MAR14-2013-020138

Abstract for an Invited Paper
for the MAR14 Meeting of
the American Physical Society

Bounds on Epistemic Interpretations of the Quantum State from Contextuality

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The status of the quantum state is perhaps the most controversial issue in the foundations of quantum theory. Is it an epistemic state (representing knowledge, information, or belief) or an ontic state (a direct reflection of reality)? In the ontological models framework, quantum states correspond to probability measures over more fundamental states of reality. The quantum state is then ontic if every pair of pure states corresponds to a pair of measures that do not overlap, and is otherwise epistemic. Recently, several authors have derived theorems that aim to show that the quantum state must be ontic in this framework. Each of these theorems involve auxiliary assumptions of varying degrees of plausibility. Without such assumptions, it has been shown that models exist in which the quantum state is epistemic. However, the definition of an epistemic quantum state used in these works is extremely permissive. Only two quantum states need correspond to overlapping measures and furthermore the amount of overlap may be arbitrarily small. In order to provide an explanation of quantum phenomena such as no-cloning and the indistinguishability of pure states, the amount of overlap should be comparable to the inner product of the quantum states. In this talk, I show, without making auxiliary assumptions, that the ratio of overlap to inner product must go to zero exponentially in Hilbert space dimension for some families of states. This is done by connecting the overlap to Kochen-Specker noncontextuality, from which we infer that any contextuality inequality gives a bound on the ratio of overlap to inner product.