An Argument for 4D Blockworld from a Geometric Interpretation of Non-relativistic Quantum Mechanics

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Abstract

We use a new, distinctly " geometrical " interpretation of non-relativistic quantum mechanics (NRQM) to argue for the fundamentality of the 4D blockworld ontology. We argue for a geometrical interpretation whose fundamental ontology is one of spacetime relations as opposed to constructive entities whose time-dependent behavior is governed by dynamical laws. Our view rests on two formal results: Kaiser (1981 & 1990), Bohr & Ulfbeck (1995) and Anandan, (2003) showed independently that the Heisenberg commutation relations of NRQM follow from the relativity of simultaneity (RoS) per the Poincaré Lie algebra. And, Bohr, Ulfbeck & Mottelson (2004a & 2004b) showed that the density matrix for a particular NRQM experimental outcome may be obtained from the spacetime symmetry group of the experimental configuration. This shows how the blockworld view is not only consistent with NRQM, not only an implication of our geometrical interpretation of NRQM, but it is necessary in a non-trivial way for explaining quantum interference and " non-locality " from the spacetime perspective. Together the formal results imply that contrary to accepted wisdom, NRQM, the measurement problem and so-called quantum non-locality do not provide reasons to abandon the 4D blockworld implication of RoS. But rather, the deep non-commutative structure of the quantum and the deep structure of spacetime as given by the Minkowski interpretation of special relativity (STR) are deeply unified in a 4D spacetime regime that lies between Galilean spacetime (G4) and Minkowski spacetime (M4).
Taken together the aforementioned formal results allow us to model NRQM phenomena such as interference without the need for realism about 3N Hilbert space, establishing that the world is really 4D and that configuration space is nothing more than a calculational device. Our new geometrical interpretation of NRQM provides a geometric account of quantum entanglement and so-called non-locality free of conflict with STR and free of interpretative mystery.
In section 2 we discuss the various tensions between STR and NRQM with respect to the dimensionality of the world. Section 3 is devoted to an explication of the Kaiser et al. results and their philosophical implications. Likewise, the Bohr et al. results and their implications are the subject of section 4. In section 5, we present our geometric interpretation of quantum entanglement and " non-locality. "

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