Howard Wiseman

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Howard Wiseman
Griffith University, Brisbane, AU

Ensembles of Bohmian trajectories: Real, Surreal, and Hyper-real

As suggested by me several years ago, and demonstrated more recently in the group of Steinberg, an ensemble of trajectories can be experimentally reconstructed with minimal assumptions about a system if one can make weak measurements of velocity and strong measurements of position. In particular for a particle with dynamics described by Schroedinger's equation, the thereby reconstructed trajectories are exactly those of Bohmian mechanics. In this sense, at least, one can claim the ensemble as something “real”. However, under certain circumstances --- when a detector can “fire” even when the Bohmian trajectory bypasses it --- Bohmian trajectories have been criticised as being “surreal". I discuss how this is the flip-side to the nonlocality of Bohmian mechanics, which we know must be present in any realistic interpretation of quantum mechanics. I present joint experimental work with the Steinberg group with entangled photon pairs proving this point. Finally I discuss a relatively new, “hyper-real” approach to quantum mechanics in which the entire ensemble of Bohmian trajectories is taken to exist simultaneously. The profligate multiplication of reality in this “many interacting worlds” approach (joint work with Hall and Deckert) actually has some conceptual advantages over both the standard many worlds interpretation and the standard Bohmian interpretation. I will present numerical and analytical results suggesting that with a sufficiently enormous ensemble, the wavefunction may be superfluous.

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