Complete Micro-physics Unifying Copenhagen QM and EPR: Non-connected Space Embedding

ABSTRACT. We unexpectedly show that complete micro-physics unifying Copenhagen QM and EPR (that restores to micro-matter causality and locality) is possible. There are two ways to unify physics: the Standard Model approach is that mathematics first and experimental foundation second, the priority of matter evolution over anything; our approach is that experimental foundation first and mathematics second, the priority of space evolution over matter evolution. Our work gives a brand new approach in the field of unified physics. First, similar to Turing's modeling of computation, we model the spatial process of quantum experiments; give the barest essentials of the space process (as a necessary condition for unified physics): the micro-to-current space process does not have the exchangeability of observers. Second, the revolutionary concepts produced by space process modeling forces us to introduce a new geometry model: non-connected space embedding. Namely, 3-dimensional micro-space is embedded in the 3-dimensional current space in a non-connected way, and the embedding produces a mapping from microscopic space to current space and makes the complete microscopic form into an incomplete quantum form described in terms of state space. In this way, the unification of Copenhagen QM and EPR can be achieved. Space embedding, which has a more reliable experimental basis than the Standard Model, overturns the traditional space theory.

1. Introduction

Einstein, Podolsky and Rosen constructed a thought experiment (EPR experiment) in 1935 EPR paper to demonstrate the incompleteness of quantum theory, and asserted that the complete theory of micro-physics would be possible [1]. The purpose of this paper is to prove that (a) the complete theory of micro-physics that unifies the Copenhagen QM and EPR (particularly, restores to micro-theory causality and locality) is possible; (b) The experimental foundation of the unification is the strict definition of quantum experiments and the non-exchangeability of observers; (c) EPR experiment is type I false quantum experiment.

1.1. Experimental foundation has precedence over mathematical foundation for unifying Copenhagen QM and EPR

There are two opposite ways to unify theories of physics. (1) Priority of mathematical foundation over experimental foundation, the priority of matter evolution over anything. First, people find a profound mathematical foundation to link the theories together and derive predictions about matter evolution. Second, the new mathematics force people to find experimental foundations to fit the mathematics, that is, to find clever experimental designs to verify the predictions. The Standard Model is an example. (2) Priority of experimental foundation over mathematical foundation, the priority of space evolution over matter evolution. First, people find the experimental foundation to determine revolutionary concepts of space. Second, the new foundation forces us to find clever mathematical foundation to fit the experiments. "Unifying Copenhagen QM and EPR" means to restore to micro-matter causality and locality and to provide evidence that the root of quantum characteristics is space evolution. This is something that the Standard Model can't do. We will use the second method to

achieve the unification. We will prove that the desired experimental foundation is the non-exchangeability between current-observer's coordinate system and micro-observer's coordinate system.

1.2. Underlying idea of unifying Copenhagen QM and EPR: they have the same development trend and defects

At first glance, the conflict between Copenhagen QM and EPR cannot be reconciled, because Copenhagen QM believes that state function without hidden variable is a perfect description of quantum phenomena; EPR believes that state function is not a complete description and the complete description of the micro-reality that preserves causality and locality exists. However, the following analysis of the spatial process provides an underlying idea of unifying EPR and Copenhagen QM. (1) The core of Einstein's theory (as the basis for EPR) is to deal with exchangeable observers (observer's systems) in terms of transformations (one-to-one mapping) of coordinate systems within connected spaces. Unfortunately, Einstein's theory only considers the co-variance of the physical form with respect to the lateral transformations (for example, the invariance of the space-time interval under Lorentz transformation), and does not consider the exchangeability of the observer in the depth direction at all. We have shown that the micro-space in the depth direction is not connected to the current space (including the non-exchangeability of the observers) [2][3]. The logical development of Einstein's theory should be to deal with the changes of the physical form in the depth direction with respect to the movement of observer's coordinate system. Exactly speaking, this development should investigate whether the movement (transformation) between micro-observer's and current-observer's coordinate system makes the complete description to be incomplete. (2) The core of Copenhagen interpretation is "micro-reality is restricted to observation". We have shown that quantum observation involves spatial process from micro-space to current space, involves the movement of the micro-observer's coordinate system to the current-observer's coordinate system [3]. This mapping requires that we must deal with the changes of the physical form and the exchangeability of observers with respect to the movement of the coordinate system in the depth direction. In the next section we will show that Copenhagen QM has the same defects as Einstein's theory: (1) They never considered the spatial process and coordinate system movements in the depth direction. (2) While they use intrinsic geometry to describe the motion of matter, they never considered whether there is the carrier of coordinates in micro-space in the geometrical sense of intrinsic geometry.

Now, unexpectedly and surprisingly, we have seen that Copenhagen QM and EPR share the common development trend and defects, and lead us to a common experimental foundation: non-exchangeability between micro-observer and current-observer.

1.3. EPR experiment is a false quantum experiment

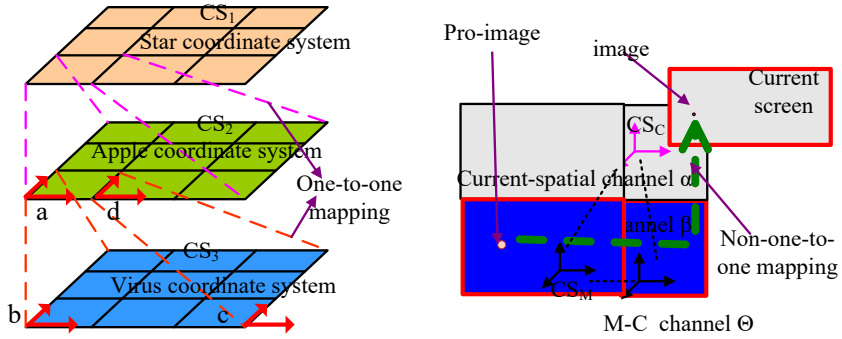
The definition of quantum experiments is not self-evident. The mathematician gave a strict definition of calculations 80 years ago. Physics need a strict definition of quantum experiments such that (1) gives rules for the moving coordinate systems while giving rules for measuring in a coordinate system; (2) distinguish between true and false quantum experiments. We will show that EPR experiment is a wrong design, it does not satisfy the definition of quantum experiment, because it takes no account of the non-exchangeability of micro-observer and current observer in the depth direction.

2. Definition of quantum experiment and criterion of false quantum experiment

Before section 4, this paper only studies the experimental foundation of unified physics, and does not discuss the mathematical structure of the unified theory.

2.1. First defect: experiments did not provide rules for moving the coordinate system

(1) The observer uses the coordinate system to examine the galaxies, where the points in the coordinate system represent stars. He then scales down the coordinate system twice so that the points of the coordinate system are apple size and virus size, respectively. The rule of coordinate system movement is implemented by means of light signals as shown in Fig. 1a, and there is a mapping determined by light signals between the points of the two coordinate systems. The distance between the two points in the coordinate system CS_1 can be measured by the observer O_C in terms of his signal tool and transmitted to the coordinate system CS_2. The rule of movement of the coordinate system in the depth direction is that there is common carrier of coordinate (including signal response), and the signal responding provides a transformation relationship between the two coordinate systems, that is, scaling down or up. Since the two movements (scaling down or up) do not produce a change in coordinates and coordinate differences, for the coordinate system moving along the loop a-b-c-d-a the observation does not change. The most important experimental fact since the birth of quantum mechanics is that there is no operable signal responding system that can travel through micro-space and current space. We call it the Heisenberg-Bohr prohibition [2][4][5], which relates to the basis of the Einstein theory, the signal responding system. It is very regrettable that physicists have been reluctant to face this fact. As shown in Fig. 1b, when the observer O_C scales the coordinate system CS_C such that the scale of the point is an atomic scale, he moves the coordinate system S_C to the coordinate system CS_M of the microscopic observer CO_M. However, for these two coordinate systems, there is no common signal responding system, and thus there is no common carrier of coordinates and coordinate differences. By the Heisenberg-Bohr prohibition, no experimental tools can provide information on CS_M and the relationship between CS_M and CS_C. Consequently, when the CS_C moves back along the loop, it is impossible to make the observations unchanged. We can compare a case of differential geometry. Suppose that an observer with a vector starts at a point on a sphere and is moved by a parallel propagation along a closed loop, and according the rule given by differential geometry, the observer usually finds that there is a discrepancy for the vector when he returns to the starting point.



(a) Coordinate system moving along the loop a-b-c-d-a

(b) Coordinate system moving along the loop current-micro-current

Figure 1 Moving coordinate system in the depth direction

The first defect of theory of quantum experiment is that experiments cannot give rules for the movement of coordinate system from daily scale to atomic scale in the depth direction. The

exchangeability between the micro-observer O_M and the current observer O_C (including measuring tools) is not experimentally or theoretically valid. Confusingly, physicists have never complained about the lack of experimental basis for the rules of coordinate system movement.

2.2. Second defect: no one has made spatial process modeling of quantum experiment

Feynman pointed out in his lecture that the Stern-Gerlach experiment (S-G experiment) can stand as a prototype for the description of all quantum mechanical phenomena [6]. We showed that the analysis of S-G experiment and the delayed choice experiment leads to two modeling: mathematical modeling of micro-matter process and spatial process modeling in real space [3]. In fact, there is no essential difference in spatial process for high-energy experiments and the Stern-Gerlach experiment nearly a hundred years ago. What makes us feel incomprehensible is why physicists (as scientists) have not modeled the spatial processes of quantum phenomena for a century. The second defect of theory of quantum experiment is that no one has made spatial process modeling of quantum experiment. Our analysis of the spatial processes of S-G experiments and delayed selection experiments is as follows.

(1) As shown in Fig.1b, the spatial region in which the experiment is located includes the current spatial channel α, the micro-spatial channel β in the lateral direction, and the M-C spatial channel Θ in the depth direction. (2) The potassium (or silver) atoms reach the entrance into the detector in the micro-spatial channel β, collapse to one spin-direction eigenstate. (3) In the channel β the collapsed potassium atoms, by means of ionization and avalanche, finally correspond to the current events (dot signals) on the detector screen. Due to the duality of the wave-particles and the probability characteristics of the state vector, there is no one-one correspondence between the atoms at both ends of β, there is no one-one correspondence between the collapsed potassium atom and current events (signals). (4) Due to the Heisenberg-Bohr prohibition, the correspondence between the atoms and its counterparts (i.e., the dot signals) cannot be directly confirmed by the signal responding traversing the two spaces. Namely, the validity check of the correspondence can not be carried out in β. The validity check depends on the extrinsic recursion invoking itself, and is limited to the extrinsic description in current space (see Sec. 2.3.). (6) The extrinsic recursion of the validity check leads to the undecidability of the pro-image in quantum experiments. For example, for a dot-signal on the current screen (as a counterpart of a microscopic object), it is impossible to determine its corresponding potassium atom and provide the related label. The undecidability of the pro-image, which is the carrier of coordinate in inherent coordinate system, makes the physical realization and mathematical description of moving coordinate system to be impossible. The above analysis shows the non-exchangeability between microscopic and current observers in quantum experiments. In other words, for a hundred years people have been using the assumption that the experimental record is unchanged through the current-micro-current loop, but this assumption is unverifiable and erroneous. For micro-events, only the expression of the scaling down current coordinate system limited by the extrinsic recursion is allowed.

2.3. Definition of quantum experiment

The definition of computation depends on operability in Turing's theory. The definition of quantum experiments depends on the operability of the coordinate system (reference frame) and the operability of coordinate-system movement. Our method is the same as the method used by Turing. Turing's method is to model, that is, to reduce the computations to their barest essentials. Our method is to model, that is, to reduce quantum experiments to their barest essentials, and to define quantum experiment as an abstract system that reflects in a mathematical-physical way the real spatial process.

Definition of quantum experiment. (1) Quantum experiment consists of the measurement in

current coordinate system (reference frame) CS_C and mapping (correspondence) τ from micro-event to current event. The mapping τ is such a spatial process that involves the current spatial channel α, the micro-spatial channel β in the lateral direction, and the M-C spatial channel Θ in the depth direction. The measuring operation in current coordinate system CS_C, which depends on the current signal responding and associates with the causality and locality, is defined by classical physics. There is no need to express the measurement operation as a mathematical program like the Turing machine. (2) The mapping (correspondence) τ satisfies the following conditions. (a) The effectiveness of τ is limited by the Heisenberg-Bohr prohibition, and there is no operable signal responding that traverses the microscopic region and the current coordinate system CS_C. (b) The mapping τ is non-one-to-one mapping mathematically. (c) The validity of the mapping τ depends on the extrinsic recursion invoking itself, and "extrinsic" means that the validity check can only use the current data (extrinsic data) of the current coordinate system RS_C. (d) Due to the extrinsic recursion, for the mapping τ, the pro-image as the carrier of coordinate is undecidable when the image is determined. (e) Since the pro-image, which is the carrier of the micro-coordinate and coordinate difference in micro-space, is undecidable, the micro coordinate system CS_M is not obtained by means of moving the current coordinate system CS_C. That is, the current coordinate system RS_C is not allowed to be transformed into an CS_M along the current-micro-current closed loop and then moved back to the human laboratory to be converted into an CS_C. It is allowed only that CS_C is scaled down as CS_M by the observer. When a micro-event maps a current event, the micro-event is described in terms of the scaling down current frame of reference rather than a inherent frame of reference.

Since the extrinsic recursion is so important, the following explanation is necessary. For example, in S-G experiment, due to the Heisenberg-Bohr prohibition, the mapping τ between potassium atoms and its counterparts (i.e., the dot signals) cannot be directly confirmed by the signal responding traversing the two spaces. In the experiment all data are finally provided by current counterparts of the atoms, which are the signals of the detector screen. The theory that describes the correspondence between the atoms and its current counterpart is called micro-to-current theory that involves ionization, signal amplification, etc. Due to the Heisenberg-Bohr prohibition, the validity of this micro-to-current theory again requires experimental verification. Again, it involves new validity check, and so on. Thus, the validity check finally leads to a series that involves invoking itself. For this series physicist is able only to operate current reference system, and there are extrinsic data provided by current counterparts in current space only. We call this process extrinsic recursion. To illustrate the extrinsic recursion, Figure 4a shows an analogy of the extrinsic recursive process. It must be emphasized that the following experiments are not true quantum experiments: (a) to make a measurement in micro-region for obtaining numerical labels of micro-objects; (b) to make a measurement in micro-region for performing a collapse of superposition states into an eigenstate.

2.4. Criterion of false quantum experiment

For false quantum experiment the basic assumptions are: rejecting the Heisenberg-Bohr prohibition, rejecting τ to be a non-one-to-one mapping, rejecting the undecidability of the pro-image that serves as the carrier of coordinate, and accepting the invariance under current-micro-current loop. The philosophical ideas implied by false quantum experiments are: (1) The case of the closed loop of the human-laboratory-to-galaxies-laboratory-to-human laboratory is extrapolated to the case of the closed loop of (current-laboratory)-to-(micro-laboratory)-to-(current-laboratory). (2) Imaging that future humans or aliens will bring new technologies, so that the invariance of closed loop transformation can be realized. We reject the above philosophical thinking. We proposed the criterion for false quantum

experiments, which define three kinds of false quantum experiments as follows. (1) Type Ⅰ false quantum experiment: The micro-objects is sent to a micro-scale detector S within the micro-spatial channel, and people obtain micro-data at S. (2) Type Ⅱ false quantum experiment: the micro-scale detector S is connected to a current detector S', and the micro-scale signals are amplified to convert one-to-one into the current signals in S'. (3) Type Ⅲ false quantum experiment: at each point in the micro-spatial channel, there is a type II false quantum experiment for each micro-object such that the micro-scale signals about it can be converted into the current signal in S'.

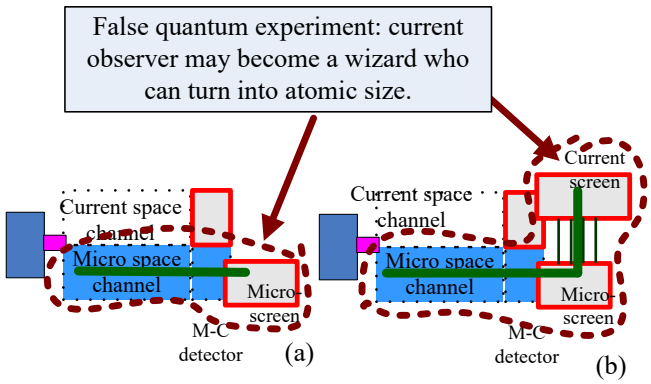


Figure 2 False quantum experiment

3. EPR experiment is type Ⅰ false quantum experiment

3.1. Original EPR experiment

EPR experiment is a thought experiment. EPR assumed that there are two particles, which interact from the time t=0 to t=T, and after time T there is no longer any interaction between the two particles. For this system they, in terms of the properties of δ-function, constructed a specific wave-function ψ such that is common eigenfunction of two operators (momentum-sum operator and coordinate-difference operator). EPR experiment provided the three measurements: (a) measurement of the momentum of the first particle and its outcome p; (b) measurement of the momentum of the second particle and its outcome –p; (c) measurement of coordinate-difference of the two particles and its outcome $(x_2-x_1)=a$. When the observer measures the momentum of the particle 1 to obtain the result p, and then measures the coordinate of the particle 1 to obtain the result x_1, since the distance a is sufficiently large, it is confirmed that the coordinates and momentum of the particle 2 are x_1+a and -p, respectively, regardless of the influence of the information transmission. People called this correlation pair a quantum entanglement.

3.2. Current observer and micro-observer

Since the establishment of quantum mechanics, there has been no effectiveness theory of quantum experiments. EPR experiments as a thought experiment must be constrained by the effectiveness and the exchangeability of observers. We must distinguish between current observer and micro-observer in EPR experiments.

(1) According to the Heisenberg-Bohr prohibition, for the current observer O_C, there is no signal responding system that can traverse the current and microscopic space, which allows him to determine the coordinates and momentum of the particles 1 and 2 by means of the signal responding. The current observer of EPR experiment is defined as an observer who uses the carriers of the coordinates and coordinate-differences of the current reference system, which are "physical reality" in the EPR sense

due to their causality and locality. The current observers in the current space can only obtain the information of particles 1 and 2 by these "physical reality" by means of quantum experiments defined in Section 2.3.

(2) The micro-observer O_M is defined as an original member in the micro-space and can manipulate the microscopic particles 1 and 2 using microscopic scale devices such that they are separated after time T there is no longer any interaction between them. According to the definition of EPR, he uses the same signal responding as the observer O_C to make measurements. Exactly speaking, the EPR implies the assumption that: (a) there is a scaled-down transformation (or correspondence) between the current coordinate system and the micro-coordinate system; (b) there is a signal system that traverses the two systems to characterize the correspondence between the coordinate carriers, and to ensure the validity of the correspondence between the coordinate carriers. However, we have shown that this assumption is invalid. It must be emphasized that physicists with the belief "we will know, we must know" have been reluctant to accept the fact that the information obtained by the micro-observer cannot be transmitted to the current observer's system by means of a real signal responding system. The effectiveness of the correspondence between the current measuring system and the microscopic measuring system depends on the extrinsic recursion.

3.3. EPR experiment is type Ⅰ false quantum experiment

According to the design of EPR, the operating procedures of EPR experiment are as follows. (1) Current observer scales himself down to the reference system to an atomic scale and enter to the micro-spatial channel β. (2) He uses the micro-scale detector $M(p_1)$ to measure the momentum of the first particle. The momentum-sum operator and coordinate-difference operator are commuting operators. According to quantum mechanics, the measurement causes the state collapse. He obtains one of the eigenvalues on the microscopic screen, for example, p. At this time, the momentum of the second particle is -p obtained by the micro-scale detector $M(p_2)$. (3) EPR implies an assumption that microscopic observers use the imaginary microscopic measuring tool, which is equivalent to current light signal, for information transmission within the microscopic spatial channel β. He, using the micro-scale detector $M(x_1)$, measured the coordinates of the first particle and obtains the measuring value x_1 on the microscopic screen, and another microscopic observer far enough, using the micro-scale detector $M(x_2)$, obtains the measuring value $x_1 + a$ of the second particle. According to the definition of quantum experiment in Sec. 2, such an experiment is a type 1 false quantum experiment because (a) EPR assumes that microscopic observers use microscopic measuring tools to operate and record and to transferring information in the microscopic spatial channel β. However, the idea that an observer moves himself with his measuring tool into micro-space has no experimental or theoretical basis. (b) There is no spatial process within the M-C channel Θ, and the spatial process is a necessary condition for true quantum experiments.

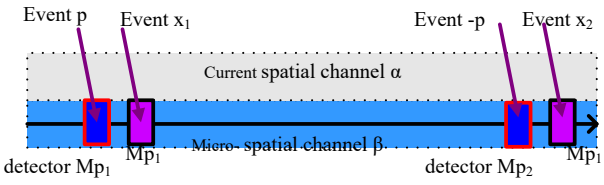
3.4. Effective EPR experiment without rule of moving coordinate system

The EPR experiment, as a true quantum experiment, must satisfy the following conditions: non-one-to-one mapping, extrinsic recursion, undecidability of the pro-image, no verifiable rule that moves the intrinsic microcosmic coordinate system to the current space. As shown in Fig. 1b, the EPR experiments that can be performed have four M-C detectors Θp_1, Θp_2, Θx_1, Θx_2, involving the current channel α and the micro-channel β, and M-C channel Θ. Consider the following two cases.

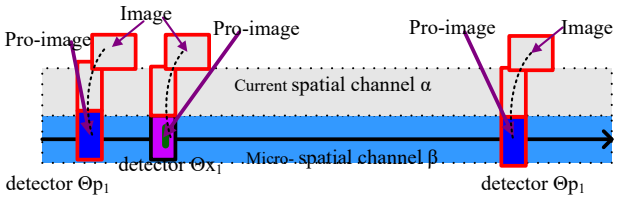
(1) Single EPR pair. (a) First step. According to quantum mechanics, in the microscopic channel β, the momentum measurement carried out by microscopic observer causes the state collapse, and the micro-events Mp and M-p occur. The microscopic observer attempts to transmit the information of the

momentum eigenvalues p and -p to the current observer within the current geometry through the correspondence within the M-C channel. However, because there is no rule for moving the microcosmic coordinate system, the transmission is impossible; current observers, by means of M-C detectors (say, ionization detectors) Θp_1 and Θp_2, can only obtain the current events Cp_1 and Cp_2 Corresponding to eigenvalues p and -p respectively. The current observer attempts to confirm that the pro-images of Cp_1 and Cp_2 are Mp and M-p, respectively. The validity of the correspondence between pro-image and image is guaranteed by the extrinsic recursion, and means that this correspondence is consistent with the statistical characteristics of the known quantum experiments. Since the pro-image is undecidable, it is not guaranteed that the pro-images of the measurement results obtained by the detectors Θp_1 and Θp_2 must be p and -p, respectively. (b) Second step. The microscopic observer makes the coordinate measurement of the first particle and the obtained eigenvalue is x_1, then he tries to transmit the information to the current observer within the current geometry through the correspondence in the detector Θx_1. However, for the current observer, the following difficulties are unsolvable: since the extrinsic recursion and the undecidability of pro-image, he cannot judge that the pro-image of the signal of Θx_1 is the same as the pro-image of the signal obtained by Θp_1. Consequently, for a single EPR particle pair, an EPR experiment that can be performed is not possible.

(2) Ensemble of EPR pairs. For the ensemble of EPR particle pairs $\{E_{M1}\}$ and $\{E_{M2}\}$ in the micro-channel β, the quantum experiment causes the state vectors to collapse, the current observer obtains the corresponding current events $\{E_{C1}\}$ and $\{E_{C2}\}$ respectively by means of the M-C detectors Θ_1 and Θ_2. The extrinsic recursion guarantees that the correspondence is consistent with the statistical characteristics of the entangled pairs, but does not guarantee that the pair of the current events within the current channel α to be the pair within the micro-channel β. It must be emphasized that the extrinsic recursion, the undecidability of pro-image of the mapping, and the absence of the rule of moving coordinate system, are the basic principle of quantum entanglement experiments.



(a) Original EPR assumes that micro-observers use microscopic measuring tools to operate, record in the microscopic spatial channel β. EPR does not consider M-C spatial process at all.



(b) In effective EPR experiment, the pro-image is undecidablefor. For a single EPR particle pair, an EPR experiment that can be performed is not possible.

Figure 4 Original EPR experiment is a false quantum experiment

4. Complete physics unifying Copenhagen QM and EPR: Non-connected space embedding

4.1. Method unifying physics: experimental foundation first and mathematics second

The unified physic is the ultimate description of the relationship between all physical spaces and related material forms. As pointed out in Section 1.1, there are two methods of unifying physics. We use the second method: the experimental foundation first and the mathematical foundation second; space evolution first and matter evolution second. The steps are as follows: (1) We divide the physical space into three parts: (a) current space: the spatial process from the human coordinate system to the galaxy coordinate system, and (b) micro-space: the spatial process from the elementary particle coordinate system to the atomic coordinate system, (c) Micro-current space: the spatial process from the atomic coordinate system to the human coordinate system. We create such a mathematical model that characterizes the barest essentials of the spatial process. The space evolution modeling is the ultimate experimental foundation of unified physics. (2) The barest essentials force us to find a new space theory that fits these essentials.

4.2. Current space modeling and micro-space modeling

(1) Let us consider the spatial process from the human coordinate system to the galaxy coordinate system. For thousands of years, all experiments done by humans have involved the spatial process of the current space. The mathematical model of this spatial process has been established in classical physics and differential geometry. For this model the barest essentials are as follows. (a) The current space is expressed as a coordinate system. The current observation η, in terms of which any matter form is expressed as a set of points of the coordinate system, is defined as the correspondence between the measured object and the corresponding coordinate carrier, and the corresponding is the coincidence of the measuring object with the coordinate carrier. The operable carrier of the coordinates and coordinate differences give the basis for the calculation of the metric properties of the intrinsic geometry. (b) There are two kinds of operable transformations of the observer's coordinate system: lateral transformations and depth transformations (movements). For the transformation (as one-to-one mapping), the pro-image and the image are fixed. (c) The two observers are exchangeable, that is, the rules for exchanging two observer's coordinate systems can always be given. Therefore, the barest essentials of the mathematical model of the current spatial process are: the coordinate system, the coincidence of the measuring object with the coordinate carrier, the transformation of the coordinate system as a one-to-one mapping, and the exchangeability of observers.

(2) Let us consider the spatial process of micro-space. For a century, all quantum experiments done by humans involved spatial process in micro-space. All quantum experiments have shown that micro-matter follows the same principles of quantum mechanics and are therefore all within the same micro-space. Due to the Heisenberg-Bohr prohibition, human laboratory cannot directly obtain information on the spatial process of micro-space by means of signal tools that transcend micro-space and current space. Therefore, the modeling of the microscopic spatial process depends on the modeling of the spatial process of the micro-current space.

4.3. Why is the description of current reality complete?

According to EPR, in the complete description the reality is causal and local. Why is the description of current reality complete? In current space the coordinate carrier is causal and local. The current observation η is defined as the correspondence between the measured object and the corresponding coordinate carrier, and the validity of the correspondence is determined by the coincidence of the measured object and the coordinate carrier, so that the coincidence ensures that the measured object is causal and local. Therefore, the completeness of the description of the current reality comes from the coincidence of the measured object and the coordinate carrier. The core essential of the current spatial process is the coincidence of the measured object and the coordinate carrier. The coincidence is a

prerequisite for the decidability of the pro-image and the exchangeability of observers.

4.4. Extrapolation in the study of space theory is a bad method

Extrapolation in the study of space theory is a bad method. For centuries, physicists have never considered establishing mathematical models from all tested experiments for the micro-current space process. They only use extrapolation; that is, the spatial process from the human coordinate system to the galaxy coordinate system is extrapolated to the micro-current space process. We reject this extrapolation. Just as Turing's purpose in his theory was to reduce computations to their barest essentials, our purpose is to reduce the spatial processes of quantum phenomena to their barest essentials. Our approach is: (1) modeling, (2) the modeling forces us to find new space theory.

4.5. Modeling of micro-current spatial process

We have shown in Sec. 2 that the barest essential of the micro-current spatial process is the correspondence τ from micro-event e_M in the micro-spatial channel β to the current event e_C in the current spatial channel α (τ is defined as the measurement of micro-object O_C). The principal difference between the correspondence τ and the current correspondence η is as follows. (1) τ is not an one-to-one correspondence (mapping). (2) The coincidence of e_M and the current coordinate carrier is impossible. The validity of the correspondence τ is not determined by the coincidence of e_M and the current coordinate carrier, and is determined by the extrinsic-recursive process invoking itself. The extrinsic recursion only guarantees that τ is consistent with the knowledge of all known quantum experiments. (3) The correspondence τ does not guarantee the decidability of the pro-image of the mapping, and there is no possibility that the e_M coincides with defined microscopic coordinate carrier. (4) The microscopic coordinate system that expresses the micro-events is not obtained in terms of verifiable transformation from current coordinate system to the microscopic coordinate system. That is, there is no decidability of movement of coordinate system. Obviously, (3) and (4) are the consequences of (1) and (2). The above four points are supported by all known quantum experiments. We write the above four points as: non-oneone mapping, extrinsic recursion, undecidability of pro-image, and non-exchangeability of observers, and often abbreviated these four points as "non-exchangeability of observer". The non-exchangeability of observers is the result of spatial process modeling of quantum phenomena and is the experimental fact supported by all known quantum experiments.

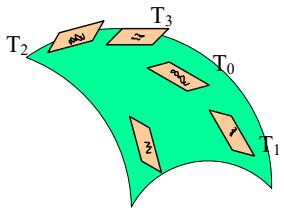
4.6. The experimental foundation of unified physics requires opening new space theory that fits to it

The non-exchangeability of observers overturns the traditional theory of microscopic space. Over the past century the most important experimental facts provided by quantum experiments have been the Heisenberg-Bohr prohibition and the non-exchangeability of the observers based on extrinsic recursion, rather than the results of high-energy experiments. These facts bring the following revolutionary space concepts: (a) The two spaces without common coordinate carrier are topologically disconnected, so there is no connectedness between the micro-space and the current space. (b) There are many possible relevance between micro-space and current space. Mathematicians have never studied the relationship between non-connected spaces. The method of unifying Copenhagen QM and EPR is "experiment first and mathematics second", the experimental foundation of micro-current space process forces us to propose a new geometric relationship between the micro-space and the current space, which satisfies the EPR requirement (that is, the microscopic causality is retained). The underlying idea of this geometric relationship is as follows. The non-exchangeability means that the coordinate system expressing state function is not the micro-observer's coordinate system in the

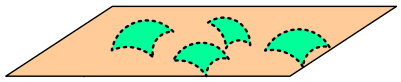
micro-spatial channel, there is no connected path between them. Consequently, the quantum form expressed by the state function is produced through mapping from the micro-observer's intrinsic form to current space. Namely, the quantum form expressed by the state function is a new mathematical form, which the non-exchangeability forces the inherent micro-system to generate in the current space. As shown in Fig. 4a, for a surface embedded in Euclidean space R_3, a geometer is defined to live only on tangent plane. Without knowing the embedded and connected paths, he cannot exchange measuring systems with observer living on surfaces, and only a discrete statistical projection of the metric properties of the surface can be observed. Thus, he interprets these projections as quantum properties on another plane which he calls a microscopic plane. Finally, either through discrete projections on T_0 or from other tangent planes T_1, T_2, T_3, etc, he developed a like-quantum theory that characterizes the metric properties of the surface based on invoking observations and knowledge on the tangent planes. Obviously, the like-quantum descriptors given by the observers living in the tangent plane must be incomplete.

4.7.Non-connected space embedding: unifying Copenhagen QM and EPR's completeness

We use the second method to find the experimental foundation of the unified physics (non-exchangeability of observers). This situation forces the physicist-mathematician to develop a geometric form for the new geometric relationship to fit the experimental foundation. We propose "non-connected space embedding" satisfying both the Copenhagen QM and the EPR as follows. As shown in Fig. 4a and 4b, the 3-dimensional neighborhood of the micro-space is embedded in the current 3-dimensional space in a non-connected way. The microscopic form inherent in micro-space is complete reality, and the state function is a mapping picture due to non-connected embedding (including extrinsic recursion). Based on the logical analysis of the spatial process of quantum experiments, we amend the Copenhagen interpretation, EPR and the micro-current geometry respectively. After the amendment, the conflict between Copenhagen QM and EPR will be eliminated, and it is possible to restore locality and causality in micro-physics.



(a)The geometer lived on the tangent plane T_0 explains the projections as quantum properties of another plane, finally, through the projections on T_0, T_1, T_2, etc, he developed a like-quantum theory that is certainly incomplete.



(b) 3-dimensional neighborhood of the micro-space is embedded in the current 3-dimensional space in a non-connected way

Figure 4 Non-connected space embedding

(1) The de-philosophical "reality is restricted to observation" is interpreted as "microscopic reality is restricted to quantum observations (quantum experiments) in the current space." The main points of the definition of quantum observation are as follows. (a) The quantum observation consists of the measurement in current coordinate system CS_C and mapping (correspondence) τ from micro-event to current event involving spatial channel α, β and Θ. (2) The mapping τ is non-one-to-one mapping, there is no operational signal responding that traverses both microscopic and the current space. (c) The validity of τ depends on the extrinsic recursion invoking itself. (d) For the mapping τ, the pro-image as

the carrier of coordinate is undecidable. (e) The micro coordinate system CS_M is not obtained by moving the current coordinate system CS_C, but is obtained by scaling down the current coordinate system. The observation in the micro-spatial channel β is derived and cannot be carried out. (f) The existing formulism of quantum mechanics is perfect and does not require modification.

(2) For EPR, only consider the restoration of the locality and causality of microscopic reality. (a) The state function is not complete, because its validity depends on the extrinsic recursion, not a description of the inherent form in the microscopic space. (b) No need to introduce hidden variables in state functions.

(3) The micro-space disconnects with the current space, the micro-space is embedded in the current space in non-connected way, and the embedding produces the map τ. The Copenhagen interpretation and EPR are unified in this way. (a) The material form inherent in microscopic space is complete, is causal and local; (b) quantum form is the image produced by the mapping τ based on non-exchangeability of observers in the depth direction, which depends on group representation: isomorphism between algebraic structure of global property of micro-system and the corresponding extrinsic form under mapping τ. (c) Due to the non-exchangeability of observers, this complete reality is experimentally undecidable.

4.8. Comprison of space embedding with Standard Model and string theory

The advantage of the space embedding model is that its source is not philosophical idea, but the modeling of the micro-current space process, which only involves the correspondence and movement between the two coordinate systems in the depth direction. The barest essentials of the space process are so general and simple that any physicist can check whether it is right. The Standard Model and string theory are lame theories because they disregard the micro-current space process modeling and only deal with the material evolution and topological properties between subatomic scale space and atomic scale space. The gauge group on which the standard model is based ultimately comes down to the micro-observer's coordinate system. The "non-exchangeability of observers" strongly limits the differential geometry that describes physical space. We ask ourselves: the subatomic space process of the Standard Model is ultimate description, or micro-current space evolution is ultimate description? The non-exchangeability of observers overturns traditional space theory, and rules all unified theories, including the Standard Models, string theory, multi-world interpretation, decoherence, and so on. Non-exchangeability puts them in a dilemma: either to find experimental evidence to overturn non-exchangeability, or to have their assumptions subverted.

5. Conclusions

5.1. EPR experiment is type Ⅰ false quantum experiment

(1) The EPR experiment is a type I false quantum experiment because the spatial process within the M-C channel is removed, and the observer is supposed to be a wizard who can turn into atomic size, and to observes and to makes records in terms of microscopic screen in micro-space. (2) For any single quantum entanglement pair in a microscopic spatial channel, the validity of its verification is undecidable, because its validity depends on the extrinsic recursion, and there is no decidability of the pro-image for the observed current event. For the ensemble of quantum entanglement pairs in the microscopic spatial channel, only statistical experimental verification is performed.

5.2. Method of establishing space theory

(1) Our method establishing space theory is the opposite of the Standard Model method. It is that

mathematical foundation first and experimental foundation second. (2) The modeling we use is similar to Turing's method in building his computation theory. The Turing machine provides a universal computation procedure, and all computable procedures (which involve recursive processes) can be reduced to elementary and effective operations. In quantum experiments, only the operation of the counterpart of the micro-object in the current space is effective. The principal difference between quantum observation and Turing machine is that the former involves the movement of the coordinate system within the micro-to-current space channel; the movement of the coordinate system depends on the extrinsic recursion; and there is no verifiable rule for moving the coordinate system.

5.3. Effectiveness of thought experiment

Since the establishment of quantum theory, several well-known thought experiments have been proposed, such as EPR and Schrödinger's cat experiments. Due to the lack of rigorous experimental theory, people have taken no account of their effectiveness. We introduce the definition of quantum experiments and prove that the EPR experiment is a type I false quantum experiment, the Schrödinger's cat experiment is a type II false quantum experiment [2], and the "retrospective decision" interpretation of the delay selection experiment uses the type III false quantum experiment [3].

5.4. Flaw of Einstein's theory

The core of Einstein's theory is the equivalence of the laws of physics. The verifiability of equivalence is based on the interchangeability of the observer. The flaw of Einstein's theory is that he did not consider that quantum experiments do not support the exchangeability of observers in the depth direction.

5.5. Non-connected space embedding: unifying Copenhagen QM and EPR's completeness

EPR opened the question of whether or not a complete description of micro-reality exists. Our work leads the problem of complete theory to the problem of space evolution. Based on the discussion of the non-exchangeability of the micro-observer, we conclude that: (1) The quantum system is not complete, because of the non-connectedness between the micro-space and the current space, but not the contradiction involving state-function indicated by EPR. (2) The theory of hidden variables should be discarded, because it ignores the spatial process of quantum experiments. (3) Mainstream physicists have been focusing on the matter evolution. In contrast, our work gives a brand new approach in the area of quantum physics: based on the modeling of spatial process in quantum experiments, we introduce a new space model of the physical world: microscopic space is embedded in the current space in a non-connected way, and the embedding produces a mapping from microscopic space to current space and makes the complete microscopic form into an incomplete quantum form described in terms of state space. The experimental foundation of our space model is: Heisenberg-Bohr prohibition, dependence of validity check of the M-C correspondence on extrinsic recursion, the undecidability of the pro-image that is the carrier of coordinate in inherent coordinate system, the undecidability of the movement of the micro-observer's coordinate system. In this way, the unification of Copenhagen QM and EPR can be achieved. However, due to the non-exchangeability of observers, this complete description of micro-reality is undecidable. The undecidability is the ultimate mechanism of the physical world, which rejects the ultimate description of our universe, and means that no workable experimental foundation within current geometry can ever be strong enough to prove or disprove the ultimate origin of current geometry. The starting point of our work is that really is restricted to observations within the current geometry, so it should be said that Copenhagen interpretation unifies EPR.

REFERENCES

[1] A. Einstein, B. Podolsky, and N. Rosen, Phys. Rev. 47, 777 (1935)

[2] Bowen Liu, Disconnectedness experiments negating the validity of the Standard Model, viXra:1807.0178.

[3] Bowen Liu, Delayed choice experiment and disconnectedness of microscopic space, viXra:1809.0430.

[4] W. Heisenberg, Physics and Philosophy. Prometheus Books, New York, 1999.

[5] N. Bohr, Atomic theory and the description of nature. New York. 1934.

[6] Feynman, R.P., Leighton, R.B., Sands, M.: The Feynman Lectures on Physics: Quantum Mechanics, vol. III. Addison-Wesley, Reading (1965)