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Uncovering the Hidden Defects of the Basic Equations of Quantum Mechanics on the Basis of Scientific Philosophy

Altayev Namaz Karabalievich

Candidate of Chemical Sciences, Republic of Kazakhstan

ABSTRACT

From the very beginning of his development, Einstein was very critical of the main results of quantum mechanics. That is why in 1925, when the main papers on matrix mechanics were published, he wrote to his friend Besso [1] as follows: "The most interesting theoretical achievement of recent times is the Heisenberg-Born-Jordan theory of quantum states. A real witchcraft calculus in which infinite determinants (matrices) appear instead of Cartesian coordinates. It is highly witty and, due to its complexity, is insured against proving erroneous." In this connection I wish to say the following. A lot of time has passed since this thought was made. Therefore it makes sense to try to prove that the results of matrix mechanics actually contain defects. In the paper an attempt is made to prove that it is really so.

***Corresponding author**

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

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§1. How Heisenberg Solved the Problem of the Relationship Between Unobservable And Observable Quantities

As it is known the essence of his theory, which further received the name matrix mechanics, Heisenberg formulated when writing the abstract of the article [2]. He wrote:

"This paper attempts to derive a framework for quantum-theoretical mechanics that is based solely on relations between fundamentally observable quantities." (1)

Here I will first describe how and in what sequence Heisenberg obtained his results. For this purpose I will use those results, which are available in the article [3]. In this article, J. Mehra presented Heisenberg's results in a more simplified version. As it is written in [3] Heisenberg in obtaining his results at first jointly considering Newton's equation

$$F = m\frac{d^2x}{dt^2} \qquad (2)$$

and the equations of the theory of elasticity

$$F = -kx \qquad (3)$$

Then I got the equation

$$m\frac{d^2x}{dt^2} = -kx \qquad (4)$$

Thus he obtained on the basis of (4) the equation

$$\ddot{x} + \omega_0^2 x = 0 \qquad (5)$$

for the harmonic oscillator and also the equation

$$\ddot{x} + \omega_0^2 x + \lambda x^3 = 0 \qquad (6)$$

for an an-harmonic oscillator. Further he took into account the fact that the classical periodic motion x(t) can be decomposed in Fourier series:

$$x(t) = \sum_{\alpha=-\infty}^{\infty} a_\alpha e^{i\alpha\omega t} \qquad (7)$$

In quantum theory, the coefficients a and frequency ω depend on the quantum number n . Therefore, instead of the relation (7) Heisenberg wrote x(t) in the form

$$x(t) = \sum_{\alpha=-\infty}^{\infty} a_\alpha(n) e^{i\alpha\omega_n t} \qquad (8)$$

Then he replaced the terms of the Fourier-decomposition (8) with terms of a new type,

$$a(n,\ n-\alpha)e^{i\omega(n,\,n-\alpha)t} \qquad (9)$$

which correspond to the transition from state n to state n–α.

Heisenberg further assumed that the perturbation term is a small correction. Therefore, he decided to use the classical method of perturbation theory, i.e., he assumed that

$$x(t) = a_1\cos(\omega t) + \lambda a_3\cos(3\omega t) + \lambda^2 a_5\cos(5\omega t) + \ldots, \qquad (10)$$

Then reformulated this equality quantum-theoretically in the form

$$x(t) - (n, ,n-1)\cos[\omega(n,n\text{-}1)t] + \lambda\,(n,n\text{-}3)\cos[\omega(n,n\text{-}3)t] + \ldots \qquad (11)$$

He also decomposed the frequencies into a series over λ:

$$\omega(n, n-1)=\omega_0(n, n-1)+\lambda\omega_1(n, n-1)+\ldots \quad (12)$$

Substituting these expressions, i.e. equality (11) and (12), into equation (6) he obtained at λ=0

$$[\omega_2^2-\omega^2(n, n-1)]\,a(n, n-1)=0 \quad (13)$$

That is the solution for the harmonic oscillator-and in the first approximation

$$[\omega_0^2-\omega^2(n, n-3)]\,a(n, n-3)+a(n, n-1)\,a(n-1, n-2)\,a(n-2, n-3)=0 \quad (14)$$

for the an-harmonic oscillator. Thus he found that the quantities (n, n- α), which he called transition amplitudes, are defined as solutions of the equations of motion (13) or (14) only with an accuracy to a constant.

He then set himself the task of refining these solutions, in which there are still uncertainties due to the presence of constants. For this purpose he took as a basis the relation

$$\int m\dot{x}dx=J=nh \quad (15)$$

which was established in due time within the possibility of the old quantum theory. Then substituting the Fourier expansion (8) for x(t) into this relation, he obtained

$$nh=2\pi m\sum_{\alpha=-\infty}^{\infty}|a_\alpha(n)|^2\alpha^2\omega_n \quad (16)$$

Further replacing this formula by its derivative in n, and using the relation (16) as an intermediate step, he replaced the derivative by the difference and obtained

$$h=4\pi m\sum_{\alpha=0}^{\infty}[|a(n, n+\alpha)|^2\omega(n+\alpha, n)-|a(n, n-\alpha)|^2\,\omega(n, n-\alpha)] \quad (17)$$

This equality is the quantum Heisenberg condition. At joint consideration of (13) and (14) and also (17) it is possible to determine the transition amplitude through transition frequencies. Therefore at this stage Heisenberg made the following conclusion. That by this means the problem of fundamental differences between such unobservables as x(t) and observables as transition amplitude a (n, n- α) and transition frequency is solved.

Thus, in conclusion of this paragraph I would like to say the following. Heisenberg obtained his main results by determining the frequency of transitions through coordinate matrices. However, as it was pointed out by the author of the book [4] this fact leads to the following thought. That there is a shadow of doubt about the truth of the results obtained in the work [2]. For the concept that is unobservable under the name of coordinate matrix, in some sense is still preserved. Besides in this work for the first time at attempts to solve the problem of theoretical physics began to appear multiplications which are not commutative. Of course, this was also the moment when it suggests that there are some defects in the results obtained. As it is mentioned in the article [5] Heisenberg himself really had such doubts. Therefore, he was even ready to give up his work. However, as is known further events began to develop along a slightly different path. For Born and Dirac were in the belief that this fact is a sign that begins to reveal some deep truths. Therefore further, although the main purpose in writing the article [6,7,8] was to improve and clarify the results obtained in the paper [2], but in fact it did not turn out so.

Now I want to say what I think about the reasons why this happened. For this purpose let us recall the following facts. Heisenberg obtained his results in a way where the possibility of the Newton equation (2) was taken as a basis.On the other hand, when obtaining the main results of the paper [6-8] the possibility of the canonical Hamilton equation was already taken as a basis:

$$\frac{dq_i}{dt}=\frac{\partial H}{\partial p_i},\ \frac{dp_i}{dt}=-\frac{\partial H}{\partial q_i} \quad (18)$$

Of course, this was an essential step to further results to get directly on the path of truth. For it was a moment when it was now possible to follow the advice given by the philosopher William James in his Pragmatism:

"If you encounter contradictions, introduce a finer distinction." (19).

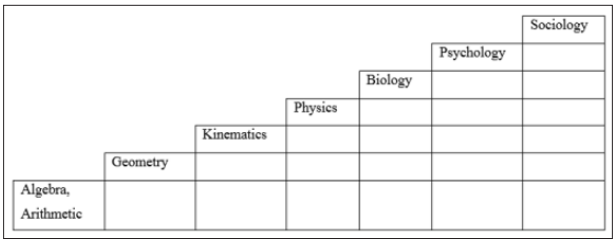
Further on in §2 I will try to show how this goal was achieved in a way where from the very beginning the possibility of the fundamental ideas of scientific philosophy was taken as a basis.

§2. On How, Taking As A Basis The Ideas Of Scientific Philosophy, It Was Possible To Obtain Relations Between Fundamentally Observable Quantities

As it was pointed out above the essence of the basic thoughts of matrix mechanics Heisenberg formulated at writing the thoughts contained in lines (1). On the other hand it is known about the following. In 1926, when there was a conversation between [9] Einstein and Heisenberg, after a seminar which took place in Berlin, Einstein remarked the following. That
"Only theory decides what is observable and what is not". (20)

By this he meant to say the following. That first of all it is expedient to find out exactly what is the essence of the theory. However, as we know from this remark of Einstein, Heisenberg did not make a corresponding conclusion. Therefore, the essence of the question about the interrelation of observable quantities as well as their principal differences from such unobservable quantities as x(t) remained to the end undisclosed.

Now I will tell you how this problem was solved on a new way. That is in the way where from the very beginning the basic ideas of scientific philosophy, which were taken into account with the help of scheme-1, were taken as a basis:



In my opinion, in the way where the ideas taken into account with the help of scheme-1 are taken as a basis, it is actually possible to solve exactly what the essence of the theory is. For I agree with the essence of this approach
algebraic equations, arithmetic equations (21)
is taken for the results that can fulfill the roles of the basis of a theory of thought (22).

Therefore, further, when the problems are solved on this basis
geometry, kinematics, physics (23)

It is possible to obtain the basic equation of theoretical physics in the form (18).

Therefore, further when solving (18) for
α) of many orderly moving particles subordinate to the force
β) of many chaotically moving particles
the possibility of obtaining new results arises. That is, the equations

$$\frac{\partial S}{\partial t}+\mathrm{H}\left(q_i,\frac{\partial S}{\partial q},t\right)=0$$

$$\mathrm{H}(q_i\frac{\partial S}{\partial q})=\mathrm{E}$$

$$\psi+\frac{8\pi^2 m}{\hbar^2}(\mathrm{E}\text{-}\mathrm{V})\ \psi=0 \qquad (24)$$

$$\frac{\partial \rho}{\partial t}-[\mathrm{H}\rho]=0$$

$$[\mathrm{H}\rho]=0$$

$$\rho_i=exp\frac{F-\varepsilon_i}{kT}$$

$$\rho_{n,i}=exp\frac{\Phi+\mu n+\varepsilon_i}{kT} \qquad (25)$$

That is, equations that make sense in a space whose dimensionality is 3N+1 and 6N+1. On the other hand, further from (24) and (25) we obtain more results

$$\mathrm{E}=\alpha+\mathrm{k}\beta_i$$
$$\Psi=\sum_{ir}C_{ir}x_r \qquad (26)$$

$$n_A^0=\frac{n^A}{\frac{1}{n_A}exp\frac{\varphi-\mathrm{f}}{kT}+1} \qquad (27)$$

That is, the results on the basis of which relationships between fundamentally observable quantities are established. And these results can be obtained by taking advantage of the possibility of **method of separation of variables, method of abolition of variables** (28).

Therefore, these results make sense in ordinary three-dimensional space. I would like to say the following. Successful implementation of such a program is a very important point of this approach. For the necessity of realization of such a program follows from the very essence of the new approach. The approach where from the very beginning the equation of algebra and arithmetic is taken as the basis of the theory of thinking. Therefore, this very fact requires that further problems should be solved on the basis of the possibility of such methods as (28). That is why at the very end it is possible to arrive at the results (26) and (27)), which already make sense in the usual three-dimensional space. The natures of these results can be understood as obtained relations for the relationship between the observed quantities. In this case the natures of these results can be understood as results inherent to quantum theory. That is ratios with the purpose of obtaining which Heisenberg developed his theory. And also to find out exactly what are the differences of these observables from such unobservables as coordinates and momentum of particles. Thus it was possible to solve the problems on necessity of solutions of which Einstein noted. However, only after the essence of the results on the basis of which it was possible to understand the meaning of the theory.

At this point, I would like to say one more thing. Acceptance of the possibility of ideas taken into account with the help of scheme-1 really turned out to be very important. For further on this way it was possible to come to the realization of the following [10]. That since a long time there have been ripening.

The results that can be taken into account by means of scheme-2 and 3 (theoretical physics); scheme-4 and 5 (probabilistic physics); scheme-6 and 7 (unification of the basis of physics). That is, it was possible to come to the realization that by taking advantage of the possibility of the idea of scientific philosophy it was indeed possible to introduce subtle differences in the way when one tries to solve equation (18) for many particles. For in this case it is already possible to realize that equation (18) should now be solved on two independent paths. Thus it is possible to obtain results on the basis of which the Heisenberg problem is solved more correctly than it was possible within the framework of the possibility of matrix mechanics. And the results of the form (26) and (27) can be obtained in such a way that at their obtaining such illogical results as non-commutativity of multiplication do not appear now. Thus on this way it was actually relatively easy to come to obtaining solutions on the basis of which the main goal was achieved. That is to come to obtaining solutions on the basis of which the peculiarities of interrelations between such observable quantities as particle concentrations and transition frequencies are correctly established.

The analysis of the obtained results allows us to realize the following. It was possible to realize that in the case when the results (26) and (27) were obtained, their nature can be understood as a justification for the results

$$\mathrm{E}=-\frac{me^4}{2\hbar^2} \qquad (29)$$

$$2\pi\mathrm{r}=\mathrm{n}\lambda$$

$$\mathrm{K}=\frac{n_{AB}}{n_A\ n_B}$$

$$\theta=\frac{bn_A}{1+bn_A} \qquad (30)$$

Note the results (29) and (30) earlier was obtained at the solution of the problem for many orderedly and chaotically moving particles. And these results then have been obtained with accuracy of probabilistic physics. And also for the description of experimental

data. Therefore at their obtaining also features of interrelation between the observed quantities were established. However, with the accuracy of the definitions of the constant. Therefore, in the case when the results (26) and (27) could be obtained as justifications for (29) and (30) thereby obtained results on the basis of which the Heisenberg problem was successfully solved.

Now I would like to emphasize the following. The analysis has shown, that at reception of the highest stated results successfully managed to solve problems only for a case when the problem on interaction of substances with substance (SIS) is solved. However, as it is indicated in [10,11], taking as a basis the possibilities of the results obtained at this stage, further it is possible to solve satisfactorily also the following problems. Problems on the interaction of substances with radiation (VVSI) and problems on the interaction of substances with heat (VVST). For example, at the solution of the VVSI problem, it is possible to obtain a theoretical justification for the Planck equation obtained in 1900. On the other hand, when solving the WWCI problems, it is possible to obtain justifications for the Poiseuille relation, as well as for Ohm's law. Thus it is possible to explain more correctly the nature of superfluidity and superconductivity. Thus, having in mind all this it is possible to draw the following conclusion. That on this new way of those problems for the purpose of solution of which the results of matrix mechanics were developed it is possible to solve more correctly. For in obtaining the main results (29) and (30) as well as results (26) and (27) one really does not have to deal with such results as non-commutativity of multiplication. And this became possible only after one managed to successfully use the possibility of the idea of scientific philosophy. For on this way the results could be obtained in the way when the possibilities (21) are taken as a basis for (22). Thereby the use of the possibility of the correspondence principle as such is rejected. Note on this way the refusal is made also from use of results of the old quantum theory. For example, such as (15). For on this new way of such problems when there arises a necessity to take into account the roles when the number of degrees of freedom is much more than one it is possible to solve quite differently. On this way of such problems can be correctly solved in the case when it is believed that in obtaining ((24) and (25) from (18) used the possibilities of multidimensional spaces with dimensionality equal to 3N+1 and 6N+1. Moreover, the nature of these numbers can still be understood as numbers of degrees of freedom at which equations (24) and (25) make sense. Therefore, further results of the form (29) and (30) can be understood as results that make sense in an ordinary three-dimensional space. The analysis still allows us to draw the following conclusion. That the solutions (29) are obtained for the case when many particles move in an ordered manner obeying the force. Whereas the solution (30) is obtained for the case when many particles move chaotically.

§3. On What gave new results to reveal the Main Defects Inherent in the results of Matrix Mechanics

Jointly analyzing the results obtained in the field of matrix mechanics (§1) and the results obtained in §2 for solving the same problems, one can notice the following. In the way where from the very beginning the possibility (21) was taken as (22), the relations between the observables are obtained more successfully than it was possible to obtain within the framework of the possibility of matrix mechanics. In our opinion, the main reason for this is summarized as follows. The possibility of the correspondence principle on the basis of which Heisenberg obtained his results is not quite suitable for the correct solution of such problems. As it has been shown above for the solution of such problems the possibilities of equations of algebra and arithmetic are more suitable. For when taking as a basis the possibilities of algebra and arithmetic equations further Hamilton's equation (18) for many particles can be solved on two independent paths. That is, subtle distinctions are introduced for this purpose. What I mean here is the following fact. That one has to use the possibility of 3N+1 and 6N+1 dimensional space in the case when one solves equation (18) for many orderly and chaotically moving particles. Therefore, the solution of each of these problems becomes noticeably easier. Here I would like to emphasize the following. When obtaining the results of matrix mechanics, the introduction of such a subtle distinction is not used at all. On this way, for example, when from the possibility of Hamilton's equation (18) one tries to obtain the equation for the harmonic oscillator, the following result is taken as a basis:

$$\mathrm{H} = \sum_{n=1}^{\infty} \left[\frac{p_n^2}{2} + \frac{\omega_n^2 q_n^2}{2} \right] \qquad (31)$$

As we can see this relation (31) is written at joint consideration of the role of both kinetic and potential energy. Therefore, further, when at the very end of the results on the basis of which the relations between the observed quantities are established, such results cannot be obtained correctly. Such results are obtained for the relations of the coordinate and momentum matrix, and also the transition frequency. Of course, all this is a consequence of the following fact. On this way in that case when equation (18) is solved for many particles, these problems are tried to be solved considering simultaneously the roles of both kinetic energy and potential energy. That this is an essential defect can be verified by analyzing the following results. As it is known for the equation of an oscillating string

$$\frac{\partial \psi}{dx^2} - \frac{1}{c^2} \frac{\partial^2 \psi}{\partial t^2} = 0 \qquad (32)$$

consistent with the decision

$$\text{ø}(\mathrm{x}, \mathrm{t}) = \sum_{n=1}^{\infty} q_n(t) \sin \frac{\pi n}{L} x \qquad (33)$$

with the ends fixed at x=0 and x= L. Here q obey the equations:

$$\ddot{\mathrm{q}}_n + \omega_n^2 q_n = 0 \qquad (34)$$

where

$$\omega = \frac{\pi C}{L} n \qquad (35)$$

As it is not difficult to notice here equation (34) as well as equation (5) is an equation for the harmonic oscillator. However these equations are obtained in different ways. Therefore, further based on (5) and (34) results inherent to quantum theory also obtained in different ways. For example, Heisenberg in the way where (5) is taken as a basis as a result of quantum theory wrote expression (8). Then he also wrote expression (9) for the case when there is a transition from state n to state n-α. On the other hand, when similar results are attempted in the way where equation (32) is taken as a basis then results (34) and (35) have to be obtained in a completely different way. On this way in order to understand the nature of (35) as a result inherent to the quantum theory of nature equation (32) will have to be interpreted as an equation having the sense of a solution. And it is obtained at solution of

equations (18) for many subordinated particles. Even under the assumption that at its obtaining one has to use the possibility of multidimensional space.

Thus, on the basis of the analysis of the above stated, we can come to the following conclusion. That at the time of obtaining the main results of matrix mechanics [6-8] it was not possible to realize that the most valuable part of the results obtained by Heisenberg is only equation (5). For this result (5) was obtained by solving (2) for many particles subordinate to the connections. What is so simple at first can be guessed at an intuitive level. Then one can realize that there is a possibility for its theoretical proof. Of course for this purpose realizing that there are such results as (32), (33), (34), (35). That is, results whose nature can be understood as having the sense of solutions obtained from (18). And for the case when (18) is solved for many particles subordinate to the connection. However, as it is known at reception of results of matrix mechanics all this has not been realized yet. In my opinion all this means the following. That then it was not realized that all results which Heisenberg has received using the possibility of expression (8) and (9) were the results received on a false way. For example, it was not realized that the weakest point of the results obtained by Heisenberg is the following. What processes with transitions he tried to describe with the help of expressions (9). However the analysis of the results obtained on a new way where the ideas of scientific philosophy are taken as a basis gives an opportunity to realize the following truths. That processes with transitions can be correctly described only in the way where the possibilities of basic equations (25) should be taken as a basis. That is the basic equations of Gibbs statistical mechanics.

In conclusion, I would like to say the following. On this new way of all these truths it became possible to realize only after it was possible to understand that there are ideas which can be systematized with the help of scheme-1. About how further on such basis it was possible to come to the correct decision of all these problems about WWCB, WWCI, WWST it is written in books and articles texts which are available on sites: scicom.ru namaz-altaev.kz.

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