AGPhil 6: Quantum Theory I

Time: Wednesday 16:30–18:15 Location: H-HS III

Invited Talk AGPhil 6.1 Wed 16:30 H-HS III

Quantum metaphysics — •Alastair Wilson — University of Birmingham, Birmingham B15 2TT, UK

Philosophy, specifically natural philosophy, used to be our main route to understanding the deep underlying structure of reality. Physics emerged out of natural philosophy during the Scientific Revolution, and over the past few centuries it has come to seem as though physics is all we need to understand the natural world. But is there still any role for philosophy to play? In this talk I'll argue that metaphysics and physics overlap in their subject-matter, and that they can work together to help us understand some of the deepest mysteries of nature: chance, possibility and necessity. My focus is objective modality: the possibilities, necessities and contingencies inherent in nature (if any there be). What bearing does progress in physics have on objective modality? A prioristic modal metaphysics is conceived as demarcating a space of possibilities that is epistemically prior to and independent of the discoveries of science. Naturalistic metaphysics is metaphysics which brings scientific considerations to bear on modal questions; the greater the role given to science by an approach to modality, the more naturalistic that approach. I develop and defend a fully naturalistic reductive account of objective contingency in nature, drawing on resources from Everettian (many-worlds) quantum mechanics. I distinguish four degrees of naturalistic involvement in the theory of modality; the proposed quantum modal realism is naturalistic in all four senses. I also sketch some consequences of the account for the methodology of metaphysics.

AGPhil 6.2 Wed 17:15 H-HS III

How to be a wave function realist—and why you should not be one — •Tushar Menon — University of Cambridge, Cambridge, UK — University of Bonn, Bonn, Germany

Wavefunction realism is a metaphysical proposal for non-relativistic quantum mechanics according to which the state vector of quantum mechanics is interpreted as a complexvalued physical field in a (very) high-dimensional space. This high-dimensional space is its true arena, in the sense that it represents the fundamental spatial ontology associated with quantum theory. In this paper, I articulate an objection to wavefunction realism that applies even in its originally intended domain of non-relativistic quantum mechanics. I argue that the metaphysical motivation behind the arena view of physical space, together with a standard position regarding the definability of observables, mandate a belief that it is a principal fibre bundle, not a configuration space that should be taken to represent the physical arena of a non-relativistic quantum system. I conclude by considering amendments to the position, none of which, I contend, capture the original spirit of the proposal.

AGPhil 6.3 Wed 17:45 H-HS III

Why wavefunction realists should be Hilbert-space fundamentalists — •David Schroeren — Philosophy Department, 1879 Hall, Princeton University, Princeton, NJ 08544, USA

I argue that wavefunction realists should endorse *Hilbert-space fundamentalism*: the thesis that the Hilbert space of abstract 'kets' characterizes a fundamental physical space in its own right. I proceed as follows. For a system with spin, the wavefunction-realist physical field is mathematically characterized by an element of the form $\psi(x) \otimes |\varphi\rangle$, where $|\varphi\rangle$ is a ket in a spin Hilbert space $\mathcal{H}$ spanned by basis elements $|j, m\rangle$ for $-j \leq m \leq j$. The goal is to show that wavefunction realists should be fundamentalists about Hilbert spaces $\mathcal{H}$ as *linear* spaces rather than as projective spaces that consist of rays. My argument proceeds from two observations: first, that the actual world is such that its quantum properties are characterized in terms of *projective* representations of symmetry groups rather than linear ones; and second, that the nature of projective representations of $SO(3)$ entails that spin is half-integer-valued, rather than integer-valued. I then argue both that we *can* and *should* regard this as a physical explanation of the fact that spin is half-integer valued. Subsequently, I argue that the relevant explanation is contrastive: if the world had been such that its physical properties are characterized by linear representations of symmetry groups *rather than projective ones*, then spin would be integer-valued. Finally, I argue that this contrastive explanation implies fundamentalism about spin Hilbert spaces as linear spaces.