International Journal of Scientific & Engineering Research, Volume 5, Issue 2, February-2014 315
ISSN 2229-5518

Epistemological and ontological aspects of quantum mechanics

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Abstract: We want to stady two important class of the interpretation in quantum mechanics, Epistemological and Ontological interpretation.

Index Terms (Keywords) — Epistemological interpretation, Ontological interpretation, Copenhagen interpretation, Quantum logic, Hidden Variables, interpretation (Bohm's interpretation), Quantum logic.

1 Introduction

The founders of relativity theory and quantum mechanics were as concerned with the epistemological and ontological aspects and mathematical consistency of these theories. Quantum theory is fundamentally indeterministic in that it does not supply definite predictions for the results of measurements. It supplies only probability predictions, here I would like to explain the epistemological and oncological aspects of Quantum theory.

Quantum mechanics has provided much controversy in philosophical interpretations. Renew all those ancient questions, in the light of quantum theory indicate that a new ontology is building by the non-classical theories, a class of questions such as: what are space and time? Is space time absolute, and a thing in its own right? Or is it a system of relations among physical bodies, so that if there were no bodies and no events, there would be no space time? What is mind, what is matter? Does the realm of quantum theory exist independently from ourselves and our measurements? Or do we somehow create the very things that we measure, rather than discover what is already there? And so on, moreover renew another class of questions also indicates that a new epistemology is building by the non-classical theories, such as: Is science the only source of knowledge? What is commonly called scientific method? How should we acquire scientific knowledge? How should we test theories? Are theories justified by observations alone, or do other factors (values, simplicity, social conditions) play a role? What is the nature of evidence in science, in general? Realism? or Anti-realism?

2 Epistemological and Ontological Interpretation

In order to show that non-classical theories generate an ontology and an epistemology for the facts, events and things, let us consider quantum theory. The role which quantum theory would play to resolving some of the seemingly paradoxical aspects of quantum theory generates a class of interpretations, with reference to the following interpretations:

Copenhagen interpretation, Transactional interpretation, Hidden Variables interpretation (Bohm's interpretation), The Statistical interpretation, The Consistent histories interpretation, The Ensemble interpretation, The Many worlds interpretation, The many minds interpretation, The many histories interpretation, The Decoherence interpretation and some other interpretations.

According to some of the interpretations, the first thing that strikes the imagination is a revolutionary change in our world around and its facts, events and entities, a revolutionary change in objects, processes, qualities and relationships, so that we must add some objects (parameters) to the world or we must ignore some physical entities like electron being. In this picture we accept that human beings do have libertarian or free will, then we must accept that the world is not entirely governed by natural law. Some have argued that if the world is not entirely governed by natural law, then the task of science is rendered impossible. However, the development of quantum mechanics gave thinkers alternatives to these strictly bound possibilities. Proposing a model for a universe that follows general rules but never had a predetermined future. If the world is not completely governed by natural law then we must deny causality.

The Copenhagen interpretation expresses that entities such as electrons do not exist when they are not being observed or measured in some way, but spread out as a cloud of probability with a definite probability of being found in one place and another probability of being detected somewhere else, and so on. The Copenhagen interpretation of quantum theory says any quantum entity which has a choice of possibilities exists in a superposition of states, a mixture of all possibilities, until its measurement. Then, and only then, there is a 'collapse of the wave function' and it settles into one of the states.

According to the Hidden variables interpretation or Bohm's interpretation, all the usual versions of quantum mechanics are incomplete, and that there is an underlying layer of reality (a kind of sub-quantum world) which contains additional information about the world. This additional information is in the form of the hidden variables. If physicists knew the values of these hidden variables, the argument runs, they could predict the precise outcomes of particular measurements, not just the probabilities of getting particular outcomes.

These kind of interpretations can be called Ontological interpretation.

According to some other interpretations, the first thing that strikes the imagination is a revolutionary change in our essential and basic knowledge. In other words we must change our epistemological system, not our world around or its facts, events and entities. In this picture the world is entirely governed by natural law and human beings don't have libertarian or free will to add or remove the real entities. If the world is completely governed by natural law, then we can save causality.

The quantum logic interpretation says that everyday logic cannot be applied to the quantum world. Everyday logic is called Boolean logic. The revolutionary nature of Quantum mechanics has led some philosophers and physicists to suggest that certain basic changes be made in the language of physics.

The most extreme proposals for such modification concern a change in the form of logic used in physics are as follows:

1. Change, in the formation rules (rules specifying the admitted forms of sentences). Philip Frank, Moritz Schlick and Martin Strauss, together expressed the view that, under certain conditions the conjunction of two meaningful statements in physics should be considered meaningless. They suggested a change, in the formation rules. Strauss argued the formation rules of the language of physics should be modified.
2. Change, in the transformation rules (rules by which a sentence may be derived from another sentence or set of sentences). Garrett Birkhoff and John von Neumann suggested a change, not in the formation rules, but in the transformation rules. They proposed that physicists abandon one of the laws of distribution in propositional logic.
3. Change, in the traditional two-valued logic (by this change two-valued logic will be replaced by a three-valued logic). In such a logic, each statement would have one of three possible values: T (true), F (false), and I (indeterminate). The classical law of the excluded third (a statement must be either true or false; there is no third possibility) is replaced by the law of the excluded fourth. Every statement must be true, false, or indeterminate; there is no fourth alternative. In other words, there are situations in modern physics in which, if certain statements are true, other statements must be indeterminate. Hans Reichenbach, suggested that the traditional two-valued logic be replaced by a three-valued logic. Reichenbach found it necessary to redefine the customary logical connectives (implication, disjunction, conjunction, and so on) by truth tables much more complicated than those used to define the connectives of the familiar two-valued logic. In addition, he was led to introduce new connectives.

3 Conclusion

Despite the large number of interpretations and ideas in Quantum Mechanics all of them are said to fall into two primary categories, which are defined in contrast to each other: ontological interpretations and epistemological interpretations. The basic proposition of these two categories pertains to the nature of reality in Quantum Mechanics, and the primary distinction between them is the way they answer the fundamental question: "What must we change in quantum mechanics, entities or their properties? The answer which physicists give to this question split them into two great camps. Those who asserted the primacy of entities to their properties comprised the camp of ontologist physicists. The others, who regarded their properties as primary, belong to the various schools of Epistemologists".

Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions. Authors are strongly encouraged not to call out multiple figures or tables in the conclusion—these should be referenced in the body of the paper.

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