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

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Potential competing interests: No potential competing interests to declare.

The author aims to analyze the distinction between 'quantum jumps' and 'wavefunction collapse' in quantum mechanics.

From a scientific research perspective in quantum physics, the manuscript does not present any new theoretical ideas or original calculations. Instead, it resembles lecture notes on quantum mechanics and, moreover, contains errors as the author uses definitions and concepts different from the standard ones.

1) One conceptual mistake in the paper is as follows:
The author claims that "the collapse of the wavefunction does not occur at the level of a single particle" (written even in the abstract). This statement is incorrect, as any expert in quantum mechanics can confirm. I will explain why, as the reasoning is straightforward. Consider the classic double-slit experiment with a single electron. After passing through the two slits, the electron's wavefunction becomes delocalized in the transverse direction of propagation, meaning there is an equal probability of finding the electron after either the first or second slit. However, when the electron strikes the screen, the detector registers a single, well-defined click at a specific position in space. This indicates that the electron has not been destroyed but is now localized at that point (= the wavefunction is localized at that point). This phenomenon corresponds to the "collapse" of the wavefunction, also referred to as a "projective or strong measurement". There is also a historical (and pedagogical) experiment conducted by the Hitachi group, beautifully demonstrated in a video available on YouTube (see https://www.youtube.com/watch?v=PanqoHa_B6c - and its references). In this experiment, single electrons are emitted one at a time, allowing the observation of individual 'clicks' corresponding to single electrons and the gradual formation of an interference pattern as more electrons are collected. Each click represents a clear instance of wavefunction collapse.

2) The fact discussed by the author—that we must repeat the experiment many times to visualize the probability distribution (or, more precisely, the probability density) on the screen—is well known. Indeed, this process shows how the probability distribution is operationally defined in relation to the mathematical construct of the wavefunction.

3) As I understood, the main message of the work is that if we send many non-interacting electrons, all in the same quantum state (i.e., the same wavefunction), we can directly observe the probability distribution. This is quite obvious for experts in quantum mechanics, as this procedure is equivalent to performing many repeated experiments in a single shot. Indeed, this is also why, in the double-slit experiment with classical light (i.e., involving many photons), we observe interference fringes on the screen.

4) While the collapse is associated with an ideal projective (or strong) measurement, other types of measurements are also possible, as is well known in the theory of quantum measurements. These depend on how the measurement apparatus (or pointer) is coupled to the quantum system and how information is extracted.

The notion of "quantum jump" introduced by the author is different from the concept of quantum jump well established, both theoretically and experimentally, in quantum physics. See, for example, books:

- Quantum Measurement (Braginsky & Khalili)

- Quantum Noise (Gardiner & Zoller)

- Quantum Measurement and Control (Wiseman & Milburn)

- The Quantum World of Ultra-Cold Atoms and Light BOOK 1: Foundations of Quantum Optics (Gardiner & Zoller)

and see also the reference:

https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.56.2797

and many other works on the subject.