WORKSHOP
Spacetime: Emergence and Mereology

Lisbon & Zoom, May 30, 2023

Programme & Abstracts

8:50-9:00 Welcome

9:00-10:00 Sam Baron, Dianoia Institute of Philosophy (online)
10:00-10:45 Alex Murphy, University College London

10:45-11:00 Break

11:00-12:00 Baptiste Le Bihan, University of Geneva
12:00– 12:45 Nathaniel Gan, National University of Singapore (online)

12h45-14:30 Lunch

14:30-15:15 Jacopo Giraldo, University of Lisbon
15:15 – 16:00 Lucy James, University of Bristol

16:00 – 16:15 Break

16:15-17:00 Yazan Freij, University of Milan
17:00-17:45 Enrico Cinti, University of Geneva and University of Urbino
17:45-18:45 Christian Wüthrich, University of Geneva

Spacetime: Function and Fundament
Sam Baron, Dianoia Institute of Philosophy (online)

According to spacetime functionalism, spacetime is whatever plays the spacetime role. Spacetime functionalism has been used to understand how spacetime emerges from a more fundamental, non-spatiotemporal reality described by a theory of quantum gravity. It has been argued, however, that spacetime functionalism cannot capture spacetime emergence, because it requires that the more fundamental quantum gravity ontology is spatiotemporal after all. I will provide a response to this argument. The key is to distinguish between different ways in which the ontology of a theory of quantum gravity might be considered more fundamental. I suggest that for the right understanding of fundamentality, spacetime functionalism can indeed be used to understand the emergence of spacetime.

The Birth and Death of Lewisian Spacetime Functionalism
Alex Murphy, University College London

Evidence that spacetime is non-fundamental has emerged. This motivates some to adopt spacetime functionalism – i.e. spacetime is what spacetime does. Since functional entities are often non-fundamental, the functionalist notes, this secures our spatiotemporal talk whilst accommodating such evidence. Furthermore, it provides a familiar conceptual shape to the task of explaining how spacetime relates to fundamental physical ontology. I discuss two such approaches – Knox's inertial spacetime functionalism and Baker's spacetime cluster functionalism. Both maintain that spacetime is whatever realises a certain functional role in our physical theory. Knox argues that spacetime is whatever determines the structure of inertial frames. I argue her account relies on semantic descriptivism – the view that reference is mediated by definite descriptions which select referents. This is a problem. Kripke's arguments have undermined descriptivism generally, but the view is especially troublesome in the case of scientific concepts. It holds successful reference of such concepts hostage to the truth of our theory – the reference failure problem. Furthermore, since the descriptions we associate with these entities change with our theories, the view cannot explain how scientists across time can discuss the same entities – the referential continuity problem.
Descriptivists respond by associating terms with a cluster of descriptions held by a linguistic community. That way, failure to meet any single description doesn't entail reference failure. Furthermore, the flexibility this provides makes referential continuity easier. Baker makes this move, claiming that spacetime is a cluster concept. Following Hoefer and Martí, I argue he fails to overcome both problems. Though his account provides more semantic flexibility, the issues remain unresolved. Moreover, by including fundamentality as a criterion, Baker undermines the original motivation for functionalism. Spacetime functionalism was meant to accommodate newfound evidence that spacetime isn't fundamental. Unfortunately, it fails on semantic grounds. We must relate spacetime to fundamental physical ontology another way.

Beyond Spacetime Functionalism. A Defense of Spacetime Composition
Baptiste Le Bihan, University of Geneva

The possible emergence or non-fundamentality of spacetime has perplexed physicists and philosophers on numerous fronts. It has been suggested that this emergence can be understood through the lens of functional realization, as advocated by proponents of spacetime functionalism. In this talk, I aim to argue briefly that spacetime functionalism is better conceptualized as spacetime eliminativism. I will defend the realist perspective that regards spacetime as a composition of non-spatiotemporal, perhaps causal, building blocks.

Locating Spacetime's Parts
Nathaniel Gan, National University of Singapore (online)

Some leading physical theories suggest that spacetime is non-fundamental (e.g., Wüthrich, 2019). In response, some have adopted a mereological view of the relation between spacetime and nonspatiotemporal fundamental entities, under which the latter compose the former (Bihan,

2018). Baron and Le Bihan argued against the mereological view on the grounds that non-spatiotemporal entities, having no location, violate highly intuitive principles regarding location (Baron, 2020, 2021; Baron & Bihan, 2022). One can avoid inconsistency by restricting the principles to spatiotemporal entities, but this leaves the resulting mereology for non-spatiotemporal entities too sparse, particularly regarding location. This paper suggests that proponents of mereological spacetime emergence can defend their view by turning to mereotopology, which supplements mereology with topological notions. Mereotopological theories were initially formulated to model relations between spatiotemporal entities, but the objects of mereotopology need not be spatiotemporal. Hence, mereotopology can model relations between non-spatiotemporal entities in a location-like manner. Mereotopology concerns the connection relation. A theory of connection will be proposed, as well as a bridge principle relating connection with location. The theory includes axioms that are analogues of the location principles identified by Baron and Le Bihan, so when the theory is taken to govern all physical entities, non-spatiotemporal entities can be said to satisfy these principles in some form. Moreover, assuming a minimal set of core mereological principles, the location principles can be derived from the proposed theory via the bridge principle, so the spatiotemporal features represented by the location principles can be said to emerge from more fundamental features. Since mereotopology is a rather natural extension to mereology, this approach to spacetime emergence is relatively metaphysically lightweight. And since the derivation of the location principles assumes little by way of mereology, the proposed approach is compatible with most views on the mereology of physical entities.

Geometry and Measure of Spatial Extension
Jacopo Giraldo, CFCUL/RG2, University of Lisbon

In this paper I present a novel account of spatial extension according to which to be Spatially Extended just is to be Extended Simpliciter (SEES), i.e., to have a one dimensional projection of the exact location of at least one of its parts that is Lebesgue extended. There are two accounts of spatial extension mainly discussed in the literature: Spatial Extension as Mereological Extension (SEME) and Spatial Extension as Lebesgue Extension (SELE): a spatial entity is mereologically extended if and only if its exact spatial location has at least one proper part, whereas a spatial entity is Lebesgue-extended if and only if its exact location's Lebesgue measure, relative to a given dimension, is greater than 0. In contrast to SEME, SEES is based on a measure of spatial extension. Unlike SELE, SEES conceives spatial extension as absolute rather than relative to geometrical dimension. I defend that being based on a measure and being absolute are essential to a correct characterization of spatial extension, both being features of SEES. Therefore, I conclude that, ceteris paribus, SEES is a better candidate than both SEME and SELE.

Geometry of Emergent Spacetime
James Lucy, University of Bristol

This presentation discusses the geometric features that are, of necessity, to be attributed to spacetime, considered as an emergent structure. The set of relations that connect quantum

gravitational structure to general relativistic spacetime must be able to reconstruct the essential geometric features of the latter. Having a clear understanding of the implications the constraints of general relativity is thus of paramount importance for this project, and is a prerequisite for giving a robust characterisation of the emergence relations. This presentation focuses on the question of hyperbolicity: under what conditions is an emergent spacetime required to be hyperbolic? This draws on the ambiguity surrounding the status of cosmic censorship conjectures in general relativity, since one version of strong cosmic censorship entails global hyperbolicity. I argue that hyperbolicity is insisted upon for merely pragmatic reasons, being a useful feature for simplifying mathematical models of known phenomena. It need not, therefore, be required of the global structure of spacetime. A relaxation of the requirement of global hyperbolicity would mean that the emergence relations connecting quantum gravitational structure to spacetime need not reproduce an emergent structure that is hyperbolic, except in certain limiting cases.

Spacetime Composition: Not so Unfamiliar After All
Yazan Freij, University of Milan

Recent approaches to quantum gravity seem to suggest that spacetime is not a fundamental entity but rather emerges at a higher level from a non-spatiotemporal structure. To conceptualise how emergent spacetime might come into being, it has been suggested that we should think of spacetime as being mereologically composed of spacetime regions which are in turn composed of non-spatiotemporal parts. However, some philosophers have stated that even if spacetime composition can be shown to be coherent, it would still be different from how we ordinarily conceive the mereology of concrete objects. In this paper, I reformulate four principles that are taken to be intuitive for mereological composition. In their original formulations, these principles suggest that spacetime cannot be composed of non-spatiotemporal parts. My reformulations, however, seem to allow for the possibility of spacetime composition. I also show that these reformulations still satisfy our mereological intuitions and that, therefore, spacetime composition is still familiar enough to us.

The Fate of Spacetime in Holography
Enrico Cinti, University of Geneva and University of Urbino

The problem of the disappearance of spacetime has long been recognised as one of the most pressing philosophical and conceptual issues facing theories of QG. In this chapter, I will look at this issue within AdS/CFT, focusing in particular on the relationship between the non-perturbative definition of QG given by the duality and the semiclassical description of gravity given by the effective field theory in the bulk. By thinking in particular about the interior of black holes and the reconstruction map connecting their effective description to their fundamental one, I come to the surprising conclusion that the standard answer to the problem of the disappearance of spacetime, i.e. emergence, is inadequate in this case, at least as standardly formulated. Instead, I suggest that a more flexible and less ontologically demanding approach is required, whose basic tenet is that only operational data is required to make sense of the appearance of spacetime.

Geneva Has a Plan

Christian Wüthrich, University of Geneva

Spacetime functionalism is best equipped to avoid the problem of empirical incoherence in quantum gravity. While work in the philosophy of mind has proven useful in developing a suitable form of spacetime functionalism, there are various ways in which the templates from the philosophy of mind are inadequate to the task. First, the direction of 'explanation' runs parallel to the direction of functional reduction in quantum gravity, whereas the two directions are opposed in the Canberra plan of functional reduction of mental states. Second, in quantum gravity, unlike in the case of mind, we should expect 'near-realization' or mere approximation to emergent spacetime to take central stage. These two failures of the Canberra plan in the philosophy of mind suggest its being replaced in quantum gravity with a new plan.