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Peer Review

# Review of: "On the Unreasonableness of the Quantum Nonlocality Debate"

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Review of "On the Unreasonableness of the Quantum Nonlocality Debate" by J. Lambare

The author's premise, the unreasonableness of the quantum nonlocality debate, is valid (IMHO) but the development does not add clarity and perhaps increases the unreasonableness the author recognizes.

Nonlocality is not defined well, as the author recognizes. But the definition proposed is unreasonable. "Nonlocality is identified with the idea of instantaneous action at a distance." Instantaneous action at a distance violates established and well-tested special and general relativity. Both the EPR paper and J.S. Bell's papers identify that something (which is not identified) is not right. Given relativity, whatever nonlocality is, it is not instantaneous action at a distance. Determining what non-locality is, is the problem, not a definition. Stating this as a problem may present a better basis for discussing the unreasonableness the author recognizes.

The statement: "a Nobel Prize having been awarded for the empirical falsification of the Bell inequality" appears to this reviewer to be the author's view.

Definition 2 (realism) weakens the paper in this reviewer's view as it moves a physics paper into the metaphysical. The author also notes the desire to avoid metaphysical discussions later in the paper.

Determinism (i.e., realism) is understood (but not defined) in metrology as two equal repetitive measurements. Without the second measurement verifying the first, the first measurement result is not valid (i.e., real). Heisenberg's uncertainty experiments are not measurements in this metrology view, as the first "measurement" changes the system (demolishes) so the second "measurement" is not of the same system as the first. Metrology (i.e., classical) measurements are described here: https://en.wikipedia.org/wiki/Quantum_nondemolition_measurement



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The seven fallacies identified by the author have merit and also do not. It depends on the definitions applied, as the author explains. Since the basic problems (as stated by EPR and J.S. Bell) are not resolved, some of the definitions (both identified here and elsewhere) must be incorrect. Identifying these seven fallacies, while the basis for the author's unreasonableness argument, does not provide (IMHO) the basis of a strong argument. Perhaps identifying each fallacy with the QM and metrology definitions of: real, deterministic, local, non-local, and measurement result could begin a better argument.

The paper's strengths (IMHO) emerge in section 4. The formal development in (4) - (12) makes the difference between hidden variables (which can only be non-local[i]) and QM very clear. Recognizing that this hidden variables view is a metrology view, the resolution of these measurement issues, Relative Measurement Theory (RMT), was published in Measurement in February 2018 (https://www.sciencedirect.com/science/article/pii/S0263224117306887). RMT provides in Annex A a development with experimental evidence that correlates with (12).

4.2 Counterfactual Definiteness (CFD). In metrology, it is well known (but not well defined) that repetitive measurement results (of an unchanged observable and measurement instrument) at sufficiently high precision will not be the same but will have a normal (Gaussian) distribution. This effect may be described in metrology papers as the central limit theorem (which is more a rule of thumb than an accepted theory).

This experimental fact about repetitive measurement results violates CFD and Definition 3. Repetitive classical measurement results are equal only when the lower bound of precision is defined to be greater than a calibration state (see https://www.qeios.com/read/SH5D0Z for a definition of calibration state).

Section 5. This reviewer suggests avoiding the term "localists"; it is ad hominem, and the range of definitions used by different authors is too wide.

The discussions in this section would benefit from a review of Mermin's[ii] clear paper on his experimental understanding of entangled measurements.

[i] C. S. Unnikrishnan, Establishing J. von Neumann's result of the incompatibility between hidden variables and quantum mechanics. *Academia Quantum* 2025;2. https://doi.org/10.20935/AcadQuant7657doi:10.20935/AcadQuant7657

[ii] N. D. Mermin, Bringing home the atomic world: Quantum mysteries for anybody, *American Journal of Physics*, Vol 49 (10), October, 1981. Richard Feynman described this paper as, "...one of the most beautiful papers in physics."

## Declarations

**Potential competing interests:** No potential competing interests to declare.