Review of: "Relation Between Quantum Jump and Wave Function Collapse"

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Potential competing interests: No potential competing interests to declare.

This paper addresses the ongoing debate on wave function collapse (WFC) in quantum mechanics and explains the subtle differences between quantum jumping (QJ) and WFC. The authors argue that in the case of single-particle systems, wave function collapse does not normally occur in a classical way due to the fact that only a single eigenvalue is selected during measurement. On the other hand, in multi-particle systems (such as Bose-Einstein condensates (BEC) or photon ensembles), macroscopic quantum jumps (MAJ) can happen, which lead to the observed wave function collapse. The paper offers an in-depth exploration of how measurements can influence the probability distributions across these different systems.

Strengths:

1-The proposed paper provides a clear differentiation between quantum jump (QJ) and wave function collapse (WFC) and addresses key areas of confusion in the existing literature.

2-The introduction of macroscopic quantum jumps (MAJ) in multi-particle systems provides an interesting extension of existing concepts. This is especially true in the context of large quantum systems such as BECs and photon ensembles.

3-This paper explores the measurement process in both single-particle and multi-particle systems and provides specific examples (e.g., photon counting, alpha decay) to back up its theoretical claims.

4-By exploring quantum jumps (QJ) and wave function collapse (WFC) in the context of macroscopic systems, this paper can have significant implications for a variety of domains ranging from basic quantum mechanics to quantum computation.

Weaknesses:

1-Although the paper's theoretical arguments are solid, there aren't many specific experimental ideas or recommendations on how to validate its assertions, particularly when it comes to the nature of wave function collapse in multi-particle systems.

2-The concept of a "virtual ensemble" in single-particle quantum mechanics is introduced in the paper, but it is not fully defined or illustrated to clarify what this term actually means physically or how it fits into the larger context of quantum mechanics.

3-Although the authors present macroscopic quantum jumps, they do not offer a thorough explanation of how WFC takes place during the change from microscopic to macroscopic quantum states. I believe this needs more explanation,

especially regarding how collective effects in many-particle systems lead to observable collapse.

4-Even though the work briefly discusses the implications of quantum measurement in many-particle systems, it falls short in addressing the function of decoherence in relation to wave function collapse and macroscopic quantum jumps.

Recommendation:

Some action could be taken by the authors in order to enhance the quality and impact of the paper, particularly:

1-To evaluate the phenomena of wave function collapse and quantum jumps in single- and multi-particle systems. The authors should suggest some experimental configurations or observation techniques.

2-The concept of “virtual ensemble” should be clarified and coupled with established quantum mechanical concepts. Readers will get a better understanding of how this concept works within the proposed framework if more specific reasons or theoretical concepts were provided.

3-The paper should expand more on the process by which macroscopic quantum jumps (MAJs) lead to the collapse of the wave function. Providing a clearer approach to how collective effects in multi-particle systems result in the observed collapse will strengthen the claims of the study.

4-Authors should include additional discussion about decoherence in the framework due to its importance in quantum measurement theory. This is especially the case for multiparticle systems such as BEC, where macroscopic superposition can play an important role.

5-This study would benefit from deeper connections with existing interpretations of quantum mechanics, such as von Neumann's measurement theory as an example. This will effectively demonstrate the study's contributions to the ongoing discussion regarding this concept.