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Bohmian mechanics: a legitimate hydrodynamic picture for quantum mechanics, and beyond

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In brief, we can say that what we now know as Bohmian mechanics arose as a suitable response, from David Bohm, to Von Neumann's theorem about the impossibility of hidden variable theories. Perhaps due to its misunderstood simplicity and elegance, it had to be revisited and given the form of an emergent theory from a deeper quantum stochastic description. Whatever the case, an ontology around it immediately appeared to explain the quantum world, which has brought more problems to this approach than benefit. If, however, we leave aside these complicated issues and we pragmatically focus on what Bohmian mechanics really says and what it does not, we discover a different perspective to think, understand, and explain that quantum world, which has nothing to do with hidden variables, with notions closer to the former Madelung (quantum) hydrodynamics.

That is an issue that I gladly had the chance to talk about on many occasions with Basil Hiley, and which constitutes the central point of this talk. More specifically, along the talk we are going to see and discuss how, when Bohmian mechanics is put on the level of other quantum representations (i.e., as another legitimate representation with its own transformations that allow us to go from one to another), one can obtain deeper physical insights on quantum interference and coherence, the so-called Bohmian trajectories become an indirect measurable quantity (as evidenced by the renowned concept of weak measurement) and hence they have nothing of "surreal", or there is a tight connection with optics even though Schrödinger's equation is a diffusion-type equation rather than a wave equation in strict sense.

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