AGPhil 3: Philosophy of Physics 3

Zeit: Dienstag 13:15–16:15 Raum: VMP6 HS G

Hauptvortrag AGPhil 3.1 Di 13:15 VMP6 HS G

Individuation, Entanglement and Composition for Fermions — •Adam Caulton — MCMP, LMU Munich, Germany

Permutation symmetry in many-particle quantum mechanics can take one of two interpretations. According to the first interpretation, the transformations under which physical quantities (such as the joint Hamiltonian) are invariant represent a literal permutation of the constituent particles. According to the second interpretation, those transformations are construed as "gauge", i.e. a reshuffling of non-representative elements in the mathematical formalism. My talk explores the consequences of taking this second interpretation, especially for fermions.

The first consequence I will explore concerns the individuation of particles. I show how single-particle quantities may be found, and even reduced density operators may be defined, in a permutation-invariant way.

The second consequence concerns entanglement. In particular, non-separability of the joint state can no longer be taken as a sufficient condition for entanglement between the constituent systems. A natural surrogate may be defined, which agrees with the proposals of Ghirardi, Marinatto and Weber (2002). This surrogate is further justified by an analogue of Gisin's theorem for permutation-invariant systems.

The third and final consequence, which is a little more metaphysical, concerns the composition of fermionic joint systems. I argue that fermionic systems disobey classical mereology, the theory of parts and wholes developed by Leśniewski and Leonard & Goodman.

AGPhil 3.2 Di 14:00 VMP6 HS G

The Einstein-Reichenbach Correspondence on the Geometrization of the Electromagnetic Field — •Marco Giovanelli — FORUM SCIENTIARUM Doblerstraße 33 72074 Tübingen

This paper analyzes a correspondence between Reichenbach and Einstein from the spring of 1926, concerning what it means to 'geometrize' a physical field. The content of an unpublished typewritten note that Reichenbach sent to Einstein on that occasion is reconstructed, showing that it was an early version of sec.49 of the Appendix to Philosophie der Raum-Zeit-Lehre, on which Reichenbach was working at the time. In the note Reichenbach proposed a toy-geometrization of the electromagnetic field: general relativistic equations of motion are rewritten in a way that also charged particles, under the influence of an electromagnetic field, follow their 'natural path' defined by a non-symmetric affine connection. Einstein criticized Reichenbach's note from a technical point view (in particular charged particles cannot all move on geodesics of a single connection), but agreed with its philosophical point: the geometrization does not mean something essential. The paper draws two lessons from this episode: From a historical standpoint, the correspondence inaugurated a philosophical reflection about the role played by geometric considerations in physical theories. From a systematical standpoint, pace Reichenbach, his theory shows the limits of any attempt to impose geodesic equations of motion to a non-universal force.

AGPhil 3.3 Di 14:30 VMP6 HS G

The Friedmann Equations. From a Historical and Philosophical Point of View — •Andrea Reichenberger — Alfried Krupp School Laboratory, Ruhr-University Bochum

In this paper a critical review of the Friedmann equations is provided from a historical and philosophical point of view. In the early twenties of the last century the Russian physicist Alexander Friedmann presented solutions of Einstein's field equations which permit models of the universe that are homogeneous and isotropic, but not static (as opposed to Einstein's assumption that the universe is static). Nowadays the expansion of the universe has been strongly confirmed by experiment, observation and calculation, in particular by precision measurements of the Cosmic Microwave Background Radiation and by studies of galaxy clustering. However, one lesson we can learn from history is that expanding universe models sets additional restrictions regarding conditions of space-time orientability and stable causality. Friedmann himself was fully aware of that fact. Deeply influenced by David Hilbert's foundational program for the "axiomatization of physics", he found his nonstatic solutions of the field equations through critical reflection on Hilbert's interpretation of the principle of causality.

15 min. break

AGPhil 3.4 Di 15:15 VMP6 HS G

Topos Quantum Theory and Quantum Set Theory: a Unification — •Benjamin Eva — University of Bristol, Bristol, United Kingdom

In this paper, we will present a new formal framework that unifies two long running research programmes in the foundations of quantum theory: topos quantum theory (TQT) and quantum set theory (QST). In particular, we will show how this new framework allows us to transfer ideas and results between the two settings in a natural way that greatly improves the expressive power and the physical significance of both formalisms. The presentation will focus on the logical aspects of the new framework, and show how the traditional quantum logic of QST can be related to the intuitionistic quantum logic of TQT via a new form of paraconsistent quantum logic that arises naturally from the representation of the orthcomplement operation in TQT.

AGPhil 3.5 Di 15:45 VMP6 HS G

On the Einsteinian View of Quantum States — •Florian Boge — Philosophisches Seminar, Universität zu Köln, Deutschland

The status of state descriptions by wave functions in quantum mechanics (QM) has always been subject to heavy debates, since at any given time these can only assign definite values to a limited subset of measurable magnitudes. Von Neumann's analysis of the measurement process lead to cats ending up 'dead and alive at the same time'.

Some, most notably Einstein, have hence urged to regard wave functions merely as a measure of our *knowledge* about a system's true state. Despite many difficulties, this view has become fashionable again in recent years. N. Harrigan and R. W. Spekkens have developed a formal framework for construing the quantum state of a system in terms of knowledge. For so called *ψ-epistemic models* it is required that probability distributions $p_\psi(\lambda)$ and $p_\phi(\lambda)$, associated with quantum states ψ and ϕ, can have non-trivially overlapping supports. This makes the true states λ hidden variables.

Of course we know from Bell's theorem that such hidden variables must be *nonlocal*, but Spekkens and Bartlett et al. have developed models which—seemingly—reproduce significant parts of QM locally, including interference phenomena. Building on a theorem by Hardy and the Reeh-Schlieder theorem, I will demonstrate that the ψ-epistemicist ultimately has to appeal to nonlocal elements in his models of interference, which undermines the apparent success.