Review of: "Consistent Interpretation of Quantum and Classical Mechanics"

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I was invited by the AI employed by Qeios to comment on this article presumably because many of the keywords employed by the author have been matched to several papers I wrote on the same topic. So here we go.

The topic of the paper – to bridge quantum and classical mechanics in a consistent manner – is of utmost foundation importance. However, this problem has been with us for nearly a century, since the inception of quantum mechanics, so it is prudent to take a modest approach when attempting to contribute to this topic.

Here, the author sets the aim quite high, by proposing to rewrite the general postulates at the basis of quantum theory in order to give an interpretation of quantum mechanics consistent with classical physics. However all of the statements made in this paper are based on the wavefunction of the hydrogen atom. This might sound a bit surprising, since this simple wavefunction can hardly be expected to capture the full span of the interpretational difficulties (think of entanglement and non-locality, the measurement problem, causality, the double slit etc.). So a first advice might be for the author to set more modest goals : interpreting the hydrogenic wavefunction is already interesting without the need to incur into encompassing all of quantum theory by making unproven bold assertions (some of which might not be correct, see below).

The introduction should be more focused on what the author is really doing in the paper (interpreting the hydrogenic wavefunction and spectrum), and the terms employed should be properly defined. For example in the 3rd sentence of the introduction, the author writes about « the realist position ». This term is ambiguous – at first I thought the author was endorsing wavefunction realism[1], although it turns out to be the opposite, so this should be clarified. A few lines below, the author redefines the uncertainty principle, in a way that I don't find consistent ; maybe it would help if the author first recalls the standard uncertainty principle, before embarking in expounding a new interpretation. The same can be said when discussing a « revised » Born rule in Sec. 2. The author appears to define particle and wave properties as a function of a wavepacket's width. This is done in a hand-waving manner, and it hardly looks consistent (localized wavepackets generally spread ; a single particle wavefunction can be given as a superposition of localized wavepacket…). This point should be made more rigorous.

The connection between classical and quantum observables seems to be done in a rather ad-hoc and limited way, presumably because the author only has the hydrogen wavefunction in mind. In particular the author does not mention the results obtained in the fields of semiclassical physics and quantum chaos [2][3], that investigated the correspondence between quantum features (wavefunction structure, energy levels…) and the corresponding classical dynamics (regular dynamics, conserved actions, chaotic dynamics) ; for a simple graphical example displaying the correspondence for a hydrogen atom in a magnetic field, see Fig. 1 of [4]. Note that the author's statement indicating that orbital angular momentum states do not exist in classical physics is not correct as such – spherical harmonics have a corresponding classical distribution (see Fig. 1 of [5] for a side by side comparison ; for other examples see[6]). Note also that the connection afforded by semiclassical methods also includes a correspondence between entanglement generation and the corresponding classical dynamics (see [7] for a study on the hydrogen molecule).

Finally, several bold assertions are made without explaining in which sense they should be understood, so the reader will feel the author is making incorrect statements. For instance the author writes "the state function cannot be a physical wave for two reasons", none of which are compelling: the first one (linear combination argument) would already be incorrect for many type of waves (such as acoustic waves in a bounded region); the second reason (impossibility of incorporating a particle-property into the wavefunction) is disproved by the existence of theories such as the de Broglie-Bohm theory [8], which gives a consistent account of non-relativistic quantum mechanics, including the hydrogen atom discussed by the author. Another example is the single sentence by which the author "rules out" the existence of Feynman paths, although there are protocols proposing the observation of such paths [9][10].

To sum up, I think in this article the author should retreat from rewriting the general postulates of quantum theory and focus instead on giving a more complete account of how to interpret the quantum mechanical states of the hydrogen atom and attempt to make it consistent with classical physics. The alternative would imply to extend the paper in order to discuss topics such as entanglement, non-locality, measurements and discuss how to make them consistent with classical physics.

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