AGPhil 9: Quantum Mechanics I

Time: Thursday 11:00–13:00 Location: AGPhil-H14

AGPhil 9.1 Thu 11:00 AGPhil-H14

A Heuristic Route to Nonlinear Quantum Mechanics — •Alireza Jamali — 3rd Floor - Block No. 6 - Akbari Alley - After Dardasht Intersection - Janbazane Sharghi - Tehran - Iran

It is known since Madelung that the Schrödinger equation can be thought of as governing the evolution of an incompressible fluid, but the current theory fails to mathematically express this incompressibility in terms of the wavefunction without facing problem. In this paper after showing that the current definition of quantum-mechanical momentum as a linear operator is neither the most general nor a necessary result of the de Broglie hypothesis, a new definition is proposed that can yield both a meaningful mathematical condition for the incompressibility of the Madelung fluid, and nonlinear generalizations of Schrödinger and Klein-Gordon equations. The derived equations satisfy all conditions that are expected from a proper generalization: simplification to their linear counterparts by a well-defined dynamical condition; Galilean and Lorentz invariance (respectively); and signifying only rays in the Hilbert space.

AGPhil 9.2 Thu 11:30 AGPhil-H14

Evidence for Interactive Common Causes. Resuming the Cartwright-Hausman-Woodward Debate — •Paul M. Näger — University of Münster, Germany

The causal Markov condition (CMC), which is a central principle of causal modelling, requires that conditional on a common cause the correlation between its effects vanishes (the common cause screens off the correlation). Since Salmon (1978) presented the first counterexamples, joined by van Fraassen (1980, 1982) and Cartwright (1988 and many more), there is a debate about whether there are also common causes that fail to screen off (interactive common causes, ICCs), violating the CMC. Since indeterminism is a necessary requirement, the most serious candidates for ICCs refer to quantum phenomena. In her seminal debate with Hausman and Woodward, Cartwright early on focussed on unfortunate non-quantum examples (chemical factory). Especially, Hausman and Woodward's redescriptions of quantum cases saving the CMC remain unchallenged. This paper takes up this lose end of the discussion and aims to resolve the debate in favour of Cartwright's position. It systematically considers redescriptions of ICC structures, including those by Hausman and Woodward, and explains why these are inappropriate, when quantum mechanics (in a dynamic collapse interpretation) is true. It first shows that all cases of purported quantum ICCs are cases of entanglement and then, using the tools of causal modelling, it provides an analysis of the quantum mechanical formalism for the case that the collapse of entangled systems is best described as a causal model with an ICC.

AGPhil 9.3 Thu 12:00 AGPhil-H14

Aristotelian Grounding for GRW's Flash Ontology — •Ryan Miller — University of Geneva, Switzerland

The flash (i.e., event) ontology for the GRW objective-collapse formulation of quantum mechanics (Goldstein et al., 2012) has become popular for maintaining both a primitive ontology in 4D spacetime (Allori et al., 2014; Allori, 2015; Tumulka, 2017) and serious Lorentz invariance (Tumulka, 2009; Petrat & Tumulka, 2014a, 2014b; Tumulka, 2021). Valia Allori's (Allori et al., 2008; Allori, 2016) straightforward reading of this ontology suggests that the flashes are fundamental, grounding both the other elements of the theory and our everyday macro-scale ontology. This view has come under pressure on both points, however: Tim Maudlin (1997, 2010, 2011, 2019) argues that the GRW wavefunction cannot be wholly grounded in the flashes, while Elizabeth Miller (forthcoming) argues that flashes are an inadequate ground for everyday macro-scale ontology.

I suggest resolving these difficulties with the GRW flash ontology by grounding the flashes in entangled macro-objects. On this Aristotelian proposal, macro-objects like Schrodinger's cat maintain the entangled wavefunction that governs their micro-scale powers, realized in flash events. Because entangled particle families flash together (Maudlin, 2011), the density of micro-events will support macro-observations without the GRW parameters departing from observed values (Feldmann & Tumulka, 2012). Neo-Aristotelian grounding is thus attractive for GRW's flash ontology.

AGPhil 9.4 Thu 12:30 AGPhil-H14

Does the weak trace show the past of a quantum particle in an unperturbed system? — •Jonte R Hance[1], John Rarity[1], and James Ladyman[2] — [1]Quantum Engineering Technology Laboratories, Department of Electrical and Electronic Engineering, University of Bristol, Woodland Road, Bristol, BS8 1US, UK — [2]Department of Philosophy, University of Bristol, Cotham House, Bristol, BS6 6JL, UK

We investigate the weak trace method for determining the path of a quantum particle in an unperturbed system. Specifically, looking at nested interferometer experiments, when internal interferometers are tuned to destructive interference, we show that the weak trace method gives misleading results. This is because the methods used experimentally to obtain the weak value of the position operator necessarily perturb the system, hence, in some cases the assumption that weak coupling being equivalent to no coupling is incorrect. Further, even if we assume there is no disturbance, there is no reason to associate the weak value of the spatial projection operator with the classical idea of 'particle presence', especially if it has features which go against the classical ideas associated with a particle being present (i.e. a particle having a single, continuous path). Experiments performed that are claimed to support the interpretation simply show the effects of this coupling acting as measurement, rather than tapping into the underlying reality of what happens in a quantum system when no-one is looking.