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The Quantum Manifestation of Information †

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Abstract: Information is already clearly presented in quantum theory; yet, concealed by matter/energy, it can be revealed only on the premise that the data of information is highlighted. Exploring the mysterious "quantum information" is of great significance for both quantum and information theories. The secret of information is hidden in quantum observation. Quantum phenomena are information as receptive relation. It is in this sense that quantum information is the manifestation of information.

Keywords: information; quantum phenomena; receptive relation; manifestation

1. Introduction

The complexity of the information concept not only becomes more bewildering because of the introduction of "quantum information", it also makes it more complex to understand quantum theory itself. Many ideologists, including physicists and philosophers, have an intuition; that is, there is an important intrinsic relation between quantum mechanics and information. Quantum mechanics has long become a crucial pillar for theoretical physics, yet from the perspective of information, there are added some misty layers. "Nevertheless, the question, 'What is quantum information?' is still far from having an answer upon which the whole quantum information community agrees" [1] (p. 3). "Many philosophers and physicists have expressed great hope that quantum information theory will help us understand the nature of the quantum world. The general problem is that there is no widespread agreement on what quantum information is" [2] (p. 171). In quantum theory, where information enjoys a particularly prominent place, no consensus has been reached in answering the question of, "What is quantum information?", which also suffices to illustrate the complexity of understanding the concept of information.

Taking the critical role of quantum phenomena for information understanding into consideration, our understanding of quantum information relates to the understanding of information in a fundamental way. As a crucial part of information understanding, the understanding of the concept must be put into a bigger picture of philosophy; conclusions will be limited to the domain of quantum theory if we do not jump out.

2. The Secret of Information in Quantum Observation

For humans, there is a special correlation between the concept of information and quantum theory. The correlation is important and offers some mutual implications, which are reflected in studies on quantum information, consciously or unconsciously, although the implications have not been fully displayed yet.

The mutual implications between the concept of information and quantum theory have not been displayed because there lacks a precise understanding of what quantum information is. The understanding of quantum information holds the key to a precise understanding of the concepts of information and quantum.

The understanding of the mysterious relation between quantum mechanics and information may be a most peculiar scenario in the human history of cognition. Information

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is unprecedentedly highlighted in quantum mechanics because, in fact, the quantum phenomenon itself is information. Nevertheless, we have been missing chances to discover the secret of information via the intrinsic relation between the two, and we therefore realize that a flimsy veil cast by the era of time could as well be a hefty curtain of iron with historical limitations. This is a special scenario of paradigm change that is understandable; one of the paradigms is in the domain of matter/energy, and the other is in the totally different domain of information.

Studies on quantum information provide important revelations to deepening information understanding; this is due to the fact that information phenomena in the quantum domain are, at least by appearance, totally different from those in classical physics. The complexity of quantum phenomena adds to the mystery of "quantum information".

3. Quantum Phenomenon Is Information as Receptive Relation

For many people, quantum information may seem to hide more deeply than classical information, whereas, in fact, the opposite is true: The indirectness of observation in the quantum domain instead makes information highlighted. Therefore, rather than saying that quantum information implies further understanding of the secrets of information, and thus relevant studies have deeper waters to explore, it would be better to say that quantum information suggests the direct presentation of the basic concept of information, and that quantum phenomena come nearer to information itself. This is why it is at least a misunderstanding that "quantum information" is now regarded as a field of research and even as a subject of information.

In the current understanding, "quantum information" is a theory of information. "Quantum information is a rich theory that seeks to describe and make use of the distinctive possibilities for information processing and communication that quantum systems provide. What draws the discipline together is the recognition that far from quantum behaviour presenting a potential nuisance for computation and information transmission (in light of the trend towards increasing miniaturization) the fact that the properties of quantum systems differ so markedly from those of classical objects actually provides opportunities for interesting new communication protocols and forms of information processing. Entanglement and non-commutativity, two essentially quantum features, can be used" [3] (p. 45). Combining quantum and information for a subject of quantum information obviously is relevant to the characteristics of the quantum system that differ from those of classical physics although, fundamentally, it is an illustration of the information characteristics of quantum phenomena themselves. The physical phenomena in classical physics also have information characteristics, but since the receptivity of the human as a receiver can be ignored in matter/energy interactions, it is fine to see it as a purely matter/energy interaction without considering the information characteristics of the interaction, and that is how information is concealed. However, in quantum physics, the receptivity of the human as a receiver can no longer be ignored; thus, the information characteristics are highlighted: a quantum phenomenon is information as a receptive relation [4]. Since a quantum phenomenon is information, systematic studies on quantum information would enter a peculiar situation where quantum physics and information hold the keys for each other.

4. Quantum Information Is the Manifestation of Information

With regard to information understanding, so-called "quantum information" is indeed rich in revelations; yet, its peculiarity is, in fact, the peculiarity of a signal in the quantum domain. Studying the peculiarity of a signal is undoubtedly a part of studies on information, but it is not a must for understanding information itself. In this sense, "quantum information" is not information of a different kind. Even the so-called "intrinsic randomness" is not a patent of quantum information. "Intrinsic randomness marks the difference between quantum and classical information: quantum information is a type of information that is only possible in a world in which there are intrinsically random events" [1]. It is not limited to the quantum level, but rather is a character of all relations and processes. In other words, information as receptive relation has intrinsic randomness without exception, only that the intrinsic randomness can be more tolerably ignored in interactions that mainly feature matter/energy (e.g., classical physics) and less so in interactions that mainly feature information (e.g., quantum physics). Fundamentally, intrinsic randomness originates from the uniqueness of specific things; and, in interaction, even the identical particles in terms of space can be totally different in terms of time. Since information cannot separate from specific contexts and time flows, it is less independent from time and space than matter/energy; put specifically, it can be an abstract concept with time/space specifications, and it cannot be simply generalized. This explains why it is almost impossible to abstract multi-factor information interactions with the method of bisection. At bottom, the so-called "intrinsic randomness" is not a natural characteristic of things, but a characteristic described by the agent.

There is still a way to go for quantum information studies. And the "information quantum mechanics" of today refers to studies on quantum physics and has little to do with understanding information itself; yet, starting from the view of information is indeed a key for deepening our understanding of quantum physics.

Since humans cannot directly perceive microscopic objects, humans as advanced receivers cannot avoid self-involvement on the same macro scale. In this vein, the idea that "where there is intention, there is information" no longer applies. Instead, through approaches similar to backing away, we can perceive scenarios that, before, were hard to be perceived; and something unprecedented emerges in the quantum domain; that is, while the picture of matter/energy blurs, that of information gradually comes into focus—quantum information itself is a typical receptive relation.

From a macroscopic perspective, regarding the green of leaves as an objective fact is like covering one's eyes with leaves so that one can see nothing else. It is not just the green; in fact, our concept of the shape of a leaf is also "perceived" by our human eye. To perceive the leaf with a receptor that perceives differently from the human eye, considering that the space a leaf occupies is much larger than the summation of the space that every atom of the leaf occupies, the leaf may be perceived as something similar to how we perceive the solar system; thus the leaf can be regarded as something "hollow and spacious", which is totally different from the characteristics of a leaf in our concept—let alone that the space an entity occupies is relatively spoken, and the positions referred to in observations are mutually dependent. In addition, the space itself is something stipulated by the human receiver according to perception, which can be easily neglected because of its objectivity. In this vein, the leaf in our eyes is "perceived", and as an effect of the perception, it is information as a receptive relation; a photo of the leaf works in a way similar to that of human eye; that is, it is also the result of encoding, a matter/energy or conceptual (symbols or codes) existence that can serve as the secondary source. It is of great importance to make this clear for the understanding of information as well as that of quantum mechanics.

The information understanding of quantum mechanics is closely related to the special informational correlations of quantum mechanics, and if we carry it through, we may even reach an informational quantum theory in its true sense. With regard to the pure matter/energy natural science, "the sorrow of physics" comes from the natural limitations of human perception and the shackles of anthropological characteristics. Luckily, shapes and forms play a lesser role (if not no role at all) in the domain of information. In today's information domain, there is a need similar to that in Newton's time, as we need modern Newtons to restart the journey from the level of information and lead our cognition by assiduously depicting the concept of information.

In the history of human cognition, the establishment of every significant theory goes through a process where the vague fundamental concept gradually comes into focus and becomes a precise scientific concept. "For the purposes of science, information had to mean something special. Three centuries earlier, the new discipline of physics could not proceed until Isaac Newton appropriated words that were ancient and vague—force, mass, motion, and even time—and gave them new meanings. Newton made these terms into quantities, suitable for use in mathematical formulas. Until then, motion (for example) had been just as soft and inclusive a term as information. For Aristotelians, motion covered a far-flung family of phenomena: a peach ripening, a stone falling, a child growing, a body decaying. That was too rich. Most varieties of motion had to be tossed out before Newton's laws could apply and the Scientific Revolution could succeed. In the nineteenth century, energy began to undergo a similar transformation: natural philosophers adapted a word meaning vigor or intensity. They mathematicized it, giving energy its fundamental place in the physicists' view of nature" [5] (pp. 7–8). Similar to basic concepts such as "energy" and "movement"; the concept of "information" must also go through such a process of clarification. Since information is far more complex, the process can be so winding that, due to a lack of mature conditions, we have missed the clear presentation of information by quantum mechanics many times.

5. Conclusions

The clear presentation of information in the domain of quantum mechanics, with its special characters, can be easily neglected. On the one hand, it is specialized, and not many can systematically understand its basic concepts; on the other, the quantum domain has always embodied a large number of mysteries and conundrums; thus, experts have been engaged in exploring quantum mechanics and relevant scientific and philosophical problems. In addition, information is presented via quantum thanks to the indirectness of the observer's perception, which in turn conceals the way to understanding information as a receptive relation because quantum mechanics is presented by mathematical forms. This makes the presentation of information in quantum mechanics a totally different role from that of the presentation in big data as our understanding of information develops. Nevertheless, quantum theory has a unique advantage in information understanding and studies, that is, the empirical scientific correlations of information.

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