AGPhil 5: Philosophie der Physik IV

Time: Friday 9:30–12:30 Location: H 2033

Invited Talk AGPhil 5.1 Fri 9:30 H 2033

Spacetime is as spacetime does — •Christian Wüthrich and Vincent Lam — University of Geneva, Switzerland

Theories of quantum gravity generically presuppose or predict that the reality underlying relativistic spacetimes that they are describing is significantly non-spatiotemporal. On pain of empirical incoherence, approaches to quantum gravity must establish how relativistic spacetime emerges from their non-spatiotemporal structures. We argue for spacetime functionalism, i.e. the idea that in order to secure this emergence, it is sufficient to establish that only those features of relativistic spacetimes functionally relevant in producing empirical evidence must be recovered. In order to complete this task, an account must be given of how the more fundamental structures instantiate these functional roles. We illustrate the general idea in the context of causal set theory and loop quantum gravity, two prominent approaches to quantum gravity.

AGPhil 5.2 Fri 10:15 H 2033

Have We Lost Spacetime on the Way? Narrowing the Gap Between General Relativity and Quantum Gravity — Baptiste LeBihan and •Niels Linnemann — University of Geneva, Geneva, Switzerland

In the recent literature much has been written on the emergence of general relativity from quantum gravity theories. Important features of space and time are taken to be missing in quantum gravity, allegedly requiring an explanation of the emergence of spacetime from non-spatio-temporal theories. We explore which aspects of spacetime are emergent in different approaches to QG and within GR and highlight that Lorentz symmetry remains generally untouched. In any case, any approach to QG seems to start with an in-built distinction between something time-like and something space-like. We point out that spacetime in an important sense is already emerging in the context of GR when understood from a dynamical perspective. We conclude that the alleged explanatory gap between GR and non-spatio-temporal QG theories might be reduced and that the problem of spacetime emergence may fruitfully be reshaped as a problem about the interpretation of GR itself.

15 min break

AGPhil 5.3 Fri 11:00 H 2033

Limits of Bronstein's Cube: Compound Reduction and Overlapping Domains in State Space Approaches to Inter-Model Reduction — •Joshua Rosaler — Institute for Theoretical Particle Physics and Cosmology, RWTH Aachen University

The so-called "Bronstein Cube" of physical theories attempts to characterize the relationships among the theories of modern physics by placing them at the corners of a cube, where movement along any dimension of the cube represents a limit as some constant of nature is taken to zero or infinity. The picture of inter-theory relations suggested by the cube suggests that these different limits should commute - for example, the classical limit as Planck's constant vanishes should commute with the non-relativistic limit in which the speed of light approaches infinity. Elsewhere, I have argued that the relevance of this approach for the behavior of real physical systems is at best obscure, and defended an alternative, model-based approach to reduction in physics that focuses on the relationships between the state spaces of different models (Rosaler 2017), (Rosaler 2015). Here, I will explain how reductions between different models can be composed on this state-space based approach, and also the sense in which different reductions may be said to "commute" on this picture.

References

Rosaler, J. "Reduction as an A Posteriori Relation." The British Journal for the Philosophy of Science, 2017.
Rosaler, J. "Local Reduction in Physics." Studies in History and Philosophy of Modern Physics, 2015.

AGPhil 5.4 Fri 11:30 H 2033

The Emergence of the Classical World from a Bohmian Universe — •Davide Romano — Rome, Italy

I shall present a general strategy for the classical limit problem in the context of the de Broglie-Bohm theory. In this framework, the problem reduces to the following questions: 1. Why does the wave-function disappear in the classical regime? 2. Why do the Bohmian trajectories become (approximately) Newtonian? The answer to the first question is due to the formation of well-localized effective wave-functions for the subsystems of entangled states. This process also provides a physical explanation for decoherence effects of open quantum systems. Concerning the second question, I will suggest a solution that makes use of a combination of decoherence and quantum potential (Q). It is well-known, in fact, that when Q is negligible the Bohmian particles follow a Newtonian trajectory. Problem: Q cannot be made negligible for all the states (Q=constant for a stationary wave, for example). However, the classical regime is necessarily a decoherence regime, and it can be shown (Zurek, Habib and Paz (1993), Coherent states via decoherence, Physical Review Letters) that the emerging wave functions from decoherence will be Gaussian states. This is a good result: in fact, the quantum potential of a Gaussian state is negligible under the conditions of big mass, small de Broglie wave-length and negligible quantum action. These conditions are the hallmark of the classical regime: this finally shows that a macroscopic Bohmian system in interaction with the environment will follow an (approximately) Newtonian trajectory.

AGPhil 5.5 Fri 12:00 H 2033

Dualities from the 'external' point of view and the possibility for emergence of space-time — •Eugene Chua — Munich Center for Mathematical Philosophy (MCMP)

Physicists have claimed that there is emergence of space-time from quantum entanglement, in the context of gauge/gravity dualities. However, can dualities accommodate emergence?

I first consider the 'simple view* of emergence-as-failure-of-reduction. After introducing dualities via AdS/CFT, I argue for the simple view*s inadequacy: it cannot categorize a duality as either reduction or emergence. However, one might reply that dual theories are equivalent (what De Haro [2017] calls the *internal* view) so there should be neither emergence nor reduction. Hence, the simple view was right to withhold categorization. I problematize this reply by arguing for the internal view*s inadequacies. On one reading it is too strong: dual theories supposedly have the same semantic content, including physical interpretations. By considering examples including Fraser's [2017] discussion of analytic continuation, I show that this reading is inadequate. On another reading, though, it is too weak: it suggests dual theories have the same physical content given a duality, but this does not imply the relevant equivalence. I conclude that the external view - on which dual theories are distinct - appears more plausible; hence emergence-as-failure-of-reduction is inadequate. Finally, I defend an account of emergence-as-dependence-plus-autonomy-and-novelty, and show that this sort of emergence remains a possibility given fundamentality assumptions.