Qeios

Peer Review

Review of: "Axiomatic Foundation of Quantum Measurements and Survival Effect"

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Review of Axiomatic Foundation of Quantum Measurements and Survival Effect (AFQM) by Ken Krechmer

AFQM is a rigorous, well-developed paper that reminds this reviewer of von Neumann's "The Mathematical Foundations of Quantum Mechanics" (MFQM). This is meant as a high compliment. Considering the rigorous development, the introduction would benefit from a synopsis identifying the following eight sections and four appendices. The ninth section, titled Conclusion, is an excellent summary of the paper.

Technical comments:

1. Both AFQM and MFQM consider an observable to be independent, i.e., not relative. In metrology, an observable is termed "measurand," i.e., relative to a measurement process. In this reviewer's opinion, quantum mechanics (QM) treats measurements between two variables (e.g., p and q) as relative and produces results that are local (in the J. S. Bell sense) and probabilistic (i.e., normalized). Metrology treats all measurements as relative to a unit standard in a Cartesian coordinate system (i.e., an independent reference) and produces results that are independent (non-local) and statistical (i.e., not normalized). While both approaches are fully functional, the change from independent observable (QM) to independent reference (metrology) appears to this reviewer to be the basis for the differences between QM and classical (metrology) measurement results.

Perhaps the environmental system (ES) in AFQM could be recast into a reference?

2. This reviewer is not familiar with the references the author has given for rigged Hilbert space. With this proviso, rigged Hilbert space (Appendix B) with a dense subspace and its space of antilinear

 doi.org/10.32388/JPZVUI

(antidual?) functionals seems to this reviewer to be similar to the manifold and complementary manifold development in MFQM. Perhaps it would be helpful to other readers to point out the similarities or explain the differences.

3. AFQM and MFQM recognize the need for a statistical space or statistical operator, respectively. This reviewer sees that AFQM develops rigged Hilbert space as a means to include a statistical space. MFQM develops the statistical projection operator (P sub [small phi]). Again, it might be helpful to other readers to point out the similarities or explain the differences.

4. The non-ideal conditions discussed in Section VI seem (to this reviewer) to be correlated to the lack of independent references rather than correlated to uncertainty.

5. Multiple different uncertainty relations have been developed after recognizing weaknesses in Heisenberg's. These include Kennard, Robertson, and Ozawa. Ozawa's development seems to this reviewer to be the most rigorous (and experimentally verified). How do these other forms of uncertainty relate to the survival effect (Section VII)?

In summary, this paper, while very well developed, does not appear to this reviewer to offer significant additions to the state of the QM art. Perhaps if an independent reference from metrology were addressed, more significant additions would be possible.

Declarations

Potential competing interests: No potential competing interests to declare.