RE-DISCUSSING THE UNCERTAINTY PRINCIPLE FROM THE PERSPECTIVE OF INFORMATION AGENCY THEORY

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Abstract: *Since the proposal of the uncertainty principle, the debate between determinism and indeterminism has been extremely intense and has remained unresolved for a long time. This is mainly because the cognitive model in the macroscopic dimension has been adopted to analyze microscopic particles during the debate, thus falling into misunderstandings. In this context, it is necessary to provide a philosophical explanation for the uncertainty principle from the perspective of information agency theory. From the perspective of information agency theory, the cognitive framework of subject-information-object reveals the root of uncertainty. In the microscopic field, the indirect and delayed reflection of particle properties by the object information field, the limitations of the physiological and cognitive structures of the subject, and the changes in the particle state and deviations in information presentation by the tool system jointly contribute to the uncertainty of the state of microscopic particles. Similarly, uncertainty also exists in the macroscopic field, but it is not as obvious due to the relatively simple information agency links. This analysis helps to deeply understand the inevitability of uncertainty at the epistemological level, and at the same time prompts us to view the truth of the uncertainty principle comprehensively and from a developmental perspective, promoting in-depth understanding and research of relevant scientific achievements.*

Keywords: *Uncertainty principle; Single-slit electron diffraction experiment; Information agency theory; Information field*

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1. Introduction

The uncertainty principle proposed by German physicist Werner Heisenberg is an important theory reflecting the motion laws of microscopic particles in quantum mechanics and is regarded as a prominent feature that distinguishes quantum theory from classical theory [1]. This principle derives the uncertainty relation from the single-slit electron diffraction experiment, indicating that the position and momentum of a microscopic particle cannot be determined simultaneously during measurement, triggering a fierce debate between determinism and indeterminism in the philosophical community. Since the end of the 19th century, classical physics has achieved unprecedented and rapid development. "All known physical phenomena seem to find their explanations in a universal theory of matter (that is, particles), and radiation (that is, fields)" [2]. At that time, most scholars supported determinism based on strict causal relationships. However, with the proposal of the uncertainty principle in quantum mechanics, the fact that the future cannot be predicted at the subatomic level has led to increasing support for the philosophical position of indeterminism in the academic community. Many scholars such as Einstein and Bohr have participated in the debate for decades without reaching a conclusion. One of the important reasons is that the above debate and even the uncertainty principle itself use the way and perspective of humans in the macroscopic dimension to understand the world to examine the state of microscopic particles. Therefore, it is necessary to reinterpret the uncertainty principle and the behavior of microscopic particles behind it from a new perspective, and this perspective is the perspective of information agency theory.

2. Explaining the Causes of "Uncertainty" from the Perspective of Information Agency Theory

According to the information agency theory proposed by philosophy of information, the subject's cognition of the object passes through multiple levels of mediation such as the object information field, the physiological structure of the subject's own nervous system, the cognitive structure previously constructed by the subject, the materialized means of the subject's cognition of others, and the accumulations of natural and social history [3]. In the scope of

information agency theory and modern physics, the generation of uncertainty has profound roots at multiple levels. First, in terms of the object information field, what stimulates the senses is actually the information field rather than the object itself [4]. Taking microscopic particles as an example, the reflection of particle properties by their information field has significant indirectness and delay. In the single-slit electron diffraction experiment, the electron information needs to go through the conversion of electromagnetic fields and photon fields before reaching the observer. During this process, the properties of the particles change and there is a time difference, resulting in the position information presented on the film being difficult to match the instantaneous momentum of the electrons, greatly increasing the difficulty of simultaneously determining the coordinates and momentum of the particles. At the same time, the information field of microscopic particles is extremely vulnerable to interference from external factors. Given that "there are extensive and universal connections of various forms of fields among objects" [5], during the observation process, microscopic particles will interact with the surrounding environment, thereby changing their information fields. For example, electrons will be affected by electrostatic forces and quantum entanglement, and the receiving medium will also distort their position information, seriously interfering with the judgment of the particle state.

From the perspective of the subject factor, the subject factor in the information agency theory covers both the individual and group levels. Here, the focus is on the physiological and cognitive limitations of the group. The physiological structure of humans limits the receptor threshold and information reception method. Since the senses cannot directly recognize microscopic particles, they usually need to be transformed into a macroscopic form for observation, such as the "Schrodinger's Cat" and the single-slit electron diffraction experiment of electrons. However, this transformation is prone to cause information disorder because microscopic particles may not have a single choice of discrete states in the macroscopic sense [3] or coordinate-momentum states. In addition, human cognition is deeply bound by the social and historical background. The terms and means used to describe and detect microscopic particles are products of the times. Classical mechanics has prompted people to use momentum to

describe microscopic particles. If major breakthroughs are made in future technology, experimental designs are also likely to change. This demonstrates that the uncertainty may stem from the incompleteness of cognition. Both the EPR paradox proposed by Einstein and the related work of the Key Laboratory of Quantum Information of the Chinese Academy of Sciences [6] can prove this.

In terms of the tool system, the universal existence of the object information field causes the tool system to inevitably interact with microscopic particles during observation, thus changing the particle state and affecting information presentation. To conform to the physiological and cognitive structures of the subject, the tool will display the particles in a macroscopic and special form, thereby covering up their real states. Moreover, there is a delay phenomenon in the reception and transmission of the information field by the tool, and there are differences in the transmission times of different types of information, such as position and velocity information. This easily causes a time mismatch, making the observed microscopic state full of uncertainty and difficult to simultaneously determine the coordinates and momentum of the particles.

The uncertainty of microscopic particles stems from the distortion of the object by the cognitive mediation. Since such information mediation links also exist in the macroscopic cognitive process, uncertainty also exists in the essence of the macroscopic world. For example, the discovery of Prigogine's dissipative structure means that "some properties discovered by quantum mechanics at the microscopic level (uncertainty relations) reappear at the macroscopic level", and "randomness is still dominant at the macroscopic level" [7]. However, in daily life, people tend to hold a deterministic view. This is mainly because macroscopic objects are highly compatible with human thinking and terminology, the information is perceived through fewer mediation links, and the phenomena of information delay and distortion are not obvious. In addition, the motion of macroscopic objects is usually relatively low-speed and stable, so their uncertainty is not easily noticed. However, we must not deny the existence of uncertainty in the macroscopic world. At the same time, Boltzmann pointed out from the perspective of the molecular kinetic theory that an isolated system must evolve from a macroscopic state with a small number of microscopic states to a macroscopic state with a large number of microscopic states; it must

evolve from a state with an uneven probability distribution of microscopic states to a state with an even probability distribution of microscopic states[8]. In the language of philosophy of information, due to the interaction, transformation, and accumulation of information, the evolution trend of macroscopic or microscopic objects themselves increases the uncertainty of cognition, which constitutes a supplement to the uncertainty caused by information agency.

3. Rejecting the Position of Agnosticism

The derivation of the uncertainty principle is largely due to the distorted presentation of microscopic particles by multiple levels of mediation. However, this article does not intend to deny the correctness of the uncertainty principle, nor does it mean that microscopic particles and all objects are unknowable. In fact, the information agency theory opposes agnosticism. On the one hand, the object is the starting point of the subject's cognitive chain. Even after multiple levels of mediation, the theory finally constructed by the subject also corresponds to the object. On the other hand, the consistency between cognition and the object can be verified through repeated practices. Recognizing the possibility of the conformity between cognition and the object is also conducive to our better survival in the environment [3].

To illustrate with specific examples related to the uncertainty principle. The uncertainty principle has been corroborated by a large number of theoretical studies[9] and has achieved results in various forms of practical applications, which is sufficient to indicate that the uncertainty principle is an effective explanation of the motion laws of microscopic particles. However, this effectiveness is relative and conditional: on the one hand, the reflection of the motion laws of microscopic particles by the uncertainty principle is presented in a macroscopic and human-related form, and the state of the microscopic particles themselves is processed and reconstructed; on the other hand, the uncertainty principle has environmental and era limitations and needs to be supplemented by the continuous advancement of research. By extension, human cognition of different things in all dimensions conforms to the above discussion: we should both recognize the possibility of humans knowing things and also see that this cognition is always relative and conditional due to the

existence of multiple levels of mediation. It can be seen that as a philosophical thought related to the entire cognitive process, the information agency theory also has positive explanatory significance and guiding role for us to understand other scientific research achievements.

4. Conclusion

Analysis grounded in information agency theory demonstrates that the derivation of the Uncertainty Principle is epistemologically difficult to avoid, while simultaneously revealing that its correctness is relative and conditional. Interpreting the Uncertainty Principle through the lens of information agency theory enables us to provide philosophical support for it in a manner that is more closely aligned with the object itself, more consistent with modern scientific achievements, and more congruent with the laws of cognition. Furthermore, this perspective necessitates adopting a comprehensive and developmental attitude when considering the validity of the Uncertainty Principle.

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