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Clarification of the Nature of Quantum Theory Based on Scientific Philosophy

Altayev Namaz Karabalievich

Candidate of Chemical Sciences, Republic of Kazakhstan

ABSTRACT

It is known that there was a disagreement between Bohr and Einstein about the nature of the fundamental equations of quantum mechanics. In 1949, in the work "Remarks on Articles," Einstein clearly expressed his thoughts on this issue. He wrote: "All this discussion was needed only to clarify the following. By attempting to defend the thesis that statistical quantum theory can in principle give a complete description of individual systems, we come to highly improbable theoretical concepts. On the other hand, the aforementioned interpretive difficulties of the theory disappear if quantum-theoretical descriptions are considered as descriptions of ensembles of systems".

***Corresponding author**

Namaz Karabalaevich Altayev, Candidate of Chemical Sciences, Republic of Kazakhstan.

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In this controversial matter, M. Born was a supporter of Bohr. Therefore, in 1961, in the article "Remarks on the Statistical Interpretation of Quantum Mechanics," he defended the truth of quantum mechanics against the criticism of some physicists. Nevertheless, he was forced to write in this article: "The situation here is so confused that the choice is only this: either be content with a weaker adaptation of concepts to the system of formulas - this is the goal of the so-called 'Copenhagen interpretation' - or change the rules of thinking itself, the logic”. Thus, he probably meant the following. There must be a special kind of logic. That is, quantum logic.

In this article, taking the idea of scientific philosophy as a basis, it is proved that this is indeed the case. It is shown that this special kind of logic is the equations of algebra and arithmetic. Taking them as the basis of the theory of thinking, it is further proved that the fundamental equations of quantum theory are the fundamental equations not of quantum mechanics but of quantum statistical mechanics. Thus, it is proved that in this matter, the path of truth was closer to Einstein's thoughts.

§1. As is known, in 1900, Planck, when he began studying problems in the field of interaction of matter with radiation (IMR), took the possibility of Maxwell's equations as a basis [1]

$$\nabla^2 E - \frac{1}{c^2}\frac{\partial^2 E}{\partial t^2} = 0,$$

$$\nabla^2 H - \frac{1}{c^2}\frac{\partial^2 E}{\partial t^2} = 0, \qquad (1)$$

Then, considering that based on (1) it is possible to obtain

$$\frac{8\pi v^2}{c^3} \qquad (2)$$

Further received

$$\rho_v = \frac{8\pi v^2}{c^3} \times \bar{u} \qquad (3)$$

where ρ_v is the radiation density, $\bar{u}$ is the average energy of the oscillator. Then, taking as a basis the possibility of relations

$$S = k\, lnW \;,\; W = \frac{(N+P-1)!}{(N-1)!\,P!} \;,\; E = p\varepsilon \;,\; E = Nu, \qquad (4)$$

got

$$\bar{u} = \frac{\varepsilon}{exp\frac{\varepsilon}{kT} - 1}, \qquad (5)$$

Then from (3) and (5) obtained

$$\rho_v = \frac{8\pi v^2}{c^3} \times \frac{hv}{exp\frac{hv}{kT} - 1} \qquad (6)$$

where =hv. Here, ε is the quantum of energy, v is the frequency, is Planck's constant. As is known, it was then possible to understand that based on (6) it is possible to satisfactorily describe experimental results [2]. Therefore, the problem of proving (6) arose. Accordingly, it was necessary to prove (1), (2), (4), and (5) as well. Naturally, for this, it was necessary to take the possibility of the main results previously obtained in the field of theoretical physics as a basis. In 1911, Planck, taking the possibility of Gibbs' canonical distribution function as a basis, obtained

$$\bar{u} = \frac{\sum_n E_n \exp\left(-\frac{\varepsilon_n}{kT}\right)}{\sum_n \exp\left(-\frac{\varepsilon_n}{kT}\right)} = \frac{\varepsilon}{exp\frac{\varepsilon}{kT} - 1}, \qquad (7)$$

Thus, he obtained proof for (5). It is also known that Planck then stated that from now on, in the development of the foundations of quantum theory, it is necessary to use the concept of quantum action as the main one. Thus, he moved the role of the concept of quantum energy to the background. Poincare immediately raised the question of the role of the number of degrees of freedom in the case when the concept of quantum actions is put in the main place. To which Planck replied, "**For several degrees of freedom, the quantum hypothesis is not yet formed, but I think it is impossible to do it**". Further events developed as follows. The advancement of the concepts of quantum actions to the main place turned out to be very useful. For Bohr, who learned about this idea from Rutherford in 1913, came to the conclusion that there are results [3]

$$mvr = n\hbar \qquad (8) \qquad\qquad v = \frac{me^4}{4\pi\hbar^3}\left(\frac{1}{n^2} - \frac{1}{k^2}\right) \qquad (9)$$

That define the meaning of the first and second postulates. On the other hand, in 1923, de Broglie, who learned about this idea from his brother concluded that there is a relation [4]

$$\lambda = \frac{h}{mv} \qquad (10)$$

Moreover, he realized that (10) could be reached by jointly considering the relation

$$2\pi r = n\lambda \qquad (11)$$

And relation (8). Subsequently, Schrödinger, in 1926, obtained the equation

$$\Delta\Psi + \frac{8\pi^2 m}{\hbar^2}(E - V)\Psi = 0 \qquad (12)$$

By developing de Broglie's ideas. Then he realized that there is a direct connection between this equation (12) and the main equations of the Hamilton-Jacobi theory. Thus, at that time, he came very close to realizing the following. That now, as the main equations of theoretical physics obtained by solving the Hamiltonian equation

$$\dot{q}_i = \frac{\partial H}{\partial p_i}, \quad \dot{p}_i = -\frac{\partial H}{\partial q_i} \qquad (13)$$

For 1) many particles subjected to external force and 2) many chaotically moving particles, it is possible to consider the equation

$$\frac{\partial S}{\partial t} + H\left(q_i, \frac{\partial S}{\partial q}, t\right) = 0 \qquad\qquad \frac{\partial \rho}{\partial t} - [H\rho] = 0,$$

$$H\left(q_i, \frac{\partial S}{\partial q}\right) = E, \qquad (14) \qquad\qquad [H\rho] = 0, \quad \rho_i = \exp\frac{F - \varepsilon_i}{kT}, \quad \rho_{i,n} = \exp\frac{\Phi + \mu n - \varepsilon_i}{kT} \qquad (15)$$

$$\Delta\psi + \frac{8\pi^2 m}{\hbar^2}(E - V)\psi = 0$$

As can be easily noticed, this was a time when physicists could have realized that there is a necessity to consider these equations (14) and (15) as the main equations of theoretical physics. Then, it was necessary to interpret the nature of (14) and (15) in such a way that it led to the substantiation of relations (1), (2), (4), and (5). Thus, to attempt to obtain strict theoretical proofs for equation (6). However, as is known, at that time, physicists could not realize that such possibilities exist. Because the authority of Bohr, who obtained relations (8) and (9) based on the analysis of (6), was very high in the scientific world. Therefore, at that time, for further development of the foundations of theoretical physics, the following step was taken. They accepted the possibilities of the correspondence principle as the basis of the theory of thinking. Therefore, at first, Heisenberg, following this path, obtained the initial version of the main equation of matrix mechanics [6]. Then, in the work of Born-Heisenberg-Jordan, an equation of the form [7]

$$\begin{aligned} &\dot{q}_i = \frac{\delta H}{\delta p_i}, \ \dot{p}_i = \frac{\delta H}{\delta q_i}; \\ &q_i q_s - q_s q_i = 0; \\ &p_i p_s - p_s p_i = 0; \\ &p_i q_s - q_s p_i = \frac{h}{2\pi i}\delta_{is} \end{aligned} \qquad (16)$$

for the case when the number of degrees of freedom can be varied arbitrarily. Subsequently, Schrödinger, who was strongly influenced by the new ideas of matrix mechanics, based on equation (12), obtained his temporary equation

$$i\hbar\frac{\partial\Psi}{\partial t} - H_\Psi = 0 \qquad (17)$$

Then they concluded that there is an equivalence between the basic equations of wave and matrix mechanics. Dirac wrote about it as follows [8]: "**In the original Heisenberg version of the theory, functions did not exist: they appeared in quantum mechanics after Schrödinger's work was published. Then it turned out that the wave function corresponds to one of the states, for example, to one of the stationary states of Bohr's theory. Operators transforming one wave function into another are thus related to two states. Thus, it was established that Schrödinger's and Heisenberg's theories are equivalent**". Then physicists realized that there is a need to interpret the nature of these equations. It is believed that this problem was successfully solved by M. Born [9]. Moreover, he accepted ideas as the basis, which are as follows: "**the square of the modulus of the wave function ψ was assumed to be equal to the probability that the particle is at a given point at a specific time**". As is known, Born's probabilistic interpretation was not initially accepted by Einstein and Schrödinger. However, Bohr and many other physicists accepted it. Therefore, these new ideas were accepted as the basis by Dirac and Jordan when they developed their versions of the transformation theory. These ideas were also accepted as the basis by Bohr and Heisenberg when they came to the main ideas of their principles. Thus, at that time, physicists had the conviction that it was precisely these equations that were the main equations of quantum theory. It was concluded that such equations are the main equations of quantum mechanics (QM) (17) and (16). Therefore, it seemed to them that now, based on these equations, more specific problems could be solved.

As is known, the first problem they started solving again turned out to be the IMR task. However, this time they began to solve this problem as the necessity of developing the foundations of quantum electrodynamics (QED). Note that when obtaining the main equations of QED, not only the main equations of QM were taken as a basis, but also Maxwell's equation (1). Therefore, further attempts to solve these QED equations began to encounter difficulties related to infinities. Then the belief arose that these difficulties could be overcome using the renormalization procedure. Of course, this method, when it is necessary to use the possibility of the renormalization procedure to obtain meaningful solutions, was not natural. Dirac thought so all his life. He thought that perhaps the fact that it happened this way is because we have not yet managed to obtain the true equation of QED. However, as is known, despite this, the main ideas developed in that case were taken as the basis for obtaining many results. For example, such as quantum field theory, the standard model, and string theory. It is also widely known that many theorists still hope that in the future we will be able to obtain the true equation of QED. Because only in this case will it be possible to substantiate (1), (3), (4), (5), and (6). Thus, new results obtained as a substantiation for (6) can be accepted as the main equation of QED. Now, I will try to explain how it was possible to solve this problem on a new path, where the ideas of scientific philosophy were accepted as a basis.

§2. About how I had to start my creative activity with the aim of obtaining substantiated relations like

$$\theta = \frac{bn_A}{1+bn_A}, \quad (18) \qquad K = \frac{n_{AB}}{n_A \cdot n_B}, \quad (19)$$

I have already written in [10]. I also wrote that when I started dealing with this problem, I learned that it had already been solved in 1937 by the Leningrad theorist LE Gurevich [11]. Then, when I tried to use his results to describe experimental data, I realized the following. The author did not clearly realize that he had obtained new results of exceptional importance. He interpreted his results in the language of the method of the statistical sum. What is usually very fashionable in theoretical physics. However, I realized that to use his results for the correct description of experimental data, it is necessary to interpret them in the language of the free energy method. I also wrote that when I gave a report on May 22, 1974, at a seminar in front of the theorists of the Institute of Chemistry of the USSR Academy of Sciences to get feedback, the seminar refused me. Then, after a discussion, I was left for six months in the department to establish clarity together. During this period, it was not possible to establish clarity. Nevertheless, it was found that there is sense in my interpretation. I was given permission to defend. I promised them that I would definitely achieve clarity. I also wrote that I managed to achieve this after many years. Moreover, only after coming to the realization of the following truth. That there are fundamental ideas of scientific philosophy that can be systematized using Scheme-1 and Schemes No. 2, No. 3 (theoretical physics), No. 4, and No. 5 (probabilistic physics), No. 6, and No. 7 (unification of the basics of physics) [12].

I want to especially note the following. After realizing that there are results such as

$$E_i = a + k\beta_i, \qquad \Psi_i = \Sigma_{ir} C_{ir} x_r, \quad (20)$$

$$n_{\acute{A}}^0 = \frac{n^0}{\frac{1}{n_{\acute{A}}} exp\frac{\varphi - f}{kT} + 1} \quad (21)$$

I realized that all these results were obtained only when solving the interaction of substances with substances (ISS). I realized that when obtaining (21), it was indeed possible to substantiate (18) and (19). Then I paid attention to the fact that using the formulas of work [11], it is still possible to obtain results

$$n_{\hat{o}}^0 = \frac{n^0}{\frac{1}{n_{\hat{o}}} exp\frac{\varphi - f}{kT} - 1} \quad (22)$$

Then I noticed that the nature of formulas (21) and (22) can be understood as clarifying the formulas of Fermi-Dirac and Bose-Einstein statistics. Thus, I understood that by accepting new ideas and results as a basis, it is possible to solve the ISS problems as well. Then, gradually, I came to the realization of all the ideas and results written in §1.

Now I will tell how, based on new results, it was possible to obtain equations

$$\rho_v = \frac{8\pi v^2}{c^3} * \frac{hv_{\varphi f}}{\frac{1}{n_\phi} exp\frac{hv_{\varphi f}}{kT} - 1} \quad (23)$$

as a substantiation for (6) obtained by Planck in 1900. This became possible after I realized the following truths. When obtaining Schrödinger's equation (14), it is necessary to use the possibility of 3N + 1 space. On the other hand, this meant that in a similar way it is possible to substantiate Maxwell's equation (1). Thus, on this path, it was possible to substantiate (2) as well. In 1906, Einstein wrote that in the future it will be necessary to substantiate the first factor of equation (6) [13]. So, on this new path, it was possible to solve this problem as well. I want to say the following. The nature of equation (23) was accepted as the main equations of QED. Thus, it was possible to understand that to obtain it, the possibilities of equations other than QM equations were accepted as a basis. The possibilities of equations (14) and (15) were accepted. That is, the equations of classical statistical mechanics. As well as the results inherent in quantum statistical mechanics.

In conclusion, I will tell you what I understand when I say that on this new path, it was possible to correctly understand exactly what the true essence of quantum theory is. On this new path, where the ideas of scientific philosophy were accepted as a basis, it was possible to realize the following. The nature of the equations of algebra and arithmetic, which were accepted as the basis of the theory of thinking, needs to be accepted as the main results of quantum logic. After that, the results obtained when solving the problem of geometry-kinematics-physics can also be obtained as inherent in quantum geometry, quantum kinematics, and quantum physics.

Here, I think it is appropriate to recall the following. In 1900, at the Solvay Congress, Planck stated that from now on, the concept of quantum action should be used as the main concept of quantum theory. Then Poincare immediately asked him about the role of the number of degrees of freedom in such a case. Planck replied that "**for several degrees of freedom, the quantum hypothesis is not yet formed, but I do not think it is impossible to do it**". Poincare also asked, "What is the connection between Planck's method and Gibbs's method?" The discussion was about (p, g) space. As is known, further theoretical physics developed so that correct answers to these subtle questions were not obtained. That is why later it led to the fact that the main equations of quantum theory were accepted as the main equations of QM.

Moreover, such that when obtaining them, the possibility of the correspondence principle was accepted as a basis. Thus, the possibility of developing quantum theory to reveal its true essence was lost. Because to correctly solve such a problem, from the very beginning, it was necessary to accept the equations of algebra and arithmetic. Thus, it was necessary to prove that the **fundamental concept of quantum theory is the concept of quantum energy, not the concept of quantum actions**. Poincare came to such a conclusion in the article [14]. By obtaining new results, it was possible to prove that this is indeed the case.

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