

To cite this article: Yeuncheol Jeong (2026). RANDOM AND ARBITRARY CONTINGENCIES IN HISTORY OF SCIENCE AND TECHNOLOGY [8] – THE MARGINAL STATUS OF BOHMIAN QUANTUM MECHANICS, International Journal of Applied Science and Engineering Review (IJASER) 7 (3): 154-156 Article No. 278 Sub Id 412

---

## **RANDOM AND ARBITRARY CONTINGENCIES IN HISTORY OF SCIENCE AND TECHNOLOGY [8] – THE MARGINAL STATUS OF BOHMIAN QUANTUM MECHANICS**

**Yeuncheol Jeong**

Department of History, Sejong University, Seoul, Korea

DOI: <https://doi.org/10.52267/IJASER.2026.7317>

### **ABSTRACT**

David Bohm transformed Schrödinger equation into a form of Newton's second law of motion, revoking causality, determinism and realism in quantum mechanics. However, the newly created term of quantum potential in Bohm's transformation is taken to be non-physical to many physicists. Besides, Bohm's quantum mechanics came one generation later after Copenhagen counterpart. At the same time, Bohm could not advocate his quantum mechanics with other physicists, due to his involuntary exile from the US, leading to the marginality of his theory in the general physics community today.

**KEYWORDS:** Bohm, Schrödinger equation, Newton's second law of motion, hidden variable theory, ontological interpretation, causality, determinism, realism, McCarthyism, quantum potential

### **INTRODUCTION**

In 1925, based on the matter wave by de Broglie, Schrödinger proposed his wave equation to establish the so-called wave mechanics. At the same time, based on the empiricism by Bohr, Heisenberg proposed the so-called matrix mechanics from his matrix algebra, which was later combined with the wave mechanics to become quantum mechanics in the modern text book.

Quantum mechanics together with the uncertainty and the complementary principle proposes a radically different world view, such as anti-realism, indeterminism, and non-causality. In this world view, all sub-atomic phenomena are random and arbitrary with no causal and physical reality involved. Quantum mechanics itself is simply a tool to calculate the probability of the corresponding particular phenomena. It has been known that Einstein was not happy with the quantum mechanical world view and he never accepted it throughout his entire career.

### **Bohmian Quantum Mechanics**

Since the establishment of quantum mechanics, one of the most famous scientific debates between Einstein and Bohr centered around the concept of random probability. According to Bohr and Heisenberg, the wave in Schrödinger's wave equation is nothing but a probability wave, not a physical wave of any kind. This is known as Copenhagen interpretation. However, Einstein believed that just calculating probability of a random event is not good enough for describing the sub-atomic world. After moving to Princeton university in the US, Einstein shared his view on quantum mechanics with David Bohm who just got his Ph.D. under the guidance of Oppenheimer at UC Berkley and moved to Princeton as an assistant professor in the physics department.

Bohm published a textbook (Bohm, 1979) on quantum mechanics before he realized that Copenhagen interpretation was not fully satisfactory. He was then led to have a serious and skeptical conversation with Einstein on quantum mechanics, and became confident that Copenhagen interpretation of quantum mechanics was incomplete. Finally, in 1950, he proposed his own interpretation on quantum mechanics as a hidden variable theory of quantum mechanics in which he transformed Schrödinger's wave equation into a form of Newton's second law of motion. Since Newton's second law completely describes a future location of a particle, given its initial position and momentum, this new transformation by Bohm could presumably revitalize causality, determinism, and realism. In this new interpretation, Schrödinger's wave is a guiding wave for a particle under Newton's second law of motion. Although the particle follows a deterministic and causal trajectory, its initial position is not completely known at our current level of precision measurement. Thus, the stochastic uncertainty of the initial position ends up giving us a probable distribution of final positions for the particle. But, Bohmian probability of uncertainty is not an intrinsic uncertainty of a quantum system as in the case of Heisenberg uncertainty principle. Rather, it just reflects our ignorance on the initial value of the quantum system, while the system itself follows an exact causal relation.

Also, in Bohm's quantum mechanics, a quantum system can be described as a particle and a wave. The particle follows a completely deterministic trajectory while the wave guides the particle throughout the trajectory. On the other hand, in Copenhagen interpretation of quantum mechanics, a quantum system is either a particle or a wave depending on the measurement device an observer chooses to use for the measurement, as Bohr claims this as the complementary principle.

Nonetheless, physicists are reluctant to accept Bohmian hidden variable theory of quantum mechanics, later known as the ontological interpretation of quantum mechanics. Their main reason against Bohm is due to the quantum potential, an additional term on top of a classical potential in Bohm's transformation from Schrödinger's equation to Newton's second law of motion. The quantum potential is responsible for

all the quantum phenomena, affecting all corners of the universe instantaneously. This non-local feature of the quantum potential apparently violates the principle of relativity, although it is due to Schrödinger's equation itself which is non-local in the first place. At the same time, the quantum potential sometimes diverges, which gives the physicists at that time an impression that the quantum potential is not physical thus unnecessary entity.

However, these may not be the main reasons why Bohm's quantum mechanics has been marginalized in the physics community. Like many other Jewish physicists such as Einstein and Oppenheimer, during the second world war, Bohm was also sympathetic to Stalin's Soviet Union, which caused him a big trouble after the war in the anti-communism sentiment of McCarthyism in the US. After being fired by Princeton university as an assistant professor, Bohm was forced to leave the Us and moved to Brazil, to Israel, and eventually to England. During this involuntary "exile", Bohm had no opportunity to communicate with other physicists, losing a chance to widely advocate his quantum mechanics. Einstein's silence on Bohm's quantum mechanics was another aggravating factor. On top of it, Bohmian quantum mechanics was proposed in 1950, one generation after the solid establishment of Copenhagen quantum mechanics in 1925.

According to Cushing (Cushing, 1994), the marginality of Bohm's quantum mechanics is due to the followings. First, it was announced one generation late after the establishment of Copenhagen quantum mechanics. Second, Bohm had no opportunity to communicate his ideas with other physicists, due to his involuntary exile. Losing a chance to widely advocate his quantum mechanics, Bohmian quantum mechanics has been systematically neglected in the general physics community even today.

## CONCLUSION

Bohm's quantum mechanics tried to revoke causality, determinism and realism in a quantum mechanical system. However, Bohm's quantum mechanics came too late after the standard quantum mechanics by Bohr and Heisenberg. On top of it, Bohm could not communicate his quantum mechanics with other physicists, due to his involuntary exile from the US after the second world war. All of these random and arbitrary historical contingencies contributed to the marginality of Bohm's quantum mechanics in the general physics community today.

## REFERENCES

- David Bohm, *Quantum Theory*, 1989, revised ed., Dover Publications, Inc.  
James Cushing, *Quantum Mechanics: Historical Contingency and the Copenhagen Hegemony*, 1994, University of Chicago Press