CAN QUANTUM MECHANICS BE CLEARED FROM CONCEPTUAL DIFFICULTIES?

Volodymyr Krasnoholovets

Institute of Physics, National Academy of Sciences
Prospect Nauky 46, UA-03028 Kyïv, Ukraine

http://inerton.cjb.net

20 July 2002

Abstract

The major conceptual difficulties of quantum mechanics are analyzed. They are: the notion "wave-particle", the probabilistic interpretation of the Schrödinger wave \( \psi \)-function and hence the probability amplitude and its phase, long-range action, Heisenberg’s uncertainty principle, etc. The probabilistic formalism is developed in the phase space, but not in the real one. Elimination of the difficulties is likely if we are able to develop quantum mechanics in the real space. Such a theory in fact can be constructed, however, it should proceed from deepest first principles starting from the notion of a 4D space-time, the notion of a massive particle in the space, the principles of the motion of a particle, etc. The theory should be characterized by short-range action that automatically means the introduction of a quantum mechanical force. It is shown that the aforementioned force makes it evident and, moreover, is able to appear on the macroscopic scale. A simple experiment, the express test, which in fact proves the macroscopic manifestation of quantum mechanical force, is proposed for the demonstration in the quantum curriculum.

Key words: quantum mechanics, space, matter waves, inertons

PACS: 03.65.Bz Foundations, theory of measurement, miscellaneous theories; 03.65.w Quantum mechanics; 03.75.-b Matter waves; 14.80.-j Other particles (including hypothetical)
1 Introduction

Eugene Wigner was keenly interested in mathematical problems of interpretation of quantum mechanical laws and, in particular, he actively studied the problems of measuring. His studies arrived him at the formulation of the following problems of orthodox quantum mechanics, i.e. its difficulties [1]: (i) the vector of state “the object plus the instrument” cannot be distinguished from the mixture of states; (ii) a possibility of the measuring only state $\sigma^{(\nu)}$ of a quantum system can be measured only in the case when the instrument is a very large system; (iii) quantum laws allow one to obtain only probabilistic correlations between results of several consequence observations of the quantum system. He particularly emphasized the importance of a macroscopic instrument in the problem of measuring: just the instrument should reduce the wave package (or sometimes the vector of state). While on the subject of hidden variables, Wigner [2] noted that we could not obtain directly their magnitudes. He noticed that the measuring the distribution of magnitudes of hidden variables still remained undetermined, or fuzzy.

Nowadays, however, researchers concern on some other aspects of the foundations of quantum mechanics, which have been revealed in the course of recent studies associated with the phenomenon of entanglement states. One of the main problems which is examined at present is a possibility for nonlocality of quantum theory. Bell [3] introduced some new aspects to the problem of completeness of quantum theory. He formulated a locality requirement introducing some additional variables, so called local hidden variables. Such a study initiated a long series of thought experiments, which then resulted in some actual experiments (however, the experiments involved photons as quantum entities, which, strictly speaking, are entities of quantum electrodynamics, but not quantum mechanics). In particular, we should mention here research by Stapp [4,5] who has carried out a detailed analysis of both theoretical and experimental results, which touch questions like these: Is quantum theory local or nonlocal? and Is nonlocality is real? Stapp has adduced many arguments for this or that point of views and specifically noted that quantum theory is still formulated as an indeterministic theory.

Indeterminism is a very important starting point of modern quantum theory. However, would we are based on the other assumption?.. This question indeed is very interesting as the searching for the answer could clarify the major fundamental physical notions and culminate in the discovery of a series of new links between them, which so far were still hidden from researchers including those who follow Louis de Broglie and David Bohm, pioneers of determinism.

2 White gaps in quantum concept

1. First of all let us take a good look at the term ”conceptual difficulties”. The term implies that the doctrine under consideration features strong discrepancies between characteristics, which it describes, and methods, which the doctrine uses.
In the case of quantum mechanics, the situation is dramatized by the fact that one more characteristic should be ascribed to a canonical particle, namely, the particle as such is transformed to a certain "particle-wave". And this is the first conceptual difficulty of quantum mechanics! Indeed, how can one understand the particle-wave? In 1924 de Broglie, when wrote his remarkable relationships

\[ E = h\nu \quad \text{and} \quad \lambda = h/p, \]  

(1)

assumed that some real wave was connected with the moving particle and that just this wave guided the particle. In expressions (1) parameters \( E \) and \( p \) (the energy and the momentum) belonged to the particle, but the frequency \( \nu \) and the wavelength \( \lambda \) were characteristics of a wave that should accompany the particle at its motion in the real space. Especially as relationships (1) enable one to derive the Schrödinger equation [6].

**Corollary 1.** De Broglie’s transparent idea that a moving particle is accompanied by an actual wave did not receive any further development.

**2.** The Schrödinger equation written in 1925 was successfully applied to the calculation of energies of equilibrium states of an electron in the Coulomb potential of a proton, which practically coincided with the experimentally measured spectrum of the hydrogen atom. Such an excellent correspondence between the prediction of the theory and the experimental results gave immediate impetus to the construction of the probabilistic formalism of quantum mechanics. Born’s and Heisenberg’s abstract formalism replaced de Broglie’s common sense. Thus, Born’s probabilistic interpretation of the Schrödinger wave \( \psi \)-function rejected any conceivable physical content from the \( \psi \). Nowadays a quantum system is described by the probability amplitude \( |\psi|^2 \) and its phase \( \phi \) that includes information on the energy, momentum and coordinate of the particle and it is also implied that \( \phi \) involves information on the wave characteristics of the particle, some frequency \( \nu \) and wavelength \( \lambda \).

**Corollary 2.** In the modern interpretation, the wave \( \psi \)-function is quite abstract. However, it is believed that at the measuring process the abstract wave function collapses to a measurable actual point particle.

**3.** At the same time, the existence of the actual wave properties in particles, i.e. the matter waves, received empirical confirmation in the diffraction experiments. Therefore, particles in fact possess wave properties and this automatically implies that the pure probabilistic interpretation of the \( \psi \)-function is not complete.

Recently Briner et al. [7] has published an experimental work entitled "Looking at Electronic Wave Functions on Metal Surfaces", in which they demonstrate the colored spherical and elliptical figures, which the authors called "the images of \( \psi \) wave functions of electrons". Virtually they gave the evidence that the electron is not a point-like object, though the high energy physics asserts that it is a point object with the size no larger than \( 10^{-17} \) cm. Thus they fixed an actual perturbation of the space around an electron in the metal! Thereby, the authors subconsciously rose against the probabilistic interpretation of the \( \psi \) wave accepted by the Copenhagen School concept and, moreover, they practically proved the fallaciousness of the statement of the concept.
Corollary 3. Experimental data point to the fact that the wave $\psi$-function is not abstract but a measurable matter.

4. Furthermore, the Schrödinger and Dirac formalisms say nothing about true trajectories of the quantum system studied that is a direct consequence of the probabilistic approach to the description of quantum phenomena. Of course, one could use Feynman diagrams for any entity, with their point-like particles and photons, all having some absolute position and momentum. However, we cannot get the true path. Instead we must draw infinitely many Feynman diagrams and then calculate the Feynman’s path integrals, which make it possible to find out only the most verisimilar trajectory of the quantum system.

Once again, this is because of the fact that conventional quantum mechanics is developed in the phase space, but not in the real one. Indeed, can one clarify the duality of a “particle-wave” in the real space where only a particle and a wave can separately be determined? The same is noted by Ligare and Olivery [8]: “it is not always clear which aspects of classical wave behaviour are related in a fully quantum-mechanical treatment, or where to draw the line between wave-like aspects and particle-like aspects and how to justify the division”.

When we talk about the real space we imply a 3D space or a 4D space-time, in which one can assign exact position, velocity and momentum to an object at any time. A wave can also simply be given in a 3D space or 4D space-time, but in this case the space should possess clear defined condensed matter properties.

Corollary 4. If we wish to understand the “particle-wave”, we must turn to the consideration of quantum mechanics in a space filled with a subquantum medium that was first pointed out by de Broglie (see e.g. Ref. [9]).

5. Next negative aspect is that the probabilistic formalism severe suffers from long-range action. By conventional quantum mechanics, particles can interact simultaneously even if they are spaced at any quantity of kilometers, Ehrenfest [10]. Long-range action of quantum mechanics was also emphasized by Pauli [11]; in particular, he noted that quantum mechanics bears up against a hypothetical basis that the speed of the interaction in the quantum mechanical range $c = \infty$ and that the gravitational interaction is negligible, the constant of gravitational interaction $G = 0$.

For instance, let us turn to the problem of hydrogen atom, a typical example of long-range action in quantum mechanics. The radial part of the Schrödinger equation written for a particle in a spherically symmetric electrostatic potential $V(r)$ has the form (see, e.g. Schiff [12])

$$-\frac{\hbar^2}{2m} \frac{d^2\chi}{dr^2} + \left[ V(r) + \frac{l(l+1)\hbar^2}{2mr^2} \right] \chi = E\chi$$

where $\chi(r)$ is the radial wave function. The second term in the square brackets is stipulated by the potential energy associated with the moment of momentum of the particle. The potential energy

$$V(r) + \frac{l(l+1)\hbar^2}{2mr^2}$$
ensures the stability of the particle orbit. In the case of the hydrogen atom the potential $V(r) = \frac{e^2}{4\pi\varepsilon_0 r}$ and the equation of related motion of an electron and proton has the form similar to Eq. (2).

However, it should be noted that the Schrödinger quantum equation (2) includes the potentials $V(r)$ written in pure classical terms, much as in the problem of Newton gravity! $V(r)$ is a usual classical presentation of the motionless charge and the electromagnetic field that surrounds it. The mass $m$ that enters into quantum equation (2) is also a pure classical parameter. Hence even the most comprehensive quantum mechanical description of the quantum system studied is only a quasi-classical pattern.

**Corollary 5.** If we remain devotees of orthodox quantum mechanics, the fundamentals will be kept in the shade of its statistical conformities.

6. Although there are Heisenberg’s uncertainties for the coordinate and momentum and the energy and time of a particle,

$$\Delta x \Delta p \geq \hbar; \quad \Delta E \Delta t \geq \hbar,$$

we are not able to write any similar relation for the particle mass, which should also be fuzzy in a undetermined volume, the same as the particle itself (the mass must follow the particle!!), as the probabilistic formalism prescribes.

De Broglie [13,14] studied this problem and came to the conclusion that the dynamics of particles had the characteristics of the dynamics of the particles with a variable proper mass. He was the first to indicate that the corpuscle dynamics was the basis for the wave mechanics. With the variational principle, he obtained and studied the equations of motion of a massive point reasoning from the typical Lagrangian

$$L = -M_0c^2\sqrt{1 - v^2/c^2}$$

in which the velocity $v$ of the point and the velocity of light $c$ were constant along a path. De Broglie’s pioneer research allows one to suggest that a real wave, which indeed has to accompany the moving particle, must complement the deficient value of the momentum and the energy of the particle. Then, say, we know the momentum and the energy, but have uncertainties in coordinate and time. If we assume the existence of an actual wave that travels in the space together with the particle, we can readily propose that the particle is entrained by the said wave and, therefore, position and time of the particle become in fact undetermined in a concrete point as they become functions of the traveling wave.

**Corollary 6.** Heisenberg’s uncertainty is a direct consequence of the probabilistic approach to quantum phenomena when only one of two subsystems is taken into account, namely, we treat the behaviour only a particle, but totally ignore the real wave, which accompany the particle.

7. All correct theories should be Lorentz invariant, i.e. they and Einstein’s special relativity should agree (see, e.g. Ref. [15]). Nevertheless, the Schrödinger equation is not Lorentz invariant but it perfectly describes quantum phenomena and we trust wholly the results derived from the equation. How is it possible?
It seems that the disagreement between the strong theoretical conclusion and the experimental veracity is hidden in the statistical approach to the Schrödinger formalism. Indeed, relationships (1) allow the derivation of the Schrödinger equation as well [6], but what exactly do the relationships describe? In recent papers by the author [16,17] the inner sense of relationships (1) was studied in detail starting from an idea that the physical reality represented a space net that came into the interaction with a moving particle. This allowed the derivation of the Schrödinger equation from deepest first principles that in fact removed a very unpleasant conflict that so far took place between nonrelativistic quantum mechanics and special relativity: Unlike the traditional presentation, the Schrödinger equation gained in paper [17] is Lorentz invariant owing to the invariant time entered in the equation.

**Corollary 7.** The Schrödinger equation is Lorentz invariant.

8. There is no correct determination of values $E$ and $\nu$ in the expression $E = h\nu$ applied to a moving canonical particle. In one case $E = \frac{1}{2}m_0 v^2$ (see, e.g. Schiff [12], p. 33), and in the other one $E = m_0 c^2(1 - v^2/c^2)^{-1/2}$ (see, e.g. Schiff [12], p. 364). Which is true?

The problem has been studied by the author in paper [18], in which the motion of a relativistic particle has been treated based on a generalized lattice model of the real space. It has been shown that if the moving particle interacts with the space, the feedback governs the quantum system in question and the system undergoes the phase transition when its velocity $v$ trends to $c$. In the case $v << c$, an associated real wave, which guides the particle, carries the particle’s kinetic energy $E = \frac{1}{2}M_0 v^2$; in the case $v \to c$ the associated wave becomes closed inside of the range covered by the Compton wavelength $\lambda = h/mc$ of the particle and hence the kinetic energy of the particle is given by the total energy of the region, $E = m_0 c^2(1 - v^2/c^2)^{-1/2}$.

**Corollary 8.** Allowance for the interaction of the quantum system under consideration with the real space clarifies difficult questions of quantum mechanics and, in particular, gives the unambiguous answer to the question [18]: What is nature of the phase transition, which occurs in the quantum system, that turns us from the description of the system based on the Schrödinger equation to that resting on the Dirac one?

9. What is spin? It is one more mystery of the microworld. In quantum mechanics spin is perceived to be a certain inner property of canonical particles. Quantum field theories define spin as an "inseparable and invariable property of a particle" (see e.g. Ref. [15], p. 17). That is all.

As a rule the notion of spin of a particle is associated with an intrinsic particle motion. Several tens of works have been devoted to the spin problem. Major of them is reviewed in recent author’s papers [18,19]. Main ideas of the works quoted in Refs. [18,19] are reduced to a moving particle that is surrounded by a wave, or a small massless particle, or an ensemble of small massless particles, which engage in a circular motion.

Of course, it seems quite reasonable to assume that spin in fact reflects some kind of proper rotation of the particle. However, canonical particles possess also electrodynamic properties and the operation "rotor" is the principal characteristic of the particle electromagnetic field. Therefore, the accord between quantum elec-
trodynamics and quantum mechanics of a particle requires the abandonment of the idea of rotation with respect to the notion of the particle spin. This means that we should associate the rotational electromagnetic field generated by a canonical particle with the particle’s proper rotation of some sort.

Particle physics also cannot offer any reasonable answer to the question on the problem of spin, as this branch of physics does not deal with spatial images of particles which, nevertheless, are the main subject of its study. If quantum mechanics considers particles by means of their abstract $\psi$ functions, particle physics treats the subject basing on all the more abstract notion of fundamental symmetry.

In the author concept [16-19] particles are determined just as spatial images (or objects) in the real space, which in fact makes it possible to investigate the notion of spin in detail. In this case along with an oscillating rectilinear motion, the particle undergoes also some kind of an inner pulsation, like a drop. The two possible orientations of pulsations either along the particle velocity vector or diametrically opposite to it are associated with the particle spin [18].

**Corollary 9.** The notion of the particle spin can be determined only in the framework of quantum mechanics constructed in the real space. Two possible own pulsations of the particle in the real space are exhibited by two so-called spin-1/2 projections in the phase space. An integer-valued spin is the property of a composite quantum system.

**10.** Dirac [20] considering links between general relativity and quantum mechanics noted that although the relativity posed the objections to an aether, quantum mechanics practically removed them. This automatically means that a vacuum, which is hazy something or nothing in all modern quantum theories (quantum mechanics, quantum electrodynamics, chromodynamics, etc.), should be replaced by a concrete subquantum substrate. High energy physics working on submicroscopic scales proposes some Higgs condensate, which would be initial at the creation of the physical world. Nonetheless, the Higgs condensate of models of grand unification of interactions is not constructed in a real 4D space-time and moreover, it does not give any idea in what way it can manifest itself in quantum mechanics. We emphasize that it is quantum mechanics that is the most reliable basis for all the other quantum theories. Because of that any new quantum concept should produce orthodox quantum mechanics as a limiting case of the theory constructed. However, either quantum chromodynamics, or some other contemporary theory (such as string theory) is not able to mutate in the orthodox quantum mechanical formalism. Quantum field theories and their derivatives suffer from undetermined field variables $\varphi, \varphi^4$ and so on. Group methods also isolate themselves from both the constitution of the space and the direct measurement.

General relativity does not deal with any substrate, its major subject is geometry. However, we should not forget that the relativity separates the mass from the geometry, i.e. matter from space. Nonetheless, if we assume that matter appears from the space, which in turn is a substrate, we immediately arrive at the conclusion that the matter should interact with such a space: the space itself becomes material.

**Corollary 10.** A quantum theory constructed with regard to the connection of a quantum system with the real space in which the system is found will arrive us at very new horizons in both the subatomic area (the strong and electroweak
interaction would be revised) and macroscopic one (the theory of gravity would be developed starting from quantum mechanics as well).

3 Quantum mechanical force

As of now, quantum entanglement, the property that allows two particles to behave as one, no matter how far apart they are, has been much investigated. Experimentally, if we measure the state of one particle, we instantly determine the state of the other. Researchers probe the possibility to teleport not just quantum states of photons, but also of more massive particles. And it is anticipated that the phenomenon could one day allow us to teleport objects by transferring their properties instantly from one place to another.

In interesting theoretical work [21] interference and entanglement have recently been studied in the frame of a so-called intrinsic approach. As a rule classical states are prescribed to the phase space, while quantum states, which are considered as linear functions on the dynamical variables, assign to the vector space formalism (the Hilbert space). Density matrices belong to bilinears in the vectors. The authors [21] propose a generalized method of restoring an entangled pure state (a purification of the linear vector) from mixed states of the subsystems involved in entanglement. The pure density matrix is then treated as a measure of entanglement for the quantum system in question. In orthodox quantum mechanics linear operators, which act on the Hilbert space of states, are associated with observables. For instance, the Wigner distribution \( f(x) \) is related to observables as well. Nevertheless, although \( f(x) \) is defined in the Hilbert space [21] its arguments belong to the phase space (note in the general case the Wigner function is determined as \( f(x, p, t) \)). So the phase space and the Hilbert one appear as interconnected, though the Hilbert space describes strictly stationary states of the quantum system in question.

From the viewpoint of conceptual difficulties of quantum theory, the entanglement represents some synthesis of nonlocality and long-range action considered above. These two difficulties as well as all the other ones are associated with the area of existence of quantum mechanics, i.e. the phase space, in which orthodox quantum mechanics is constructed. However, all the problems are remedied by passing on to quantum mechanics derived on a deeper fundamental basis, namely, the real space.

Such a theory, submicroscopic quantum mechanics, indeed has recently been developed by the author (see self reviews [19]). It is argued that a particle moving in the real space is surrounded by a cloud of elementary excitations called "inertons", which appear due to friction of particle-on-superparticles (where superparticles are building blocks of the real space, see also Refs. [22]). The particle along with its inerton cloud moves as a typical real wave. Inertons, which accompany the particle, represent a substructure of its matter waves and, because of that, they are carriers of the particle inert properties.

Thus, just inertons teleport quantum states of one particles to the other ones. The mass of inertons can easily be estimated [23]. Besides, the inerton and the photon are not fundamentally different: It is an inerton that is an undercoat for the photon, i.e. the photon is an inerton, which is supplemented by the electromagnetic
polarization [24]. We know that photons are carriers of the electromagnetic interaction (or electromagnetic force) between both quantum entities and macroscopic objects. Therefore, since the photon is a complexly built quasi-particle whose base is the inerton, we immediately get the conclusion that inertons should be carriers of both the quantum mechanical interaction (or quantum mechanical force), which acts between quantum entities, and the pure mechanical interaction, which occurs between macroscopic objects. In the last case inertons manifest themselves as carriers of the force of inertia, which is the major mechanical force. Indeed, everyone can recall that any abrupt halt is attended with the further inexplicable jog. The reason can simply be explained in the frame of the submicroscopic concept: our own cloud of inertons continues to push us slightly when we instantly pull up. In the case of a quantum system the impact of inertons should intensify oscillations of a particle(s), which in turn yields an option to guide the particle(s) to another place, including the so-called tunneling. In other words, in the quantum case a flow of inertons can be treated as a confinement field, which exacts control over the system behaviour. Besides, inertons having the energy and the momentum carry also local deformations, which result in the induction of the gravitational potential around a particle or a classical object [25].

One can put a question whether inertons, as carriers of the quantum mechanical force, can be measured on the macroscopic scale. Yes, they certainly can. Recent research has shown [26,27] that Egyptian pyramids were functioning as peculiar plants, which projected (or teleported?) the Earth by transferring its properties to the pyramids. In other words, especially the Great Pyramid of Giza was constructed (by modern estimates several tens of thousand years ago [27]) as a transducer that converted the Earth inerton field into a microwave electromagnetic radiation [28]. In fact, the ancients possessed the detailed knowledge on the constitution of the universe. For instance, we meet in the Bhagavad-gītā [29]: "Yet there is another nature, which is eternal and is transcendental to this manifested and unmanifested matter. It is supreme and is never annihilated. When all in this world is annihilated, that part remains as it is.” Besides, quite recently Roy [30] has found the clue to decoding the Vedic manuscripts and nowadays we could ascribe another title to the Rgveda, namely: Ultramodern Handbook on the Constitution of Space, Particle Physics and Cosmology (see also Ref. [28]). It is interesting to note that the theory of space, which is developing by Bounias and the author [16-19,22-25], exactly corresponds to the pattern stated in the decoding Rgveda [30].

The Earth’s inerton waves are generated along West-East line owing to the proper rotation of the Earth (in other words, the rotation of the Earth results in its interaction with the space). In our own experiment [31] (see also Ref. [28]) we could fix changes caused by the Earth inerton field in samples that were stayed in a resonator for 30 days. The construction of the resonator is very simple; it consists of two faces bonded together in the top and distant one from another at the bottom. The faces should be oriented to the East and the West. Thus our resonator resembles a small model pyramid in a certain sense. The result obtained directly demonstrates the existence of the quantum mechanical force on the macroscopic scale. In paper [31] we showed that an external inerton field (the Earth’s inerton field) influenced the system studied in the same manner as the ultrasound. This allows us to elaborate a facility that should record the quantum mechanical force by using of rapid method.
Figure 1: Resonator made of two plates (for instance, transparent organic glass) and the device (rather pocket) that measures the inerton radiation in the resonator interior.

Figure 1 depicts the stunning demonstration experiment: in the resonator the device measures the inerton radiation of the Earth. The antenna of the device is turned at a concrete frequency $\nu_0$, which is generated by the proper electronic circuit. In the presence of inerton radiation, frequency $\nu_0$ should be altered. If we turn the resonator on 90° so that its faces become oriented to the North and South, the device will not record any radiation; along the North-South line the Earth does not revolve and therefore in this direction no stable inerton flows are available [31]. The device described is not a fantasy. Similar devices constructed by engineers ("Demon," "Urga" and "Tesey") have already been used by some geologists and architects in Moscow and Kharkiv at the construction of model pyramids in Russia and Ukraine. The pyramids whose height varies from 10 to 44 m were built for both scientific studies and business purpose (see Refs. [32,28]). The said devices measured noise that was several times greater inside of the pyramid than that of outside.

4 Concluding remarks

In this outline we have analysed basic confusing points of conventional quantum mechanics. They are very strong, though still are not virtually treated in the physics literature. Nevertheless, we have to mention here the very interesting recent work by Arunasalam [33] in which he considers discrepancies in views on the fundamentals by famous physicists: Einstein, Dirac, Feynman, Pauli, Bethe and others. Arunasalam brings up the views on the fundamental problems expressed by different sets of giants of physics and shows that the views are in sharp contrast (for instance, covariance versus invariance, relativistic versus nonrelativistic electron theories, etc.). He is completely right when notes that "such conflicts put heavy burden on the conscience
of any physics teacher. After all, a good physics teacher has a responsibility to explain to the students which view is the correct one.”

The problems posed by Arunasalam [33] indeed are considerably importance. However, it seems that those problems arise from the fact that the fundamental physics is still resting on an undetermined basis. For instance, when we talk about charge conjugation $C$ and $CPT$ violation, we neither know nor understand what do the notions charge, space, and time mean exactly. These notions still are not determined exactly at all! The same take place in all other examples: (i) the total angular momentum includes the vector potential $\vec{A}$, but what does the latter mean?! (ii) The problem “covariance versus invariance” is determined only in the framework of phenomenological consideration; quantum mechanical behaviour of the system studied change the problem very significantly. (iii) The problem “relativistic and nonrelativistic theories of the electron” strongly depends on the notions of spin and the vector potential $\vec{A}$, which completely do not understandable in the framework of conventional quantum theories.

Thus, only transition to sub atomic physics is capable to clarify the discrepancies described by Arunasalam [33]. We need a detailed microscopic theory of the real space, the notions of matter and time derived from the space and the identification of the process of motion of matter in the space. All these problems have been raised by the author and partly already solved in works [16-19,22-25,28]. The theoretical results obtained have found rigorous experimental verification [31,34,35] (see also Ref. [28]) and the device (that has been developing) shown in Figure 1 is reliable evidence of credibility of the proposed concept.

Further studies aimed at the understanding the constitution of the real space and the generation of matter and physics laws in the space promise a major breakthrough in fundamental science and advance in technology.

References

[1] E. P. Wigner, Symmetries and reflections, (Mir, Moscow, 1971), pp. 141-169 (Russian translation).

[2] Ibid., pp. 294-302.

[3] J. S. Bell, Speakable and unspeakable in quantum mechanics (Cambridge University Press, 1987).

[4] H. Stapp, Nonlocal character of quantum theory, Am. J. Phys. 65, 300-304.

[5] H. Stapp, From Einstein nonlocality to von Neuman Reality, Lawrence Berkeley National Laboratory Report LBNL-44712; Decoherence, Quantum Zeno Effect, and the efficacy of mental effort: closing the gap between being and knowing, Lawrence Berkeley National Laboratory Report LBNL-44229.

[6] L. de Broglie, Heisenberg’s uncertainty relations and the probabilistic interpretation of wave mechanics (Mir, Moscow, 1986), p. 42 (Russian translation).
[7] G. Briner, Ph. Hofmann, M. Doering, H. P. Rust, A. M. Bradshaw, L. Petersen, Ph. Sprunger, E. Laegsgaard, F. Besenbacher and E. W. Plummer, Looking at electronic wave functions on metal surfaces, Europhys. News 28, 148-152 (1997).

[8] M. Ligare and R. Oliveri, The calculated photon: Visualization of a quantum field, Amer. J. Phys. 70, 58-66 (2002).

[9] L. de Broglie, Interpretation of quantum mechanics by the double solution theory, Ann. de la Fond. L. de Broglie 12, 399-421 (1987).

[10] P. Ehrenfest, Einige die Quantenmechanik betreffende Erkundigungsfragen, Z. Phys. 78, 555-560 (1932).

[11] W. Pauli, Raum, Zeit und Kausalität in der Modernen Physik, Scientia (Milan) 56, 65-76 (1936).

[12] L. I. Schiff, Quantum mechanics (McGraw-Hill Book Company, Inc., New York – Toronto – London, 1955), Ch. IV, Secs. 14 to 16.

[13] L. de Broglie, Sur la Dynamique du corps à masse propre variable et la formule de transformation relativiste de la chaleur, Comptes Rendus 264 B (16), 1173-1175 (1967).

[14] L. de Broglie, On the basis of wave mechanics, Comptes Rendus 277 B, no. 3, 71-73 (1973).

[15] L. B. Okun, Elementary particle physics (Nauka, Moscow, 1988) (in Russian), p. 197.

[16] V. Krasnoholovets and D. Ivanovsky, Motion of a particle and the vacuum Phys. Essays 6, 554-563 (1993) (also arXiv.org e-print archive quant-ph/9910023).

[17] V. Krasnoholovets, Motion of a relativistic particle and the vacuum Phys. Essays 10, 407-416 (1997) (also quant-ph/9905077).

[18] V. Krasnoholovets, On the nature of spin, inertia and gravity of a moving canonical particle, Ind. J. Theor. Phys. 48, 97-132 (2000) (also quant-ph/0103110).

[19] V. Krasnoholovets, Space structure and quantum mechanics, Spacetime & Substance 1, 172-175 (2000) (also quant-ph/0106106); Submicroscopic deterministic quantum mechanics, International Journal of Computing Anticipatory Systems (2002), in press (also quant-ph/0103110).

[20] P. A. M. Dirac, Is there an aether? Nature 168, 906-907 (1951).

[21] V. I. Man’ko, G. Marno, E.C. G. Sudarshan and F. Zaccaria, Interference and entanglement: an intrinsic approach, quant-ph/0207033.

[22] M. Bounias and V. Krasnoholovets, Scanning the structure of ill-known spaces, to appear in Kybernetes, Int. J. Systems and Cibernetics.

[23] V. Krasnoholovets, On the mass of elementary excitations of gravitational interaction, Spacetime & Substance 2, 169-170 (2001) (also quant-ph/0201131).
[24] V. Krasnoholovets, On the notion of the photon, *Ann. de la Fond. L. de Broglie* **27**, 93-100, (2002) (also quant-ph/0202170).

[25] V. Krasnoholovets, Gravitation as deduced from submicroscopic quantum mechanics, submitted (also hep-th/0205196).

[26] C. Dunn, *The Giza power plant: technologies of ancient Egypt* (Bear & Company Publishing, Santa Fe, 1998).

[27] S. Mehler, *The land of Osiris* (Adventures Unlimited Press, 2001).

[28] V. Krasnoholovets, Does modern science tends to the knowledge base of the ancients? *HERA magazine* (Rome, in Italian), no. 7 (2002), in press; The Great Pyramid as a wind trapping site, *ibid.*, no. 7 (2002), in press [see also V. Krasnoholovets’ Home Page in the section Recent Events].

[29] ´Sri ´Srimad A. C. Bhaktivedanta Swami Prabhupada, *Bhagavad-gītā as it is*, Bhaktivedanta Book Trust, Moscow, Leningrad, Calcutta, Bombay, New Delhi (1984), Ch. 8, Verse 20.

[30] R. R. M. Roy, *Vedic physics. Scientific origin of Hinduism* (Golden Egg Publishing, Toronto, 1999).

[31] V. Krasnoholovets and V. Byckov, Real inertons against hypothetical gravitons. Experimental proof of the existence of inertons, *Ind. J. Theor. Phys.* **48**, no. 1, 1-23 (2000) (also quant-ph/0007027).

[32] V. Krasnoholovets, On the way to disclosing the mysterious power of the great pyramid, [http://gizapyramid.com](http://gizapyramid.com) (see in Research Articles)

[33] V. Arunasalam, Do incompatible views exist among the giants of physics?, *Phys. Essays* **14**, 76-81 (2001).

[34] V. Krasnoholovets, Collective dynamics of hydrogen atoms in the KIO₃-HIO₃ crystal dictated by a substructure of the hydrogen atoms’ matter waves, submitted (also http://arXiv.org/abs/cond-mat/0108417).

[35] V. Krasnoholovets, On the theory of the anomalous photoelectric effect stemming from a substructure of matter waves, *Ind. J. Theor. Phys.* **49**, 1-32 (2001) (also http://arXiv.org/abs/quant-ph/9906091).