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RESEARCH ARTICLE

On Purported Physical Realizations of So-called Quantum Information Technologies

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Abstract

Bell's inequality is derived by resorting to a hidden-variable theory devised for resolving the Einstein-Bohr debate on the conceptual foundations of quantum mechanics. The legitimacy of quantum superposition for describing the physical world is the essence of the debate. Einstein argued against the legitimacy of quantum superposition. Testing Bell's inequality by experiment with the experimental result explained by Bell's theorem opened the door to so-called quantum information technologies. In quantum information theory, "quantum bit" (or "qubit" for short) in a form of quantum superposition is supposed to carry quantum information. Although most physicists believe that Einstein's vision of the physical world contradicts the experimental result of testing Bell's inequality, actually neither the experimental result nor Bell's theorem is relevant to Einstein's viewpoint. In the present paper, a new principle, the general principle of measurements, is proved as a mathematical theorem. Based on this principle, the experiment for testing Bell's inequality and so-called experimental evidence for physically realizable "qubit" are scrutinized. The findings are as follows. The experimental result of testing Bell's inequality and the measurement outcomes of experiments involving "qubit" are all erroneously explained. Bell's inequality failed to capture the essence of the Einstein-Bohr debate, and Bell's theorem is irrelevant to Einstein's vision of the physical world. Quantum mechanics can be completed by using disjunction ("or") as the logical relation between the orthonormal vectors that span an arbitrarily given Hilbert space without resorting to any hidden-variable theory, while the mathematical setting will remain essentially unchanged. All kinds of "qubit" violate the general principle of measurements and can only describe imaginary objects that do not exist in the physical world. The findings inevitably lead to a very regrettable conclusion: Quantum information has no physical carers and all quantum information technologies are not physically realizable.

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1. Introduction

Since the inception of quantum mechanics, its conceptual foundations have been controversial and are still debatable even today [1][2][3]. The quantum-mechanical description of the physical world is based on quantum superposition, and random phenomena can always be observed in measurement outcomes of experiments that involve quantum superposition. Needless to say, probability can describe any observed random phenomenon. But the observed random phenomenon deserves a reasonable explanation. However, quantum mechanics is claimed to be intrinsically probabilistic without giving any explanation of the observed random phenomena. This is why Einstein questioned the theory by calling it “the fundamental dice-game” [4]. The quantum-mechanical description denies the objective existence of definite properties of the physical world prior to measurements, which contradicts Einstein’s vision of the physical world. According to Einstein’s viewpoint, before we can describe the physical world reasonably by observing its properties based on measurements, the properties must exist independently of human consciousness. In the sense above, Einstein considered the quantum-mechanical description incomplete. But he also considered that the theory might be completed [1].

Derived by resorting to a hidden-variable theory, Bell’s inequality used to be considered the only hope of completing quantum mechanics [5][6]. But the hope is shattered. Bell’s inequality failed when tested by experiment[7][8][9][10][11][12]. According to Bell’s theorem [13][14], quantum mechanics in its current form seems to have already been a complete theory, and Einstein’s viewpoint in his debate with Bohr seems to be wrong. Were Bell’s theorem relevant to Einstein’s vision of the physical world, the quantum-mechanical description would be legitimate, which implies that either or both of realism and locality, the two fundamental hypotheses underlying Einstein’s viewpoint, should be abandoned. Renouncing either or both of the hypotheses opened the door to so-called quantum information technologies, such as quantum computation and quantum communication [15][16][17][18][19][20][21][22]. In quantum information theory, “quantum bit” (or “qubit” for short) in a form of quantum superposition is supposed to carry quantum information. Consequently, quantum information technologies all stem from what Einstein called “the fundamental dice-game” [4]. Nowadays most physicists believe that Einstein’s vision of the physical world contradicts the experimental result of testing Bell’s inequality.

In the present paper, a new principle, the general principle of measurements, is proved as a mathematical theorem. Based on this principle, the experiment for testing Bell’s inequality and so-called experimental evidence for physically realizable “qubit” are scrutinized. The findings are as follows. The experimental result of testing Bell’s inequality and the measurement outcomes of experiments involving “qubit” are all erroneously explained. Bell’s inequality failed to capture the essence of the Einstein-Bohr debate, and Bell’s theorem is irrelevant to Einstein’s vision of the physical world. Quantum mechanics can be completed by using disjunction (“or”) as the logical relation between the orthonormal vectors that span an arbitrarily given Hilbert space without resorting to any hidden-variable theory, while the mathematical setting will remain essentially unchanged. All kinds of “qubit” violate the general principle of measurements and can only describe imaginary objects that do not exist in the physical world. The findings inevitably lead to a very regrettable conclusion: Quantum information has no physical carers and all quantum information technologies are not physically realizable.

In Section 2, Einstein’s vision of the physical world and Bell’s theorem are revisited. In Section 3, the general principle of measurements is proved as a mathematical theorem for revealing scientific truth concealed by erroneously explained measurement outcomes of experiments that involve quantum superposition. In Section 4, completing quantum mechanics by using disjunction (“or”) as the logical relation between the orthonormal vectors, which span an arbitrarily given Hilbert, is demonstrated. In Section 5, so-called experimental evidence for physically realizable “qubit” is scrutinized. In Section 6, the results obtained in this study are briefly discussed. In Section 7, the paper is concluded with a summary of the reported findings.

2. Einstein’s Instincts and Bell’s Theorem

In a letter to Born, Einstein expressed clearly his vision of the physical world[4]:

> *“We have become Antipodean in our scientific expectations. You believe in the God who plays dice, and I in complete law and order in a world which objectively exists, and which I, in a wildly speculative way, am trying to capture. I firmly believe, but I hope that someone will discover a more realistic way, or rather a more tangible basis than it has been my lot to find. Even the great initial success of the quantum theory does not make me believe in the fundamental dice-game, although I am well aware that our younger colleagues interpret this as a consequence of senility. No doubt the day will come when we will see whose instinctive attitude was the correct one.”*

According to Bell’s theorem, the day mentioned by Einstein has come. Nowadays most physicists consider the experimental invalidation of Bell’s inequality as an experimental fact and believe that Einstein’s vision of the physical world is wrong. However, neither the failure of Bell’s inequality nor Bell’s theorem is relevant to Einstein’s vision of the physical world.

Bell’s inequality is derived by resorting to a hidden-variable theory devised for resolving the Einstein-Bohr debate on the conceptual foundations of quantum mechanics. But the supreme success of the quantum theory has prevented anyone from considering the theory entirely wrong. This is why Bell and his followers merely tried to reinterpret quantum mechanics and kept the theory in its current form intact [23]. Keeping current quantum theory intact presumes the legitimacy of quantum superposition. Consequently, Bell’s inequality cannot capture the essence of the Einstein-Bohr debate and failed when tested by experiment.

In fact, the failure of Bell’s inequality is unavoidable even before any actual experiment is performed to test it against quantum mechanics, no matter how the inequality is derived based on whatever hypotheses. In current quantum theory, quantum superposition plays two closely related roles in experiments involving this notion. Consider an experiment with single microscopic objects of a given kind. Quantum-mechanically, a wave function ψ in a form of quantum superposition describes each of the objects. On the other hand, ψ is also used to calculate probabilities of the outcomes corresponding to the objects. In other words, ψ not only describes an arbitrarily given single object to be measured in the experiment but also serves to calculate the probability of the outcome measured. Because ψ presumes the legitimacy of quantum superposition, which already predetermines the fate of Bell's inequality, it is not surprising at all when Bell's inequality failed.

For instance, consider the optical experiment with single pairs of correlated photons for testing the CHSH inequality derived by Clauser, Horne, Shimony, and Holt [7]. The CHSH inequality is a generalization of Bell's inequality[5]. In this optical experiment [8], one of the roles is to describe each of the pairs by the so-called "entangled state" given in a specific form of quantum superposition; the other is to calculate, based on the same "entangled state", the probability of the outcome measured. Although this twofold role can guarantee that the quantum-mechanically calculated probabilities always agree with the corresponding results obtained by measurements, unfortunately, as a consequence of presuming the legitimacy of quantum superposition, the agreement between the quantum-mechanically calculated probabilities and the experimental results conceals the real scientific truth. In general, measurement outcomes of various experiments that involve quantum superposition, including the experimental result of testing Bell's inequality, are all erroneously explained.

3. Experiment and Scientific Truth

As indicated in the previous section, experiments and measurements may not always reveal scientific truth; sometimes scientific truth is even concealed by erroneously explained measurement outcomes of experiments. The general principle of measurements can reveal scientific truth concealed by erroneously explained measurement outcomes of experiments that involve quantum superposition; the truth is revealed by explaining random phenomena observed in the outcomes.

The real world is the only place where physical quantities can be measured. Consequently, all physical quantities must be measured based on mathematical models of space and time of the real world, not anywhere else. The mathematical model of space in the real world is the three-dimensional Euclidean space R^3 endowed with the metric given by the usual distance function between two points in the space. The mathematical model of time elapsed in the real world is the set of nonnegative real numbers R_0 equipped with the metric given by the usual distance function between two nonnegative real numbers. Points in R^3 represent precise space coordinates, and elements in R_0 are precise time coordinates.

Proving the general principle of measurements needs to review a few definitions in topology. A metric space is denoted by (X, d), where X is a set, and d is a metric on X. Let r be a positive real number. For $x \in X$, the open ball with center x and radius r is

$$B(x; r) = \{y \in X; d(x, y) < r\}.$$

Any open subset of X is a union of open balls. All open subsets of X constitute a metric topology for X. The set X and the metric topology form a metric topological space. Consider $x \in S$ where S is a subset of X. If there exists $r > 0$ such that

$$B(x; r) \cap S = \{x\},$$

then x is an isolated point of S.

Theorem 3.1. *(**The General Principle of Measurements**) Precise space and time coordinates are practically unattainable by measurements.*

Proof. Measuring a point x in the space perfectly precisely requires x to be an isolated point of R^3. Consider an arbitrarily given $x \in S$, where S is an arbitrary subset of R^3. There is no $r > 0$ such that

$$B(x; r) \cap S = \{x\}.$$

This shows that R^3 has no isolated point. Similarly, unless time t is an isolate point of R_0, it is impossible to measure t perfectly precisely. To see this, consider $t \in S$, where S is an arbitrary subset of R_0. An open “ball” now is an open interval

$$B(t; r) = (t - r, t + r).$$

There are two cases: $t = 0$, and $t > 0$. If $t = 0$, no open interval centered at t is a subset of R_0. If $t > 0$, there is no $r > 0$ such that

$$S \cap B(t; r) = \{t\}.$$

The condition for t to be an isolated point is not satisfied in either case. Consequently, R_0 has no isolated point. This completes the proof of the general principle of measurements.□

All issues about measurement instruments and accuracy of measurement outcomes in practice have nothing to do the general principle of measurements. Nevertheless, this new principle can reveal the scientific truth concealed by erroneously explained measurement outcomes of various experiments that involve quantum superposition; it can also explain the random phenomena observed in measurement outcomes of such experiments. The following fact is helpful for understanding the importance of the principle.

Remark 3.2. Any single measurement makes no sense statistically and cannot explain the random phenomenon observed in the corresponding experiment. The random phenomenon can only manifest itself in a large number of measurement outcomes obtained in different repetitions of the experiment under purported the same experimental conditions that depend on precisely specified space and time coordinates. A single measurement corresponds to only one outcome in one repetition. Because precisely specified space and time coordinates are unattainable by measurements, “the same experimental conditions” violate the general principle of measurements and hence do not exist in the real world.

Usually, microscopic objects are not at rest. For instance, photons propagate in space. Consequently, it is necessary to consider their propagating directions and orientations of polarizers for measuring the photons. Any direction or orientation in space corresponds to a unique point on a unit sphere. The sphere is a subset of R^3. It is also worth noting the following fact:

Remark 3.3. The points on the unit sphere are irrelevant to spatial positions of microscopic objects.

As illustrated with examples below, the general principle of measurements can explain random phenomena observed in measurement outcomes of various experiments that involve quantum superposition, and quantum mechanics is not intrinsically probabilistic. The observed random phenomena are due to lack of knowledge about precise space and time coordinates for specifying “the same experimental conditions”.

Example 3.4. Consider the single pairs of perfectly correlated photons for testing the CHSH inequality in the optical experiment [8]. The pairs are described by the “entangled state” in a form of quantum superposition. Let the orientations of two spatially separated polarizers be parallel. There are only two different outcomes, i.e., (+, +) and (-, -), obtained with equal probabilities [8]

$$P\{(+,+)\} = P\{(-,-)\} = \frac{1}{2}.$$

At either polarizer, the detected photons have purportedly the same (desired) polarization direction and follow purportedly the same (desired) propagating direction. Consider the precise space coordinates corresponding to the following directions and orientations used to specify “the same experimental conditions” for testing the CHSH inequality:

a. the same (desired) propagating direction and the same (desired) polarization direction specified purportedly for each photon,
b. the actual propagating direction and the actual polarization direction of each photon, and
c. the same (desired) orientation of the polarizer specified purportedly for measuring each photon and the actual orientation for measuring each photon.

According to Theorem 3.1, the space coordinates corresponding to the directions and orientations listed above are all unattainable by measurements and hence unknown. From Remark 3.2, “the same experimental conditions” specified by such coordinates violate the general principle of measurements and do not exist in the real world. The actual propagating directions of different photons are almost surely different; the actual polarization directions of different photons are almost surely different. In addition, the desired orientation and the actual orientations for measuring different photons are also almost surely different. Three tiny volumes serve as the approximations to the precise space coordinates. The first volume contains the coordinates of desired and actual propagating directions. Similarly, the second contains those of desired and actual polarization directions, and the third contains those of desired and actual orientations of the polarizer. Moreover, the “entangled state” for describing the pairs and for calculating the probabilities of the measurement outcomes is invalid and illegitimate, because it takes precise space coordinates for granted and violates the general principle of measurements.

As shown above, the general principle of measurements can explain the random phenomenon exhibited in the outcomes of measuring the polarizations of perfectly correlated photons. The experimental result of testing the CHSH inequality should not be considered as evidence for the claim that quantum mechanics is intrinsically probabilistic.

Example 3.5. Consider a particle described by a wave function $\psi(x, t)$ given by a coherent superposition of energy eigenstates. Clearly, ψ depends on time and spatial position of the particle. Each of the energy states is assigned a nonzero probability calculated in quantum mechanics without explaining the observed random phenomenon. According to the quantum-mechanical description, before an experiment is performed to measure the energy, the particle is claimed to have more than one energy states at the same time t. By Theorem 3.1 and Remark 3.2, the quantum-mechanical description makes no sense physically and the quantum-mechanically described particle does not exist in the real world. As explained by the general principle of measurements and Remark 3.2, the observed random phenomenon does not support the claim that quantum mechanics is intrinsically probabilistic.

Example 3.6. Quantum-mechanically, a spin-1/2 particle is described by a form of quantum superposition with two eigenvectors spanning a Hilbert space. The eigenvectors correspond to possible outcomes obtained by performing a Stern-Gerlach experiment for measuring the spin of the particle in a specified direction. Neither time dependence of the superposed states nor spatial motion of the particle needs to be considered in this example. According to the quantum-mechanical description, the particle is claimed to be in two states along every direction simultaneously and hence has no definite spin in any direction. When a measure is performed in an arbitrarily given direction, the outcome is either “spin up” or “spin down” with the corresponding probability, which is considered as evidence for the claim that quantum mechanics is intrinsically probabilistic. Again, by Theorem 3.1 and Remark 3.2, the claim is wrong.

4. Hilbert Space in Quantum Mechanics

The quantum-mechanical description denies the objective existence of definite properties of the physical world prior to measurements, which contradicts Einstein’s vision of the physical world. Nevertheless, Einstein never excluded the possibility of completing quantum mechanics. The general principle of measurements paves the way towards completing quantum mechanics by replacing conjunction with disjunction between the orthonormal vectors that span an arbitrarily given Hilbert space. Using disjunction as the logical relation between the orthonormal vectors not only can be justified by the general principle of measurements; it is also consistent with the definition of a general Hilbert space. In fact, the concepts for defining a Hilbert space in general are all highly abstract and have no practical meanings. Orthogonality specified by an inner product is the most important concept to define a Hilbert space. The orthogonality for defining a Hilbert space in general is a purely mathematical concept without any practical meaning. Assigning practical meanings to the orthogonality is unnecessary.

Moreover, for a Hilbert space in general, it is even unnecessary to specify the logical relation between orthogonal vectors. In fact, the logical relation between orthogonal vectors in a specific Hilbert space can even be neither conjunction nor disjunction. For a given application, practically meaningful concepts are necessary to define a specific Hilbert space for describing practically meaningful objects, and conjunction may serve as the logical relation between the orthogonal vectors in that space. But the orthogonal vectors must not correspond to mutually exclusive properties simultaneously belonging to the same object.

Example 4.1. The classical prototype of a Hilbert space was first studied by D. Hilbert with applications to the theory of integral equations. This Hilbert space consists of infinite sequences of complex numbers. The logical relation between the orthogonal vectors is neither conjunction nor disjunction. It is not necessary to specify the logical relation.

Example 4.2. With the inner product defined for the Euclidean vectors,R^3 is a Hilbert space. For this Hilbert space, the orthogonal Euclidean vectors do not represent mutually exclusive properties simultaneously belonging to any geometric object, and the logical relation between the orthogonal vectors is conjunction.

Needless to say, the logical relation between the orthogonal vectors that span a specific Hilbert space can also be disjunction. For the Hilbert space in quantum mechanics, the logical relation between the orthonormal vectors must be disjunction as required by the general principle of measurements. Different outcomes corresponding to mutually exclusive properties are obtained by measuring different microscopic objects of the same kind in different repetitions of the experiment in question. Each outcome yields a definite property of the physical reality belonging to the corresponding microscopic object. The definite property exists independently of human consciousness.

Consequently, a definite value corresponding to the outcome can be assigned to the object, even though the precise space and time coordinates for measuring it are unknown; the value can even be taken from a continuum and hence cannot be obtained by measurements, such as position and momentum of a particle moving in space. Therefore, by using disjunction as the logical relation between the orthonormal vectors, quantum mechanics can indeed be completed without changing the mathematical setting essentially! Hidden-variable theories are irrelevant to the real world.

On the other hand, violating the general principle of measurements can result in using an imaginary microscopic object to characterize different microscopic objects measured in different repetitions. No outcome is obtained by measuring the imaginary object described by quantum superposition. The imaginary object does not exist in the real world.

After completing quantum mechanics within the framework of the Hilbert space without resorting to any hidden-variable theory, there will be two entirely different notions of quantum superposition: one lies at the heart of current quantum theory, which will be referred to as “superposition (conjunction)”, and the other uses disjunction to serve as the logical relation between the superposed orthonormal vectors, which will be denoted by “superposition (disjunction)” to avoid confusion.

Example 4.3. In current quantum theory, the notion of “commutator” used to prove uncertainty relations precludes simultaneous assignment of values to some physical quantities for a particle described by superposition (conjunction). The commutators and uncertainty relations serve to argue against Einstein’s vision of the physical world and are hindrances of completing quantum mechanics. For instance, the commutator used to prove Heisenberg’s uncertainty relation precludes simultaneous assignment of values to position and momentum of the same particle. Because superposition (conjunction) merely describes imaginary particles that do not exist in the real world, the arguments based on the commutators and uncertainty relations are not physically meaningful.

Example 4.4. Consider again Example 3.4. In the optical experiment for testing the CHSH inequality[7][8], the single pairs of perfectly correlated photons are described by the “entangled state” in a form of superposition (conjunction). As shown in Example 3.4, the “entangled state” violates the general principle of measurements and hence is illegitimate for describing the single pairs of the correlated photons in the real world. Violating the general principle of measurements brings about using an imaginary pair to characterize different pairs of the same kind measured in different repetitions of the experiment. No outcome is obtained by measuring the imaginary pair described by the “entangled state”. The imaginary pair is claimed to have no definite polarizations before measurements [8]. By no means can such an imaginary pair exist in the real world. The measurement outcome corresponding to each single pair in the real world yields an element of the physical reality independent of human consciousness, even though the actual orientations of the polarizers for measuring the pair are unattainable by measurements and unknown.

5. No Evidence for Physically Realizable “Qubit”

All kinds of “qubit” are expressed by physically meaningless superposition (conjunction). Because superposition (conjunction) violates the general principle of measurements and can only describe imaginary objects that do not exist in the physical world, no physical object can carry so-called quantum information. However, in quantum information theory, some experiments in quantum physics are considered as experimental evidence for physically realizable “qubit”. Actually, as demonstrated by the following two examples, there is no such evidence. In each example, a popular experiment is scrutinized.

Example 5.1. Consider the experiment with single photons. In this experiment, a single photon is described by superposition (conjunction) with two superposed polarization states. The single photon is of course a physical system. But its quantum-mechanical description, i.e., superposition (conjunction), is physically meaningless. The explanation of the measurement outcomes of this experiment is incorrect, which violates general principle of measurements by taking precise space coordinates for granted. The space coordinates are used to specify “the same experimental conditions” for measuring the photons. In the real world, the photons are measured in different repetitions of the experiment; each single photon can at most be detected only once. The experimental conditions for measuring different photons in different repetitions cannot be the same. An imaginary single photon described by physically meaningless superposition (conjunction) is used to characterize different photons. The imaginary photon does not exist in the real world and is not a physical carrier of so-call quantum information.

Example 5.2. In the experiment considered in Example 3.6, a single spin-1/2 particle is described by superposition (conjunction) with two eigenvectors spanning a Hilbert space. Although the particle is a physical system, its quantum-mechanical description, namely, superposition (conjunction), is not physically meaningful. The explanation of the measurement outcomes of this experiment is incorrect, which violates the general principle of measurements by taking precise space coordinates for granted; the coordinates are used to specify “the same experimental conditions” for spin measurements. In the real world, the particles are measured in different repetitions of the experiment; each single particle can at most be measured only once. The experimental conditions for measuring different particles in different repetitions are different. An imaginary single particle described by physically meaningless superposition (conjunction) is used to characterize different particles. Just like the imaginary photon, the imaginary particle does not exist in the real world either and is not a physical carrier of so-call quantum information.

As demonstrated above, the evidence for physically realizable “qubit” is actually a false assumption. Based on this false assumption, so-called physical realizations of quantum information processing systems, such as various quantum computers (including topological quantum computing systems) and various quantum communication networks, are essentially erroneously explained results of experiments in quantum physics. Consequently, none of so-called quantum information technologies is physically realizable.

Quantum information theory stems from an mistaken belief that quantum mechanics is a complete and correct description of the physical world. Based on this belief, it is claimed that quantum information processing cannot be precluded, unless quantum mechanics is wrong [16]. However, neither the belief nor the claim can stand the test of time. Quantum mechanics in its current form is indeed incomplete. But incompleteness is not incorrectness. Based on the general principle of measurements, quantum mechanics can be completed by replacing conjunction with disjunction between the orthonormal vectors that span an arbitrarily given Hilbert space. Therefore, the completed quantum theory will not change current quantum theory essentially and does not necessarily imply current quantum theory failing to be correct.

6. Discussion

Before the inception of quantum mechanics, the following statement reflects a commonsense held by physicists.

Statement 6.1. *The same experimental conditions will produce the same results of experiments with physical objects.*

In the above statement, physical objects are studied by classical physics; precise space and time coordinates are also necessary to specify the experimental conditions. In the outcomes of measuring physical objects studied by classical physics, random phenomena can also be observed. The random phenomena are mainly caused by lack of knowledge about some factors that can be successfully explained by statistical physics. Therefore, the general principle of measurements is hardly noticeable and hence ignorable. In this sense, Statement 6.1 is approximately true.

The old commonsense is changed by quantum mechanics and replaced by the new one held by all physicists now. The new commonsense is characterized by the statement below [24].

Statement 6.2. *The same experimental conditions do not produce the same results of experiments with physical objects studied by quantum physics.*

However, in Statement 6.2, the experimental conditions must be specified by precise space and time coordinates. According to the general principle of measurements, “the same experimental conditions” do not exist in the real world. Therefore, Statement 6.2 is misleading. Random phenomena observed in outcomes of measuring physical objects studied by quantum physics cannot be explained by statistical physics. But statistical physics is not the only way to explained random phenomena observed in outcomes of measuring physical objects. Statement 6.2 is partly responsible for the mistaken belief that quantum mechanics in its current form is a complete and correct description of the physical world, and hence is also responsible for the false claim made in quantum information theory that there is no fundamental obstacle to building so-called quantum information processing devices. After investing enormous amounts of time and money in the attempt to build “quantum information processing devices” that cannot be realized physically, now it is the time to stop waisting time and money in such hopeless attempt!

7. Conclusion

In the present paper, the experiment for testing Bell’s inequality and so-called experimental evidence for physically realizable “qubit” are scrutinized. The scrutiny is based on the general principle of measurements proved as a mathematical theorem. The findings are as follows. The experimental result of testing Bell’s inequality and the measurement outcomes of experiments involving “qubit” are all erroneously explained. Bell’s inequality failed to capture the essence of the Einstein-Bohr debate, and Bell’s theorem is irrelevant to Einstein’s vision of the physical world. Quantum mechanics can be completed by using disjunction (“or”) as the logical relation between the orthonormal vectors that span an arbitrarily given Hilbert space without resorting to any hidden-variable theory, while the mathematical setting will remain essentially unchanged. All kinds of “qubit” violate the general principle of measurements and can only describe imaginary objects that do not exist in the physical world. The findings inevitably lead to a very regrettable conclusion: Quantum information has no physical carriers and all quantum information technologies are not physically realizable.

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