Reinterpreting the Double Slit Experiment: Quantum Jumps and Hidden-Values

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Abstract: ***This paper proposes a novel interpretation of the double slit experiment, addressing the wave-particle duality and providing an explanation of quantum jumps and hidden-values in quantum mechanics. It suggests that quantum systems oscillate between its dimensions creating an intermittent presence in 3D and consequently, to its coexisting particle. By building on a previous theory of space, the author suggests that quantum systems get in-and-out of 3D space giving an oscillatory presence to its space. This experiment consists of the evolution of a divided quantum space, so the two propagation zones will be subject to a destructive interference, and its particle will be subject to quantum jumps between its intermittent and divided presence in 3D. Explaining why only a compact particle reaches the final screen meanwhile, consecutive particle will reveal an interference pattern. A hidden-values concept is introduced, offering a clearer understanding of why quantum mechanics is complete and the effect of prior detection on outcomes. This novel framework provides a deeper understanding of this mystery that is at the heart of quantum mechanics.***

Keywords: double slit experiment, George Thomson, quantum jump, wave particle duality, destructive interference, hidden-values.

1. Introduction

In 1801, Thomas Young [1] conducted the two-slit experiment with coherent light and demonstrated the undulatory behavior of light. With this revelation, Christian Huygens and Robert Hooke´s wave thoughts were confirmed over Newton´s corpuscular theory. Later in 1905, Einstein [2] showed that photons (electromagnetic waves) were compact entities (chunks or Quanta) emphasizing Planck´s mathematical achievement revealing that nature´s presence deals with some type of intermittency. Later, in 1923 De Broglie [3] proposed the reversed feature, that particles behave as waves. Finally in 1927, Clinton Davisson & Lester Germer and, George Paget Thomson [4] demonstrated that electron behaves as wavy particles. This was later extended to atoms and molecules reinforcing nature´s wave-particle reality.

The basic version of this experiment consists in a beam of individual electron that overpasses a barrier through two slits. These slits have an opening and separation in relation to the particle size and De Broglie´s wavelength; so, interference will happen between the two slits-sources. Finally, an additional screen detects the arrival of this electron in a compact place. When consecutive electrons are tested, their compact arrivals form a varying density typical of an interference pattern between two waves. Furthermore, the incorporation of detectors at the slits provides the information that the electron passes through a given slit and its consecutive pattern will change dramatically to a classical expectation of two dense zones.

This crucial experiment challenges our classical expectation; fortunately, these two irreconcilable roles (particle versus waves) are understood as the coexistence of two entities. Even more, an intermediate detection changes drastically the information of the quantum system and resets its evolution to a mono-deterministic one. Richard Feynman called it “a phenomenon which is impossible […] to explain in any classical way, and which has in it the heart of quantum mechanics” [5].

2. Analysis

According to this novel interpretation [6], the quantum system deals with two coexisting entities and not with the duality of one entity. A wavy space containing its compact entity. This space can be divided by a double slit screen (this case), by a beam splitter, by the opposite trajectory of entangled particles, etc. but still continue as one coherent system embracing the conservation laws of energy, momentum, charge, etc. The common expression that the universe is made of “stuff in a media” expresses this coexistence of elemental particles in quantum space.

There is no philosophical contradiction as the authors show in a previous paper [7]. The slits are sufficiently big that the compact particle can pass through one of them but its quantum space is much bigger so it covers both slits and gets divided. The presence in 3D of this space is intermittent, going in-and-out of our observable 3D and one part of its divided space can interfere destructively if the other part is out of phase. In other words, one part at 3D and the other part out of 3D. This destructive interference implies a zone where the compact particle is less probable to exist.

This intermittent presence is crucial for obtaining the interference pattern and this experiment reinforces the proposal of a quantum wavy presence in 3D. The oscillation is between its longitudinal dimension in such a way that the presence fluctuates between the observable 3D and its 4^{th} dimension. The 4^{th} dimension is understood as C*tau [8], the time “tau” that is in the heart of quantum mechanics, i.e., Planck´s periodic tau (tau = constant action “h” divided by its energy). Not the time of events or Minkowski´s Ct, where “t” is the passage of time and its value depends on its arbitrary initial value. This C*tau or Lambda (λ = C*tau) or energy´s wavelength is a scalar value, not a vector as used in the spacetime grid. Gravity is like a drag due to the equivalent acceleration of a deformed space by the presence of energy. It's a space-energy relation as given by Lorentz´s length contraction, i.e., energy is the one that affects space and not the "time of events" acting over space. Both values of space and time are scale-reduced by its local energy; so, a scalar Lambda (not vectorial) complements the observable 3D vector configuring a 4D longitudinal reality.

The term "quantum jump" is used to describe when a system modifies its energy level or state. This change doesn´t assume intermediate values, it changes drastically to the next one; that is the reason why the term "jump" is used. The author uses this term in an extended way, to express the change from one presence in 3D to the next one, even when the particle maintains its energy level. The particle modifies its position without a trajectory in between and that is understood as a spatial jump. Like the electrons in its atomic orbitals, a jump is possible because of its momentary existence out of 3D. Furthermore, "jumping" from one fraction of the space to another farther one meanwhile, the system is still coherent. Like the jumps between the different trajectories of a photon when its space has been divided by a beam splitter. Not a divided photon, just a divided wavy space.

These quantum jumps are also appropriate to describe the continuous changes of eigenvalues without passing through prohibited intermediate values, i.e., jumping between them. Like the change between a spin up to a spin down. Even more, it can also be used when an interaction occurs and an elemental particle is transformed into another particle; quantum jumps between the previous 3D presence to the next 3D presence thanks to its passage through the 4th dimension.

The lack of complete information in a quantum system makes it possible for a versatile and aleatory presence in 3D of its multiple eigenstates. With a one-by-one presence of one eigenstate in 3D per fluctuation. This is one of the axioms of this Theory of space. A hidden-value concept describes this quantum characteristic of just appearing one eigenvalue meanwhile, the rest of the eigenstates is still valid at the 4th dimension. If over time the system acquires more details, then the system will consider the current eigenvalue for the future presence. This additional information is a consequence of a conditioning of nature. It includes the case of an observation, known as the collapse of the wavefunction or measurement problem. But that isn´t the only type of interaction, there are the probabilistic ones like the tunnel effect. Nonetheless, these events have happened since the beginning of the universe´s existence, without human awareness or consciousness.

That is what happens in this experiment when a detector is active at one slit. This additional information of the electron´s passage through a given slit, determines the future behavior of the system or resets the system to an evolution of one source. In other words, the wavefunction begins at the last point the particle interacted (electron gun or slit detection), and ends when the particle interacts with the final detecting screen.

3. Visualizing this crucial experiment

The following drawings show how the particle evolves. Each drawing simplifies a given presence in 3D. Figure 1A shows a small particle capable of passing through the slit meanwhile, its bigger space won´t. Figure 1B shows the three fragmented spaces; one in the upper slit, the other bouncing back unable to pass, and the third one at the lower slit. Figure 2A shows this divided space and its particle with a probabilistic presence in them. Figure 2C has an intermittent presence in 3D with a probabilistic behavior. Figure 2D shows the interfered space due to the oscillating phase between the two passages. Figure 3E shows a further position of these subspaces with a coherent presence. Finally, Figure 3F shows the probabilistic arrival of the compact particle.

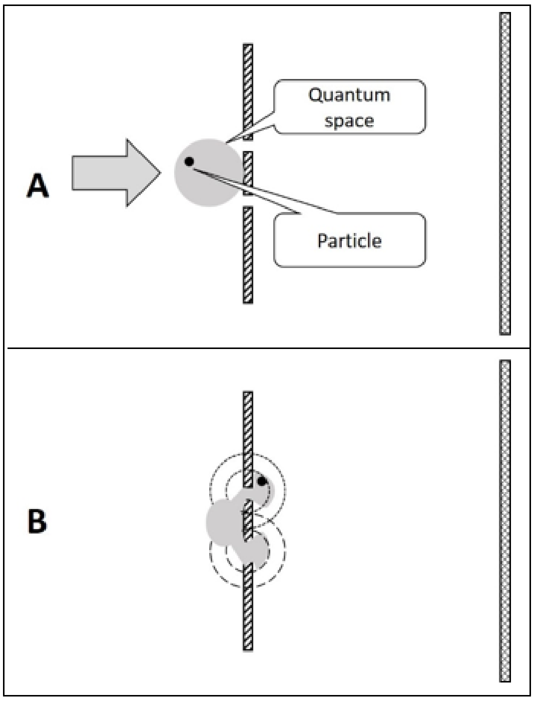

Figure 1: A and B

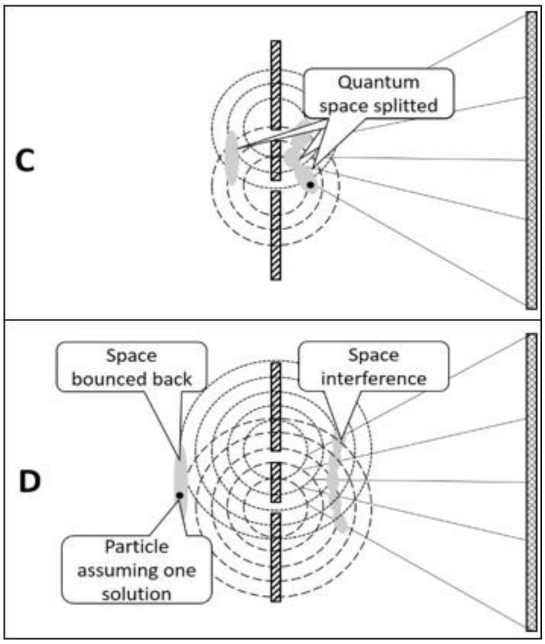

Figure 2: C and D

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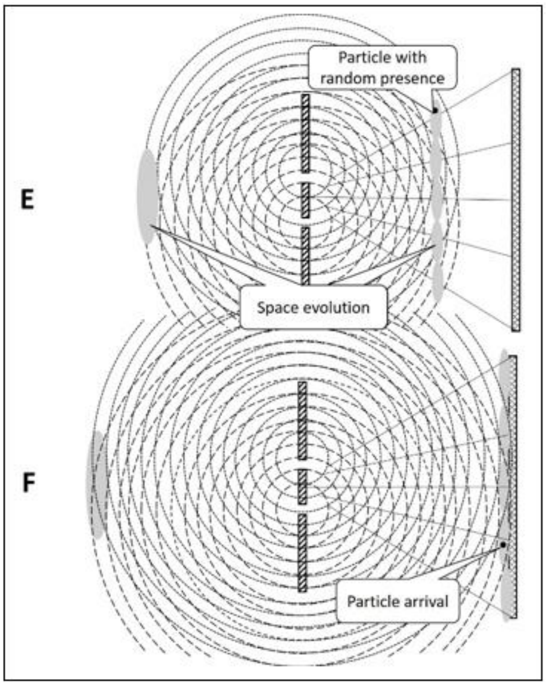

Figure 3: E and F

4. Conclusions

This study is significant because it offers a novel solution to this crucial experiment where compact particle behaves as waves, also known as the wave-particle duality. It contributes to the broader understanding of quantum duality and offers a different alternative than the pilot wave of Broglie-Bohm´s theory [9]. It differs from the determinism of Bohmian mechanics to a poli determinism maintaining a probabilistic behavior in the core of quantum 3D presence.

In other words, it considers a poli deterministic scenario due to the multiple eigenstates; no indeterministic concept. The quantum versatility of multiple solutions is contained under the 4^{th} dimension but its presence in 3D only reveals one eigenstate. It can be understood as a hidden-solution and it overcomes the hidden-variable theory. By this, Einstein´s concern about quantum mechanics vanishes. A probability is just in its presence in 3D and not in the core of its existence. Like rolling a dice at the rate of Planck´s energetic frequency, its fleeting single value of the upper face (3D) has no conflict with its multi values-faces system.

Nonlocality at 3D was a great objection of Einstein to quantum mechanics interpretations [10]. The theory of space presents an extended locality at the 4th dimension during its fleeting stay explaining in a compressive way how entangled particles conserved their momentum.

This novel presentation of oscillating existence as a coexistence of two entities avoids the reasonable concern of a dual role of one entity. There is no need for a complementarity concept proposed by Niels Bohr. The interference pattern observed in this famous experiment reveals that quantum presence deals with the evolution of **waves**. Furthermore, Max Born´s interpretation of Schrödinger´s wavefunction in 1926 [11] reinforces the idea of a **probabilistic presence**.

This novel interpretation provides a robust theoretical foundation considering the core evidence of a **wavy presence**. It also is consistent with the math and experiments of quantum mechanics. This study is significant because it offers potential advances in our understanding of quantum mechanics. It provides an alternative framework to existing theories such as Bohmian mechanics, by proposing a poli deterministic model with a **probabilistic presence** in 3D.

Declarations

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Thomas Young, (1804). "The Bakerian lecture. Experiments and calculation relative to physical optics". Philosophical Transactions of the Royal Society of London. **94**: 1–16. DOI: 10.1098/rstl.1804.0001

[2] Albert Einstein, (1905) "Zur Elektrodynamik bewegter Körper", Annalen der Physik **17**: 891; English translation On the Electrodynamics of Moving Bodies by George Barker Jeffery and Wilfrid Perrett. Published in 1923 by Methuen and Company Ltd. https://www.fourmilab.ch/etexts/einstein/specrel/www/

[3] Louis Victor de Broglie, "[On the Theory of Quanta]". Nature **112** (2815) 540

[4] George Paget Thomson; Alexander Reid, (1927). "Diffraction of Cathode Rays by a Thin Film". Nature. **119** (3007): 890. Bibcode: 1927 Natur.119Q.890T. DOI: 10.1038/119890a0

[5] Richard P. Feynman; Robert B. Leighton; Matthew Sands (1965). The Feynman Lectures on Physics, Vol. 3. Addison-Wesley. pp. 1.1–1.8. ISBN 978-0-201-02118-9.

[6] J. Oreste Mazzini, (April 2021) “Space, main actor of Quantum and Relativistic Theories” Int’l Journal of Science and Research **10/4**, (436- 442), DOI: 10.21275/SR21406195404.

[7] J. Oreste Mazzini (December 2023) “Philosophy in quantum mechanics novel interpretation supports Einstein´s objection” Int’l Journal of Science and Research 12/012, (1295 - 1297), DOI: 10.21275/SR231215193142.

[8] J. Oreste Mazzini (September 2023) “A new interpretation of the Special Theory of Relativity” Int’l Journal of Science and Research 12/09, (1509 - 1514), DOI: 10.21275/SR23918031232.

[9] David Bohm, (1952). "A suggested Interpretation of the Quantum Theory in Terms of Hidden Variables, I". Physical Review. 85 (2): 166–179. DOI: 10.1103/PhysRev.85.166.

[10] Albert Einstein; Boris Podolsky; Nathan Rosen, (May 1935) "Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?". Physical Review (Submitted manuscript). **47** (10): 777–780. DOI: 10.1103/PhysRev.47.777.

[11] Max Born, (1926). "[On the quantum mechanics of collisions].” Zeitschrift für Physik. 37 (12): 863–867. DOI: 10.1007/BF01397477. S2CID 119896026.