

Research on the Compatibility of Quantum Science and Marxist Philosophy

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Abstract: As an epoch-making achievement in the field of natural science, the scientific principles of quantum mechanics, such as nonlocality, entanglement and decoherence, and role at a distance, have triggered many different interpretations and controversies in the field of philosophy, among which idealism, metaphysics, and agnosticism are based on which to question or even deny dialectical materialism. Marxist philosophy has always closely interacted with natural science. In the face of new and old propositions in quantum mechanics, such as uncertainty principle, quantum tunneling, large distance zero interaction measurement, and Poincare regression of multi particle quantum system, we can promote its compatibility with the new world outlook and methodology of quantum science in the intertextuality interpretation. Quantum mechanics reveals the "intermediate phenomenon" in the process of understanding the micro world, highlighting the dialectical characteristics of materialistic epistemology; It emphasizes probability, but denies that uncertainty is subjective conjecture, defending the objectivity of existence; For the movement and change of things, the status of the contingency category has been improved and the linear causality has been exceeded, but the existence of universal and inevitable connection has not been fundamentally denied.

Keywords: Quantum mechanics, Marxist philosophy, Scientific methodology, Compatibility

1. Introduction

On October 4, 2022, the Nobel Prize in physics was issued, and the pioneering experiment of entangled quantum states by Alain Aspect, John F. Clauser and Anton Zeilinger was recognized by the world. This is of great significance. On the one hand, it reflects the pioneering prospect of quantum mechanics, and as a new breakthrough in natural science, it constantly changes and constructs the scientific cognition and practice mode, boosting human thinking ability and methods to a new leap; On the other hand, from the proposal of Bell inequality to the falsification, it shakes and even refutes the localized implicit variable hypothesis of Einstein, Popper and Bohm, and once again vividly presents the high complexity and multidimensional nature of quantum mechanics. Since the birth of quantum mechanics for a century, the interpretation of quantum mechanics, especially the philosophical interpretation, has been debated, and different interpretation paths have been generated. Among them, the interpretation paths, such as consciousness and wave function collapse, the objectivity of measuring object, and multi world idealism, lead quantum mechanics to the question of knowability and objectivity in philosophy, and thus question the scientificity of Marxist philosophy.

However, this is actually a metaphysical interpretation of the complexity of quantum mechanics. As a scientific method, Marxism has always closely interacted with natural science, enriched and developed, and is open and transcendent. Every scientific progress, as Engels stated in *Ludwig Feuerbach and the end of German classical philosophy*, makes "new cognitive materials are provided on an unprecedented scale", and then "establishes a connection" and "becomes organized" in these natural scientific discoveries [1]. If we look at it from a more complex perspective and dialectical perspective, and based on the intertextual interpretation of Marxism and quantum mechanics, we can precisely explore the compatibility between the philosophical interpretation of quantum mechanics and Marxist scientific methodology. Nowadays, Chinese scholars have made certain achievements in the research of quantum mechanics' world outlook [2, 3], logic [4], hermeneutics [5, 6], information theory [7], foreseeing a new transformation and new task of the philosophical paradigm [8], and have also made explorations and dialogues on new science and technology such as big data [9, 10], artificial intelligence [11] from the perspective of Marxist methodology, but generally speaking, for the implication of Marxist scientific methodology in quantum mechanics, No one has systematically sorted it out. This paper is an attempt to present the complex relationship between quantum mechanics and Marxist scientific methodology from three levels.

2. Organization of the Text

2.1. The dialectical relationship between the progress of natural science and the development of Marxist Philosophy

As a natural science achievement, quantum mechanics must have the universal characteristics of all-natural science achievements. The achievements of natural science symbolize the realistic power of human beings to understand and transform the world. On the one hand, because of its "breakthrough", it is beyond the Convention. On the other hand, the achievements of natural science constitute the understanding of the essence of things and the disclosure of internal laws. Therefore, it often poses a double challenge to philosophical theory: some focus on questioning, and some focus on construction. Therefore, when the dual nature of "query construction" acts on the development of Marxist philosophical methods, it becomes an inevitable theoretical appeal to seek the internal laws of the world, to question, reflect and broaden the boundaries of the scientific methodology group.

At the construction level, Marxist methodology is open and transcendent. In every scientific and technological progress, there will be a methodology that transcends specific science and technology. It will be absorbed and condensed into Marxism more general and abstract deep-seated principles and methods. It can be said that every scientific and technological progress is an opportunity for the development of materialist dialectics. In *Ludwig Feuerbach and the end of German classical philosophy*, Engels proposed that "with every epoch-making discovery in the field of natural science, materialism is bound to change its form" [1]. From the perspective of Marxist methodology, the advent of the three scientific achievements of nature in the 19th century - cell theory, conservation and transformation of energy, and the scientific theory of biological evolution, has led people to realize the universal connection method, development dialectics, and contradiction transformation analysis; Later, in the late 1940s, the advent of information theory, system theory and cybernetics deepened the understanding of materialist methodology group. With the successive establishment of dissipative structure theory, synergy theory and catastrophe theory in the 1970s, the cognition of system connection in materialist dialectics was further improved: as a special category of connection, system connection stipulates the contact mode of things from the perspective of interaction between the whole and parts, The corresponding methodology, system analysis method, is a methodology group [12] connecting modern system science methods and materialist dialectics. Based on materialist

dialectics, it puts forward new categories such as "entropy increase", "synergy", "hierarchy", "structure" and "mutation". Not only does the theory of systematic entropy increase lay the methodological groundwork for the later philosophical basis of reform and opening up [13], but Popper's "conjecture and refutation" method [14] has also been critically absorbed by today's problem-oriented method and the method of asking for directions.

However, at the questioning level, scientific and technological progress will also be filled with questions about the scientificity of Marxist philosophical methods. On the one hand, this is due to the rigid, one-sided and rigid interpretation of the traditional textbook model. On the other hand, many schools of philosophy have been deconstructed by traditional natural sciences in the past and become what Engels called "excluded natural philosophy" [1], These old "residual forces" always want to find evidence in the new science and revive it. For example, in a very long period of time, different from the developmental method revealed by the theory of evolution, the entropy increase theory is based on the second law of thermodynamics, but it deduces a "degenerate concept system". For example, the "heat death theory of the universe" is a doubt on the eternal development view and methodology of materialist dialectics; With the development of neuroscience and computer virtual reality, "Zhuangzhou Mengdie" has upgraded to "brain in a VAT", which has become a modern demonstration of the materialist method of skepticism, solipsism and subjective idealism to refute objectivity.

2.2. The cognitive construction process of quantum science and Marxist Epistemology

In the classical physics system, such as Newton's "mathematical principles of natural philosophy", it is often aimed at an objective problem, repeatedly experimenting in the determined variables, summarizing the phenomenon to determine the correlation coefficient, and then put forward a fundamental formula (such as the law of universal gravitation), with the accurate solution of such problems (such as the trajectory of free fall) as the confirmation to grasp the essence of things. Until 1900, William Thomson, the father of thermodynamics, proposed the "two dark clouds" of classical physics. In order to solve one of them, that is, the blackbody radiation problem in classical physics, Max Karl Ernst Ludwig Planck worked out a mathematical equation that was highly consistent with the experimental data and won the Nobel Prize for it. However, for the interpretation of the meaning of the equation, Planck thought hard and failed to get its solution because it appeared the premise of the equation of the common sense of anti-classical physics - the discontinuity of energy. In traditional epistemology, the cognitive subject constructs a theoretical model based on the existing object information and puts it into practice to test, form a formula (or axiom), and then try to predict the objective existence. In the process of continuous confirmation and trial and error, people gradually determine the scope of application of the theoretical model constructed by the subject thinking, so as to realize the correction of the theory. The question is, what are the criteria for confirmation and trial and error? Does error correction mean that it obscures another practical dimension of theory?

Not only Planck equation, but also a large number of such problems have been encountered in the beginning of quantum mechanics. A simple and common example of middle school physics is: the time t obtained by solving the quadratic equation of one variable in the trajectory of two cars meeting. If there is a negative value $-t$, that is, the root increment should be discarded, because there is no negative time in objective existence. However, the solution of the equation in quantum mechanics, which has been tested by a large number of experiments and is obviously inconsistent with the objective existence in one aspect, that is, the value that should be discarded or ignored as an additional root in the past, reveals another possibility, that is, to explore the unknown characteristics of the objective existence.

At that time, Einstein did not avoid the idea of solving the "discontinuity" equation, based on which he put forward the concept of "photon", and used this formula to answer the photoelectric

effect; By 1912, Niels Henrik David Bohr had solved a series of problems of electronic orbit according to the law of hydrogen atomic radiation spectrum and the idea of Planck Einstein's "quantization" and "discontinuity" equations. At this point, the objective unknown characteristics and the objective laws of quantum mechanics came out. In 1924, Louis Victor de Broglie further deduced a conjecture formula based on previous studies, and thus deduced that substances have volatility. So far, the interaction and correlation between the formulas are consistent with Planck's and Einstein's formulas, and have been proved by accurate numerical values in the experiments for many years. To sum up the important findings of the three initial periods of quantum mechanics, we can see the appearance, application and comparison of the three epistemological methods by comparing the above-mentioned scientific achievements of artificial intelligence.

First, judging logic according to phenomena is a well-known epistemological approach. Look for the internal inevitability between phenomena and pay attention to the absolute strong correlation [9]. As Mao Zedong revealed in the theory of practice, people start from the "feeling and impression stage" of "only seeing the phenomenon of each thing in the process, seeing the one sidedness of each thing, and seeing the external connection between each thing" [15], and then put forward concepts, judgments and reasoning. At the stage of perceptual cognition, "people have not yet been able to create a profound concept and make a logical (i.e., logical) conclusion. The continuation of social practice has made people repeat what they feel and impress in practice many times, so a sudden change (i.e., a leap) in the process of cognition has occurred in people's minds and concepts have emerged." [15] from the perspective of cognition, "The time that people use concepts in their minds for judgment and reasoning... Is the second stage of cognition." [15] thus finding the internal logic of complex phenomena. The above-mentioned epistemological principle of "knowledge begins with data" in AI skips the second stage and directly recognizes the laws between phenomena.

Second, judging phenomena according to phenomena is a big data AI epistemological method. For example, alpha doesn't pay attention to "chess way", "chess way" and "mental method" in playing chess, but only to the appearance of the chessboard; Marketing basket analysis does not focus on why diapers and beer should be sold together, but only on the inevitable connection between the phenomenon of buying A and buying B, which is shown by big data. In other words, this epistemological method obtains knowledge from the contingency between phenomena and does not study the internal mechanism. [9] on the one hand, this is due to the complexity of the cognitive object, which makes it difficult to grasp all the properties and essence. On the other hand, the cognitive subject's pursuit of the truth of cognition has turned, paying more attention to the law between phenomena.

Third, judging phenomena according to logic is the epistemological method of quantum mechanics. Solving phenomena according to mathematical formulas (one of logic) is a new contribution of quantum mechanics to epistemological methods. From the solution of the formula, people have found many potential concepts (strictly speaking, conceptualization is a logical existence), but due to the limitation of the actual cognitive ability, people have not been able to find the corresponding objective things. When we review the construction process of quantum mechanics, the obtained understanding of the law has a very ingenious feature: in order to explain the mathematical formula pieced out by the world, it leads to an unreasonable solution when solving a problem. At first, people did not realize its corresponding physical entity and practical significance. But at the same time, quantum mechanics has confirmed that the physical entity and practical significance corresponding to people's habits are only a phenomenon. For example, to see light, the traditional understanding believes that the essence is that light reaches the retina. In the understanding of quantum mechanics, there is an intermediate phenomenon behind the so-called essence. Even a single photon can enter the retina in the form of waves and particles. The different understanding of the intermediate phenomenon has little influence on the judgment of "this thing", but it has great differences on the deduction of "other things" and the

construction of the whole cognitive system. This also means that we need to develop more verification systems to achieve a deep understanding of the phenomenon.

This is why early quantum mechanics was full of various explanations that contradicted each other and were difficult to unify. In other words, there are two new enlightenments of the quantum mechanical epistemological method of judging the phenomenon from logic and mathematically solving the assertion that the phenomenon must exist: on the one hand, it is just opposite to the big data artificial intelligence epistemological method. The quantum mechanical epistemological method points out that there are still unknown "intermediate phenomena" in the essence (logic) we identified [16], which is ignored in traditional epistemology. But in the microcosmic world, we must face it squarely if we want to seek objectivity. On the other hand, as long as the formula (logic) holds, although people do not know its meaning for the time being, there must be a phenomenon corresponding to it in reality. Formulas can be substituted, transformed and solved. Every time an incomprehensible solution is found, it marks an unknown objective thing, which is just opposite to the path of traditional epistemological methods.

2.3. Uncertainty principle and Marxist materialism

Although implicit variable interpretation, multi world interpretation, orthodox interpretation and new Copenhagen School interpretation have been controversial in a certain historical period, with the continuous development of the quantum mechanics system over the past century, especially the continuous enrichment of experimental materials and the continuous improvement of verification methods, some basic propositions have been gradually verified, and then formed a philosophical discussion. Among them, the principle of uncertainty has been absorbed by agnosticism and idealism for a long time, obscuring the philosophical methods contained therein, especially the compatibility with Marxist methodology. Werner Heisenberg, a mainstream interpreter of quantum mechanics who invented matrix mechanics to explain quantum processes, has a famous conclusion which has been confirmed in many experiments, that is, positional uncertainty(Δx) And momentum uncertainty(Δp) Both meet a relationship.

The early interpretation of Heisenberg uncertainty principle was mainly from the measurement level, that is, due to the cost of measuring microscopic objects themselves. In the micro world, the existing state of many things will change due to the historical activity of "observation", and even form a "non-ontology" existing state due to "observation". In this regard, one of the traditional methodologies appeals to the future, believing that with the development of cognition, we can finally grasp the essence; The second is to reflect on noumenon and deny material noumenon and its objectivity. Later, Heisenberg proposed a correction: position uncertainty(Δx) And momentum uncertainty(Δp), is the characteristic of things, and has nothing to do with the advancement of observation means [17], that is to say, there is no such possibility: with the development and change of observation methods and means, the object can be less affected by the subject's activities and the uncertainty disappears. The problem it reflects is that from this perspective, only the material view with dialectics and the objective analysis with dialectical thinking can be regarded as the materialist method in the true sense.

The understanding of material in Marxist methodology does not stay in the specific material and its application, especially in the material understanding of social history and the objectivity of predicting the development of human society. This is a way to explain objectivity from the whole and identify materiality from the sum of relations. The uncertainty principle reveals that the measurement of a pair of conjugate quantities such as position and momentum (or azimuth and moment of momentum) is not what we understand in conventional thinking. As long as the information is sufficient, all uncertainty states can be eliminated; Atomic nuclei and electrons are not like the motion of celestial bodies in the classical mechanical model, but show the state of "nuclear cloud" and

"electron cloud". Even if all conditions are accurately controlled, the state of atomic nuclei and electrons will not be completely consistent with the last observation, but will appear in a specific position with probability, thus turning the existence of certainty into a probabilistic existence. The understanding of substance is transformed into the material view of superposition of various existing states.

However, the existence of probability and uncertainty is precisely the existence of objectivity. The grasp of material by Marxist materialist method starts from an abstract category. Its objectivity, which is not transferred by subjective will, is the fundamental difference from the so-called unmeasurable and unrecognizable assertions of agnostic philosophy. Accordingly, the objective analysis method of things does not mean that we have completed the objective analysis of things only after we have completed the specific judgment of things themselves. This is why Engels' historical resultant force theory and Marxist economic determinism can "determine" and "predict" human history on a macro scale belong to the same kind of methodology pedigree. Let's analyze another example: in the excellent traditional Chinese culture, there are many methodologies of traditional Chinese medicine that are worth introspecting into today's scientific and Technological Methodology, the most obvious of which is the analysis of the objective causes of disease. For example, for a cold, traditional Chinese medicine believes that the essence is "the external attack of the pathogenic wind and cold, and the loss of lung qi", and the method is "treating the disease with Xin and Wen, relieving the exterior, and dispersing the lung and dispersing the cold". Western medicine believes that the essence is "virus and bacterial infection", and should be "anti-inflammatory" and "anti-virus". Even though it has not yet reached the quantum level to see how the cold is cured, long-term practice has shown that both are very effective in clinical practice. The essence of the two theories also has predictive function in other aspects (perfectly in line with our expectations for any complete theory). Therefore, it can be said that the two essential analysis methods reveal different essence and emphasize different methods, but even if they fail to reveal more thorough, profound and omniscient underlying logic, they are still objective and reliable conclusions.

In another sense, "historical resultant force theory" and "economic determinism" judge the interaction and overall system of things, and their scientificity and explanatory power are of guiding significance because of their overall objectivity. In quantum mechanics, the speed of decoherence is proportional to the number of particles in the system [18]. Therefore, in macro objects, the decoherence process tends to be infinitely short due to the sufficient number of particles and will not show the existence of superposition states [19], which is objective on the whole. The quantum in the entangled state has a new type of connection that exists objectively. It is an objective property that human beings can grasp in practice, and it also has the overall objectivity. In classical physics, the essential analysis of things is to grasp the certainty of things, such as space-time certainty, quality certainty, change certainty, so as to realize the prediction of things; In quantum mechanics, the analysis of the nature of things is to step back to grasp the probability and relevance of things, such as the deterministic relationship between position uncertainty and momentum uncertainty, the deterministic relationship between energy uncertainty and time uncertainty (as shown in the following figure), and the deterministic relationship between wave function variables, so as to realize the prediction of things; These predictions are objective existence states that do not depend on human will.

2.4. Connection, change, development and Marxist Dialectics in the quantum world

As we all know, materialist dialectics is the scientific methodology of Marxism, and its five core categories, as the scientific methodology system of Marxism, are the theoretical support for the exploration of the world outlook and methodology. Especially in the dialectical category of necessity and contingency mentioned by Engels in *Ludwig Feuerbach and the end of German classical*

philosophy, "what is judged to be inevitable is composed of pure contingency, and the so-called contingency is a form in which inevitability is hidden" [1] however, As early as more than ten years ago, some scholars explained in the traditional textbooks (the traditional philosophy is that necessity determines the future and direction of the development of things, contingency can occur or not, and it is in the subordinate position of necessity, which is defined as "non-essential connection", "external connection" and "external contradiction" Therefore, in terms of methodology, it is easy to pay attention to the grasp of stable connection, and despise the exploration of accidental connection, special connection and the transformation to essential connection. It is difficult to explain the qualitative change of things brought about by contingency, and the contradictory transformation between contingency and inevitability. In the last century, some scholars tried to use the category of probability as the dialectical unity of contingency and inevitability. For example, in a box with the same number of red and green balls, it is probable to draw red balls, which means there is a 50% probability. However, in the quantum context, the ball can be both red and green, and the probability category is difficult to implement all scenarios. The category of inevitability and contingency is questioned, especially in its basis and transformation process. His idea that necessity and contingency are both internal contradictions of things and the distinction between "maximum possibility" and "minimum possibility" has been newly confirmed in the system of quantum mechanics. The current interpretation equates "necessity and contingency" with "essence and phenomenon" and "internal and external" to a certain extent, but it is not accurate. The dialectical relationship between necessity and contingency, and the internal relationship between "quantitative change and qualitative change" and "reality and possibility" are likely to be explained in a unified way in the level of quantum mechanics.

In his letter to borgius, Engels elaborated that contingency is the "supplement and manifestation" of inevitability, and inevitability "opens its own way through all kinds of contingency" [1]. Some scholars further pointed out that the realization of inevitability and contingency requires the other party to open its own way. Combined with the discovery of quantum mechanics, we can further advance a conclusion. According to the quantum tunneling effect, a particle encounters an obstacle. In the prediction of classical mechanics, if the energy of the particle is lower than the energy needed to cross the obstacle, the particle will never cross. This obstacle is called "potential barrier". According to quantum mechanics, this particle can achieve a leap in probability, which is shown as an impossible event in reality, only because its probability is too low (so that the time from the generation of the universe to its demise cannot be achieved). However, in enough quantity, long enough time and wide enough space, even if the probability is too low, there will be observable quantum tunneling effect in reality: for example, in the sun, the reason why there is long-term stable sunlight is that the quantum tunneling effect makes nuclear fusion possible at relatively low temperature. The quantum tunneling effect externalizes the possibility of accidental existence into an inevitable event, and realizes the qualitative transformation with the accumulation of uncertain quantities, thus making the development of change possible. In every quantitative change, the cumulative contingency and the numerical value of quantity become the inevitability standard to distinguish between reality and possibility, possibility and impossibility.

In methodology, it can be expressed as follows: first, contingency can also be the essential connection and stable connection of things. For example, the collapse of quantum states is accidental, but it is actually determined by the wave function. This contingency comes from the internal contradiction of things and is very stable. Another example is radioactive decay, how one atom becomes another atom, which is a sudden (accidental) process, but it can be perfectly explained by the quantum tunneling effect, and the calculation results are very consistent with reality. Second, contingency can also open its own way through necessity. For example, nuclear fusion must not be allowed to occur at the lower temperature of the solar surface, but it can also be achieved without hindering the tiny local quantum tunneling. Due to the huge volume of the sun (enough quantity,

enough time, enough wide space), these contingencies can be definitely accumulated - with a very small probability of inevitability, which is manifested as quantitative change causing qualitative change in the macro. This is why possibility becomes reality. At this time, inevitability becomes the manifestation of contingency. Third, grasp the temporary accidental superposition transformation to produce new inevitability. For example, quantum entanglement is very fragile and easy to decoherence, but a variety of conditions such as low temperature and Superconductivity (even the conditions for the occurrence of accidental minimum energy under natural evolution) can be applied to quantum informatics to make quantum keys, quantum algorithms, etc. The system has functions and features that elements do not have. If in the process of moving towards a higher-level system, some contingencies temporarily act as key elements, so that the system can present the functions of a higher-level system and give play to the inevitability of a higher-level system, so that "four or two pounds" and "one wood supports a dangerous building".

Incidentally, it is worth mentioning that another potential deepening direction of Marx's dialectics may come from Schrodinger equation. In particular, Schrodinger integrated the idea of "quantization" into the kinetic energy theorem of macro systems to describe micro systems Ψ Wave function in. The change of (x, t) in different positions and time plays an important role in predicting a series of experiments, such as double slit interference, single slit diffraction, atomic energy level, etc. Although people have not exhausted the properties of wave function (in fact, understanding the law is also an endless process), the original simple connection view, contradiction view. The concept of development may get a new explanation with the discovery of physical effects such as "quantum erasure" and "delayed selection". As Roger Penrose, the winner of the 2020 Nobel Prize in physics, wrote, "the emperor's new thinking: Considering computers, thinking, and the laws of physics were about 30 years ago [the title of the book is "the emperor's new thinking: Considering computers, thinking, and the laws of physics "]. In the past 30 years' specific scientific progress, it has not become outdated. In addition," quantization " The idea of formula calculation does not only exist in micro practice. It is precisely because understanding many phenomena on a macro scale requires a quantum worldview, so in the current scientific achievements, the possible deepening direction of dialectics is worth exploring.

3. Conclusion

According to the reports of the associated press [20], the BBC [21], the Washington Post [22], Forbes news [23], the New York Times [24], and CNN [25] on the 2022 Nobel Prize in physics, a preliminary consensus has been reached on the theoretical falsification and application of Bell inequality, which dispels the expectation of thoroughness in any theory. Numerous experiments have shown that the essence of the quantum world is uncertainty, not the uncertainty of insufficient understanding, but the thing itself and uncertainty itself. The derived method requires us to construct methods to find objectivity in uncertainty and identify authenticity in uncertainty. Engels said in *Ludwig Feuerbach and the end of German classical philosophy*: "the old research methods and thinking methods, which Hegel called" metaphysical "methods, mainly study things as invariable things" [1]. From the perspective of philosophical interpretation of quantum mechanics, we can draw a further conclusion: the real dialectical research methods and thinking methods should find more deep-seated objective correlations and get rid of the original idea that things are regarded as invariable.

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