AGPhil 3: Foundations of Quantum Mechanics: The Measurement Problem and the Many Worlds Interpretation

Time: Tuesday 11:00–12:45 Location: HS XVII

Invited Talk AGPhil 3.1 Tue 11:00 HS XVII

Is there a mechanism that produces many parallel worlds?

— •Meinard Kuhlmann — Philosophy Department, University of Mainz

My question is whether the emergence of many parallel worlds in the (contemporary) Everettian solution to the quantum measurement problem can be understood in a mechanistic fashion. I will conclude with a clear "Yes!". One crucial element in my argument will be quantum decoherence, a process that partly explains why our world appears so very classical, and which rescues the original many-worlds interpretation of quantum mechanics from one fatal objection. However, while my positive answer may first sound like untarnished good news for the mechanistically inclined lover of parallel worlds, it comes with a grain of salt: It is a proper physical mechanism that produces parallel worlds, but due to the nature of this mechanism, these worlds are not quite what one may hope for.

AGPhil 3.2 Tue 11:45 HS XVII

An interpretation-independent formulation of the measurement problem — •Antoine Soulas — University of Vienna, Austria — IQOQI Vienna, Austria

In this presentation, we do not try to solve the measurement problem of quantum mechanics (QM), but rather to properly formulate it. One of the reasons why it still lacks a precise, agreed definition is that the problem may take very different forms depending on the interpretation of QM embraced. We propose to identify the common root of the puzzle in an interpretation-independent way (i.e. as a property of the probabilities only) and derive its ontological consequences. The key point is that the violation of the total probability formula in QM does not allow to construct an objective ontology, independent from epistemology. This enables us to:

(i) shed light on the ubiquitous presence of the total probability formula in the quantum foundations literature (definition of hidden variables, historical and modern formulation of Bell's theorem, absoluteness of observed events in the local friendliness theorem, macrorealism à la Leggett-Garg, ontological models à la Spekkens...);

(ii) study how the problem manifests itself in five famous interpretations of QM (Copenhaguen, collapse-models, Bohmian mechanics, many-worlds and relational QM) : how they propose to solve it and which new difficulties arise. This provides a fresh look on the different interpretations, and allows to better compare them.

AGPhil 3.3 Tue 12:15 HS XVII

A New Perspective on Quantization and the Measurement Problem — •Simon Friederich and Mritunjay Tyagi — University of Groningen, University College Groningen

Quantization is traditionally viewed as a method for transitioning from classical to quantum theory, mapping phase space functions to self-adjoint operators on Hilbert space. While not usually linked to the measurement problem, this work examines whether refining our understanding of quantization could help vindicate single-world realism about quantum theory. We propose reconceptualizing quantization as a mapping within quantum theory, connecting phase space functions*dynamical variables with sharp values*to their corresponding self-adjoint operators. This perspective circumvents the Kochen-Specker theorem by acknowledging that promising quantization schemes generally do not preserve algebraic relations, making KA non-contextuality an implausible assumption. The criterion for quantization is that the quantum expectation value of an operator corresponds to a weighted integral of its associated phase space function with a suitable probability distribution. Applying this approach to Weyl, Wick, and Anti-Wick quantization schemes reveals that Anti-Wick quantization uniquely satisfies this interpretation. The Husimi function naturally serves as the probability distribution for Anti-Wick quantization. Further research, beyond the ontological models framework, is needed to explore the empirical and theoretical implications. This approach opens new possibilities for quantum foundations and the search for theories beyond the Standard Model.