th Bohr orbit (orbital):

$$r_{\max} = 2r_n = 2an^2 \quad (3.5)$$

In a case where the wave number k also takes imaginary values, the field will not be a wave field, and hydrogen-like atoms will be surrounded, beyond their spheres of the radius r_{\max} , with the field of the *aperiodic* structure. However, this completely contradicts reality. Thus, a limiting sphere bounds around the Schrödinger atom. Beyond the sphere, it is impossible to speak about the structure and wave properties of the atom.

Accordingly, the *normalizing factors of radial functions have a conditional character*, because they are determined by the integrals with an upper limit of integration, equal to *infinity* but not to the limiting radius (3.5). These remarks are valid also for formulae of averaged values, as, *e.g.*, an average value of inverse distances, defined by the integral

$$\left\langle \frac{1}{r} \right\rangle = \int_0^\infty R_{nl}^2 r dr = \left(\frac{Z}{a_0} \right) \frac{1}{n^2} \quad (3.6)$$

There is also another reason why this expression is incorrect. As a matter of fact, the radial functions R_{nl} define the shells of the most probable values of radii in accordance with the quantum mechanical interpretation of the wave function. These radii form a *discrete series*, which ***cannot be averaged***, as it is impossible to average an inverse series of distances. Indeed, suppose we need to know the mean wavelength of the hydrogen-atom spectrum, for example, the Balmer series. Of course, we can calculate it, but

it is a meaningless operation, because such an averaged wave does not exist in nature.

In spite of all fittings, the mean radius of an electron orbit,

$$\langle r \rangle = \int_0^{\infty} R_{n,l}^2 r^3 dr = a \frac{3n^2 - l(l+1)}{2} \quad (3.7)$$

is not proportional to n^2 . Moreover, the radial spheres define the orbits of the most probable states; therefore, the radii of stationary electron orbits are constant within the corresponding spheres. Thus, the averaging (3.7) has no meaning.

Let us turn now to Schrödinger's initial report, where the SE (1.1) was first derived on the basis of the operator and variational methods. We will consider this in an elementary form. Any material object is characterized by the kinetic and potential energies, which define its total energy

$$E = p^2 / 2m + U \quad (3.8)$$

We introduce the scalar dimensionless Ψ -function, complex in general; its field gradient is the momentum of the micro-particle, defined by the equation

$$\mathbf{p} = i\hbar(\mathbf{e}_x \partial \Psi / \partial x + \mathbf{e}_y \partial \Psi / \partial y + \mathbf{e}_z \partial \Psi / \partial z) = i\hbar \nabla \Psi \quad (3.9)$$

where \hbar is some elementary action, needed for realization of the law of equality of dimensionalities of the left and right parts in Eq. (3.9); i is the imaginary unit. Inasmuch as, in a general case, the Ψ -function is complex, components of the momentum are also, in general, complex. However, their real parts (by definition) represent the ordinary projections of the momentum along the coordinate axes. Thus, the real part of the complex momentum defines the momentum of the micro-particle:

$$\mathbf{p} = \text{Re}(i\hbar \nabla \Psi) \quad (3.10)$$

Relying on the expression (3.9), we can represent the energy (3.8) in the following way

$$E = -\frac{\hbar^2}{2m} \left(\partial^2 / \partial x^2 + \partial^2 / \partial y^2 + \partial^2 / \partial z^2 \right) \Psi + U$$

$$\text{or} \quad E = -(\hbar^2 / 2m) \Delta \Psi + U \quad (3.11)$$

Let us now introduce operators of the total and potential energies, \hat{H} and \hat{U} , according to the following expressions:

$$E = \hat{H}\Psi, \quad U = \hat{U}\Psi \quad (3.12)$$

Substituting E and U , in Eq. (3.11), with these operator expressions, we will have

$$\hat{H}\Psi = -\frac{\hbar^2}{2m} \Delta \Psi + \hat{U}\Psi \quad (3.13)$$

$$\text{or} \quad \Delta \Psi + \frac{2m}{\hbar^2} (\hat{H} - \hat{U})\Psi = 0 \quad (3.14)$$

In a case of a hydrogen-like atom, we seek the field of such a Ψ -function for which the following equalities must exist:

$$\hat{H} = W, \quad \hat{U} = -Ze^2 / 4\pi\epsilon_0 r \quad (3.15)$$

As a result, if we accept $Z = 1$, we arrive (as Schrödinger assumed) at the wave equation for the electron in the H -atom (1.1). Taking into consideration the expression (3.3), we reduce Eq. (1.1) to the standard form (3.2), $\Delta \Psi + k^2 \Psi = 0$.

Where is the blunder of principle in the above derivation of (1.1)? As is known, **any wave equation is the equation of mass processes**. It describes the result of the interaction of particles and sub-particles in space, from which the waves arise. Wave mass processes represent the **kinematic level of motion**, or the **level of superstructure**, below which is the **level of interaction**, or the **level of basis**. Because of this, the SE is **unable to describe the motion of a single electron**. In spite of this, at that time, physicists groundlessly ascribed to the SE a nonexistent aptitude (unnatural for wave equations in principle): they assumed it must describe the motion of the single electron in the hydrogen atom. This was a gross blunder.

The introduction of potentials, or potential energies of an interaction, into kinematic wave equations, means a lack of understanding of discriminate differences between the **dynamic basis of a wave; i.e., the level of mass coordinated interaction, and the level of superstructure of wave, i.e., the ordered kinematic motion**.

Thus, the divergence of the power series of the radial function in the SE is the effect of **mixing the kinematic and dynamic levels of motion**, which were formally (incorrectly in essence) joined together in the SE.

4. Wave Equation of a String

For confirmation of the above analysis, let us present one more example concerning the wave field of a homogeneous string of the length l , fixed at both ends. Every point of the string is defined by the coordinate z , and the state of its motion at time t , by the displacement from the equilibrium, and the motion itself, by the complex Ψ -function

$$\Psi(z, t) = x(z, t) + iy(z, t) \quad (4.1)$$

The Ψ -function satisfies the wave equation

$$\Delta \Psi = \frac{1}{v_0^2} \partial^2 \Psi / \partial t^2 \quad (4.2)$$

Here, $\Delta = \partial^2 / \partial z^2$ is the one-dimensional Laplacian operator; v_0 is the wave speed in the string defined by the following expressions:

$$v_0 = \sqrt{\frac{T_S l}{M}}, \quad T_S = E \frac{\Delta l}{l} S \quad (4.3)$$

where T_S is the tension, M is the mass, E is Young modulus, Δl is the lengthening, and S is the area of the cross-section of the string.

The 'real' component of the complex displacement $\text{Re } \Psi(z, t) = x(z, t)$ is called the *potential displacement*, and the 'imaginary' component $\text{Im } \Psi(z, t) = y(z, t)$, the *kinetic displacement*. The conjugated displacements make it possible to describe more completely the wave field of the string, as the *potential-kinetic wave field*. An elementary solution of the wave equation is defined in the form of the product of the string's spatial displacements, represented by the function $\psi(kz)$, and the time function $T(\omega t)$:

$$\Psi(z, t) = \psi(kz)T(\omega t) \quad (4.4)$$

where $k = \omega / v_0 = 2\pi / \lambda$ is the wave number, and ω is the circular frequency of oscillations.

The existence of two spaces-fields (4.4) allows representation of the wave equation of the superstructure (4.2) through equations of the space and time of the superstructure:

$$\Delta \psi + k^2 \psi = 0 \quad (4.5)$$

$$\partial^2 T / \partial t^2 = -\omega^2 T \quad (4.6)$$

These equations define two elementary plane-polarized transverse waves, traveling towards each other.

The kinetic energy of any atom of the string, at *the level of the wave basis* of the field, can be presented in the following forms (details are in [2]):

$$\varepsilon_k = \hbar_1 v_1 / 2 = \hbar \omega_1 = \hbar_1 \omega_1 / 2 = m v_0^2 / 2 \quad (4.7)$$

$$\text{where } \hbar = \frac{m v_0 l}{2\pi} = \frac{1}{2} \hbar_1 = \frac{1}{2} m v_0 \lambda_1 \quad (4.8)$$

is the wave action of an atom during the transmission of an excitation along the whole length $l = (n/2)\lambda$ of the string, it is the action at the level of the wave basis; $\hbar_1 = m v_0 \lambda_1$; $n = 1, 2, 3, \dots$; m is the mass of an atom of the string. On this basis, the wave number squared k^2 [in (4.5)] can be presented in the following form

$$k^2 = \omega^2 / v_0^2 = 2m\varepsilon_k / \hbar^2 \quad (4.9)$$

Then the amplitude equation for the wave motion of the string (4.5) takes the form of the SE:

$$\Delta \psi + (2m\varepsilon_k / \hbar^2) \psi = 0 \quad (4.10)$$

Introducing some potential energy of interaction of atoms $\varphi(z)$ (that, unconditionally, is inadmissible for the wave equation; we have stated that already) and designating the total energy of oscillations of an atom of the string in a cross-section S by the letter W , we can write:

$$\varepsilon_k = W - \varphi(z) \quad (4.11)$$

On the basis of such a 'generalization', the wave number becomes

$$k = \omega / v_0 = \sqrt{2m\varepsilon_k / \hbar^2} = \sqrt{[W - \varphi(z)]2m / \hbar^2} \quad (4.12)$$

and, corresponding to it, the frequency of the wave field of the string becomes

$$\omega = v_0 \sqrt{2m[W - \varphi(z)] / \hbar^2} \quad (4.13)$$

Both become functions of the coordinate z of points of the string, $k = k(z)$ and $\omega = \omega(z)$. Actually, the wave number k is the constant quantity, defining some frequency of the wave field ω , which bonds the wave system in a single whole.

According to such a 'generalization', all points of the string must oscillate with different frequencies. The absurdity of the above-described formal 'deduction' of the relation (4.12) is clear and no sane physicist will agree with the 'generalized' wave equation of the string in the form that follows:

$$\Delta \psi + \frac{2m}{\hbar^2} [W - \varphi(z)] \psi = 0 \quad (4.14)$$

The falsity and senselessness of such a formal generalization-derivation [as is actually also realized in the SE (1.1)] is obvious.

5. On the Physical Meaning of Ψ -functions

Let us present Eq. (3.2) in the form of the product of Ψ -function by the operator binomial as

$$(\Delta + k^2)\Psi = 0 \quad (5.1)$$

Because the Ψ -function is unequal to zero, we obtain the operator equation for the simplest value of the operator Δ (regarding Δ as a variable operator magnitude): $\Delta + k^2 = 0$. Solving this quadratic equation, we have

$$\Delta = -k^2, \text{ and } \nabla = -ik \quad (5.2)$$

since $\Delta = \nabla^2$. In the wave Ψ -field, the momentum (3.9) of an arbitrary particle takes the form

$$\mathbf{p} = i\hbar \nabla \Psi = \mathbf{k} \hbar \Psi \quad (5.3)$$

or, in the scalar form,

$$p = i\hbar \nabla \Psi = k \hbar \Psi \quad (5.4)$$

What does this equality represent by itself? Any physical parameter P (of an arbitrary physical wave field) has its own fundamental wave measure, or a period-quantum P_q . Using this quantum, the value of a parameter P can be presented by the quantitative relative Ψ -measure:

$$\Psi = P / P_q \quad (5.5)$$

In a general case, the parameter P is the complex quantity

$$P = p_k + ip_p \quad (5.6)$$

Let us agree to call the ‘real’ part of Eq. (5.6) the ‘kinetic’ component, and the ‘imaginary’ part, the ‘potential’ component of the P -parameter (the usefulness of this terminology is justified in [2])

By virtue of this, Ψ -measure of the zero physical dimensional-ity will be a *complex wave function* with the argument,

$$i(\omega t - \mathbf{k}\mathbf{r}) = i(\omega t - k_x x - k_y y - k_z z) \quad (5.7)$$

which indicates that the quantitative measure of the P -parameter is changing in space and time. The presence in (5.7) of the imaginary unit i is not casual. It simplifies calculations and has a deep philosophical meaning [2, 3]. The argument (5.7) meets general physical principles.

Thus, the *wave structure of any physical parameter P* is presented by the following scalar measure:

$$P = P_q \Psi \left[i(\omega t - k_x x - k_y y - k_z z) \right] \quad (5.8)$$

If P is the momentum, then Eq. (5.4) can be written as

$$p = k\hbar\Psi \left[i(\omega t - k_x x - k_y y - k_z z) \right] \quad (5.9)$$

The relative elementary harmonic measure

$$\Psi = \Psi_m \exp \left[i(\omega t - k_x x - k_y y - k_z z) \right] \quad (5.10)$$

of any parameter P satisfies the differential equations with: **1)** the spatial partial derivatives of the second order

$$\partial^2 \Psi / \partial x^2 = -k_x^2 \Psi, \quad \partial^2 \Psi / \partial y^2 = -k_y^2 \Psi, \quad \partial^2 \Psi / \partial z^2 = -k_z^2 \Psi \quad (5.11)$$

$$\text{or} \quad \Delta \Psi = -(k_x^2 + k_y^2 + k_z^2) \Psi = -k^2 \Psi \quad (5.12)$$

and **2)** the partial time derivative of the second order

$$\partial^2 \Psi / \partial t^2 = -\omega^2 \Psi \quad (5.13)$$

Equations (5.12) and (5.13) form the *wave equation of the harmonic Ψ -function*:

$$\Delta \Psi = \frac{1}{v_0^2} \partial^2 \Psi / \partial t^2 \quad (5.14)$$

Obviously, the sum of elementary measures constitutes the measure of the general character; therefore, we assume that Eq. (5.14) also defines the wave field of the measure of an arbitrary parameter. Because in any point under the steady-state wave motion the product of its spatial (amplitude) $\psi(\mathbf{k}\mathbf{r})$ and time $T(\omega t)$ components represents Ψ -function, the wave equation (5.14) therefore falls into the amplitude and time equations:

$$\Delta \psi + k^2 \psi = 0 \quad \text{and} \quad \partial^2 T / \partial t^2 = -\omega^2 T.$$

The constant parameters, k and ω , are determined on the basis of boundary conditions. Since these equations describe Ψ -measures of arbitrary physical parameters, the difference of their wave structure comes down to the difference of kinematic types of the corresponding wave fields. The basic wave fields are the plane, cylindrical, spherical, and complicated (spherical-cylindrical) fields. Therefore, these fields, to an equal degree, successfully describe not only the atomic structure [1, 4], but also the structure of mega-objects that is demonstrated in [2].

6. Conclusion

As we have seen, the numerous contradictions and blunders of the abstract mathematical model that was put forward by Schrödinger, and which is inherent in QM, do not endure critique. However, QM theorists continue developing this model. It is currently represented in the form of generalized and extended equations, including the relativistic invariant of them, *etc.* Maybe such a *status quo* exists because all faults found, including those stressed here, are as yet unknown to the wide scientific community. But the basic SE (and consequently any other equations based on the basic one) is in fact false. It has significance only from the point of view of history of the philosophical and logical errors of the past. The errors have made QM into a great caricature about the world of real wave processes, while the extensive publicity created an illusion as if mankind deals with a great theory.

In fact, QM is at best a phenomenological theory, with the definite fitting of it to the experiment. And what is more, the possibilities of modern mathematics are so impressive that it can represent any abstract absurdity as a profound theory (or its development), and fit that to any experiment.

At the present stage of development of science, in particular of atomic physics and atomic technologies, QM is omnipresent. In the course of many decades, ideologists have forgotten the fact that the correspondence of any theory with experiments done so far does not quite mean that the given theory is true and uniquely possible. The opinion that QM perfectly describes the micro-world has been propagated and strengthened in the consciousness of people.

But QM does in the highest degree render a distorted description of the micro-world. QM so significantly distorts the real picture of the micro-world that it becomes a world of theoretical monsters and quantum chaos, but not the world of real images. This situation is a definite danger to technological progress. Technology deals with real material objects, and we live in a real world; accordingly, our knowledge about Nature must also be concrete and truly reflect reality, insofar as far as possible. In particular, the development of nano-technology, where dimensions of devices tend towards magnitudes comparable with atomic sizes, requires as early as possible knowing the *real spatial* structure of atoms. However, that is not even an objective of modern physics because of the domination of QM, with its postulate on the impossibility of imagining a clear spatial structure of micro-objects at the atomic and subatomic levels,

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