AGPhil 5: Foundations of Quantum Mechanics I

Time: Wednesday 14:00–16:30 Location: HS XVII

AGPhil 5.1 Wed 14:00 HS XVII

In Place of Quantization: A Universal Group-Theoretic Approach to Quantum Mechanics — •Gerald Goldin — Rutgers University, New Brunswick NJ, USA

This talk summarizes and expands on very recent results with David Sharp at Los Alamos, where we obtain a universal kinematical group for quantum mechanics directly from fundamental physical assumptions, without quantization in the usual sense. One then obtains distinct quantum systems with different configuration spaces, standard and exotic particle exchange statistics, and other properties, directly by classifying the inequivalent unitary representations of a single infinite-dimensional group. The method applies to arbitrary physical spaces, and does not seem limited to any particular space-time symmetry structure.

Here I explore whether such a unifying group-theoretic description can extend to dynamical as well as kinematical observables, and what that means. I also discuss some further ramifications and philosophical perspectives. Nature does not quantize classical dynamics; the latter merely approximates quantum phenomena in macroscopic domains. Quantization methods are essentially addressing an *inverse problem* regarding measurement, which is now more clearly characterized.

Reference: G. A. Goldin and D. H. Sharp, arXiv:20404.18274 [quant-ph]

AGPhil 5.2 Wed 14:30 HS XVII

How can we detect localized particles? — •Alexander Niederklapfer — London School of Economics and Political Science, United Kingdom

The consensus in philosophy of physics is that quantum field theories are, on the fundamental level, not about particles. However, almost all contact of the theories with empirical observations happens in terms of particle experiments. Thus, it is an important task to recover the particle phenomenology from the theory, and one of the main aspects of this is localizability: there are several no-go theorems that show that there cannot be localized states in quantum field theories, and there are as many attempts to reconcile this with the appearance of being able to detect localized particles in experiment.

I compare approaches by Wallace, Halvorson and Clifton, Haag, and Buchholz in terms of their ontological commitments about the non-localizability of physical systems. While some of them employ mathematically similar methods to recover a particle notion, I propose that the differences of the approaches can be attributed to the different stances on the representational relations of the theory not only with the physical systems themselves, but, more importantly, the representation and role of the actual particle measurement devices and methods. This, in turn, shows that some of the reasons to reject a particle ontology for QFTs rest on assumptions about measurement that are still controversially discussed in the literature.

AGPhil 5.3 Wed 15:00 HS XVII

Revisiting the Copenhagen Interpretation of QM — •Christopher Tyler — Vision Sciences, City St-George's, University of London

The core synthesis of QM is the Copenhagen Interpretation, whose basic form restricts interpretation solely to the measurement of energetic transition events and the mathematical theory that predicts their frequencies of occurrence, implying that no implicit or hidden variables should be postulated to mediate the theoretical analysis. Yet, the consensus view is that the underlying entities involved local particles with defined trajectories in quantum superposition of probability distributions of multiple possible states resolved by the observation of transition events, in violation of the Copenhagen proscription of such underlying variables.

An alternative view that is rarely considered is that that the mathematical theory, epitomized by the Schroedinger equation, directly describes the deterministic evolution of the overall energy state of the system, implying that *material points are nothing but wave-systems* (Schroedinger, 1926), consistent with the soft energy patterns of the recent Compact Muon Collider results, and that the detection events are not instantaneous state transitions but time-resolved nonlinear interactions of the energy wave with the atomic structure of the absorption matrix. Recognition of the nonlinearity of the detection events can resolve many paradoxical aspects of QM in favor of a deterministic interpretation of the quantum realm.

AGPhil 5.4 Wed 15:30 HS XVII

Re(l)ality: The View From Nowhere vs. The View From Everywhere — •Nicola Bamonti — nicola.bamonti@sns.it

Using the fiber bundle framework, this work investigates the conceptual and mathematical foundations of reference frames in General Relativity by contrasting two paradigms. 'The View from Nowhere' interprets frame representations as perspectives on an invariant equivalence class, while 'the View from Everywhere' posits each frame representation as constituting reality itself. This conception of reality is termed 'Relality'. The paper critically examines the philosophical and practical implications of these views, with a focus on reconciling theory with experimental practice. Central to the discussion is the challenge of providing a perspicuous characterisation of ontology. The View from Nowhere aligns with the so-called 'sophisticated approach on symmetries' and it complicates the empirical grounding of theoretical constructs. In contrast, the View from Everywhere offers a relational ontology that avoids the abstraction of equivalence classes. The paper may establish multiple points of contact with discussions on the ontology of Relational Quantum Mechanics. In particular frameworks like the View from Everywhere and the Relality definition can offer valuable insights in that context

AGPhil 5.5 Wed 16:00 HS XVII

Quantum Relativism Tame and Feral — •Timotheus Riedel — Université de Genève, Département de Philosophie, Rue De-Candolle 2, 1205 Genève, Switzerland

A new trend towards relativism has taken hold in quantum foundations, as evidenced by lively debates about perspectivist approaches like Relational Quantum Mechanics, QBism, and pragmatism. However, these debates often suffer from a lack of clarity regarding the conceptual commitments of relativist interpretations. Two key questions are: (i), whether they allow for cross-perspective communication, and (ii) whether they postulate absolute facts about which facts obtain relative to which observer.

I suggest that relativist interpretations can usefully be categorised as either 'tame' or 'feral' along these two dimensions. Specifically, a relativist interpretation counts as tame if and only if it enables cross-perspective communication and maintains second-order absoluteness. Moreover, I argue that standard arguments against absolute facts in the quantum domain - based on Wigner's Friend or Extended Wigner's Friend scenarios - only support feral interpretations. This is because the commitments of tame relativists render them vulnerable to 'revenge arguments': structural replicas of the original arguments against absolute facts that, however, target absolute facts about relative facts instead. This suggests that quantum relativism is only tenable if we can make sense of its particularly radical manifestations.