AGPhil 14: Quantum Mechanics

Time: Thursday 11:30–13:00 Location: PTB SR AvHB

AGPhil 14.1 Thu 11:30 PTB SR AvHB

A two-worlds interpretation of quantum mechanics — •Hans Christian Öttinger — Quantum Center and Department of Materials, ETH Zürich, HCP F 43.1, CH-8093 Zürich, Switzerland

The stochastic nature of quantum mechanics is more naturally reflected in a bilinear two-process representation of density matrices rather than in squared wave functions. This proposition comes with a remarkable change of the entanglement mechanism: entanglement does not originate from superpositions of wave functions, but results from the bilinear structure of density matrices. Quantum interference is not an additive superposition mechanism, but rather a multiplicative phenomenon. A strict superselection rule, which can be motivated by obtaining quantum mechanics as a limit of quantum field theory (Fock space), requires that the content of fundamental particles in quantum systems is well-defined. The proposed bilinear representation of density matrices is given in terms of two stochastic jump processes.

These ideas are illustrated for the Einstein-Podolsky-Rosen and double-slit experiments. The expression of the stochastic nature of quantum mechanics in terms of random variables rather than their probability distributions facilitates an ontological viewpoint and leads us to a two-worlds interpretation of quantum mechanics.

AGPhil 14.2 Thu 12:00 PTB SR AvHB

A Presupposition of Bell's Theorem — •Carsten Held — Untergraben 13, 99423 Weimar

The most prominent version of Bell's theorem consists of the Bell-CHSH inequality and a quantum-mechanical example that violates it. The inequality is shown to rest on the non-trivial presupposition that the values of elementary spin quantities are scalars, and not, e.g., vectors. In the version considered, the theorem's argument succeeds for scalars and fails for vectors. However, the reference to vector values can be motivated by the physics of spin. Hence, recognizing the presupposition suggests a critical reassessment of the theorem.

AGPhil 14.3 Thu 12:30 PTB SR AvHB

Are quantum subsystems invariant? — •Guilherme Franzmann — Nordic Institute for Theoretical Physics and Stockholm University, Stockholm, Sweden

What is a physical subsystem? How classical physical subsystems localized in spacetime (causally independent) are identified from quantum ones? Traditionally, classical systems have been *uniquely* identified with quantum systems, typically represented as factors in Hilbert space for finite-dimensional systems or associated with a local (microcausality) algebra of operators in QFT. Both representations aim to instantiate a specific prescription of subsystems' independence, that they must be statistically independent for state preparations and measurements. Despite this prescription, it is easy to show that canonical linearized quantum gravity prevents us from obtaining a gauge-invariant local algebra, thus undermining one of the conditions needed for statistical independence of subsystems in QFT. Arguably, this precludes most of the modeling associated with early universe cosmology as well as current attempts to model gravity-induced-entanglement table-top experiments. Nonetheless, primarily it presents a major roadblock towards a theory of quantum gravity. In this talk, after reviewing the aforementioned points, I will propose that a way forward is that the unique identification between quantum and classical systems should be dropped, and instead this mapping should be dynamical, which opens the possibility for a single-world unitary quantum mechanics.