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RANDOM AND ARBITRARY CONTINGENCIES IN HISTORY OF SCIENCE AND TECHNOLOGY [4] – THE NON-CAUSAL FRAMEWORKS OF COPENHAGEN QUANTUM MECHANICS

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ABSTRACT

Copenhagen interpretation of quantum mechanics has become a groundbreaking fundamental approach toward the sub-atomic world, even though Einstein himself never fully acknowledge its frameworks. The interpretation assumes that all the quantum processes and phenomena are random and arbitrary. All we can do is the probabilistic understanding of random occurrences. This empiricist' ideas of anti-realism, non-causality, and indeterminism have been a text standard presentation of quantum mechanics today. Physics textbooks today follow the interpretation, describing all the sub-atomic phenomena as random, arbitrary and non-causal, solely dependent on probabilistic pure chance.

KEYWORDS: non-causal, anti-realism, indeterminism, Copenhagen interpretation, wave mechanics, matrix mechanics, Bohr's hydrogen atom, matter wave, quantum jump, random probability

INTRODUCTION

After the discovery of a negatively charged electron by J.J. Thomson, Rutherford identified a positively charged nucleus of an atom. It was then Niels Bohr in 1913 who proposed the first model for a hydrogen atom with negatively charged electrons' quantized orbits circling around the positively charged nucleus. Based on his model, he could explain the Lyman and Balmer series of the hydrogen emission lines which were already well established experimentally. For example, the electron transition from n=3 to n=2 corresponded to the H-alpha emission of the hydrogen atom of which wavelength was already firmly measured before. However, this electron transition from one orbit to another turned out to be a quantum jump meaning an instantaneous relocation of an electron between some discrete electron's orbits.

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The Non-Causal Frameworks of Quantum Phenomena

It was Albert Einstein himself who claimed that the instantaneous electron's transition from one orbit to another in Bohr's atomic model severely violates the principle of relativity. On the other hand, Bohr reacted to Einstein's criticism by pointing out an incredible match between the known observed wavelengths of the hydrogen emission lines and his calculated ones from the hydrogen model predictions. In this respect, at least, Bohr could explain the phenomena involved in the observed hydrogen emission lines. From an empiricist's point of view, Bohr's atomic model could save the phenomena although the theoretical basis of his model was not well established from the point of view of Einstein's relativity theory.

This kind of Bohr's empiricism has some historical precedents in such a famous historical case of Newton's gravitation when Newton wrote "I have not as yet been able to discover the reason for these properties of gravity from phenomena, and I do not feign hypotheses" (Newton 1999, p.974). Newton felt satisfied after deriving Kepler's third law of planetary motion based on his first, second and third laws of motion together with his law of universal gravitation. He did not feel necessary to explain why the gravitation was only attractive, what kind of medium the gravitation required, and how fast the gravitation propagated in an empty space etc. It was only Descartes who needed to come up with an idea of the gravitational medium called plenum with a vortex motion between plenum to propagate the gravitational force. However, for Newton, all those ideas of Descartes regarding the gravitation was not only unnecessary but also simply being "hypotheses" which Newton did not feign at all.

After Bohr saved the atomic phenomena based on his hydrogen model, he proposes a further empiricist's view as the complementary principle in which both an observer and an instrument for the observation together create phenomena in the sub-atomic world. Bohr's complementary principle denies sub-atomic entity such as electrons and nuclei only to establish the related phenomena as the fundamental basis in describing the sub-atomic world. Relying on this complementarity, Bohr's hydrogen model became simply a calculating device with which the hydrogen atomic emission lines such as the Lyman-alpha line can be calculated using the heuristic concept called quantum jump. Thereby, the idea of quantum jump is no longer a physically impossible trouble but it was only a model-based heuristic device which has no reality involved. As long as the atomic model remains to be useful in describing the phenomena, Bohr does not have to invoke some hypotheses for the model. Those inner working ideas in the model such as quantum jump are simply a sort of heuristic devices, not a realistic physicality, thus successfully defending his idea of quantum jump against Einstein's criticism for it.

This empiricist' anti-realism by Bohr toward the sub-atomic world further claims non-causality in the quantum phenomena. In this line of reasoning, Heisenberg's uncertainty principle further guarantees

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indeterminism after Heisenberg proposes a matrix mechanics based on linear algebra of discrete mathematics. However, almost at the same time, through a differential wave equation, Schrödinger also proposes a wave mechanics based on de Broglie's concept of a matter wave. Nevertheless, Heisenberg re-interprets Schrödinger's wave as a mathematical probability wave not as a physical wave that de Broglie originally envisions.

Finally, after Heisenberg's matrix mechanics was then renamed as quantum mechanics. This quantum mechanics embraces the empiricist' ideas of anti-realism, non-causality, and indeterminism, establishing the so-called Copenhagen interpretation of quantum mechanics. In the interpretation, all the processes of sub-atomic phenomena are fundamentally random and arbitrary only with some probability involved which is then calculable from the matrix or the wave equation. So, as all modern physics textbooks describe nowadays, the sub-atomic processes are non-causal, in-deterministic and anti-realistic. This Copenhagen interpretation is now believed to be a groundbreaking fundamental approach for the technological and theoretical frameworks in this modern era, even though Einstein himself never fully acknowledges its frameworks in which all the quantum processes and phenomena are basically random, arbitrary and probabilistic.

CONCLUSION

The empiricist' ideas of anti-realism, non-causality, and indeterminism have been the basis of Copenhagen interpretation of quantum mechanics. Eventually, the interpretation has become a text standard presentation of quantum mechanics today despite the fact that some prominent physicist such as Einstein, Schrodinger, and de Broglie never fully accepted it. So, all modern physics textbooks describe all the sub-atomic phenomena are basically random and non-causal. We only calculate the probability of the phenomena involved. An actual occurrence of quantum phenomena is solely dependent on random probability i.e. pure chance.

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