A Theory of Electron Behavior: Wave-Particle Duality without Superposition

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Abstract

This paper presents an alternative interpretation of electron behavior in quantum mechanics, proposing that electrons switch between particle and wave states upon measurement, rather than existing in a superposition of both states. The theory offers a non-superposition-based view of quantum phenomena, addressing the standard wave-particle duality through a simplified model in which the electron behaves as a wave when unmeasured and behaves as a particle upon interaction with a measuring device. This interpretation challenges traditional views of quantum superposition and collapse, providing a more intuitive understanding of electron behavior in specific experimental contexts.

Introduction

Quantum mechanics, since its inception, has been characterized by the wave-particle duality of particles such as electrons. This duality is often described through the Copenhagen interpretation, which invokes superposition-a state in which particles exist in multiple states simultaneously until observed. According to this view, an electron's wave function represents a combination of possibilities that collapse into a definite state when measured.

However, this paper proposes an alternative model in which the electron exists solely as a wave when not measured, and transitions to a particle upon interaction with a measurement apparatus. This model is inspired by the well-known double-slit experiment and other quantum phenomena but deviates from the superposition and wave function collapse paradigm. By suggesting that the electron does not inherently exist in a superposition of wave and particle states, this model seeks to explain electron behavior more intuitively and without relying on abstract concepts like superposition.

Theory: Electron as Wave and Particle

In this theory, electrons are assumed to be waves when not measured, meaning they exhibit the typical characteristics of wave-like behavior, such as interference. The concept of "wave" here refers to the electron's ability to spread out over space and interact with various potential outcomes, such as slits in the double-slit experiment. When the electron is not measured, it behaves as a wave and can create interference patterns, as demonstrated in the classic double-slit experiment.

Upon measurement, however, the electron "collapses" into a particle state, wherein its position is localized. The key difference here is that this theory does not rely on the wave function collapsing due to the act of observation, but instead suggests that the electron simply switches states based on the measurement apparatus and interaction. Thus, the electron is not in a superposition of wave and particle states; it is either a wave (when unmeasured) or a particle (when measured).

Logical Arguments Against Superposition as a Necessary Assumption

1. Causality and Measurement:
Superposition implies that particles are in multiple states at once, which defies our classical intuitions about causality and the physical reality of a particle. Instead, in this model, the electron behaves as a wave when not interacting with a measurement device, and as a particle only when the measurement occurs, without invoking the idea of multiple simultaneous realities or superposition.

2. Practical Limitations of Superposition:
Superposition, as often presented in the Copenhagen interpretation, appears more as a convenient mathematical construct rather than a necessary description of the electron's true nature. Rejecting superposition as an assumption allows us to focus on the electron's behavior in a more concrete and direct way: as a wave until measured, and as a particle when interacting with measurement.

3. Paradoxes and Complexity:
Superposition has led to numerous paradoxes, such as Schrödinger's cat thought experiment. This alternative theory simplifies the wave-particle duality without invoking unnecessary conceptual complexity.

4. Experimental Consistency:
The double-slit experiment and other quantum phenomena can be understood through the electron's interaction with the measurement apparatus without requiring superposition. This theory remains consistent

with experimental observations while providing a more intuitive interpretation.

Conclusion

This paper has proposed an alternative model for electron behavior that avoids the necessity of superposition and wave function collapse. According to this model, electrons exist as waves when unmeasured and only adopt particle-like properties when measured. This interpretation simplifies the wave-particle duality without invoking the more abstract concepts of superposition, making the behavior of quantum particles more intuitive and experimentally testable.

While further experimental validation is necessary, the theory provides a clear and testable alternative to traditional interpretations, offering a pathway to deeper understanding and exploration of quantum mechanics without relying on the complicated nature of superposition and wave function collapse.

References

1. Feynman, R. P. (2010). The Feynman Lectures on Physics. Addison-Wesley.

2. Bohm, D. (1952). A suggested interpretation of the quantum theory in terms of "hidden" variables. Physical Review, 85(2), 166-179.

3. Ghirardi, G. C., Rimini, A., & Weber, T. (1986). Unified dynamics for microscopic and macroscopic systems. Physical Review D, 34(2), 470-491.