AGPhil 8: Foundations of Quantum Mechanics: Bohm and Hidden Variables

Time: Thursday 11:00–13:00 Location: HS XVII

AGPhil 8.1 Thu 11:00 HS XVII

Questioning the Dogma: A Different Perspective on Spin in Bohmian Mechanics — •Andrea Oldofredi — Centre of Philosophy, University of Lisbon

Bohmian Mechanics is a quantum theory of particles moving in three-dimensional space along deterministic trajectories. According to most contemporary Bohmians, the only fundamental property instantiated by particles is position. From it some derivative quantities can be defined, e.g. velocity and momentum. However, quantum observables are generally not considered attributes of the corpuscles. Specifically, it has been argued that spin does not refer to any physical property of the particles.

Moreover, many Bohmians claim that one must be realist only towards those entities playing a fundamental explanatory role: since spin measurements are reducible to position measurements, they conclude that spin cannot be real.

Contrary to this received view, I provide arguments for the reality of spin in BM based on case studies from Bohmian quantum chemistry, where spin-dependent particle trajectories are employed. In particular, I argue that by assuming the existence of spin one obtains significant advantages over canonical BM for the explanation of the chemical bond.

If employing spin-dependent laws in BM entails relevant explanatory benefits, and if one must be committed to the reality of those explanatory essential theoretical entities, then there are reasons to argue for the reality of spin also in BM.

AGPhil 8.2 Thu 11:30 HS XVII

Which quantum foundations for the minimalist ontology framework? — •Emilia Margoni — Philosophy Department, University of Geneva, Switzerland

Michael Esfeld's minimalist ontology is committed to two axioms relating to (1) distance relations that identify simple objects (permanent matter points) while (2) the distances between them change. This article scrutinizes such a conceptual strategy to determine whether it can successfully be applied to all levels of physical reality, as Esfeld contends. To do so, it explores one of his paradigmatic sources, that is, Bohmian mechanics. Two arguments are proposed. First, while Bohm's original formulation of Bohmian mechanics and the interpretation advocated by Dürr, Goldstein & Zanghì are typically taken as mathematically equivalent, I argue that Esfeld's minimalist ontology does not cover the former's ontological richness. To secure its achievement, the minimalist ontology framework needs to i) break the equivalence between the two versions via a commitment to the nomological interpretation of the wavefunction ii) yet attribute some kind of physical efficacy to the wavefunction as a guiding parameter for the evolution of particles living in three-dimensional space. Both requirements will be critically addressed. Second, the article shows that Esfeld's metaphysical program is not only forced to rely on a theoretically suspicious formulation of quantum mechanics, but that more fundamental, under-development approaches in theoretical physics are way less reconcilable with its axioms, thus questioning its alleged universality.

AGPhil 8.3 Thu 12:00 HS XVII

Superluminal Causation in Quantum Mechanics — •Mario Hubert[1] and Frederick Eberhardt[2] — [1]LMU Munich — [2]Caltech

We want to make precise how superluminal causation can work in quantum mechanics. First, we argue, pace Egg and Esfeld (2014), that instantaneous causation can be interpreted to have a causal direction. Second, we show by assuming a counterfactual theory of causation that these instantaneous causal directions are instantiated in the de Broglie-Bohm theory for space-like separated entangled particles. Third, we argue that these instantaneous causal relations are fine-tuned in the sense of causal modeling (that is, violating faithfulness) but not in the sense of physics (relying on special initial conditions).

References: Egg, M. and Esfeld, M. (2014). Non-local common cause explanations for EPR. European Journal for Philosophy of Science, 4(2):181-196.

AGPhil 8.4 Thu 12:30 HS XVII

Modal interpretations, hidden-variables and simple realism — •Yanis Pianko — Panthéon-Sorbonne University, Paris, France — IHPST, Paris, France

I present and review the modal approach to quantum foundations in a comprehensive way, and provide a novel way to classify its interpretations. This classification can be extended to non-modal interpretations, and reveals that modal interpretations were part of a bigger framework, sometimes called "simple realism" in the literature. This novel insight, as well as the introduction of a distinction between the kinematics and dynamics of an interpretation, allows for a sharper characterization of hidden-variables theories. I then give an account of why, while the modal approach was an influential research program in philosophy of physics during the 1990's, one barely hears about it today. After presenting and classifying the various difficulties modal interpretations encountered, I identify two epistemic factors in their downfall: the mathematical abstractness of the approach, along with the lack of physical intuition; and the ad hoc flavor manifested in the structure and historical development of the overall approach. I argue that, although there were good reasons to criticize the modal approach in some regards (particularly their dynamics), some fruitful insights in contemporary quantum foundations could still be gained by a larger exposure of this approach.