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Why Bell's inequality is wrong?

Wu Xinzhong

School of History and Culture of Science
Shanghai Jiaotong University, China
E-mail:sju@sina.com

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Abstract.

This paper examines the history from EPR argument to Bell's inequality and the influence of Bell's inequality on the frontier exploration of quantum mechanics. It is found that Bell's inequality has some hidden assumptions different from EPR argument: Following Schrodinger's assumption that the measurement process of EPR experiment undergoes time, Karl Hess regards time as an implicit variable of time series, and Joy Christian obtains a local implicit variable inequality different from Bell's inequality. They extended the relativistic space-time geometric analysis method to the localized geometric morphological analysis of quantum states, and considered that the Bell's inequality reasoning did not meet the requirements of the completeness of EPR argument. Quantum statistics given by identical particles is different from classical statistics. Innovative ensemble interpretation can also solve Bell's inequality and give a demonstration of quantum non-locality. The main research progress of quantum gravity is great, but there are many divergences. According to Einstein's local realism, the new explanation and expression of quantum mechanics may open up new ideas for the study of quantum gravity.

Key words: EPR argument, Bell's Inequality, Quantum Gravity.

1. From EPR Paradox to Bell's Inequality

In 1935, Einstein, Podolsky and Rosen published papers in the 47th issue of *Physical Review*. They proposed the principle of local realism, trying to prove that quantum mechanics cannot give a complete description of microscopic systems. The 'physical reality criterion' of 'complete physics theory' given by EPR paper is that any observable quantity of a system should have an objective and definite value when it is not disturbed. The locality criterion is that if the 4-dimensional space-time interval between two measurements is space-like, there will be no causal relationship between the two measurements[1]. From these two principles, we can conclude that if the two measurements of the observable quantities of subsystems A and B are separated by a space-like interval, the measurements of A must not affect the measurements of B, and vice versa, the measurements of B will not affect the measurements of A[1].

Niels Bohr soon published a paper with the same title in the issue 48 of *Physical Review* , refuting the EPR argument. Bohr negated the epistemological criterion proposed by three scholars for the reason that the observed microscopic system, together with the observing instruments, constituted a single and inseparable system at the level of quantum mechanics. Bohr believed that in EPR experiments, the position of one system can be inferred from the position of another system; but when the position of the former system is determined, there is uncontrollable uncertainty in the momentum of the system, we can't infer the exact momentum of the latter system from the momentum of the former system according to the law of conservation of momentum, as Einstein did. Conversely, choosing to measure the momentum of the former system will inevitably lead to the uncertainty of the position of the latter system, which makes it impossible to determine the precise position of the latter system. From Bohr's point of view, the criterion of ‘not interfering with the system in any way’ in the EPR paper is ambiguous [2]: “*In the case of quantum phenomena, the infinite separability implied by such a (deterministic) explanation is excluded in principle by the requirement of describing experimental conditions*”[2].

During his tenure at Oxford University, Schrodinger became interested in EPR papers. On August 14, 1935, he presented a paper to the Cambridge Philosophical Society, which was contrary to Bohr's argument for discussing EPR papers in many respects, concerning the famous Schrodinger’s Cat experiment and the so-called ‘quantum entanglement’. Schrodinger didn’t care about the epistemological problems of complementarity and any details of the experimental device. He held that the most detailed understanding of the global wave function does not necessarily include the most detailed knowledge of its various parts. The entanglement between these parts results in the complete deviation of quantum mechanics from the classical thought line. Schrodinger regarded the EPR argument as a paradox of quantum measurement by determining the wave function of a particle and deducing the wave function of its partner particle without any interference. He reconfirmed and generalized the results of the EPR paper as a sign of serious defects in quantum mechanics [2]. In Schrodinger's view, quantum measurement requires time rather than instantaneous action, which makes the hypothesis of simultaneity of measurements implied in EPR argumentation questionable; the paradox shown in EPR argumentation “*cannot be solved in the general framework of quantum mechanics*.” [2]. In 1965, Hilary Whitehall Putnam further pointed out the incompleteness of quantum mechanics demonstrated by the Schrodinger’s Cat experiment: *“This case shows that the principle of determining the value of macroscopic observable quantities at any time is not derived from the basis of quantum mechanics, rather it is pulled in as an additional hypothesis”*[2].

It seems that quantum physicists will not be satisfied with Bohr's simple affirmation of the integrity of quantum phenomena. If Einstein and his followers’ local reality criterion is not feasible in quantum mechanics, it is necessary to discover quantum non-local phenomena through experiments and conceive a new theoretical model to explain the physical mechanism of non-local phenomena. David Bohm, who criticized the Copenhagen School and proposed the quantum potential theory, asserted in 1951 that the positive and negative electron experiments with total spin of ħ/2 should be regarded as an EPR experiment’s version. When a pair of electrons flying backwards continuously enlarges each other's space distance and makes independent measurements of them close enough, then the two measurements are separated in space-like ways. According to the law of local causality, the measurement of electron A will not have any effect on positron B [3, p255]. If we measure the spin components of electron A in the three directions of x, y and z, we can deduce the three spin components of electron B. Einstein believed that the three spin components of B particle objectively had definite values before measurement. However, from the viewpoint of quantum mechanics, because the operators representing three spin components are not commutative to each other, they can not objectively have a definite value at the same time [3]. Moreover, *"the spin directions of two particles are all uncertain, and each particle's spin directions depend on the orientation of the other and is in entanglement state.This is the EPR paradox "*[3].

Einstein believed that both the original EPR argument and the Bohm version of the electron spin experiment imply: (1) either the quantum mechanics is incomplete; 2)or the actual state of the two subsystems can be independent even if they are separated in a space-like interval. According to the local realism, we should exclude the second option. We can only consider the uncertainty of entangled states in quantum measurement, which indicates that quantum mechanics is incomplete. We need to find hidden variables outside quantum mechanics [3].

In 1964, Bell obtained the famous Bell's inequality from Einstein's local realism and the existence of hidden variables. He believed that the predictions of the theory of local hidden variables conformed to the Bell's inequality, and some predictions of quantum mechanics would destroy the inequality. The Bohm theory, which is equivalent to the empirical prediction of quantum mechanics, belongs to the theory of non-local implicit variables and can also destroy Bell's inequality.

Bell defined an implicit variable by λ. Symbol λ represents the real element of Einstein, leading to controversial measurement output problems. The random variables A, B and C of Bohm electron spin experiment are Bell's label functions $A(a, \lambda)$, $A(b, \lambda)$ and $A(c, \lambda)$, which can be assumed to be + 1 or - 1. For any implicit variable theory of local realism, Bell's inequality should be satisfied among three sets of experimental statistical mean data

$A(a,\lambda)A(b,\lambda)$, $A(a,\lambda)A(c,\lambda)$ and $A(b,\lambda)A(c,\lambda)$:

$$A(a,\lambda)A(b,\lambda)+A(a,\lambda)A(c,\lambda)-A(b,\lambda)A(c,\lambda)\leq +1 \quad (1)$$

According to all the experimental results so far and recent research results, Zhang Yongde believes that: (1) whether quantum mechanics is complete or not, and whether hidden variables or not are yet determined; (2) all experiments clearly support the superposition state of quantum mechanics, the randomness and non-locality caused by entanglement and measurement [3]. In Zhang Yongde's opinion, Feynman's path integral implements equal weight superposition of all paths in the whole space, wave packet non-local collapse and correlation collapse in quantum measurement, intrinsic space of spin state, eigenvalue and average value of physical quantity depend on the whole space, uncertainty relation and the same particle principle, divergence in relativistic quantum field theory. The dilemma of relativistic localization description of quantum fields has been highlighted, which shows that the root of quantum non-locality lies in wave-particle duality: "whether non-relativistic quantum mechanics or relativistic quantum field theory, they are non-localization theory under the cloak of localization description" [3].

After the emergence of a large number of falsification experiments of Bell's inequality, it has become a mainstream trend of thought in physics to claim that quantum mechanics has non-localized characteristics. Even in the frontier exploration of quantum gravity, various hypotheses, theories and models have been forced to accept quantum non-locality, which is in conflict with relativistic spirit. Roger Penrose described EPR-type Spin-Photon experiments in this way: *"This part of information (i.e., different polarization directions) arrives faster than light ('instantaneous'), and the knowledge of which of these two directions is actually polarized will arrive slower by transmitting the usual signals of the first polarization measurement results. In the usual sense of sending information, although the 'EPR' type of experiment does not conflict with the causality of relativity, it certainly contradicts the relativistic spirit of our 'Physical reality' image. "* [4] Penrose also mentioned in particular that in two space-like polarization measurements: "*The question of which of the two measurements first occurs has no physical significance in practice, it depends on the state of motion of the 'observer'... But if we think that the right-handed photons are measured first, we get a completely different physical reality image than the left-handed photons are measured first! (It is different measurements that cause non-local 'transitions'.) There is a fundamental conflict between the space of our physical reality, the image of time, and even the correct image of non-local quantum mechanics, and the special theory of relativity!* " [4] Penrose associates quantum nonlocality with the spatial dispersion of a single particle, the superposition of quantum states, wave packet collapse and the nonlocality of gravitational self-energy, and considers that gravitational self-energy is involved in the process of wave packet collapse of quantum measurement, and that the superposition of quantum states is related to the superposition of space-time metric of different states. Penrose's guesses are controversial, but they inspire us to consider the temporal and spatial mechanism of quantum non-local phenomena in the exploration of quantum gravity.

Like EPR correlations in quantum theory, vacuum fluctuations in quantum fields show EPR-like correlations in space-like separation regions, which play a key role in radiation phenomena and explain how particles 'diffuse throughout space' emit from dense space-time support sources without breaking causality. For example, if a quantum detector with uniformly accelerated motion is completely confined to the region I of Minkowski space-time, no causal effect should be exerted on the region II in the space-like region I. But once it makes a transition, it emits a particle in a quantum state. This is the Unrul effect of particles that can be observed in a vacuum in an accelerated motion reference system. However, the particle is 'diffused throughout the space' and, in particular, its stress energy expectation in region II is positive definite. Therefore, the excitation of our detection system in region I appears to 'cause' the increase of quantum field energy in region II [5].

As an attempt to advance the unified field theory in the framework of quantum field theory, the early string theory even introduced tachyons moving at superluminal speed. After eliminating the tachyons and introducing the additional coiling dimension, string theory can obtain general relativity under low energy approximation, and realizes the renormalization of gravitational quantization in the calculation of 2-loops Feynman graphs. Of course, string theories have the problem of EPR correlation like in quantum mechanics and quantum field theory. In the theory of loop quantum gravity, the basic unit of quantum information goes deep into Planck scale, and the entanglement of quantum states with different areas becomes the basis for the emergence of non-locality in quantized space. Some models connect the micro-geometric topology of quantum entanglement with wormholes in general relativity, and completely non-localize quantum space-time. Wen Xiaogang, who won the Dirac Prize on August 8, 2018, believes that 'topological order' represents a new world outlook. Quantum entanglement and quantum information are the basic elements of the physical world - quantum bits. Space is an ocean composed of quantum bits. Basic particles are the whirlpools of quantum bits. The properties and laws of basic particles Originated from the structure of the ocean of quantum bits, that is, the topological order of quantum bits.

2. What's wrong with Bell's inequality?

When most scholars, like H. Fritzsch's popular science dialogue, declare: *'You're wrong, Mr. Einstein!'* At that time, there were still a few physicists who followed Einstein's way of explaining quantum mechanics, exposed various errors in Bell's inequality argument, and declared that quantum nonlocality is an illusion based on various misunderstandings. Famous physicists who made statements against instantaneous effects include Murry Gell-Mann, M.O. Scully, Y.Aharonov, B.G. Englert and others [6]. Gell-Mann pointed out in '*Quark and the Puma'*: *"The false reports that the determination of one photon will immediately affect another lead to all kinds of regrettable conclusions. First, the assertion that the effect is instantaneous violates the requirements of relativity. Secondly, some authors claim that 'superluminal' phenomena can be accepted in quantum mechanics, such as predictions, that some 'psychics' can know the results of accidental processes in advance. Needless to say, these effects disturb quantum mechanics just as they have disturbed classical physics. The third kind of folly is to submit to some suggestions, such as the U.S. Department of Defense's proposal to use quantum mechanics for military communications at superluminal speeds."* [7]

Karl Hess pointed out that in Bell's inequality (1), Bell declares that λ may be anything virtual, or even a set of mathematical and/or physical objects. Assuming that λ and device are independent mathematical variables, it is a necessary and sufficient condition for Bell's inequality. But if λ can be anything, how can people prove this independence? Walter expressed it differently: "*How does Bell know that two different experiments with the same settings can be represented by the same function?*" [8]

Karl Hess developed Schrodinger's assumption that the measurement process of EPR experiment would take time. He believed that "*The EPR experiment was dealing with correlations implied always some 'simultaneity', a concept that had played a major role in Einstein's relativity theory."* [8]. Therefore, correlation pairs in EPR experiments must be measured at two different locations at the same time, or at least at a time of high correlation. Everyone knows that time is not a random variable and has a past-present-future time series, while Bell's λ is assumed to be a random variable; therefore, λ and time or space-time must be mathematically identifiable. Time variables should also be taken as real elements and entered into Bell's inequalities, but formula (1) does not take time variables into account.

Karl Hess believed *"If all the equipment stands still in a laboratory, as it usually does, we may replace space-time just by the number i of the actual experiment. Then, time is just regarded as an order parameter, which provides order as we are counting.* " [8] Thus, Karl Hess got an inequality different from Formula (1):

$$A^{i}{}_{a}(\lambda_{i})A^{i'}{}_{b}(\lambda_{i})+A^{i+1}{}_{a}(\lambda_{i+1})A_{c}{}^{i'+1}(\lambda_{i+1})-A_{b}{}^{i+2}(\lambda_{i+2})A_{c}{}^{i'+2}(\lambda_{i+2})\leqslant+3. \qquad (2)$$

This inequality, contrary to the popular Bell's inequality, does not impose any mathematical restrictions on the measurement results. It is always right and does not give a decisive difference between local implicit variable theory and quantum mechanics. Therefore, the experimental test of Bell's inequality is not enough to exclude the local realism; this kind of experiment involves two experiments in the space-like region to make the operation agreement of optical signal timing in their respective measurement time periods, thus not meeting the requirements of EPR argument.

In his article '*Bell's Inequality and Distance Effect*', Karl Hess pointed out that there are a lot of literatures published by scholars involved in the controversy of Bell's Inequality. The famous scholars are L. Accardy, J. Christian, H. A. De Raedt, A. Khrennikov, M. Kupczinsky, K. Michielson, T. Nieuwenhuisen, W. Philipp, L. Sica, Karl Hess and others [9]. Karl Hess, in other papers, argued that EPR experiments are interpreted according to Bell model without considering all the hidden variables and introducing some inferences of counterfactual conditions. There are always loopholes in the experimental verification of Bell inequality, so it will not disprove the localized realism [10].

Joy Christian tried to illuminate that quantum entanglement is an illusion in his work '*Disproof of Bell's theorem*'. He found that the completeness standard of Bell's inequality and the completeness standard of EPR argument have different topological space structures. In Bell's inequality, the product of a 3-vector real space and a 'complete' state space is projected onto the 0-sphere of the unit of{-1, +1}, that is projected to two unconnected unit points: *"*$A_n(\lambda):R^3\times\Lambda\rightarrow S^0$*, where R is a real space of 3-vectors,* Λ *is a space of 'complete' states, and* S_0 *is a unit 0-ball"* [11]. In the EPR argument, the product of a 3-vector real space and a 'complete' state space is projected to a 3-Dimensional spherical surface and further projected to a 4-dimensional space-time. So the topologically correct local maps are *"*$A_n(\lambda):R^3\times\Lambda\rightarrow S^2$ *"*[11]. *"Evidently, the range of these maps is still the set of points describing the binary results, ±1, but this set now has the topology of a 2-sphere rather than a 0-sphere."*[11] The value space of quantum states preset by Bell's inequality is inconsistent with the requirements of the completeness of EPR arguments. Along such a line of thought, Joy Christian discussed the real origin of the local realism of quantum correlation. He used the value local variables of Clifford algebra to give a negative proof of Bell's inequality, and analyzed the reasoning of GHZ theorem and Hardy theorem of Bell's inequality. Joy Christian believed that the real elements of EPR is in the unit 2-sphere, not in the 0-sphere envisaged by John Bell. Therefore, after analyzing the various multi-photons entangled topological spaces, he found that their dimensions are not consistent with the dimensions of the popular quantum information space. This exposes that the non-locality of quantum entanglement is an illusion.

Mei Xiaochun, a controversial scholar, argued that *"quantum mechanics is an ensemble theory based on high-dimensional configuration space, corresponding to classical statistical mechanics, describing a large number of micro-particles. Instead of describing a single micro-particle, the theory that corresponds to classical dynamics."*[12] *"The number of states of the system is enlarged after considering the configuration space description of the micro-particles and the symmetry of the wave function. A N-particle system is described by N! Alleles in 3N configuration space. Compressing the 3N configuration space into three-dimensional space means that a micro particle is described by N! allelic particles, or in other words, a particle is dispersed into wavy distribution.* "[12]

Mei Xiaochun used the symmetry of wave function of identical particles to understand the wavy distribution of particles in three-dimensional space, which is called wave-particle duality, and tries to eliminate the popular theories of quantum nonlocality and quantum entanglement. He pointed out that in the orthodox interpretation of quantum mechanics, when two photons are separated, *"if the measurement results show that the polarization of the photons at the point* x_1 *is + 1, the polarization of the photons at the point* x_2 *is - 1. If the polarization of the photon at the point* x_1 *is - 1, the spin of the photon at the point* x_2 *becomes + 1. That is to say, the measurement of the photon at the point* x_1 *will immediately change the state of the photon at the point* x_2 *, even though the two photons are very far apart, which results in the so-called quantum entanglement."* [12] *"According to the Identical multi-particles ensemble in configuration space, we can say that either the spin of particle 1 is + 1, that of particle 2 is - 1, or that of particle 1 is - 1 and that of particle 2 is + 1 because of the indistinguishability of identical particles. According to quantum ensemble theory, all these states are merely the states of a system in an ensemble. They are all possible, and the probability of each state is determined. We calculate their probability by quantum mechanics method. When calculating the statistical average of physical quantities, we must take them all into account.…… There is no abrupt change in the state of particle 2 in the measurement of particle 1, and there is a matter of over-distance interaction."*[12]

Mei Xiaochun and Yu Ping also considered the inconsistency between momentum operator and momentum operator in calculating kinetic energy, the difficulty in defining momentum operator in curvilinear coordinates, the problem of complex non-eigenvalue and average value of momentum operator, hermeticity and boundary condition of momentum operator, and the problem of non-eigenvalue wave function expanding according to eigenvalue of momentum operator. They believed that it is not enough to make a new ensemble interpretation of quantum mechanics, and it is also necessary to redefine momentum and angular momentum operators and give a new interpretation of the spin of particles, which makes a profound change in the mathematical and physical connotation of the original Bell inequality and dispels its decisive experiment role as quantum mechanics and EPR argument. [13]

3. Bell's Inequality and Quantum Gravity

Although the above three ideas of criticizing Bell's inequality have not yet been integrated into a new interpretation of quantum mechanics, they are consistent in defending Einstein's interpretation of local realism of quantum mechanics. Some of them also extend the space-time geometric analysis method of relativity in quantum mechanics, they provide a new way of thinking to make modern physics converge and integrate.

Kip S. Thorne, who won the Nobel Prize in Physics for discovering gravitational waves in 2017, talked about John Wheeler's hope for future unification of physics, and pointed out: "*For general relativity and quantum mechanics, in order to logically integrate the two, it is obvious that one or both of them should be modified. If this fusion is achieved, the ultimate unification of general relativity and quantum mechanics will produce a new set of powerful laws, which physicists call it as quantum gravity.*" [14] Physicists have different opinions on the possibility quantum gravity theory, which path to establish quantum gravity theory, and whether the quantum gravity theory can be reconstructed. Therefore, the study of quantum gravity has become an important link to realize the ultimate theoretical dream, and is the 'Holy Grail' that theoretical physicists yearn for.

In 1916, Einstein had known that gravitational waves exist and carry energy. In order to be compatible with atomic physics, the energy of gravitational waves should also be quantized. It was Einstein who first raised the question of quantum gravity: *"It appears that quantum theory would have to modify not only Maxwell's electromagnetic theory, but also the new theory of gravitation.*"[15] And Einstein first suggested that the preferable path of quantum gravity is to preserve quantum rules and modify general relativity. This affects most of the future quantum gravity models. In 1928, Dirac established the special relativistic quantum mechanics, namely quantum electrodynamics. Soon after, Heisenberg and Pauli of the Copenhagen School claimed in 1929 that "*quantization of gravitational fields, which is physically inevitable, can be achieved in a form completely similar to that here without any new difficulties.*"[16] But over the past 100 years, we have been amazed at the difficulty of such great physicists in underestimating the problem of quantum gravity. In 1971, shortly after Gerard't Hooft, a Dutch physicist, proved that Yang-Mills gauge field theory could be renormalized, he found that the quantization of general relativity could not be renormalized, which means that the theory of quantum gravity, which retains both the quantum rules and the basic principles of general relativity, probably does not exist. This makes physicists begin to consider super-gravity, supersymmetric quantum gravity models such as superstring and super membrane.

Lee Smolin believes that the exploration of quantum gravity has many divergences. Although early string theory has succeeded in eliminating tachyons and reducing extra dimensions, it must expand quantum field theory in a background-dependent space-time framework, which is inconsistent with the background independence of general relativity; string theory introduces more elementary particles, but does not have the support of reliable astronomical observations and physical experiments; and there are additional dimensional string theories to make the vacuum types of Calabi-Yao space numerous. The accelerated expansion of the universe, discovered in 1998, has led to a large number of string theory models coming to a dead end.

String theory is the product of quantizing the metric tensors of general relativity by replacing the particle model of basic particles with strings in the framework of quantum field theory. Loop quantum gravity established by Lee Smolin et al. is the product of quantization of affine connection of general relativity on the premise of retaining quantum rules. Some cosmological models based on loop quantum gravity conflict with the very early picture of cosmic evolution given by Big Bang cosmology. Although Einstein considers discrete space-time in some concepts of the unified field theory, it is difficult to say that loop quantum gravity based on discrete space-time is more in line with Einstein's physical ideal than string theory. They only modify general relativity in different ways.

Encouraged by a large number of experiments to prove Bell's inequality, quantum non-locality 、quantum entanglement and quantum information concepts in conflict with relativistic spirit, infiltrate into the theoretical exploration of loop quantum gravity (LQG). The unit of quantum information is the quantum bit, the smallest area quantum. The legs of the spin network in quantized space pierce the surface and excite the area quantum around the point. The direction of the legs piercing the micro-surface constitutes the state or basis of the area quantum. "*An area quantum would be a state with two identical ground states at the same time. This basic characteristic makes the area quantum have the property of superposition state"* [17]. Area quantum obeys quantum Boole logic. Shao Liang, Shao Dan and Shao Changgui argued that *"Possible entanglement between area quantum in quantized space-time, and the quantum states to ' instantaneous transmission' (i.e., the transport does not take time) caused by entanglement correlations at some point in the time course of quantization imply that the quantum space-time described by loop quantum gravity may hide some correlation in the sense of quantum mechanics, which is very similar to the spin entanglement of EPR pairs which have been known for a long time in quantum mechanics."* [17]

Inspired by the background independent method of loop quantum gravity, L. Crane put forward relational quantum theory, believing that "*the correct way to apply quantum theory to the universe is not to put the whole universe into the quantum system', but to regard quantum mechanics as 'the description of the relationship between the subsystems of the universe*" [18]. Carlo Rovelli further developed this idea. F. Markopoulou and Seth Lloyd attempted to understand the universe as *'a quantum computer capable of dynamically generating logic*' [18, p314]. "*The exchange of information between different subsystems in the universe is equivalent to describing the causal structure that determines the effect of one system on another system*" [18]. "*The idea of quantum information theory to reconstruct the concept of the universe enables us to understand how basic particles emerge from quantum space-time"*[18].

While the exploration of loop quantum gravity has been involved in the non-local storm caused by Bell's inequality, some more radical new physical models have begun to attack the principle of light speed invariance in relativity. More than 20 years ago, Lee Smolin noticed that some special calculations of loop quantum gravity actually contradicted Einstein's special relativity theory, which led him to abandon loop quantum gravity and reconsider the string theory with many defects. Influenced by Giovanni Amelino-Comelia, Joo Magueijo, Andreas Albrecht and other scholars, Lee Smolin and others seriously considered the need for mathematical and physical techniques not recognized by professional journals to form a variable light velocity cosmology (VSL) thought consistent with the special and general relativity, which is called ‘gravitational rainbow’: *“In the very early universe, when the temperature was very high, the speed of light was also very high, generally higher than today's speed of light. When we go back further, the temperature approaches Planck energy and the speed of light becomes infinite. It took longer to discover that this led to a theory of variable light speed that was also in harmony with the general relativity principle, but we finally found it.*”[18]

From Lee Smolin's sharp criticism of string theory, his pessimistic prediction of the development prospects of loop quantum gravity, and Roger Penrose's controversial exploration of the non-local effect of gravity involved in quantum measurement, we can see that the mainstream exploration of quantum gravity has been seriously misled by Bell's inequality and has entered a wilderness with many divergences. Perhaps, in the exploration of quantum gravity, we should adhere to Einstein's local realism extended from the principle of action through the medium between field theory and relativity, penetrate the space-time geometric analysis of relativity into the frontier exploration of quantum mechanics interpretation, and seriously consider whether to modify some concealed presuppositions of quantum mechanics, restart quantum gravity research under the condition of minimizing the constraints of the revised relativistic principle.

References

[1] A.Einstein,B.Podolsky,N.Rosen.*Can Quantum Mechanics description of physical reality be considered complete?*Phys.Rev.47,777(1935).

[2] Max Jammer, *Philosophy of Quantum Mechanics*, Chinese version translated by Qin Kecheng, Business Press, p270-302 (2014).

[3] Zhang Yongde, *Roots of quantum wisdom*, Tsinghua University Press, p255-265(2012).

[4] Roger Penrose, *Emperor's New Brain*.Chinese version translated by Xu Mingxian and Wu Zhongchao. Hunan Science and Technology Publishing House, p331(1994).

[5] *Quantum concepts in space and time*, Edited by R.Penrose and C.J.Ishanm, Oxford University Press, p293-301(1986).

[6] Scully.M.O.,Ahanorov.Y. and Englert,B.G.(1999) *On the locality and Reality of Einstein-Podolsky-Rosen Correlations*. In: Bonifacio, R.,ED.,*AIP,Mysteries, Puzzles and Paradoxes in Quantum Mechnics.* p47-67.

[7] Murray Gell-Mann, *Quark and Puma*, Chinese version translated by Yang Jianye and Li Xianglian, Hunan Science and Technology Press, p171(1997).

[8] Karl Hess, *Einstein was right!* Pan Stanford Publishing Pte.Ltd, p43-52(2015).

[9] Karl Hess.*Bell’s theorem and instantaneous influences at a distance.* Journal of Modern Physics,9,1573-1590(2018).

[10] De Raedt, H.A.Michielson,Karl Hess. *The Photon identification loophole in EPRB experiments:Computer models with single-wing selection*, Open Physics, 15, 713-733(2017). http://doi.org/10.1515/physics-2017-0085.

[11] Joy Christian. *Disproof of Bell's theorem*,Brown Walker Press, Second edition, p84-92(2014).

[12] Mei Xiaochun, *Interpretation of Quantum Mechanics Configuration Space Full Identity Multi-particles Ensemble*,p7-59, http://www.mxcphy.cn/pdf/qm/qm2/pdf.

[13] 13.Xiaochun Mei,Ping Yu, *The Definition of Universal Momentum Operator of Quantum Mechanicsand the Essence of Micro-Particle's Spin*, Journal of Modern Physics, 2012, No.6, p.451- 470. http://www.scirp.org/journal/jmp/**.**

[14] Kip S. Thorne, *Black Hole and Time Curve*, Chinese version translated by Li Yong, Hunan Science and Technology Publishing House, , p213(2000).

[15] 15.Albert Einstein, *Approximate Integration of the Field Equation of Gravitation*, Sitzungsberichte der Preussische Akadamie der Wissenchaften, Berlin, p688-696 (1916).

[16] 16.W.Heisenberg and W.Pauli, *Zur Quantemdynamik der Wellenfelder*, Zeit.für Physik, 56:1-61,p3(1929).

[17] 17. Shao Liang, Shao Dan, Shao Changgui: *Quantum Theory of Space and Time*, Science Press, p344-348(2011).

[18] 18. Lee Smolin,*The trouble with physics*, Chinese version translated by Li Yong, Hunan Science and Technology Publishing House,p314,p227(2008).