"QUANTUM ENTANGLEMENT"

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ABSTRACT

One of the important details of the myth of "Quantum Computers" is "quantum computing", the main detail of which is the phenomenon of "Quantum Entanglement". In particular, if two Q-bits are brought into a "Quantum-Entangled" state, it will be possible to transmit information from one Q-bit to the other by the mechanism of "Terrible Long-range Action", that is - instantaneously. As a result of the creation of such technology, the speed of calculations - carried out in "Quantum Computers" will be significantly faster compared to the speed of calculations of conventional computers. Below we will show that the creation of such technologies will be impossible for a simple reason - there is no phenomenon of "Quantum Entanglement" in physical reality.

1: – A BRIEF HISTORY OF THE ISSUE.

The question of "quantum entanglement" first appeared in Schrödinger's 1935 publication (see [1]), which was a continuation of the discussion begun earlier that year by Einstein-Podolsky-Rosen (see [2]). The authors of the publication [2] considered a thought experiment and based on incorrect arguments, made a number of incorrect statements, which were later called the "EPR Paradox". In addition to the incorrect statements, they also made a number of correct ones. E.g., the statement that - quantum mechanics does not fully describe reality - is true, since quantum mechanics describes reality using a probabilistic description, and this automatically means that it does not fully describe. Their statements in connection with the uncertainty principle in quantum mechanics were a mistake (see Part I of the text in [3]). Soon after the publication [2], N.Bohr published a response in which he pointed out the source of the errors – the incorrect use of the "Observer Factor" in discussing the processes of the microcosm (see [4]). Bohr's quite understandable and logical arguments did not convince some physicists, including Schrödinger. He continued his discussion of one detail discussed in [2] and in these discussions, and introduced the phenomenon of "Quantum Entanglement". As we noted in Part I of our text, publication [2] is often indicated as the primary source of this phenomenon. This is a misconception, and it should definitely be said that the author of the myth of "Quantum Entanglement" was Schrödinger. For the next fifteen years, these questions were not of great interest for discussion in scientific publications. But, as it turned out later, Bohr's arguments did not seem convincing to Einstein either, who shared Schrödinger's views and in one of his letters to M.Born called the mechanism that provides "Quantum Entanglement" "Terrible Long-range Action". The issue became active again in the early 1950s, when D. Bohm published his work (see [5]). Bohm attempted to circumvent Bohr's arguments by introducing into the discussion spin characteristics - that had discrete numerical values, which supposedly appeared more stable with respect to the uncontrolled influences of the "Observer Factor", than the continuous physical characteristics discussed in [2]. However, if we carefully analyze the theoretically imaginary experiment proposed by Bohm, we will easily discover that Bohr's arguments are just as effective in this case as they are against the arguments [2]. This issue will be considered in detail in the next subsection.

Let us briefly indicate the list of statements that will be considered in this part of the text:

1: Does the reasoning about spin characteristics in Bohm's theoretical problem indicate the existence of the Schrödingerian phenomenon of "Quantum Entanglement"?

Answer - it does not!

2: In the processes of the microcosm - in the case of the existence of Bohm hidden variables, does the phenomenon of quantum randomness disappear?

Answer - it does not disappear, since the phenomenon of quantum randomness is a characteristic of our capabilities - the extraction of information from acts of observation, and not a characteristic of the microcosm;

3: Is the phenomenon of quantum discreteness due to the "Observer Factor" or is it a characteristic of the microcosm?

Answer - the phenomenon of quantum discreteness is a characteristic of the microcosm and is not conditioned by the "Observer Factor";

4: Do Bell's inequalities meet any physical requirements regarding the probabilities of outcomes arising from reality?

Answer - no, they do not;

5: Do Schrödinger's "quantum entangled" physical states exist?

Answer - no, they do not.

2: – "BOHM'S PUZZLE – EXAMPLES OF QUANTUM ENTANGLEMENT"

Before describing Bohm's puzzle, let us briefly recall the thought experiment of the "EPR paradox". A quantum object with a fixed momentum, for example, a zero momentum, decays into two quantum objects, and in the process of decay, the law of conservation of momentum operates:

$$\vec{P}^{(0)}(T|T \leq t_0) = 0 = \vec{P}^{(1)}(t|t \geq t_0) + \vec{P}^{(2)}(t|t \geq t_0)\ ; \qquad (2.1)$$

$\vec{P}^{(0)}(T|T \leq t_0)$ - the momentum of the original object, which decays at the $T = t_0$ moment; $\vec{P}^{(1)}(t|t \geq t_0)$ and $\vec{P}^{(2)}(t|t \geq t_0)$ are the impulses of objects obtained as a result of decay. The authors' idea was as follows: in order to know both the coordinate and the momentum in one fixed state, we will measure the coordinate of the first object, and the momentum of the second. Using (2.1), we can also specify the momentum of the first object without changing the quantum state formed by measuring the coordinate of this object. As a result, in the specified quantum state, we will simultaneously and accurately know both the momentum and the coordinate of the first object, which will contradict the Heisenberg uncertainty principle. Accordingly - quantum mechanics, based on the uncertainty principle, does not fully describe reality. Bohr criticized this statement and pointed out that the relation (2.1) refers to objects before the act of observation, and during the measurement of the momentum of the second object, a new physical state is formed for this object - with a corresponding momentum, which we measure. The measured momentum value has no direct relationship to the momentum of the second object from (2.1) nor to the corresponding conservation law. And if the act of measurement occurs at the moment - $t = t_1$, then - (2.1) should be rewritten as follows:

$$\vec{P}^{(0)}(T|T \leq t_0) = \vec{P}^{0(1)}(t|t \geq t_0) + \vec{P}^{0(2)}(t|t_0 \leq t < t_1) = 0\ ; \qquad (2.2)$$

Where, the additional zero index denotes the fact that this law of conservation of momentum refers to the momenta of objects that existed before the act of observation. In these notations, for the measured momentum of the second object, we will have:

$$\vec{P}^{(2)}(t|t \geq t_1) = \vec{P}^{0(2)}(t|t \geq t_0) + \Delta\vec{P}^{(2)}(t|t \geq t_1)\ ; \qquad (2.3)$$

Where, $\Delta\vec{P}^{(2)}(t|t \geq t_1)$ - a change in momentum resulting from the impact of an observed action on a second object. The magnitude of this change is uncontrollable and remains "unknown" to the "observer," whether that "observer" is a human or a measuring instrument. Consequently, from the numerical value of $\vec{P}^{(2)}(t|t \geq t_1)$, we cannot reconstruct the magnitude of the impulse $\vec{P}^{0(2)}(t|t \geq t_0)$, which existed before the observation, and accordingly, we cannot reconstruct the magnitude of the impulse $\vec{P}^{0(1)}(t|t \geq t_0)$. The self $\vec{P}^{(2)}(t_1)$ - due to the uncontrolled $\Delta\vec{P}^{(2)}(t|t \geq t_1)$-impulse entering it , must be considered as a random variable. Similarly, the results of measurements of all quantum mechanical characteristics should also be considered as random variables, which is the essence of quantum mechanics (for more details, see [3]).

As we noted in [3], for "Large and Heavy" objects, it is always possible to find such an act of measurement, that the condition $|\Delta\vec{P}| \ll |\vec{P}|$ is met. For this reason, in classical mechanics, the quantitative difference between the relations (2.1) and (2.2) is so insignificant that it is quite permissible to neglect it. Due to the inertia of thinking associated with the concepts of classical mechanics, Schrödinger also ignored the argument indicated by Bohr - in the case of micro-objects, the neglect of the value $\Delta\vec{P}$ - corresponding to the "observer factor", is impossible, and the quantitative difference between the ratios (2.1) and (2.2) takes on a fundamental character. It is for this reason - the results of observation of objects in the microcosm always represent random variables. Failure to take this detail into account led Schrödinger to an erroneous logical conclusion. Let us describe the logic of this conclusion: according to the concepts of quantum mechanics, the result of measuring the momentum of quantum objects is a random variable, and as a result of its measurement, the corresponding quantum state of the object is formed. Therefore, when the impulse state of the second object is formed, which corresponds to the measured momentum - $\vec{P}^{(2)}(t_1)$, for the first object, the formation of an appropriate state must also occur, which will ensure the fulfillment of the law of conservation of momentum after the act of measurement. Accordingly, when two non-proactive objects are in the same quantum state in which the law of conservation of momentum operates, the measurement and fixation of the momentum value of one object should cause the corresponding information to propagate instantaneously and reflect on the quantum state of the second object. He called the corresponding physical state "Quantum-Entangled", and the phenomenon that ensures the implementation of conservation laws was called "Quantum Entanglement".

It is easy to think that if the "Observer Factor" is correctly taken into account, Schrödinger's assertion becomes completely unfounded, and in reality - there is no need for "terrible Long-range Action".

As already noted, Bohm tried to circumvent Bohr's arguments and instead of measuring continuous values of momentum, he introduced the observation of spins. The essence of the advantage of considering this problem is related to the discrete numerical values of the spin. Presumably, according to Bohm, the numerical values of the discrete spectrum of the spin characteristic are not subject to change under the uncontrolled influence caused by the "Observer Factor". Therefore, in this case, Bohr's arguments should not be effective either. To clearly indicate the imaginary nature of this advantage, let us briefly describe Bohm's "Puzzle example": a quantum object with zero spin decays into two objects with half-integer spin at a t_0 moment of time, and in the process of decay, the law of conservation of spin operates:

$$\vec{S}^{(0)}(T|T \leq t_0) = 0 = \vec{S}^{0(1)}(t|t \geq t_0) + \vec{S}^{0(2)}(t|t \geq t_0) \; ; \tag{2.4}$$

$\vec{S}^{(0)}(T|T \leq t_0)$ - is the spin vector of the original object that existed before the decay; $\vec{S}^{0(1)}(t|t \geq t_0)$ and $\vec{S}^{0(2)}(t|t \geq t_0)$ are spin vectors of objects obtained as a result of decay. Until the observation act, we do not know in which direction the spin vectors of these objects are oriented. What we do know is that they are opposite directions. Since the spin components of one object are not at the same time precisely measurable quantities, by analogy with the measurement of momentum - for one object we measure one component of the spin, and for the second object we measure the other component of the spin. As a result of the measurements, the first object will form a quantum state corresponding to its measured component, and the second object will form a quantum state corresponding to its measured component. If we apply the relation (2.4), without destroying the already existing state of the first object, it will be possible to specify the second spatial component of the spin vector of the same object. If we measure the Z-component spin of the first object and get $S_{(z)}^{(1)}$ = 1/2, and measure the X-component of the second object and get $S_{(x)}^{(2)}$ = 1/2, then, using (2.4), we will restore the numerical value of the X-component of the spin of the first object $S_{(x)}^{(1)}$ = -1/2, which contradicts Heisenberg's uncertainty principle for spins. From Bohm's point of view, this once again confirms the inferiority of the description of reality by the principles of quantum mechanics, which has already been noted by the authors [2].

Bohm pointed out a possible reason for this inadequacy: when describing the microworld using the quantum-mechanical method, just as when describing reality using the thermodynamic method, it is possible that in this case, too, there are hidden variables, the knowledge of which would not require the use of a probabilistic method of description, nor the corresponding "quantum entanglement," nor "spooky action at a distance," since everything would be explained and described by the classical cause-and-effect picture.

It should be noted that the details of the hidden variables are not actually essential to the logic of explaining the nature of "quantum entanglement," so we'll consider them later. For now, let's focus on the details that are relevant to the question at hand.

According to the principles of quantum mechanics, in the results of the act of measurement, the numerical values of the components of the spin vector are random variables. Despite this, we can still say the following: if two objects - obtained in the decay process of one object with zero spin - are passed through a common field created by Stern-Gerlach magnets, we can say in advance that if the trajectory of one of them deviates in one direction, the second will deviate in the opposite direction. This means that if for one of them there is a fact of trajectory deviation - corresponding $S^{(1)}_{(z)}$ = 1/2, then for the second one there will be a fact - corresponding $S^{(2)}_{(z)}$ = (-1/2). Similarly, if for one of them an empirical fact is observed - corresponding $S^{(1)}_{(z)}$ = (-1/2), for the second one there will be a fact corresponding $S^{(2)}_{(z)}$ = 1/2. Our goal is to find out whether this circumstance corresponds to Schrödinger's phenomenon of "Quantum Entanglement". To answer this question, it will be convenient to return to the classic case of coins considered in Part I of the text, which we will do in the next subsection.

3 - The Classic Analogy of "Quantum Entanglement"

As has already been noted repeatedly in previous parts of the text, according to Bohr's principle: for an observer with macroscopic dimensions, it is fundamentally impossible to observe objects in the microcosm using "soft methods". Therefore, it is very difficult to indicate classical analogues for quantum processes. However, when discussing this issue, it should also be taken into account that - one of the principles of constructing quantum theory is the so-called "**Principle of Correspondence**".

According to this principle:

Since macrocosmic objects are constructed through microcosmic objects, the laws of classical mechanics must be derived from the laws of the microcosm and, consequently, from quantum mechanics—by applying a certain limiting procedure. And between the two types of laws, the same inverse relationships must exist that exist between microcosms and macrocosms.

However, it is also clear that because of the "Observer Factor", we will never be able to carry out a direct empirical test of the adequacy of the classical analog to the quantum one. In spite of this, it should be possible to indicate certain indirect hints, since we still receive information about the processes of the microcosm only from macroscopically observable processes. This is all the more understandable when it comes to the correct application of the mathematical principles of probability theory. The phenomenon of "Quantum Entanglement" is also related to the principles of probability theory, and so adapting the related mathematical principles to examples of classical objects should not be too difficult. To this end, let's consider the events of a joint toss of two coins. Since the results of events are random, we can also introduce superposition state vectors for them that meet our expectations. In "game mode", the state vectors corresponding to coin flip events are written as follows (see Part III - [7]):

$$\psi^{(1)} = (1/\sqrt{2})\sum_{n=1}^{2}\psi^{(1)}_{[n]}\,; \qquad \psi^{(1)}_{[1]} = (1/\sqrt{2})\begin{pmatrix}1\\0\end{pmatrix}^{(1)}; \qquad \psi^{(1)}_{[2]} = (1/\sqrt{2})\begin{pmatrix}0\\1\end{pmatrix}^{(1)};$$

$$\psi^{(2)} = (1/\sqrt{2})\sum_{n=1}^{2}\psi^{(2)}_{[n]}\,; \qquad \psi^{(2)}_{[1]} = (1/\sqrt{2})\begin{pmatrix}1\\0\end{pmatrix}^{(2)}; \qquad \psi^{(2)}_{[1]} = (1/\sqrt{2})\begin{pmatrix}0\\1\end{pmatrix}^{(2)}; \qquad (3.1)$$

$\psi^{(1)}_{[n]}$ - is the state vectors of the first coin, and $\psi^{(2)}_{[n]}$ - is the state vectors of the second coin. The state vector of the two-coin system will be as follows:

$$\psi^{(1)(2)} = \psi^{(1)} \otimes \psi^{(2)} = \psi^{(1)(2)}_{[1][1]} + \psi^{(1)(2)}_{[1][2]} + \psi^{(1)(2)}_{[2][1]} + \psi^{(1)(2)}_{[2][2]} ;$$

$$\psi^{(i)\ (j)}_{[m][n]} = \psi^{(i)}_{[m]} \otimes \psi^{(j)}_{[n]} ; \qquad (3.2)$$

The condition for the completeness of mutually exclusive probabilities will be as follows:

$$< \overline{\Psi}^{(1)(2)} | \Psi^{(1)(2)} > = |\Psi^{(1)(2)}_{[1][1]}|^2 + |\Psi^{(1)(2)}_{[1][2]}|^2 + |\Psi^{(1)(2)}_{[2][1]}|^2 + |\Psi^{(1)(2)}_{[2][2]}|^2 =$$

$$= 1/4 + 1/4 + 1/4 + 1/4 = 1 ; \qquad (3.3)$$

The above ratios correspond to coins that are not related to each other in any way. To introduce the connection, we will assign a number (-1/2) to the coins on one side, and (1/2) on the other side. The state of the coin, when after tossing - in a stopped position, the number (1/2) is visible from above, is comparable with $\Psi^{(i)}_{[1]}$, and when it is visible (-1/2) - comparable with $\Psi^{(i)}_{[2]}$. Let's place these two coins close to each other in such a way that the number (1/2) is visible on the top side of both. In this state, we fasten the coins with some rigid binding structure, so that the connecting part does not cover the numbers written on the coins. If we perform the toss events of such a tightly coupled system, it is easy to understand that in the "game mode" the superposition state vector corresponding to full expectations will be:

$$|\psi^{(1,2)}_{\{1\}}\rangle = [|\psi^{(1,2)}_{[1,1]}\rangle + |\psi^{(1,2)}_{[2,2]}\rangle]/\sqrt{2} ; \qquad (3.4)$$

The corresponding condition of completeness has the form:

$$\langle\psi^{(1,2)}_{\{1\}}|\psi^{(1,2)}_{\{1\}}\rangle = 1/2 + 1/2 = 1 ; \qquad (3.5)$$

Similarly, we could make a hard link where one coin shows the number (1/2) and the other shows the number (-1/2). In this case, instead of (8) and (9), they would have:

$$|\psi^{(1,2)}_{\{2\}}\rangle = [|\psi^{(1,2)}_{[1,2]}\rangle + |\psi^{(1,2)}_{[2,1]}\rangle]/\sqrt{2} ;$$

$$\langle\psi^{(1,2)}_{\{2\}}|\psi^{(1,2)}_{\{2\}}\rangle = 1/2 + 1/2 = 1 ; \qquad (3.6)$$

Since these coins are no longer free, the superposition state vectors of these cases are also not represented as the tensor product of the corresponding superposition state vectors of the free coins specified in (3.2). It may seem that the state vectors $|\psi^{(1,2)}_{\{1\}}\rangle$ and $|\psi^{(1,2)}_{\{2\}}\rangle$ correspond to the mathematical realization of "Quantum Entanglement". In this regard, the first thing to note is that the phenomenon of "Quantum Entanglement" is defined for free objects, and not for interacting and even more so for rigidly connected objects. Accordingly, these mathematical parameterizations, only in that they are reduced superposition sums, are not facts indicating the "Quantum Entanglement" of coins. For greater clarity, we note that when the state - $|\psi^{(1,2)}_{[1,1]}\rangle$ is realized, random events are determined only by the outcome that corresponds to the pair (1/2; 1/2) - visible from above from both coins. The state $|\psi^{(1,2)}_{[2,2]}\rangle$ is implemented in a similar way in the case of the pair (-1/2; -1/2). The physical state of an individual pair is not formed as a result of the fact that the result of observing one coin induces the corresponding state of the second coin, but the state of both coins is formed simultaneously as a result of the existence of a rigid relationship, which is not directly related to the probabilistic nature of the above results. That is, the act of observation carried out on one coin is not the cause of the formation of the state of the second coin. Therefore, this case does not correspond to the phenomenon of Schrödinger's "Quantum Entanglement".

On the basis of the example considered, let us return to Bohm's "Pazzle".

4 – PROBABILISTIC SOLUTION OF THE "BOHM PUZZLE OF QUANTUM ENTANGLEMENT"

To solve Bohm's "puzzle", let's recall from the second part of the text - what the measurement of spin means. When we fix the z-component spin on an object with half-integer spin, it doesn't mean that we're measuring something that has a quantitative numerical size of (1/2). "Measuring the spin" of an object involves passing that object through an inhomogeneous magnetic field. As the flow of such objects passes through this field, the flow splits into two - and this is taken as an indirect empirical indication that the flow objects should be assigned a spin equal to 1/2. And that's only because, like orbital momentum, we assume that the eigenvalue spectrum in the case of spin is also calculated in increments equal to unity. Like orbital momentum, we believe that this characteristic is inherent in objects even before entering the field, and therefore we attribute it to objects in the free state. After that, we say that whatever the initial direction of the object's spin vector is before entering the inhomogeneous magnetic field, after entering the field, the spin vector will take such a spatial position that its one component – conditionally the Z-component, can occupy only two possible states – either in the direction of the field lines of force, or opposite. It is as if the act of spin fixation implies a spatial, i.e. - mechanical, rotation of the spin vector (see Part II-[8]). Obviously, such a spin, in addition to a discrete quantitative characteristic, corresponds to a continuous characteristic – direction, which is why the spin vector was introduced. When discussing this characteristic of micro-objects, it is again necessary to use the characteristics introduced in the first part of the text: **the spin vector before the observation corresponds to the "object for itself", and the result of observation of the spin vector corresponds to the "object for us".** The law of conservation of spin, which we have mathematically written in form (2.4), applies only to objects that exist before the act of observation. Like the impulses from the "EPR Paradox", before the act of observation, the spin vectors of the objects, produced as a result of decay, are located along the same line and are mutually opposite. In principle, we will never be able to determine empirically what spatial orientation this line has, since the result of empirical observation to fix the direction of the spin vector depends only on what physical characteristics the magnetic field in which we must pass these objects has. As a result, we do not determine what direction the spin vector had before entering the magnetic field, but only what positions the z-components of these vectors will occupy as a result of entering the magnetic field. We can consider the case when these particles are produced directly in the inner region of the Stern-Gerlach magnets. When moving in a magnetic field, their trajectories are deflected either in the direction of the Z-axis or in the opposite direction. As we noted in Part II, according to our ideas about spin, the trajectory of the object whose spin vector is an acute angle with the positive direction of the Z-axis is deflected in the opposite direction of this direction, and the trajectory of the second object is deflected in the positive direction of the same axis. This means that for one object, the state corresponding to $S_z^{(1)}$= (1/2) is realized, and for the second object, the state corresponding $S_z^{(2)}$ = (-1/2) is realized. In a probabilistic space, a state vector must be assigned to the specified physical state:

$$|\psi_1\rangle^{(1)(2)}_{(z)(z)}\rangle = |1/2\rangle^{(1)}_{(z)}\rangle \otimes |\text{-}1/2\rangle^{(2)}_{(z)}\rangle \; ; \qquad (4.1)$$

Like rigidly bound coins, this "Entanglement" is provided not by the phenomenon of chance corresponding to the act of observation, but by the spatial orientation of the spins that exist before the act of observation, and by the specifics of the interaction of the spin magnetic moment with an inhomogeneous magnetic field. To understand the essence of this statement, let us find out what the phenomenon of randomness is in these processes. To do this, the decay event of the initial object with zero spin - repeat macroscopically identical and see what happens. Obviously, we will again see two trajectories deflected in mutually opposite directions, but these trajectories can correspond to objects either in the state specified in (4.1) or in another case, which corresponds to the state vector:

$$|\psi_2\rangle^{(1)(2)}_{(z)(z)} = |\text{-}1/2\rangle^{(1)}_{(z)}\rangle \otimes |1/2\rangle^{(2)}_{(z)}\rangle\ ; \tag{4.2}$$

Since we cannot specify the direction of the z-component of the spins of these objects before entering the external field, it is obvious that the physical states corresponding to (4.1) and (4.2) must be regarded as mutually exclusive alternatives to the random event. As we noted in Part III, from the point of view of the principles of probability theory, it does not matter whether we can distinguish these objects from each other or not. The corresponding probability amplitudes, that is - the state vectors, must be mutually orthogonal, as implied in (4.1) and (4.2). That is, like rigidly coupled coins, the paired combinations represented by $|\psi_1\rangle^{(1)(2)}_{(z)(z)}$ and $|\psi_2\rangle^{(1)(2)}_{(z)(z)}$, represent mutually exclusive alternatives. In this respect, this physical circumstance is similar to the case of rigidly bound coins, although not completely. A demonstration of this is easily possible if we carry out the act of production of these objects outside the Stern-Gerlach installation and later place one of the objects in the magnetic field of the said installation. As a result, we will see that the trajectory of this object is deflected either along the field lines or oppositely. Let's say it deflected along the field, which means that when passing through the field, the third component of the spin of this object acquired an orientation corresponding to S_z = (-1/2), that is, it was in a state corresponding to - $|1/2\rangle^{(1)}_{(z)}$. As we noted above, with the help of this information, we cannot reconstruct any component of the spin vector $\vec{S}^{0(1)}(t|t \geq t_0)$ of this object, since due to the "Observer Factor" the ratio is valid:

$$\vec{S}^{(1)}(t_1) = \widehat{\mathrm{O}}(\vec{B})\ \vec{S}^{0(1)}(t_1)\ ; \tag{4.3}$$

Where - $\widehat{\mathrm{O}}(\vec{B})$ corresponds to the "Rotation Operator" of the spin vector by the magnetic field $\vec{B}$. In this "Operator" -$\widehat{\Delta(\vec{B})}$, the effect of the magnetic field on $\vec{S}^{0(1)}(t_1)$, enters in the form of an uncontrolled disturbance :

$$\widehat{\mathrm{O}} = 1 + \widehat{\Delta}(\vec{B})\ ; \tag{4.4}$$

The meaning of which is very simple - since we cannot observe either the spin vector or the possible mechanical rotation of the spin vector of the object, the operator $\widehat{\Delta}(\vec{B})$ corresponding to this act, also corresponds to an operation that is uncontrollable for us. Like the example with the momentum considered in the first part of the text, and in this case - the fixation $S_z^{(1)}(t_1)$= (-1/2), we will not be able to reconstruct the direction of the vector $\vec{S}^{0(1)}(t_1)$. The act of the decay process causes the relation (4.4) only for the spin vectors $\vec{S}^{0(1)}(t|t \geq t_0)$ and $\vec{S}^{0(2)}(t|t \geq t_0)$, which is disturbed at the moment t_1, as a result of the action of the relation (4.3). The spin component of the first object - $S_z^{(1)}(t_1)$, will be established along the lines of force of the magnetic field gradient, but how the other two components will change will be uncontrollable and therefore incomprehensible to us. The only thing we can say about these components is that if $S_z^{(1)}(t_1)$ = (-1/2), then the sum of the squares of the corresponding **X** and **Y** components will be – [(1/2)(1/2+1) – 1/4] = 1/2, but we cannot know what the values of the components themselves will be. If - in parallel with this, at the moment of moment - t_2, we measure the component $S_x^{(2)}(t_2)$ of the spin vector of the second object, then as a result of the action of the corresponding magnetic field, the direction of the vector $\vec{S}^{0(2)}(t|t \geq t_0)$ will also change uncontrollably. That is, the value of $S_x^{(2)}(t_2)$ will have nothing in common with either $S_z^{0(2)}(t|t \geq t_0)$ and $S_z^{0(1)}(t|t \geq t_0)$ - which existed before the measurement, and even more so with $S_z^{(1)}(t_1)$.

Based on all of the above, we can conclude that, as in the case of the "EPR Paradox", in the case of spins, there is no logical argument on the basis of which we could speculate about the existence of the phenomenon of "Quantum Entanglement" and the need for the existence of a "Terrible instantaneous Long-range Action" to fulfill the law of conservation of sumar spin characteristics. Based on the examples considered, we can unequivocally say:

No empirical fact and related mathematical principles require the existence of the Schrödinger phenomenon of "Quantum Entanglement," which implies the need for instantaneous dissemination of information. Due to the non-existence of this phenomenon, it will also be impossible for quantum computers to create an "instant computation" mechanism based on this phenomenon.

5 – Bohm's Hidden Variables and Bell's Rebus

As mentioned above, Bohm pointed to the possible existence of hidden variables as a possible reason for the inferiority of the quantum mechanical description. As an analogy for this possibility, he pointed to the thermodynamic description of some physical realities. The essence of the analogy was as follows: in the method of thermodynamic description we say that the motion of individual molecules of the described medium is controlled by deterministic laws, and the corresponding description of the motion of a large number of molecules of this medium is also possible in principle. However, this task is difficult to implement only because the corresponding mathematical algorithms have not been developed. Therefore, in order to simplify the description, we prefer to introduce and use the appropriate “mechanical techniques" of statistical methods (see Part I). In these mechanical "tricks", the coordinates and momenta of individual molecules appear as some hidden variables, the ignorance of which makes the statistical method of describing reality incomplete.

According to Bohm's assumption, the quantum-mechanical description may also be incomplete due to the fact that in the case of the microcosm, too, there are similar "hidden characteristics" and associated "Hidden Variables" that we cannot observe and take into account due to their small size. This creates a lack of information that forces us to move to random variables and leads us to inferiority in quantum mechanical description.

This statement should be partially accepted, since the statistical method of description does imply the fact that there is a lack of information. In the case of quantum mechanics, however, this drawback is not due to the possible existence of unknown hidden variables, but to an objective reason caused by the large differences in scales between the observer and the observed, which gives rise to the phenomenon that Bohr called the "Observer Factor."

On the other hand, as we noted in Part-I of the text, the fact that in the fixed quantum state of a micro-object we cannot specify the numerical values of the coordinate and momentum at the same time does not mean that these micro-objects do not have these characteristics at the same time. The fact of ignorance, resulting from the impossibility of indicating these quantities, must indeed cause random results of events and, consequently, the use of statistical methods of description.

However, Bohm, apart from the general analogy with thermodynamics, did not specify what types of physical quantities should be implied behind the "Hidden Variables" - coordinates and momentum, or something else.

Here we note that ignorance and impossibility of accurate and simultaneous fixation of momentum and coordinates cannot be the cause of the phenomenon of discreteness of the energy levels of the atom. Therefore, even without a lack of information, we could assume that there may indeed be some characteristics, both static and dynamic, whose existence we do not notice at the micro level, and perhaps that is why we cannot correctly explain the facts observed at the macro level.

The best example of this is light, which we have established to be a stream of corpuscular photons rather than a real physical wave structure continuously distributed in real space. But, despite this, when describing some physical realities, we still often use the wave representation as if these waves really exist. As a result, in the quantum-mechanical description of the microcosm, it is necessary to make false statements (see [9]).

It is also possible that we are making a mistake when we assert that fundamental particles are pointed, and we need to take a closer look at the ancient Greek statement: at a point with zero volume, there is a zero amount of matter, which should be a sign that the existence of matter does not correspond to zero volume. The phenomenon of the existence of matter in zero volume can never be observed directly, and only by indirect signs can we speculate about the existence of matter in such forms.

Perhaps it would be better to use the ancient Greek consideration of the need to assign to observable physical objects the minimum permissible spatial sizzes, which in Newtonian mechanics were called corpuscles. This would significantly change the problems of extended objects in classical mechanics, the representation of which is now reduced only to modeling - by counting sets of material points and the corresponding integral representations.

However, along with all this, it should also be noted that whatever types of quantities we mean behind hidden Bohm variables, their existence or non-existence cannot necessitate the introduction of the phenomenon of "Quantum Entanglement" into quantum mechanical descriptions. Such a necessity simply does not exist, and the question comes down only to the correct consideration of the "Observer Factor" and the correct application of the principles of probability theory.

It should be noted that our statement contradicts the "general line" of physics ideas formed in recent decades, according to which the existence of "Quantum-Entangled" photons is considered an empirically proven fact and "which creates a great arena of innovation in computer science" (see, e.g., [10]).

The formation of such an idea was facilitated by the publication of J. Bell, published in 1964 (see [6]). In this work, the author introduced mathematical inequalities, which, allegedly, in the case of the existence of hidden variables, should be imposed as physical constraints on random variables and their corresponding probabilities.

However, the mathematical relations that Bell introduced in his reasoning are so far from correct interpretations of the elements of the probability space that not only the status of his conclusions becomes incomprehensible, but also the interpretation of the essence of individual mathematical expressions.

Unfortunately, no one among the theorists of physics paid attention to these details, and as a result, these relations passed into experimental physics as theoretically reasoned.

Despite our assessment of Bell's claims, it is quite obvious that even without any assessment, it is impossible to prove the existence of "quantum entangled" photons by satisfying or violating any inequalities, since the phenomenon of "quantum entanglement" itself is a theoretical product, erroneously introduced into theoretical reasoning.

The solution of this experimental puzzle is also not difficult, and the point is as follows:

1) The main assertion of Bell's work is the conclusion: if the inequalities he introduced hold, then hidden variables exist and quantum mechanical randomness does not represent a characteristic of reality, and the reality of the microosm is strictly deterministic. Quantum randomness, however, arises solely from ignorance of information about these hidden variables.

2) On the other hand, if these inequalities are violated, this means that no hidden variables exist, and quantum randomness represents direct characteristics of the microworld. Accordingly, if we empirically discover a violation of these inequalities, this will be empirical proof that all the principles of quantum mechanics are empirically justified. And since the existence of the phenomenon of "quantum entanglement" follows from these principles, it follows that experimental verification of these inequalities makes it possible to prove the existence of the phenomenon of "quantum entanglement".

An attentive reader will easily understand the fallacy of this logical chain - empirical evidence of the principles of quantum mechanics does not at all follow from proof of the existence of the phenomenon of "quantum entanglement".

Therefore, it must be clearly stated that the "general line" formed in recent decades in the ideas of physics requires a critical reassessment. And on the basis of the phenomenon of "Quantum Entanglement", a "great arena of innovation" does not arise in computer science.

CONCLUSION

In our five-part text, we discussed several "Quantum Phenomena" that do not really exist and are only theoretical products based on misinterpretations of the physical and mathematical principles of quantum mechanics.

These misinterpretations are, of course, also based on subjective factors, but it would be wrong to think that subjective factors can cause serious problems for fundamental physics. Like the processes in all large statistical sets, the processes in large societies of people—including science—are governed by the "laws of large numbers," not by the subjective factors of individuals.

Since the 19th century, the number of members of scientific communities, including the physics community, has grown steadily and continues to grow. On the one hand, this makes it possible to constantly increase the number of new results, but as a result - information flows also grow exponentially. In such a situation, the tools that were used to separate reliable information from unreliable information before such a surge in information flow can no longer function successfully in the new reality created by this surge, and it becomes impossible to effectively separate reliable information from unreliable information.

To this should be added a significant factorization of physics into experimental and theoretical parts, which is due to the introduction of complex experimental and mathematical tools into these specialties. As a result, it is difficult for a theorist to understand the essence of the details of the experiments being conducted, and it is difficult for an experimenter to understand the mathematical details of theoretical concepts being created. In such circumstances, the possibility of positive mutual criticism of these two specialties is significantly weakened, and the instrument of "empirio-criticism" cannot function effectively. Without this, the development of the natural sciences becomes very difficult, and in some cases - impossible. This is the same objective and fundamental problem as the "Observer Factor" considered, which is not conditioned by the subjective factors of the observer.

In the context of globalization, when communication is also growing greatly and information technologies are developing significantly, a significant increase in information flows automatically causes significant problems. To effectively solve such problems, it will be necessary to periodically turn on the tool of "empirio-criticism". That is, on the one hand, from the standpoint of theoretical physics - to critically revise phenomenological assessments of empirical data and conclusions drawn on the basis of these assessments; on the other hand, using empirical data, critically analyze the mathematical principles introduced into theoretical physics to describe these data.

As the past two-hundred-year experience shows, it is desirable that this happens every 50 years, because it is during this time that myths are born, which develop and begin to create problems.

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