Scientific Research Publishing

Open Journal of Social Sciences, 2017, 5, 1-9
http://www.scirp.org/journal/jss
ISSN Online: 2327-5960
ISSN Print: 2327-5952

Quantum Mechanics and Multi-World Interpretation—A Dialogue between a Cat and Everett

Tiantian Yang[1*], Hailiang Che[2]

[1]School of Humanities and Social Sciences, University of Science and Technology of China, Hefei, China
[2]School of Physics, University of Science and Technology of China, Hefei, China
Email: *uptian@mail.ustc.edu.cn, che0721@mail.ustc.edu.cn

How to cite this paper: Yang, T.T. and Che, H.L. (2017) Quantum Mechanics and Multi-World Interpretation—A Dialogue between a Cat and Everett. *Open Journal of Social Sciences*, **5**, 1-9.
http://dx.doi.org/10.4236/jss.2017.51001

Received: October 14, 2016
Accepted: January 3, 2017
Published: January 6, 2017

Abstract

Quantum mechanics is an important understanding of modern physics, and one of China's first quantum experimental satellites is also launched in July of this year, but around the confusion about the interpretation of quantum philosophy, yet there has not a perfect answer today. "Schrodinger's cat" is put forward by the Austrian physicist Schrodinger in 1935; it is a name for a quantum state, its production not only has its specific physical incentives, but also has the corresponding philosophical roots. Everett, the author of the "multi-world explanation", explains that the explanation of "multi-world explanation" to the quantum philosophy from the point of view of Schrodinger's cat in physics has not only helped us understand the nature of quantum mechanics, to solve the philosophical controversy that has revolved around quantum mechanics, but also deepened our understanding of multi-world interpretations where physics and philosophy blend. This article starts with the famous experiment Schrödinger's Cat and then tells us two well-known answers to quantum mechanics in the history, that is the Copenhagen Interpretation and the Multi-World Interpretation. By comparing the differences between the two, it emphasis on the correctness of the "multi-world interpretation". Then it can deepen our understanding of the concept of "Schrodinger's Cat", "Quantum Mechanics" and multi-world interpretations.

Keywords

Schrodinger Cat Paradox, Everett, Multi-World Explanation, Quantum Mechanics

1. Introduction

"Schrödinger's Cat" is the paradox of the Austrian physicist Schrödinger in 1935

to prove the idea of a "superposition state" in quantum mechanics. In this experiment, the protagonist is a cat that is used as an experimental object, yet people do not know the result of experiment, people don't know whether the cat is survive or die, which describes the truth of quantum mechanics: In a quantum system, an atom or photon can exist in a combination of states at the same time, and these different states may correspond to different, even contradictory, results. The whole experiment was carried out in a box with a cat, and a small amount of radioactive material. In about an hour, about 50% of the probability of radioactive material will decay and release the gas to kill the cat, the remaining 50% probability of radioactive material will not decay and the cat will survive. According to the law of exclusion of the classical physics, one of these two results is bound to happen in the box, and the inside and outside observers can only know the result inside by opening the box. But in the world of quantum mechanics, whether the cat is alive or dead, we only can know when the box is opened, the external observer to "measure" the specific circumstances to know; when the box is closed, the entire system has remained uncertain state, and cat is both dead and alive. We can only know exactly whether the cat is dead or alive at the moment of opened the lid. At this point, the cat's wave function from the superimposed state immediately shrinks to an eigenstate. If the cat is on the reality, specific, macro world, we cannot find a cat with both the dead and the alive. Before you opened the lid, the cat or die, or live, how could not die not alive, or both live and die? This is simply a great impact on our existing ideas.

In the quantum world, many theories defined by classical physics are not applicable, a typical example is the experiment that leaded by Thomas Young named double-slit interference experiment. This experiment was originally developed to prove that light is composed of waves. The double-slit interference experiment tells us that because of the observable interference effects, superposition occurs at the subatomic level where a single particle can be superimposed at several positions at the same time with a certain probability in. Into reality, we cannot see an object that exists both in A and B.

Copenhagen Explanation adheres to the dualism of the theory of physics; it is a lack of thoroughness. It argues that there is a strict boundary between the microscopic quantum world and the daily macroscopic world, so that we need both quantum mechanics to describe the microscopic world and classical mechanics to explain the macroscopic world. As for the relationship between the two, Copenhagen explained that the grasp of the microscopic world needs the help of macroscopic instruments and the special role of the observer. Therefore, the status of classical mechanics is more basic. Thus, quantum mechanics is fragile, non-basic, and only can apply to the micro-closed system. Once the microscopic world is measured, then the nature of the micro-object—quantum superposition, will be disappear in the form of "wave function of random collapse" and get a definite observation result. Therefore, in the transition from the microscopic world to the macroscopic world, the wave functions are randomly collapsed, and the wave function is regarded as the probability wave. What causes the collapse

of the wave function, finally comes down to the special status of the observer. To solve the problem with the subjective factors, and then comes down to spiritual problems, through this way to let the quantum measurement problem as a philosophical problem.

According to Copenhagen Explanation, if a "macro cat" in the undetermined state of death and dynamic coherent superposition, then the cat's life and death will not be independent of the laboratory objective of existence, but depends on the experimenter The cat's wave function collapses into a dead cat or a live cat only when someone opens the box to announce the result, and the cat is in the same state of death and live before the box is opened. This paradoxical contrast between the existence of quantum superposition and the "daily observation test" makes the "radical Hagen explanation" in an awkward position, so a big wave of "Copenhagen" explanation about whether quantum measurement is correct and whether quantum mechanics It applies to both micro and macro discussions.

Thus, a large wave of discussion of whether the "Copenhagen interpretation" on the quantum measurement is correct or not and whether the quantum mechanics can be applied to both micro and macro existence or not is caused. Different scientists and scholars have put forward their own views and opinions, Multi-world Interpretation is one of the most important one. In 1957, Everett in his doctoral dissertation "quantum mechanics" of the relevant state "interpretation", the first time proposed quantum correlation state interpretation, and in modern times to obtain a more Multi-scientist recognition, his proposal and development has been in the orthodox status of quantum mechanics of the "Copenhagen Interpretation", to solve the problem of quantum mechanics provides a new method. Heisenberg and Bohr in the interpretation of Copenhagen in the macro world we do not see the existence of two superimposed on the measurement when they have collapsed, with the difference is, Everett proposed another ideas-superposition state does affect our world, we just did not notice it. As he pointed out, the mathematics in quantum theory states that when we encounter a particle with superposition states and say it is there, the superposition state will also act on ourselves, dividing us into a person who sees the particle here and a person who sees the particle there. In fact, from the point of view of future generations, it is Everett proposed in quantum physics in a universe can be divided into parallel coexistence of "multiple worlds". At the same time, scientific experiments are being explored, and physicists hope that future experiments will test the modified Schrodinger equation more directly to the point of view of the collapse of wave functions, but unfortunately in this respect our experiments capacity is still far from enough. Although some scientists have grand plans to look for evidence of superposition collapse in macroscopic objects, such as those containing 1 million particles, the best record of the number of particles in a quantum superposition experiment is currently only about 1000.

As an important aspect of the philosophy of physics of quantum mechanical problems, it has been always cause a great concern, around it, on one hand, is the measurement problem, on the other hand is the interpretation of quantum

mechanics problems. The quantum system is in accordance with the Schrödinger equation before the evolution, the process is deterministic, reversible; in the measurement, the quantum system mutations occur, the superposition state collapses randomly into an eigenstate, and its process is non-deterministic and irreversible. When we associate the microscopic state of the experiment with the macroscopic visible result, the determinism of the micro state described by quantum mechanics in the evolution process and the non-deterministic nature in the measurement process are magnified in the macroscopic world, It seems that the state of the object is determined by the subjective measurement of the observer, that is, the cat is alive or dead by the person to open the cage before they can be determined, or else in the same state of death between the unknown, Which is contrary to the phenomenon of common sense. This paradoxical phenomenon requires a scientific explanation to solve the puzzlement, the perfect description of measuring instruments, measurement systems and subjective experiment is what kind of relationship, that is what the interpretation of quantum mechanics. So what is the measurement problem? In short, in the quantum world, particles exist in the form of a superposition, such as an electron, in a non-measuring process in the form of superposition state, with different positions, momentum and spin. However, during the measurement, once the measurement is completed, only a definite result can be obtained, that is, only one of the states of the superposition state can be obtained after the measurement, but not all. This is very different from the macro world in which people have never observed the presence of superposition states. The Schrödinger equation describes the evolution of the wave function of a quantum system over time, and the evolution itself is decisive and reversible in time. In the process of measurement, the mathematically rigorous deduction of the superposition state is collapsed into one state, thus breaking the wave function evolution in mathematical continuity. Copenhagen explained that in dealing with measurement problems can be attributed to two main points, that is, macroscopical and microscopic natural separation, respectively, follow different laws; the other point is that the problem of collapse is only given a probabilistic interpretation of its essence is ignorant.

2. The "Multi-World Interpretation" Theory and Its Development

From 1927 Boer and Heisenberg presented the famous "Copenhagen Interpretation" to the multi-world interpretation of quantum mechanics proposed by Everett in 1957, the "Copenhagen Interpretation" has been in an orthodox position. Since 1950, Albert Einstein questioned the principle of complementarity has been a lot of philosophers concern to Schrodinger at a Berlin seminar publicly questioned the principle of complementarity. In 1952, the United States physicist Bohm proposed a great sensation in the physics of the hidden variable theory, interpretation of the Copenhagen caused a great impact. In the late 1950s, Gunther Ludwig presented thermodynamic explanations, which he used as a thermodynamic system, so that in the quantum mechanics, the measurements had defi-

nite results. More importantly, the 1950s physicists began to focus on cosmology and general relativity, they want to use quantum mechanics to solve the problem of gravity, but Bohr led by "Copenhagen Interpretation" advocated by the principle of complementarity does not solve these problems problem.

In 1957, Everett first explained in his doctoral dissertation "quantum mechanics" the relevant state "state", proposed quantum measurement of the relevant state interpretation (Everett, 1957) [1]. But the theory did not cause concern in the physical world, just get the support of its mentor Wheeler, More than a decade of silence has made it known as one of the "best kept secrets of this century (20th century)" by Max Jammer (Jammer, 1987) [2], the famous quantum mechanics historian. At the request of the advisor, Everett visited Bohr at Radhaal, but Everett's point of view was nothing more than a heresy for Glass and the rest of Hagen, and Everett was not Want to express his rebellion against the traditional quantum theory, he is hoping to provide a new more comprehensive theoretical explanation. The new theory is not based on any radical departure from traditional forms. The special hypothesis of dealing with observations in the old theory was ignored in the new theory. This is a modified theory, thus gaining a new characteristic. Because in the past quantum mechanical form system, any interpretation of quantum mechanics must acknowledge the measurement process of wave packet collapse phenomenon and make the corresponding explanation, Everett is from this point of view to re-put forward the quantum. In explaining mechanically relevant states, he combined macroscopic and microscopic worlds to account for measurement problems in order to resolve traditional interpretations of micro- and macro-segregation. He sees the system, the measuring instrument and the observer as a quantum system and describes it with a cosmic wave function, so that the macroscopic object is also included in the quantum system. He assumes that all systems follow the Schrodinger equation, wave function collapse does not occur, so that by eliminating the "wave packet collapse" perfect to avoid the quantum world of non-determinism, adhere to meet the determinism, so that the relative state of interpretation in physics and philosophy at the same time to gain advantage.

As a result of Everett's understanding of the branch of the world is different, in 1973, De Weite and Graham's Everett based on the draft of the doctoral thesis developed EWG theory, the late 1980s, Squire He also developed a multi-view interpretation, Albert and Roy proposed a multi-spiritual interpretation, Grievous made a consistent historical interpretation, Gellman and Harto proposed decoherence historical interpretation, and so on. In the explanation of relative states, the existence of different branches in quantum superposition states is "relative". In the EWG theory, the world is divided, and there are many different worlds in the universe. In the multi-view explanation, the measurement is the "I" "multi-branch", "multi-world" and "multi-mind" are multiple cosmological choices in the same interpretation of history. In the interpretation of the multiple minds, the division occurs at the level of the individual observer's mind, history, the decoherence of historical interpretation depicts a dynamic split pic-

ture, and so on. These complicated names and theories show the difference and independence between different kinds of explanations of the world, which indicates that there are differences in the interpretation and development of Everett's theory. It is precisely because of the many researchers have different interpretations of Everett's understanding, all will produce many different versions, or even hostile, these theories are the rich development of Everett's theory. On the multi-world interpretation, Everett himself never put forward the word "multi-world", which is a summary of his theory.

The proposed of Quantum mechanics multi-world interpretation was nearly 60 years, and more and more widely accepted by people. Since 1988, a political scientist Robert in 72 quantum physics and cosmology home survey about the world explain is right or wrong, among them, the proportion of the thought that the explanation is right is more than 58%; the proportion of disagreeing with multi-world explanations is 18%; the proportion of people who think that "Maybe it is right, but now I'm not sure" is 13%; and the proportion of "I don't know" is 11%. In July 1999, a conference on quantum computing was held at the Newton Institute in Cambridge, where the quantum mechanics explanation was again voted to refresh the Quantum Mechanics Interpretation Rankings. Among them, more than 30 interpreters adhere to the multi-world interpretation: Copenhagen interpreted as 4; modified quantum dynamics (GRW) 2; hidden variable interpretation of 2; other explanations (including the unanswered) 50 (Zhang, 2010) [3]. In February 2001, Wheeler and Max Tegmark published an article commemorating the centennial of quantum discovery. In this paper, they argue that the decoherence theory and the latest experiments show that multi-world interpretations have superseded the orthodox 120 Copenhagen interpretation and become the new orthodox explanations of quantum mechanics that most physicists have endorsed (Tegmark and Wheeler, 2001) [4].

There are also some problems in the interpretation of multi-world explanations to the problem of quantum mechanics. Everett, for example, has claimed to have solved the "measurement problem", that is, how a certain classical reality emerges from the quantum uncertainty, and still holds great objection. The key to the problem lies not in his mathematics or logic, but in a sense of hinting (hence get the name "multi-world" theory) that he realizes all possibilities. According to multi-world explanations, all possible outcomes coexist before measurement. Each possible result is independently and disjointly present in the respective divisions of the universe, and the laboratory does not need any possible results appears or does not appear and annoyance, this completely uses the physics to explain the quantum mechanics survey, does not have the magic type "collapses" appears. But, as David Lindley queried, "If this independent universe is completely non-interacting, it is impossible to do experiments in one world to reveal the existence of other universes" (Lindley, 1996) [5]. The result is that the basic idea of a multi-world interpretation theory can be free of any test, so that a multi-world explanation will fall into the transcendental metaphysical position. Everything, then it actually cannot explain anything, so John Hawthorne (John

Hawthorne), represented by the metaphysicians strongly criticized Everett's interpretation of the "ambiguity" and "do not interpretive" (Hawthorne, 2009) [6].

Therefore, from this point of view, there is a certain ambiguity in the interpretation of the world, which is one of his shortcomings, in order to become a comprehensive scientific theory, multi-world interpretation also need to improve many aspects, in addition to his explanation, but also need to address the theory embodied in a superfluous ontology and scientific fantasy.

3. The "Orthodox Position of the Theory of Multi-World Interpretation"

Through the study of quantum mechanics, Copenhagen and multi-world explanations, we have deepened our understanding of "multi-world explanations", so we can get a clearer understanding of the rationality of "multi-world explanations". Compared with the "Copenhagen explanation", we can explain "multi-world interpretation" that has a strong orthodoxy from three aspects.

3.1. Overcoming the Dualism Thought with Universality

Copenhagen explanation insists that the theory of physics should be adhered to the dualism, it is lacks of thoroughness. It argues that there is a strict boundary between the microscopic quantum world and the daily macroscopic world, so that we need both quantum mechanics to describe the microscopic world and classical mechanics to explain the macroscopic world. This is a way of using the dualism to explain the world, this is fundamentally unscientific and contrary to the principles of physics, macroscopically. It gives a clear line between macro and micro, but the Copenhagen interpretation does not give a clear distinction between micro and macro.

On the contrary, in the multi-world explanation, any additional conditions imposed by man-made are not "should", and the boundary between "macrocosm" and "microscopic world" is not consistent with the laws of physics. This involves the central paradox of quantum theory, "the unique role that spirit plays in deciding the real process", as Copenhagen's interpretation insists. According to Copenhagen, the observed behavior makes the potential reality of the electrons superimposed together into a single concrete reality, while leaving the observer's atom alone cannot make any choice. The multi-world explanation treats the wave function as a real physical existence from the perspective of realism, and the whole universe can be described by the wave function. Quantum mechanics is universally applicable to the whole universe, not just to the microscopic quantum world. We can deduce the classical physics from the principles of quantum mechanics in logic and dynamics. We can describe the microscopic and macroscopic physical world uniformly. We do not need to rely on the principle of complementarity to refer to the concept of classical physics to describe the microscopic quantum world, thereby returning the objective reality to the world of physics. In this sense, the interpretation of quantum mechanics is no longer a vague "scholarly" debate, and truly become a part of quantum mechan-

ics. Many-world explanations cancel wave function collapse by decoherence theory, adhere to the evolutionary model of monism. Eliminating the collapse of the wave function caused by the mutation, it is not only adhered to the determinism, but also in line with strict causal relationship.

3.2. Substituting Positivism with Quantum State Realism

Multi-world theory has always insisted on solving the quantum measurement problem from the standpoint of physics and objectivity, there is no additional hypothesis. It breaks the Copenhagen interpretation of the dualism of the microscopic world and the classical world with physics' sown factors and solves the problem of the relationship between the quantum world and the classical world. It affirms that the quantum superposition state is the "most true" state of the entire physical world, insisting that the quantum state is an objective, invisible, independent representation of reality. The entire universe can be described by the Schrodinger equation, and there is never a collapse of the wave function. But not caused by the "glance" of the subjectivity of the observer. The universal quantum reality in the universe provides a unified description of the microscopic and macroscopic world, thus providing us with an objective realism picture. Multi-world interpretation in the field of microscopic, macroscopic and cosmopolitan view, all insist on objective certainty to ensure the true certainty of the world, especially for the determination of the daily macro-world. The purpose of this research is to study the quantum mechanics entity, which inherits the traditional idea of exploring the physical reality, is objective and deterministic, and ultimately to understand the real objective world.

The Copenhagen interpretation from classical physics depicts the world depends on the observer, with classical physics as the fundamental to establish the concept of reality, so the reality is based on the observation of the foundation, believe that seeing is believing. Since the description of the quantum states requires the help of macroscopic measuring instruments and observers, the quantum state should be seen as a relation between the microscopic particles and the measuring instrument, and at most we can accept that the relation is real. In their view, "there is simply no quantum world", only an abstract quantum physics description.

3.3. Many Worlds Replace a Single Classic World

According to the "random collapse of wave functions" explained by Copenhagen, there is only one possibility that will become reality, and the other possibilities are collapsing randomly. Therefore, in the macrocosm of the world to observe the quantum state, it will only get a certain result, which we live in a single, classic world. Although the quantum world itself is full of diversity, with countless possibilities, but the measurement will "control" the choice of quantum, the numerous possibilities into a unique reality. On the contrary, defenders of many world interpretations have completely abandoned the artificial hypothesis of quantum theory from the objectivity of quantum theory. They believe that quan-

tum mechanics is universal, so that the formal system of quantum mechanics can truly describe the objective reality of things. In the macroscopic field, the superposition of the quantum states does not disappear, but in the process of measurement, the measured particle measuring instrument (including the observer) splits. As time goes on, the state vectors will break down in a mutually perpendicular direction. Therefore, the universe will continue to split into unobservable, but equally true multiple worlds, that the universe split into parallel universe. While the wave function is seen as the ultimate reality of the whole universe, thus in the holistic sense, so that the composition of many of the world to obtain the determinism of the results. In this reality, the universe continued to split into a number of "parallel universe". These parallel universes are not connected in physics, but are equally authentic.

4. Conclusion

Everett was not the first physicist to criticize the collapse of the wave function in Copenhagen's interpretation. But he did "open up a new territory from the quantum mechanical system of equations to obtain an inherently consistent theory of cosmic wave functions". Everett's attempt to perfect the idea of Copenhagen's interpretation in his reply to DeWitt is clear: "Copenhagen's interpretation" is incomplete and hopeless because it depends a priori on classical physics and on philosophy. It is absurd because the concept of reality in the macrocosm is completely rejected in the microscopic world. Although the first multi-world theory is not as valued as a bizarre hypothesis, there are essential differences. As we have seen, it is a natural conclusion that multi-world theory is based on a rigorous system of quantum mechanics. Compared to Copenhagen's explanation, the multi-world explanation is simple and serious, it does not require the wave function to disappear at will, but the wave function continues to split into other wave functions, forming bifurcated trees, each of which represents a complete universe. But in most cases, the coherence between these wave functions is lost due to environmental perturbations (wave packet collapse is equivalent to environmental perturbation).

References

[1] Everett, H. (1957) Relative State Formulation of Quantum Mechanics. *Reviews of Modern Physics*, **29**, 454-462. https://doi.org/10.1103/RevModPhys.29.454

[2] Jammer, M. (1987) Philosophy of Quantum Mechanics. 509.

[3] Zhang, L. (2010) Quantitative Measurement of Multi-World Interpretation. *The Review Philosophical Trends*, **7**, 85-90.

[4] Tegmark, M. and Wheeler, J.A. (2001) 100 Years of the Quantum. *Scientific American*, **284**, 68-75. https://doi.org/10.1038/scientificamerican0201-68

[5] Lindley, D. (1996) Where Does the Weirdness Go? Why Quantum Mechanics Is Strange, but Not as Strange as You Think. Basic Books, 166-167.

[6] Hawthorne, J. (2009) A Metaphysician Looks at the Everett Interpretation. *Oxford University Conference*, July 2009, 263-264.