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CRITICAL REVIEW OF FUNDAMENTAL CONCEPTS IN PHYSICS Part 3 – "Quantum Discreteness"

By

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Abstract
The idea of "quantum computers" states that discrete states of quantum objects can be used to create information bits. In this part of the text we show that the practical implementation of such ideas is impossible, since the arguments put forward as a basis for such a realization contradict the principles of quantum mechanics. Our claims are based on a deep analysis of the physical phenomenon of spin. In particular, below we analyze in detail what the random nature of quantum properties means in the case of spin. To this end, we analyze both the empirical data obtained as a result of the Stern-Gerlach experiment and the scientific reliability of the conclusions based on this incomplete information. A critical assessment of the physical concepts built on these conclusions is carried out, and an experiment is indicated as a result of which the essence of the random nature of the quantum property of spin should be investigated more fully.

Keywords: *quantum computer; Stern-Gerlach experiment; spin characteristics; fundamentally quantum-random variables*

Introduction

Let us begin the analysis with a note: to create an information bit, it is necessary to have two fully controllable discrete physical states connected by a mechanism of mutual exclusion. By control we mean the following: these states must be able to be turned on and off in such a way that when we turn on one state, it must remain on until we turn it off, and turning off this state must automatically turn on the second state. Our goal is to analyze whether it is possible or not to create such controllable mechanisms using discrete quantum states. For example, when we "turn on" the state $S_z = 1/2$ for a particle with half-spin, it should remain in this same state until we "turn it off." And when we "turn it off," the state $S_z = -1/2$ should "turn on." To determine how feasible this is, it will be necessary to discuss in detail the properties of spin characteristics.

Let us list the statements that will be considered in this part:

1. Is the magnitude of the spin vector a quantum characteristic, the result of observation of which should be a fundamentally random variable?

Answer - according to the principles of quantum mechanics, the results of observation of the physical characteristics of a quantum object, which can change in dynamics - should be random variables. Therefore - the result of measuring the spin characteristic should be a random variable.

2. Do the results of the Stern-Gerlach experiment represent direct proof that the results of observing spin characteristics are fundamentally quantum-random? Answer - no, they do not.
3. Can it be empirically shown that spin characteristics are fundamentally quantum-random variables? Answer - yes, and for this, the polarized streams obtained in the Stern-Gerlach experiment need to be passed again through a macroscopically analogous magnetic field. If individual polarized streams do not split into two, then the spin characteristic will not be quantum-random but rather a polarization-deterministic variable. If the stream splits into two again, then the spin characteristic will be fundamentally quantum-random.

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4. By what principle will an "information bit" generated by a "quantum transistor" of a half-spin qubit work - by the principle of quantum randomness or polarization determinism? Answer - according to the principles of quantum mechanics, both the "quantum transistor" and the "quantum computer" will have to work by the principle of quantum randomness.

Chapter I: “Spin” - Brief History

From a historical perspective, the most famous proof of the existence of spin is the Stern-Gerlach experiment (see (Gerlach et al, 1922)). At the time this experiment was conducted, no one knew about the existence of the spin phenomenon, and the experiment's goal was to observe and verify a completely different phenomenon. Namely, from the "planetary model" of the atom, the existence of spatial discreteness of orbits followed. And if such discreteness really existed, then the phenomenon of orbital momentum discreteness should also exist. From this model, it also followed that some electrons moving in atomic orbits could have zero orbital momentum (see, for example, (Sommerfeld, 1923)), which caused great doubts - how can one assign a zero numerical value to the orbital momentum of an object moving in an orbit? At the initial stage of introducing this phenomenon into reasoning, it was perceived only as a mathematical abstraction that made it possible to perform mathematical calculations. But Stern had an idea - perhaps this mathematics corresponds to a real physical phenomenon, and the "Stern-Gerlach experiment" was aimed at testing precisely this idea. For this, a stream of silver atoms, obtained as a result of thermal emission, was passed through an inhomogeneous magnetic field. The interaction with the inhomogeneous magnetic field of the magnetic moments of electrically neutral silver atoms, created by the orbital moments of the constituent parts of the atoms, should have caused changes in the trajectories of the atoms in the stream. Among the many discrete trajectories, it was particularly interesting to observe those that would not change direction, which would correspond to zero orbital angular momentum. The experiment found that the original stream split into two, confirming the fact of spatial discretization.

The obtained result indicated that the silver atom possesses a strange property - in an external magnetic field, the atom's magnetic moment acquires only two opposite directions. For some time, this result was among the unexplained results since the number of trajectories - two - contradicted both zero and other integer values of orbital momentum. Although no one paid attention to this, since the main goal was achieved - the existence of the spatial discretization phenomenon was shown.

Several years after this experiment, the idea of the existence of a strange magnetic moment was recorded in a scientific publication by Uhlenbeck and Goudsmit (see (Uhlenbeck et al, 1925)). On Uhlenbeck's initiative, this strange magnetic moment was called spin. The name came from the idea that, despite its strangeness, this magnetic moment should be attributed to the electron as if the electron performed some kind of intrinsic rotation, like an extended object. It should be noted that the idea of spin was connected with studies of atomic spectra, not with the result of the Stern-Gerlach experiment. A year before this publication, Pauli's article was published in which he pointed out the possible existence of a strange property of electrons that induced the presence of the phenomenon of exclusion of electrons in atomic orbits.

As Goudsmit describes in his memoirs (see (Gaudsmit, 1967)) - Uhlenbeck and he did not fully believe in the validity of spin ideas and asked Ehrenfest not to send their manuscript for publication. But as it turned out, Ehrenfest had already sent the text to the journal, and thus (Uhlenbeck et al, 1925) appeared. And as it turned out later, the idea of spin proved to be the key both for explaining Pauli's exclusion phenomenon and for explaining the spatial discretization phenomenon.

Since the electron was considered a point object and could not perform intrinsic rotations, the idea of spin raised questions. Nevertheless, this idea firmly remained in quantum mechanical concepts, with one caveat - the electron does not actually rotate, but as if it rotates. For this characteristic to interact with a magnetic field having a vector nature, this two-component spin momentum was attributed the same vector nature as ordinary orbital momenta. According to the principles of quantum mechanics, spin was associated with a corresponding operator whose algebraic properties are connected with the same spatial rotation group with which orbital momenta were connected. As a result, in the discretization of spin numerical values, a unit step mechanism was introduced, based on which - with a numerical value of the spin parameter $S = 1/2$, a two-component spin state was generated. The spin operator was represented as:

$$\hat{\vec{S}} = \vec{e}_x \hat{S}_x + \vec{e}_y \hat{S}_y + \vec{e}_z \hat{S}_z \; ; \qquad (1)$$

$\{\vec{e}_x; \vec{e}_y; \vec{e}_z\}$ are the unit vectors of physical space, and $\{\hat{S}_x; \hat{S}_y; \hat{S}_z\}$ are the spatial components of the spin operator. These operators satisfy the commutation relations:

$$\hat{S}_x \hat{S}_y - \hat{S}_y \hat{S}_x = \text{ih}\, \hat{S}_z \; ;$$
$$\hat{S}_y \hat{S}_z - \hat{S}_z \hat{S}_x = \text{ih}\, \hat{S}_x \; ;$$
$$\hat{S}_z \hat{S}_x - \hat{S}_x \hat{S}_z = \text{ih}\, \hat{S}_y \; ;$$
$$[\hat{\vec{S}}^2, \hat{S}_x] = [\hat{\vec{S}}^2, \hat{S}_y] = [\hat{\vec{S}}^2, \hat{S}_z] = 0 \; ; \qquad (2)$$

Consequently, in fixed quantum states, only the eigenvalue of $\hat{\vec{S}}^2$ and any one component can be simultaneously specified. If we realize the spin operators using matrices, we get the so-called Pauli matrices, and in this case, the operators $\hat{S}_i$ commute not only with the operator - $\hat{\vec{S}}^2$, but also with the squares of individual components, since these quadratic operators are proportional to the identity matrix and equal to each other:

$$\hat{S}_x{}^2 = \hat{S}_y{}^2 = \hat{S}_z{}^2 = \lambda^2 \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} =$$
$$= (1/4)\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}; \qquad (3)$$

Note that these relations do not correspond to the physical requirements we introduced and arise only as a result of the

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matrix realization of spin operators. In this respect, spin matrix operators differ from orbital momentum operators, in the case of which relations analogous to (3) are not realized. For recording the eigenvalues of $\hat{\vec{S}}^2$, a parameterization analogous to the eigenvalues of orbital momentum is used:

$$\hat{\vec{S}}^2 = S(S+1)\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}; \qquad (4)$$

Half-integer spin is called when the vector length equals $|\vec{S}| = \sqrt{S(S+1)} = \sqrt{3}/2$. In this case $\lambda = \pm 1/2$ and $S = 1/2$. As usual, jointly with $|\vec{S}|$, the Z-component is chosen as measurable, whose numerical values can be $S_z = \pm 1/2$.

Using such a physical characteristic, the result of the Stern-Gerlach experiment is also interpreted, but the theoretical justification for this is not simple, since the silver atom consists of many electrons, protons, and neutrons, and each of them needs to be attributed the same spin characteristic as the electron in orbit. Under these conditions, the full magnetic moment of the silver atom should remain two-component. The reliability of arguments in favor of such a possibility raises many questions, and moreover, we were unable to determine whose idea it was to explain the splitting of the silver atom stream in the Stern-Gerlach experiment through the spin of the electron in the outer orbit of the silver atom. Through various considerations, corresponding theoretical arguments were improved, and a certain representation was formed, which is indicated in quantum mechanics textbooks. Using (Sakurai, 1985) as an example, let us briefly describe the argumentation of this idea and evaluate its scientific status: The silver atom consists of 47 electrons, 47 protons, 61 neutrons, and each is attributed spin S = 1/2. To interpret the result of the Stern-Gerlach experiment with high reliability, it is necessary to show that the total spin of the silver atom will effectively correspond to the spin value at S = 1/2, and the magnetic moments corresponding to the orbital moments of the system components either do not affect the atom's trajectory at all, or if they do affect it, then so insignificantly that they can be neglected. For this, we would have to solve the Schrödinger equation corresponding to the bound state of the silver atom, which is impossible within the mathematical methods at our disposal. When describing discrete levels of multi-particle systems, a simplified analogy rule is used - the energy levels of a multi-particle bound system are constructed and ordered according to the same principles as the energy levels of a two-particle hydrogen atom, and the same rules describe the discrete energy levels of the silver atom. Obviously, this rule does not have high scientific status. The Pauli Exclusion Principle is added to the mentioned rule, with which atomic levels are constructed. Within these rules, the following representation of the silver atom structure has formed: 46 electrons of the silver atom completely fill four energy levels. The last 47th electron is located in the first orbital of the fifth energy level, which corresponds to the so-called S-term. The filling of each energy level begins with zero numerical value of orbital momentum and continues toward increasing its numerical value. The filling of the fifth level begins precisely with the last – 47-th electron, so it is attributed zero numerical value of orbital momentum. It is assumed that when moving in orbitals, all 46 electrons at four filled levels combine into Pauli pairs with $S_z = \pm 1/2$ in such a way that their total orbital moments in pairs are either equal to zero or very close to zero. According to the same Pauli principle, the total spin magnetic moment of two electrons combined in Pauli pairs is also equal to zero. And if we try to account for the effect of spatial separation of electrons in a pair, we can say that the total moment of two electrons is effectively close to zero since the Z-components of their spins are equal and oppositely directed. Although we know very little about the mechanism of strong nuclear interaction, the same considerations apply to protons and neutrons in atomic nuclei, and the total spin of the silver atomic nucleus is either assumed equal to zero, or due to the large masses of these components, the corresponding magnetic moment is quantitatively assumed very small. Both these assumptions are supported by arguments of rather low reliability. In particular, the Pauli Exclusion Principle applies to identical fermions in the same state. Separately, 46 protons and separately 60 neutrons can be considered as combining into Pauli pairs, but the 47th and 61st neutron cannot combine into a Pauli pair since they are not identical to each other. Therefore, equating their total spin to zero is not supported by real arguments. As for the significant mass of protons and neutrons compared to the electron mass, due to which the spin magnetic moments of protons and neutrons should be proportionally smaller than the corresponding magnetic moments of electrons, at first glance this argument looks logical. But it must be taken into account that when the 47th electron - as a result of the interaction of its spin magnetic moment with an inhomogeneous external field, changes the trajectory of the silver atom, its mass is effectively replaced by the total mass of the entire atom. Therefore, the statement based on the above arguments - that the magnetic properties of a neutral silver atom are mainly determined by the spin magnetic moment of the outer electron - is also not based on arguments with high scientific reliability. However, we will remain within these statements and continue analyzing the results obtained in the Stern-Gerlach experiment in the existing format.

Chapter II: Interpretation of Stern-Gerlach Experiment Results

As we already noted in the previous chapter, we will adhere to the statement that the magnetic properties of the silver atom are determined by the magnetic properties of the 47th electron located in the "S-term" of the fifth energy level. And since the orbital momentum of S-terms is considered equal to zero, the result of the Stern-Gerlach experiment is explained by the following statement: the deflection of silver atom trajectories is due to two possible numerical values of one component of the electron spin vector. As usual, this component is chosen quite arbitrarily as the third, i.e., the Z-component of the spin vector. If the silver atom has a spin magnetic moment $\vec{H} = -e\vec{S}/m$, and the external magnetic field strength vector equals $\vec{B}$, then the interaction potential is written as follows:

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$U = - \vec{B}\vec{H}$; (5)

If the direction of magnetic field inhomogeneity coincides with the Z-axis direction, a force will act on silver atoms:

$$F_z = -\frac{\partial U}{\partial z} = \frac{\partial \vec{B}}{\partial z}\vec{H}; \quad (6)$$

which will deflect the trajectories of silver atoms in the same Z direction. If the direction of the external field lines also coincides with the direction of the same Z-axis, then the force takes the form:

$$F_z = eS_z\frac{\partial B_z}{\partial z}/m; \quad (7)$$

Depending on the sign of the numerical values of S_z, we get two streams of atoms deflected in mutually opposite directions. In this case, the angle between the spin vector and the direction of the magnetic field lines will be:

$$\cos\phi = S_z/|\vec{S}| = \pm\sqrt{3}/3; \quad (8)$$

The angle value ϕ =arccos ($\sqrt{3}/3$) corresponds to the atom stream with S_z = 1/2, and ϕ =arccos ($-\sqrt{3}/3$) corresponds to the stream with S_z = -1/2. When realizing these values using Pauli matrices, the direction of the $\vec{S}$ vector turns out to be one of four possible ones, which in turn are determined by the numerical values $S_x = \pm 1/2$ and $S_y = \pm 1/2$. In this case, the directions of the $\vec{S}$ vector - although we cannot detect them in our observation acts, will have the same random character as the numerical values of S_z in this experiment.

For the correct physical interpretation of the Stern-Gerlach experiment result, it will be crucial to clarify what is meant by the statement about the random nature of the numerical values of spin components. To clarify this, in the next subsection we will turn to the principles of mathematical statistics, which should work equally in all mechanics - both classical and quantum.

Chapter III: Whether or Not Spin Measurement Results Are Random Variables

Although the spin characteristic was introduced into discussions based on phenomenological analysis of purely empirical facts, theoretical concepts of quantum mechanics, which were formed in the same period, played a large role in giving it physical essence. Below, we will analyze both the essence of this characteristic and the scientific reliability of physical arguments used in forming this essence. Let us start with a simple comparison: everyone agrees that the electron possesses mass, charge, and spin, the real existence of which can be observed in empirical facts. However, mass is in a somewhat exceptional position. In particular, the fact of its existence is revealed both in the case of freely moving "large and heavy" bodies and in the expression of potential energy corresponding to the law of universal gravitation. In the first case, mass is associated with the magnitude of inertia and therefore we call it "inertial mass." In the second case, it is present in gravitational interaction and therefore we call these masses "gravitational." After this, we say - studying many experimental facts, we could not find any difference between inertial and gravitational masses, and on this basis we introduced the principle of equivalence and identity of these two masses. This explains the participation of the same mass both in momenta and kinetic energies of freely moving bodies, as well as in potential interaction energies.

In the Coulomb interaction potential, the charges of objects participate in exactly the same way, and no one says that these charges - partially or completely - belong to the Coulomb field. Everyone says that these charges belong to corpuscular objects that carry them. Nevertheless, in mathematical expressions of freely moving charges - for example, in corresponding Lagrangians and Hamiltonians, charge - as a parameter of some physical characteristic, does not participate. We explain this by the fact that, on one hand, when a free electron moves, charge does not manifest itself anywhere, and on the other hand - and most importantly - there exist charges of opposite sign, the sum of which - in terms of interaction intensity (unlike masses), becomes smaller for the system of these charges than for individual parts of the system. This phenomenon is called "screening," and for describing dynamics, it is quite sufficient to indicate charges in the interaction potential.

Although the spin of a freely moving electron is also not observed, and as we indicated in the case of the silver atom - spins also exhibit "screening properties" in interactions, this characteristic was still attributed to the free electron. The main reason was that the goal of the Stern-Gerlach experiment was to study the phenomenon of orbital momentum discreteness. And this characteristic is defined exactly the same for freely moving objects as mass, coordinate, and momentum. Under the mentioned conditions, by analogy with orbital momentum, it seemed quite logical to connect the fact of stream splitting into two precisely with the phenomenon of magnetic moment discreteness. Therefore, precisely by this analogy, the spin characteristic was attributed to freely moving objects, which was mathematically realized by introducing multi-component state vectors. Thus, the spin characteristic became connected with the rotation group, which governs the number of spin vector components and the magnitudes of these components.

Our goal is to understand, at least partially, the physical nature of spin. Since we are dealing with a characteristic of micro-world objects, we will investigate the question from a statistical point of view and pose the question: what result will we get if we pass silver atom streams - formed in the Stern-Gerlach experiment - through the same inhomogeneous magnetic field in which these streams were formed? This question is discussed in some quantum mechanics textbooks (see (Sakurai, 1985), (Feynman et al, 1963)) and, based on the theoretical considerations presented there, it is considered that with repeated passage through macroscopically same magnetic field, the streams formed in the initial experiment will no longer split into sub-streams. It must be noted that, similar to the "EPR paradox," this question is also considered as a thought experiment. The main argument here is the idea of analogy - "as this happens in the case of polarized light

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streams." We will discuss the properties of light separately, and here we briefly note that, unlike the case of the electron, the spin property of photons does not correspond to a magnetic moment since the photon has neither mass nor electric charge. And the term "polarization" is so general that it can be used in describing completely different processes. Therefore, the analogy with light cannot be considered a high-level scientific assumption. However, let us still follow the arguments presented in these textbooks, according to which the spin characteristic is represented as a magnetic arrow-like structure that, when entering a magnetic field, begins to rotate and takes a certain spatial orientation. Let us assume that this theoretical assumption is correct, and if we observe one specific silver atom in repeated Stern-Gerlach experiments, according to the reasoning in (Sakurai, 1985) and (Feynman et al, 1963), we will get the following statistical picture: When we pass a stream of silver atoms through the first Stern-Gerlach apparatus, due to the thermo-emission origin of atoms, we do not know the initial spatial direction of their "spin arrows," and therefore these "directions for us" are random variables. It can be assumed that in the stream obtained by thermo-emission, the directions of "spin arrows" of atoms will be randomly distributed in space in all possible directions. When such a stream enters the inhomogeneous magnetic field of the Stern-Gerlach apparatus, the Z-components of "spin arrows" of one half of the atoms will align in the direction of field line gradients, and their trajectories will deflect in the opposite direction. The Z-components of "spin arrows" of the other half of atoms will be oriented in the opposite direction to field line gradients, and their trajectories will deflect in the direction of these lines. According to (Sakurai, 1985) and (Feynman et al, 1963), it should be assumed that after exiting the magnetic field, i.e., during free motion of silver atoms, the direction of the mentioned "spin arrows" remains unchanged and coincides with the direction acquired by silver atoms in the magnetic field. Let us try to find out what direction these "arrows" will actually have. If the magnetic field lines of the Stern-Gerlach apparatus at each point in space were directed strictly along the Z-axis, then it could be assumed that the "spin arrow" of a freely moving silver atom exiting the field would always be directed so that its Z-component remained unchanged. If silver atoms exiting this magnetic field enter the same inhomogeneous magnetic field, the initial direction of atoms' "spin arrows" will be the same as when they entered the magnetic field of the first device. Therefore, both streams will deflect only in the same directions as in the first case. This means that these polarized streams will no longer split into two sub-streams. In each subsequent macroscopic repeated experiment, stream deflection will always be in the same direction until the direction of silver atom momentum becomes so close to the Z-axis direction that after entering the Stern-Gerlach device, they collide with the apparatus magnets and cannot leave the device area. However, such repeated observation is not our goal anyway, since even one repeated experiment will allow us to draw a conclusion with sufficiently high reliability: If in a macroscopic repeated experiment the silver atom stream does not split into two streams, this means that the initial directions of Z-components of silver atoms' "spin arrows" either coincide with the gradient direction of the second apparatus's magnetic field, or are slightly deviated from this direction - by angles significantly smaller than $\pi/2$. And in this case, we will get deterministically repeating results in each act of such repetition - the stream will never split into two parts.

Let us analyze this problem more carefully and try to find out what picture may correspond to reality. It should be remembered that the correct conclusion can be obtained only as a result of a real experiment, not based on theoretical reasoning. Therefore, in our reasoning, we can only build assumptions: according to the "ideas of the Copenhagen School," when it comes to observations of a micro-object - "God always plays dice," and we cannot find such a "mechanical device" with which we could predict in advance the outcome of an action involving one micro-object. As we mentioned in the first part of the text (see (Baghaturia et al, 2025)) - the reason for this is fundamental and is called the "observer factor." According to the principles of quantum mechanics, the influence of an inhomogeneous magnetic field on the spin magnetic moment of a silver atom is, for us, a fundamentally uncontrollable action. Moreover, reasoning corresponding to the macroscopic picture of the experiment itself more than clearly indicates that, based on knowledge of the direction of magnetic field lines, we will not be able to indicate the direction of "spin arrows" of silver atoms exiting this field. The fact is that the spatial geometry of magnetic field line directions does not correspond to an "ideal box" inside which all field lines are directed along one specific spatial axis, and outside the "box" the field suddenly disappears like the walls of the box itself. We do not know the mechanism by which the magnetic field gradient "adjusts" one component of the spin magnetic moment along its field lines or in the opposite direction, but if we accept the position that this "adjustment" really occurs in the form of some physical rotation of the "arrow," then when the atom exits the magnetic field, the direction of the "arrow" will follow the direction of the gradient of boundary field lines. Considering knowledge about magnetic field lines, it is difficult to imagine that the direction of boundary field lines will be the same as the direction of field lines in the center of the magnet. Presumably, when moving away from the source, field strength should continuously fall to zero, and boundary field lines cease to be straight lines and will be strongly curved. From the point of view of macroscopic accuracy, the difference between these directions may be small - although this difference is macroscopically observable, but for micro-objects a simple empirical principle operates - what may be small and unimportant for "large and heavy" bodies is very large and very important for micro-objects. Quantum mechanics precisely arose as a result of this principle. Someone might have the idea to make a fairly long electromagnet and pass micro-objects through the field of such a magnet. And before these objects completely pass through the central region of the magnetic device, turn off the magnetic field so instantly that the objects do not have time to reach the boundary field lines. Anyone who has had even the

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slightest relation to electrical engineering knows perfectly well that the act of turning on and off creates very large uncontrollable inhomogeneities in fields, and what influence these changes will have on the spin polarization of objects is again beyond our control.

If our reasoning corresponds to reality (and most likely this is so), then the direction of spin polarization of a quantum object exiting the Stern-Gerlach device will turn out to be the same fundamentally random variable for us as the directions of coordinates and momenta of micro-objects during observations. Therefore, when silver atoms exit the first Stern-Gerlach device, we do not know what direction the "spin arrows" of atoms will have before entering the second device. It is difficult to imagine that electron spin behaves differently than all other dynamically changing characteristics. But if reality suddenly turns out to be as described in textbooks (Sakurai, 1985) and (Feynman et al, 1963), then spin physics will have to be transferred from quantum mechanics to classical mechanics, and substantial changes in quantum mechanical concepts will be required. Until this question is empirically clarified, it would be much more consistent - within quantum mechanics - to consider that spin is an ordinary quantum characteristic and the results of acts of its observation always have a random character.

Chapter IV: Spin as a Quantum Transistor?

As mentioned in the introduction to this section, our goal is to determine whether discrete quantum states can be used to create controllable information bits. To obtain a controllable information bit, corresponding quantum states must "turn on and off" just as in the case of an ordinary light bulb. Let us see what happens in the case of an ordinary light bulb: if in a dark room we switch the light bulb to the "on" state, it will remain in this state until we ourselves switch it to the "off" state. And no matter how many times we check whether the light bulb is "on" or not, it will always turn out to be "on" until we turn it off. Similarly, if we switch the light bulb to the "off" state, it will remain in the same state until we switch it to the "on" state. No matter how many times we repeat the indicated action and observe the results of these actions, we will always get the same deterministic result. These two mutually exclusive states of the mentioned device can be used to create a controlled information bit. For this, we need to be able to get information - whether the light bulb is burning or not. Our goal is to determine whether it is possible to create such controllable devices using discrete states of a quantum object.

Let us start with a simple remark: a device for storing information must be created by one specific quantum object, and the information bit recorded in it must be preserved by this same object for subsequent use. From this point of view, it would be convenient to realize the creation of an information bit in the case of a completely isolated quantum object. But in this case, it would be impossible to control the location of this object in space since when obtaining information corresponding to the bit, the position of the indicated object would change uncontrollably, and with further access we would no longer know where to look for "our quantum device." Therefore, the standard option remains - the quantum object must be placed in an environment where it will be easier to control its location. However, in this case, a problem will arise - creating an environment in which we could recognize "our quantum device" so as not to confuse it with similar but other quantum objects. Due to the action of the identity principle, this will be quite difficult.

Let us imagine that we have learned to use some "clever tricks" with which we can "catch" quantum objects in such a way that, on one hand, we can control their spatial position and, moreover, identical quantum objects can be well separated from each other. Let us tie an information bit to the spin states of this object. For this, in one quantum object we need to "turn on" the state S_z =1/2 and "assign" it the digit 1, or 0. Let us say we "assigned" 1. The use of the term "assigned" makes sense only when the condition is fulfilled - no matter how many times we "call" this state in the "quantum computer," exactly this state should always be detected - with the assigned number. On the other hand, any act of such "calling" is an "act of observation" of an already prepared state S_z =1/2. And according to the principles of quantum mechanics - in each act of observation, the quantum state existing before observation disappears and a new one is formed, which may coincide or may not coincide with the state in which this object was before observation. It turns out that although we "turned on" the state S_z =1/2 in our "quantum device," with each subsequent "call" of this state we can get both the state S_z =1/2 and another - S_z =-1/2 state, which corresponds to 0, not 1. That is, it will be impossible to control what specific mathematical operation our "quantum computer" will perform when executing our command. When we try to calculate the sum (2+3) using our "quantum computer," not only will the sum answer be a random variable, but the results of calling numbers 2 and 3 and the symbol "+" will also be events with random outcomes. From the above, we can conclude: the "information bit" generated by a "quantum transistor" will work according to the principle of "quantum randomness," and the operation of a "quantum computer" will also depend on "how God throws the dice in different cases of calling." As a result, we get a "computer for itself," and if we try to use it, then the "computer for us" will work like a "virus-infected computer" that will give many different answers. The "correct result" obtained by this "infected computer" we will never be able to verify using repeated calls or calculations on other similar "computers for us."

This natural "virus" - corresponding to the "observer factor," can be conditionally called the "Q-virus," in honor of the "Q-bit."

In some publications related to this topic (see, for example, (Knill et al, 1998), (Biham et al, 2004), (Lanyon et al, 2008)), such a mechanism of "quantum computing" called "purely one-qubit deterministic quantum computing (DQC1)" is indeed discussed. In this calculation method, for separate calculation acts, the "phenomenon of probabilistic results" is introduced, and the final deterministic calculation result is

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chosen as the result that appears most often in large statistics of repeated calculations. A detailed discussion of this part of the quantum myth would unjustifiably expand the scope of our analysis and would not add anything new to the considered arguments "in favor of a quantum computer for us." Therefore, we will not conduct such an analysis.

As already noted in the previous subsection, if the physical state - corresponding to S_z = ½ - possesses the properties implied in (Sakurai, 1985) and (Feynman et al, 1963), then these states will be stable with respect to our "calls," and the results of "calls" will become deterministic. However, as we have already said - if experiments show that spin characteristics really possess such "large inertial property" with respect to acts of macroscopic observation (i.e., to "calls"), then this characteristic, together with the object carrying it, should be transferred from quantum mechanics to classical mechanics, and computers built with their help will not be "quantum." In this case, our "quantum device" will also cease to be a "Q-bit" since state vectors will no longer exist, whose "superposition" was supposed to form the basis for creating a "Q-bit."

We will discuss this question in more detail in the next part of the text.

All authors contributed equally to this research, analyzing and discussing results, and preparing the manuscript text.

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