Global Scientific and Academic Research Journal of Multidisciplinary Studies
ISSN: 2583-4088 (Online)
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journals-gsarjms-home/

CRITICAL REVIEW OF FUNDAMENTAL CONCEPTS IN PHYSICS Part 5 – "Quantum Superposition"

By

Iuri Baghaturia[1], Zaza Melikishvili[2], Koba Turashvili[2,3], Anzor Khelashvili[3]

[1]School of Natural Sciences and Medicine, Ilia State University, Tbilisi, Georgia; Institute of Quantum Physics and Engineering Technologies, Faculty of Informatics and control Systems, Georgian Technical University, Tbilisi, Georgia
[2]Vladimer Chavchanidze Institute of Cybernetics, Department of Optics and Spectroscopy, Georgian Technical University, Tbilisi, Georgia
[3]Nodar Amaglobeli High Energy Physics Institute, Quantum Field Theory Laboratory, Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia

Article History

Received: 17/08/2025
Accepted: 23/08/2025
Published: 26/08/2025

Vol – 4 Issue –8

PP: - 83-89

Abstract

According to the principles of quantum mechanics, quantum superposition is defined as the sum of basis vectors of probability amplitudes. Without changing the set of basis vectors, these sums can be realized by an infinite number of different combinations of the mixing coefficients of these basis vectors. Different sets of mixing coefficients are generated by macroscopically different physical conditions under which macroscopically repeating events with random outputs occur. The set of basis vectors is determined by the corresponding quantum characteristics of a particular object. In theoretical concepts of a "quantum computer" it is assumed that when creating an information bit, each physical state corresponding to a particular superposition sum can be used as a separate part. Based on this, and ignoring that particular mixing coefficients are generated by particular physical conditions, the entire set of superposition sums is attributed to one quantum object in such a way that this object can generate many and potentially an infinite number of classical digital bits. This phenomenon corresponds to the "Q-bit". In this part of the text, our goal will be to find out - from the point of view of the principles of quantum mechanics - whether the empirical realization of the "Q-bit" will be possible. Below we show that the physical realization of this idea will be impossible, since the arguments that are given as the basis for such a realization contradict the principles of quantum mechanics and are based on false interpretations of these principles.

Index Terms*- Quantum computer; Q-bit; Quantum superposition; mutual exclusion of alternatives; contradict the possibility of interference.*

INTRODUCTION

As we noted in Part 4 of the text (see (Baghaturia et al, 2025a)), the phenomenon of superposition of probability amplitudes is a characteristic feature of probability theory and arises in all types of mechanics on the same basis - as a characteristic corresponding to our expectations. In this part of the text, our goal is to determine whether fundamentally different details appear in the probabilistic description of micro-world processes in the superposition phenomenon that have no analogues in macro-world processes. As we will show below - in the mechanics of micro-world processes, no empirical fact can be found that would indicate the existence of such details. Based on the above, we will also show that creating a "quantum transistor," i.e., a "Q-bit," which could potentially replace an infinite number of classical transistors, will actually be impossible.

CHAPTER I: Brief History of the Question's Origin

The emergence of the question of "quantum superposition" is connected to the initial principles of quantum mechanics, according to which the results of observation of micro-world processes - due to the "observer factor" - always represent random variables for us (see part 2 (Baghaturia et al, 2025b)). Therefore, description of these processes is possible only by statistical and probabilistic methods. The mathematical principles of quantum mechanics were based on M.Born's idea: the "wave-particle" dualistic nature should be attributed to micro-world objects not in the form of direct physical characteristics, but in probabilistic form. In addition to this - from empirical observations it followed that what "interfere" are not the physical or probabilistic characteristics of different micro objects with each other, but only the probabilistic alternatives of individual objects (for more details on why we use quotation marks here – see Part1 (Baghaturia et al, 2025c)). The mathematical principle corresponding to this fact found its reflection in M.Born's main idea, according to which statistical regularities obtained from phenomenological study of results of multiple events should be attributed to each quantum object in the form of probability amplitudes. As was noted in Part 4 of this text (see (Baghaturia et al, 2025a)): "The formation of the logical chain corresponding to new ideas was completed when M. Born gave an interpretation of the Schrödinger equation - as a dynamic equation for probability amplitudes. As a result, the probability space was expanded not only to abstract hypernumbers - corresponding to matrix algebra, but also to an even more abstract space of complex numbers. Since probability and probability amplitude are abstract mathematical constructions, attributing wave properties to them did not require the existence of any actually existing ethereal medium. However, such expansion of probability space can introduce into the corresponding mechanics such degrees of freedom that will require great vigilance in the physical interpretation of corresponding mathematical relationships (when insufficient attention is paid to such details, the ground is created for the emergence of myths). But at the same time, the following must also be said: the introduction of probability amplitudes for describing physical states was one of the most important facts from both physical and mathematical points of view. The fact is that introducing state vectors as a mathematical principle of probability theory allows describing statistical reality more perfectly than would be possible without these vectors."

Since the Schrödinger equation was linear and at the same time allowed the realization of wave properties, on this basis the concepts of "superposition of probability amplitudes" and "interference of probabilistic alternatives" arose in quantum mechanical concepts. And as was noted in Part 4 (Baghaturia et al, 2025c) - with such expansion of probability space, neither other fundamental principles of this space nor physical interpretations arising from these principles should be violated. At the initial stage of the formation of theoretical concepts of quantum mechanics, satisfying this condition was not a simple task, since the mathematical principles by which probability space was expanded to spaces of probability amplitudes represented a completely new mathematical phenomenon, not based on previously existing experience. The formation of the corresponding principles occurred in parallel with the formation of the concepts of quantum mechanics. This created the basis for the illusion that the indicated expansion and corresponding mathematical principles are characteristic only of quantum processes. On this basis, in the middle of the 20th century, the well-known version of defining the phenomenon of "quantum superposition" was formed (see, for example, (Feynman et al, 1963), (Feynman et al, 1965)):

1: If a particular outcome of an event involving a quantum object can be achieved in two different ways, and without external influence it is impossible to fix which method this result was achieved by, and also if such influence is not exerted, then mixed products of these vectors contribute to the formation of the numerical value of probability calculated by the superposition sum of corresponding state vectors of these alternatives constructed in the space of probability amplitudes. The corresponding terms are called "interference terms," and the corresponding mathematical phenomenon - summation of probability amplitudes of quantum alternatives - is called "quantum superposition." The numerical values of theoretical results obtained taking into account "interference" terms of the sum agree with experimental data.

2: "Quantum superposition" is a purely quantum phenomenon and has no analogue in classical mechanics.

From these ideas it followed, that superposition of probability amplitudes automatically leads to the emergence of "interference" terms in superposition sums of these probability amplitudes, which is an erroneous statement.

Over time, even more dubious details were included in the understanding of the "quantum superposition" phenomenon, and for designating the final formulation we will use versions authored by various artificial intelligences:

GEMINI: Quantum superposition is a fundamental principle of quantum mechanics that states that a quantum system (for example, an electron or photon) can simultaneously exist in several mutually exclusive states until it is observed. Simply put: in the classical world, an object can only be in one specific state at any moment. For example, a coin is either "heads" or "tails." In the quantum world (during superposition): a particle can be simultaneously both "heads" and "tails" (i.e., in a combination of both states) until we look at this object. As soon as we observe (i.e., conduct a measurement), the superposition collapses, and the particle chooses one of the specific states (for example, "heads"). This concept sounds illogical based on our everyday experience, but this is the reality of the quantum world and underlies many modern technologies, including quantum computers. The famous thought experiment - "Schrödinger's Cat" - was also created precisely to explain this principle.

SCISPACE: Quantum superposition is a fundamental principle of quantum mechanics that allows a quantum system to exist in multiple states simultaneously until it is measured. This principle is extremely important for understanding such phenomena as quantum entanglement and particle behavior at the quantum level. This concept reflects the wave-like properties of quantum objects, allowing them to simultaneously occupy different positions or states, which contradicts classical physics, according to which objects exist in one state at any point in time. Quantum superposition arises from the principle of quantum mechanical superposition, according to which a quantum state can be expressed as a linear combination of several states. This principle is formulated mathematically and is necessary for the operation of quantum computers, allowing them to perform complex

*Corresponding Author: **Zaza Melikishvili**

calculations more efficiently than classical computers. The concept of superposition challenges classical notions of measurements and reality, since it implies that exact states cannot be determined until observation occurs. The impossibility of achieving exact coordinates in quantum measurements emphasizes the inadequacy of classical interpretation of superposition, suggesting the need to rethink its physical meaning. Although quantum superposition is a cornerstone of quantum mechanics, its consequences can lead to paradoxes and difficulties in understanding reality, which will entail ongoing disputes about the nature of measurements and observations in quantum systems.

OPTICA AI: Quantum superposition is one of the basic principles of quantum mechanics, which implies that a quantum system can simultaneously be in several different states until measurement or observation occurs. This means that if we have two or more possible states, the system can be their linear combination, i.e., superposition, and only during measurement does it "choose" one specific state. The concept of superposition underlies such phenomena as quantum entanglement and quantum coherence, and has many important applications in quantum information technologies, including quantum computing and quantum cryptography. For example, as described in the article: Liu, Zhang, Guo, et al., "Creation of superposition of arbitrary states encoded in two high-Q cavities," Opt. Express 27, 27168–27182 (2019). This article emphasizes that superposition is a physical resource that is necessary for quantum information processing and quantum computing, since it causes other interesting quantum phenomena, such as entanglement and coherence.

In this part of the text, our task will be to show that the above definitions and ideas contradict fundamental principles on which discussions of probabilities and probability amplitudes should be based.

CHAPTER II: Foundations of Quantum Superposition

To clarify the details of the essence of "quantum superposition," let us consider the arguments of two demonstration examples indicated in (Feynman et al, 1965). In the first example - particles A and B collide, which we can distinguish from each other just as in Part 4 of the text we distinguished coins painted in different colors. The authors' goal is to describe the scattering of these particles in the center-of-mass system at angles π/2. For this, in the corresponding plane, particle registration detectors should be installed at equal distances and in opposite directions of one chosen axis. Let us denote one of them with the number 1, the other with the number 2. Let $\Phi_{AB}(1;2)$ denote the probability amplitude when particle A hits detector 1, and B hits detector 2. Similarly, let $\Phi_{AB}(2;1)$ be the probability amplitude when particle A hits detector 2, and particle B hits detector 1. It is assumed that the interaction causing the scattering process is symmetric with respect to rotations in the indicated plane. This means that when scattering at angles π/2, the indicated particles scatter with equal probability in all possible directions of this plane, and if the particle capture angles of these detectors do not completely cover the entire scattering plane, some particles may not hit detectors 1 and 2. If the capture angles of both detectors are equal to each other, the relation is satisfied: $p_{AB}= |\Phi_{AB}(1;2)|^2= |\Phi_{AB}(2;1)|^2$. That is, in the case of large statistics, approximately equal numbers of particles A and B will be registered in two oppositely located detectors. Let us denote the probability that particles A and B will be registered in both detectors as *W*(A;B). According to the representations of the authors (Feynman et al, 1965) - as well as generally accepted ones, since we can distinguish the corresponding physical states $\Phi_{AB}(1;2)$ and $\Phi_{AB}(2;1)$, these physical alternatives are mutually exclusive, and for calculating W(A;B) we need to use the probability addition rule:

$$W(A;B) = |\Phi_{AB}(1;2)|^2+ |\Phi_{AB}(2;1)|^2 = 2\, p_{AB}\ ; \qquad (1)$$

When A and B are identical particles, it is impossible to distinguish the corresponding physical states $\Phi_{AA}(1;2)$ and $\Phi_{AA}(2;1)$, and according to the same representations - these states no longer represent mutually exclusive alternatives. Therefore, to calculate W (A; B), we first need to add the corresponding amplitudes and calculate the desired total probability by the square of this sum:

$$W(A;A) = |\Phi_{AA}(1;2) + \Phi_{AA}(2;1)|^2\ ; \qquad (2)$$

Due to the symmetry of interaction in the scattering plane, theoretical expressions of probability amplitudes - obtained by solving the Schrödinger equation - satisfy the relation $\Phi_{AA}(1;2) = \Phi_{AA}(2;1)$, and the desired probability will be:

$$W(A;A) = |2\Phi_{AA}(1;2)|^2 = 4\, p_{AA}\ ; \qquad (3)$$

In the literature on quantum particle research, it is claimed that in α-particle scattering experiments, theoretical result (3) for identical particles is empirically confirmed, rather than (2). This statement is given in all textbooks on quantum mechanics, including (Feynman et al, 1965).

We will begin critical analysis of the proofs given in this reasoning with a simple remark for the case of different particles: The Schrödinger equation can be written even in the case of different particles, and state vectors $\Phi_{AB}(1;2)$ and $\Phi_{AB}(2;1)$ can be explicitly indicated as solutions. Since mutually exclusive alternatives correspond to these state vectors, as the authors (Feynman et al, 1965) also note, these vectors must be orthogonal to each other:

$$< \Phi_{AB}(1;2)|\Phi_{AB}(2;1) > = < \Phi_{AB}(2;1)|\Phi_{AB}(1;2) > = 0; \qquad (4)$$

In this case - from the corresponding superposition sum, the result indicated in (1) will automatically be obtained. Then it is unclear - what prevents their superposition addition. The answer to the posed question is easily obtained: the fact is that by the method by which we write and solve the Schrödinger equation, it is easily obtained that $\Phi_{AB}(1;2) = \Phi_{AB}(2;1)$, and in the case of amplitude addition we would get: W(A;B) = $4p_{AB}$, which would be an error not only according to quantum mechanical representations, but also according to probability theory principles that we indicated in Part 4 of the text using the example of macro bodies - coins. Therefore, both the authors (Feynman et al., 1965) and the generally accepted ideas offer a simple solution: in the case of distinguishable particles - without additional argumentation, one simply needs to add up the probabilities, not the amplitudes.

Let us move on to considering the case of identical particles. For experimental verification of the corresponding theoretical result, first of all, explicit indication of state vectors $\Phi_{\alpha\alpha}(1;2)$ and $\Phi_{\alpha\alpha}(2;1)$ is necessary, which will require solving the corresponding Schrödinger equation. In order for the obtained solutions to be assigned the status of probability amplitudes, it is necessary to use the probability completeness principle. As was noted in Part 4 of the text, using the example of considering macro-objects, the introduction of equalities of the type $\Phi_{AA}(1;2) = \Phi_{AA}(2;1)$ destroys the detail whose presence is necessary for correct fulfillment of the completeness condition. According to the basic principles of constructing probability spaces, state vectors $\Phi_{AA}(1;2)$ and $\Phi_{AA}(2;1)$ - like vectors $\Phi_{AB}(1;2)$ and $\Phi_{AB}(2;1)$ - must be orthogonal to each other, and these vectors cannot be equal in any way. Neither the authors (Feynman et al, 1965) nor other authors discuss this detail, and all emphasize that distinguishing identical macro bodies is fundamentally possible, while distinguishing identical micro objects is fundamentally impossible. Based on this, it is considered that the probability space of the micro-world fundamentally differs from the probability space of the macroworld. Therefore, in the reasoning, the emphasis is transferred to the assertion that only those probabilities correspond to the results of empirical observation whose superposition sums are constructed using the condition $\Phi_{AA}(1;2) = \Phi_{AA}(2;1)$. In this case, a fundamental question arises - what theoretical expression is compared with the results of empirical observations. In quantum mechanics textbooks, these theoretical expressions are indicated (see, e.g., (Davydov, 1973)), however, no one analyzes the mathematical method of their derivation. And this method does not differ in high standards of self-consistency and raises questions. We will devote a separate publication to this issue in the form of Part 6, and there we will indicate in detail what specific incorrect mathematical calculations are used in the so-called “Mott calculations” (see (Mott, 1930)).Here we will indicate only the final conclusion:
Critical reconsideration of the method of deriving the so-called "Mott formula" shows that not only were mathematical approximation methods applied incorrectly, but also the very formulation of the scattering problem by the method of solving the stationary Schrödinger equation is incorrect, since by definition such a possibility is absent in it. Consequently, comparison of experimental results of α-particle scattering with theoretical ones requires more correct mathematical calculations and correct problem formulation. Therefore, the relation given in (3) also cannot be considered empirically proven.

The example of α-particle scattering does not clearly illustrate the basic principle of quantum mechanics: it is not the characteristics of different particles that interfere, but the probabilistic alternatives of one particle. This principle is more clearly reflected in the second example (Feynman et al, 1965).

The second example is connected with experiments of passing a flow of identical particles into a system of slits. The authors (Feynman et al, 1963), (Feynman et al, 1965) consider a theoretically imaginary experiment, since, in their opinion - to obtain an "interference" pattern when particles pass through two slits, it is necessary to construct slits of very small sizes and so close that from a technical point of view - realization of such an experiment will represent a rather complex task. Thus, all statements and conclusions were based only on theoretically imaginary "empirical facts." Let us present the main statements on which the authors' logic was based:

Empirical statements corresponding to the imaginary experiment:

E_0: Individual electrons passing through openings leave spatially localized traces on the screen, which is consistent with their corpuscular nature;

E_1: When a flow of electrons passes through one micro slit, the collection of traces formed on the screen behind the opening will have the form of a Gaussian distribution, which is consistent with their corpuscular nature;

E_2: When the same flow passes through two micro slit located very close to each other, and it is not recorded through which opening a specific object passed, the collection of traces formed on the screen will have a spatial form of discretely located spots corresponding to an interference pattern, which is consistent with the manifestation of the wave nature of these objects;

E_3: If we use some device to determine which slit a particular object passes through, the set of traces formed on the screen will have a form that will correspond to the sum of the Gaussian distributions obtained when passing through individual slits. This, in turn, will correspond to the corpuscular nature of electrons.

These "empirical facts" were accompanied by **corresponding theoretical statements**:
T_1: In an ideal experiment, when a random event occurs without external intervention, the probability of the corresponding outcome of such an event is determined by the square of the complex number φ of the corresponding probability amplitude: P = $|\varphi|^2$;

T_2: When one result of an event can be achieved by two different - mutually exclusive - paths of realization of this event, and which correspond to probability amplitudes φ_1 and φ_2, the corresponding total probability of this outcome is determined by the relation: $P = |\varphi_1 + \varphi_2|^2$;

T_3: When an electron passes through two slits, and we do not record in the observation process through which specific slit the electron passed, the probability of the electron hitting a certain point on the screen is determined by the relation: $P = |\varphi_1|^2 + |\varphi_2|^2 + \varphi_1{}^*\varphi_2 + \varphi_2{}^*\varphi_1$ and in this case - the alternatives corresponding to φ_1 and φ_2 - interfere;

T_4: When an electron passes through two slits and through the act of observation we register through which specific slit the electron passed, the total probability of the electron hitting a certain point on the screen is determined by the relation: $P = |\varphi_1|^2 + |\varphi_2|^2$ and in this case the alternatives corresponding to φ_1 and φ_2 - do not interfere;

Note that the basic assertion on which the theoretical logic of these arguments is based is mystical:

One specific result from a set of statistical results can indeed be realized by moving along different, mutually exclusive trajectories. However, statistical-probabilistic description of results of such events does not imply indication of trajectories along which a specific result is realized. On the other hand, it is also obvious that if we construct a probability space according to such principles, then from the elements of this space it will be impossible to determine the physical mechanism of formation of interference terms in the square of superposition sums. Therefore, in discussions (Feynman et al, 1963) and (Feynman et al, 1965), the idea of alternative paths was put forward. However, the detail used in T_2 concerning mutual exclusion of alternatives contradicted the possibility of appearance of interference terms in squares of superposition sums, since state vectors corresponding to these alternatives should have been mutually orthogonal. In this case, the transition from T_2 to T_3 would be impossible. To overcome this contradiction, in (Feynman et al, 1965) instead of alternatives corresponding to mutually exclusive physical trajectories introduced in (Feynman et al, 1963), another variant of defining alternatives $\{\varphi_1, \varphi_2\}$ was introduced. This option is associated with movement along virtual trajectories that do not require the introduction of a mathematical condition of mutual exclusion, which automatically arises when moving along real trajectories. In this case, questions that could arise when moving along real trajectories disappear - what ensures the movement of a free electron along curved trajectories, after which it ends up at the same point on the screen. In the case of movement along virtual trajectories, such questions lose meaning, since on these trajectories empirical laws of physics should not be fulfilled. In this case, the transition from T_2 to T_3 becomes non-contradictory. Despite this "success," in this case there arises the necessity of introducing a condition corresponding to a non-physical requirement. In particular, T_4 says: "When we observe the passage of an electron through slits, the electron always passes only through one slit, and therefore trajectories corresponding to real movement of the electron through two slits correspond to mutually exclusive alternatives. And when we do not observe the passage of an electron through slits, movement corresponds to virtual trajectories and when passing through two slits - interference terms appear in corresponding probabilities. Only the first part of this condition corresponds to a physical reality: when we observe a particle, the quantum object behaves like a real corpuscle. The second part is based on a mystical statement: when we do not observe - the quantum object behaves like a virtually existing corpuscle, whose probabilistic alternatives of passage through two slits cease to be mutually exclusive. The fact that the second part is truly mystical is confirmed by a simple question: when we do not observe, how do we know how the quantum object behaves? And even more so - on what basis do we assert that alternatives of exit through two openings cease to be mutually exclusive? In this connection, it is appropriate to cite the main statement from (Feynman et al, 1963), on which corresponding quantum mechanical representations of corpuscular-wave dualism are based:

M: "One may still ask, "How does this work? What is the mechanism behind these laws?" No one has discovered any mechanism behind these laws. No one can "explain" more than we have just "explained." No one can give you a deeper understanding of the situation. We have no idea about a more fundamental mechanism from which these results can be derived. "

Despite the skepticism expressed in statement M, relying on empirical data obtained over the last several decades, it is not difficult to show that "empirical statements" E_1 and E_3 contradict real empirical facts and, consequently - there is no need to introduce corresponding dubious T-statements.

What actually follows from the forms of multiple traces corresponding to the passage of flows of quantum particles through slits, we have considered in detail in publication (Baghaturia et al, Part 1, 2025c). In this work, we showed that statement E_1 contradicts observed reality and in the case of one slit the same diffraction pattern arises as in the case of two slits. We also indicated that these diffraction patterns and mechanisms of their formation have nothing in common with superposition of real waves and that the term "interference" is not only erroneously attributed to the Huygens-Fresnel mechanism, but also its original definition introduced by Young was distorted by this. In conclusion, we noted that there are no empirical foundations and theoretical arguments on the basis of which wave characteristics could be attributed to micro-world objects. And this means that there is no need to attribute wave characteristics to elements of the probability space of quantum objects.

This mystical phenomenon of disappearance of wave or corpuscular nature is often presented as a particular case of the phenomenon of the so-called "collapse of the wave function." And the collapse phenomenon is also defined as a specificity of the quantum nature of the micro-world. In reality, as we showed in Part 4 of our text - the phenomenon of collapse of state vectors corresponds to a general and fundamental principle of probability theory that operates everywhere we use this theory in describing statistical data of multiple events.

Based on the above, it can be asserted that both phenomena - "quantum collapse" and "quantum superposition" - correspond to ordinary characteristics of probability space and there exist no "quantum phenomena" having a different nature.

Let us summarize the above as follows: in quantum mechanics, we must follow Bohr's principle - when describing the physical reality of the micro-world, in reasoning we must use only empirically observable facts and introduce only those theoretical concepts that directly follow from these facts. For example, from the empirically observable fact about the equality of probabilities $|\Phi_{AB}(1;2)|^2 = |\Phi_{AB}(2;1)|^2$ it does not follow that the relation $\Phi_{AB}(1;2) = \Phi_{AB}(2;1)$ must also be satisfied. And from the point of view of the foundations of probability theory, this relation is simply incorrect! Proving this does not present great complexity. For this, it is quite sufficient to correctly indicate state vectors $\Phi_{AB}(1;2)$ and $\Phi_{AB}(2;1)$. In particular, we must take into account that when particle A hits the first detector, this means that this same particle did not hit the second, and these two events represent mutually exclusive physical realities. Similarly, in the case of B-particle. This purely empirical circumstance means that in the construction $\Phi_{AB}(2;1)$, the state vector of particle A must be orthogonal to the analogous vector in construction $\Phi_{AB}(1;2)$. The state vectors of B-particle must be arranged similarly. Since we consider only two alternatives, we can display this circumstance with two-component columns exactly as we did in the case of coins (see Part 4 of the text):

$$\Phi_{AB}(1;2) = \Psi_A(1) \otimes \Psi_B(2) = \begin{pmatrix} \Psi_A \\ 0 \end{pmatrix} \otimes \begin{pmatrix} 0 \\ \Psi_B \end{pmatrix};$$

$$\Phi_{AB}(2;1) = \Psi_A(2) \otimes \Psi_B(1) = \begin{pmatrix} 0 \\ \Psi_A \end{pmatrix} \otimes \begin{pmatrix} \Psi_B \\ 0 \end{pmatrix}; \qquad (5)$$

Ψ_A and Ψ_B are ordinary numerical functions. We could write any other combination of columns in which the corresponding orthogonality condition (4) arising from physical requirements caused by empirical circumstances would be taken into account. Relations (5) unambiguously indicate that $\Phi_{AB}(1;2) \neq \Phi_{AB}(2;1)$. It is precisely based on errors connected with similar technical details that the myth was formed that:

"Quantum superposition represents a purely quantum phenomenon that has no analogue in classical mechanics."

This statement is valid only within the framework of that mysticism according to which - when we do not observe an electron - it passes through two slits according to "wave principles." This statement is mysticism since it contradicts the results of empirical observations. Indeed - a wave formed on the water surface actually passes through two slits as a wave, and this is an empirically observable fact. An equally observable fact is that micro objects pass only through one slit.

The most important statement of probability theory consists of the following:

According to the fundamental principles of the theory, probabilistic characteristics must be introduced only on the basis of statistical data obtained from empirical observations, and probabilistic characteristics introduced in this way must not contradict other empirically observable facts.

It is not difficult to guess that probabilistic characteristics corresponding to alternatives of virtual trajectories in principle cannot correspond to empirical observations and based on the above, are obviously deprived of the possibility - to be used in probabilistic theories.

All of the above clearly indicates that both the electron and the photon pass only through one slit - regardless of whether we observe the facts of passage or not. Consequently, to explain the mechanism of formation of diffraction patterns arising on the screen in all experiments - with one slit, and with two slits, and with three and more - there is no need to introduce wave properties for probability amplitudes through virtual trajectories. Consequently, no "interference" terms should arise in superposition probability sums (for details see Part 1 (Baghaturia et al, 2025c)).

If we consider the essence of the "Q-bit" from this same point of view, we will see that the corresponding physical state of the "Q-bit" will not be able to store more information than is done with the help of classical transistors. Indeed, mathematical parametrization of the "Q-bit" is carried out by the same mathematical tool by which the results of coin tossing are parametrized (see Part III):

$$\Psi(\theta) = [\cos\theta\, \Psi_z(1/2) \pm \sin\theta\, \Psi_z(-1/2)]$$
$$= [\cos\theta \begin{pmatrix} 1 \\ 0 \end{pmatrix} \pm \sin\theta \begin{pmatrix} 0 \\ 1 \end{pmatrix}]; \qquad (6)$$

In a state vector written in such form, we say that $\cos^2\theta$ and $\sin^2\theta$ represent probabilities of realization of corresponding physical states $\Psi_z(1/2)$ and $\Psi_z(-1/2)$. As we noted in Part III - a specific numerical value $\theta = \theta_1$ corresponds to a specific physical circumstance in which specific values of probabilities $\cos^2\theta_1$ and $\sin^2\theta_1$ are realized. For transition from numerical value $\theta = \theta_1$ to numerical value $\theta = \theta_2$, the physical circumstance of carrying out repeated events - corresponding to θ_1 - must be replaced by the physical circumstance of carrying out repeated events - corresponding to θ_2. Obviously, physical circumstances corresponding to θ_1 and θ_2 will be mutually exclusive, and state vectors corresponding to these two cases must be orthogonal to each other. Since the mathematical form of realization of relation (6) is not a carrier of this property, the corresponding mathematical problem must be formulated as follows: construct a vector space whose vectors will satisfy the orthogonality condition:

$$< \overline{\Psi}(\theta_i)|\Psi(\theta_j) > = \delta_{ij}; \qquad (7)$$

As a result, regarding "Q-bits" we can say:

"Quantum transistors" constructed using "Q-bits" and based on the phenomenon of "quantum superposition" will also obey the principle of mutual exclusion: if a "Q-bit transistor" corresponding to specific θ_i is realized, in the same physical circumstance no other "transistor" can be realized. As soon as a "transistor" corresponding to another angle θ_j is realized, the previously existing "transistor" disappears and at the same time - the newly arisen "transistor" will not differ in any way from the disappeared one and these two mutually exclusive circumstances are not remembered in any way and do not constitute a list of different "transistors." Thus - with the help of a "Q-bit," simultaneous physical realization of several, and even more so an infinite number of "classical transistors" will be impossible. The "Q-bit Quantum transistor of infinite volume" combines only those possible probabilistic results that correspond to our expectations caused by those infinitely possible types of changes in physical circumstances under which macroscopic repeated events are produced.

To demonstrate the analogy between quantum and classical "transistors," let us give an example of a switch. Suppose we have a macroscopic switch that is arranged so that to turn it

*Corresponding Author: **Zaza Melikishvili**

on, we need to press the switch button. Switching on occurs according to the following principle: when we press the switch button, with probability 1/2 switching on is realized and with probability 1/2 switching on is not realized. Obviously, we can associate state vectors of probability amplitudes with such a "transistor" according to the same mathematical principles as we associated with a coin and a "Q-bit." Similar to such a switch, we can also make such a switch where after pressing a finger on the button - realization of switching on will occur three times more often than non-switching. Corresponding state vectors also correspond to such a "transistor," whose coefficients will be appropriate. Similarly, we can make many different classical transistors that will work according to the principle of random events, and all these transistors we can manufacture by such physical change of the construction of one initial "transistor" that will correspond to the mathematical principle indicated in (6). However, it is completely obvious that if we have a "transistor" with superposition sum coefficients $\cos\theta = \sin\theta = 1/\sqrt{2}$, this "transistor" is not simultaneously a "transistor" to which coefficients $\cos\theta = \sqrt{3}/2$ and $\sin\theta = 1/2$ correspond. In exactly the same way an electron acts if we want to "mount" a "Q-bit" on it - in some physical circumstance that we create, it acts as a "transistor" with coefficients $\cos\theta = \sin\theta = 1/\sqrt{2}$, and if we create another physical circumstance - it acts as a "transistor" with coefficients $\cos\theta = \sqrt{3}/2$ and $\sin\theta = 1/2$. It is easy to understand that these circumstances are macroscopic and therefore we will be able to both arrange and control them.

Obviously, we will not be able to use such an object for such multiplication of information by which the "Q-bit" should have differed from the classical bit, and we will simply replace a properly working classical transistor with one "broken transistor" that we will call "quantum." A properly working transistor corresponds to the case when the act of switching on deterministically causes the desired result, and the act of switching off also deterministically causes the desired result. We will return to these questions in more detail in Part 7, which concerns the phenomenon of "quantum entanglement."

REFERENCES

1. Baghaturia I, Melikishvili Z, Turashvili K, Khelashvili A. Critical review of fundamental concepts in physics, part 4 - classical origins of quantum superposition. Glob Sci Acad Res J Multidiscip Stud. 2025a;4(8):53-59.
2. Baghaturia I, Melikishvili Z, Turashvili K, Khelashvili A. Critical review of fundamental concepts in physics, part 2 - the observer factor. Glob Sci Acad Res J Multidiscip Stud. 2025b;4(8):44-52.
3. Baghaturia I, Melikishvili Z, Turashvili K, Khelashvili A. Critical review of fundamental concepts in physics: Part 1 – Wave-particle duality. GSAR J Math Sci. 2025c;4(6):90-101.
4. Feynman RP, Leighton RB, Sands M. The Feynman lectures on physics, Volume III: Quantum mechanics. Reading, MA: Addison-Wesley; 1963.
5. Feynman RP, Hibbs AR. Quantum mechanics and path integrals. New York: McGraw-Hill; 1965.
6. Davydov AS. Quantum mechanics. Moscow: Nauka; 1973.
7. Mott NF. The collision between two electrons. Proc R Soc Lond A. 1930;126(801):259-267.

*Corresponding Author: **Zaza Melikishvili**