 Qeios

Peer Review

Review of: "Fundamental Issues and Measurement Problem in Quantum Mechanics"

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Review of: Fundamental Issues and Measurement Problem in Quantum Mechanics V2 by Tadashi Nakajima

This paper and the three papers by the same author referenced in this paper are working papers, as the author suggests in their conclusions. Pre-prints in general, and Qeios especially, are an excellent forum for such papers. As working papers, this author's work is acknowledged even when specific developments are not supported.

The author proposes to separate Type A (observables with eigenvalues) and Type B (theoretical) quantities, which separates the practical results from theoretical probabilities. The difference between practical measurement results (i.e., classical) and QM measurements in both theory and practice IS the measurement problem. It is circular logic to propose to resolve the measurement problem by agreeing to the measurement problem.

The difference between a MIJ (microscopic jump) and a PCA (postulate of classicality of apparatus) appears to be semantic to this reviewer. Or is the author suggesting there is some unique aspect described, or not described, by the PCA?

"A quantum jump (QJ) is the measurement of a dynamical variable to select a set of EVs" (eigenvalues). This QJ definition does not address the question raised by von Neumann (in Mathematical Foundations of Quantum Mechanics, MFQM), how does a QM observable in one state become an ensemble of states? He considered this change (Process 1 in MFQM) non-causal.

Rather than a QJ, Process 1 appears to this reviewer to be the decoherence (rejected by the author in ref 1) of each repetitive measurement result. Alternatively, the result of wave function collapse is a single

 doi.org/10.32388/BJYE1F

metrology measurement quantity result. This reviewer finds that decoherence is a satisfactory replacement for wave function collapse. However, it is the author's definition of a QJ in this paper that removes the possibility of wave function collapse.

The use of *q* (position) and *p* (momentum) as observables (from Heisenberg) has been confusing in QM, as the first observation of *q* causes a momentum change between the first and the second observation of *p*. This is a demolition observation. The second set of results after a demolition observation is different from the first and does not commute with the first. So demolition observations do not have a classical measurement counterpart, as classical measurements commute, i.e., repetitive classical measurements are equal (within a specified variation) or recognized as incorrect.

Section IIC, "A state vector has nothing to do with a single measurement." This assertion is difficult for this reviewer. It appears to arise from the Type A/Type B separation noted previously. The author suggests the difficulty of these assertions in Section V.

The author proposes (in ref 4) that the QM measurement of ensembles is distinct from the measurement of single particles. Which is correct and very useful for the author to point out, but the measurement of ensembles is not (IMHO) part of the measurement problem. The measurement problem appears in multiple measurements of single particles, which may be in ensembles, as well as repetitive measurements of a single particle, but does not appear in the measurement of ensembles of single particles.

Classically, statistical mechanics addresses the measurement of ensembles of single particles successfully (i.e., without measurement problems). Applying QM (the paper's section IV), quantum field theory addresses the measurement of ensembles of bosons successfully (i.e., without measurement problems). In both these cases of the measurement of ensembles of single particles, the measurements are locally relative (see next paragraph) in both metrology and QM. Here, local has the meaning that J. S. Bell intended.

II D Boundary conditions are required to solve problems. However, a reference is also required for measurements. Any measurement is relative, i.e., there is a reference that the measurement is made relative to. In QM and metrology (in the measurement examples discussed in the paragraph above), the reference is local (in the same system). While in metrology (in the single-particle measurement examples given in the second paragraph above), the reference (definition of a unit) is independent (not in the same system).

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In QM, a measurement unit is assumed to be fixed as unity, which cannot be a reference. In metrology, the unit is allowed to have variation relative to its non-local reference. This measurement instrument unit variation is one reason why metrology calibrates measurement instruments. This difference in the definition of units is the basis of the measurement problems.

The measurement problems were first rigorously identified in Einstein, Podolsky, and Rosen's paper. Later, J.S. Bell offered an independent rigorous development of the same problems. These rigorous developments have not made it easy to understand the measurement problems, but they do identify clearly (IMHO) that the measurement problems are not philosophical. This reviewer found the author's paper (shown as ref 2), which considers philosophical reasoning, to be off-putting. Full disclosure: this reviewer declined to be a reviewer of ref 2.

The measurement problem was resolved (IMHO) in 2018 (see Relative Measurement Theory Measurement, (Feb 2018) available at: https://www.sciencedirect.com/science/article/pii/S0263224117306887). The QM perceptions of the measurement problem are still being resolved. A draft of this reviewer's current attempts is on Qeios https://www.qeios.com/read/SH5D0Z

This reviewer thanks the author for instigating this forum to further examine the complicated QM perceptions of the measurement problems.

Declarations

Potential competing interests: No potential competing interests to declare.