AGPhil 6: Foundations of Gravity

Time: Wednesday 14:00–16:15 Location: AGPhil-H14

Invited Talk AGPhil 6.1 Wed 14:00 AGPhil-H14

Spacetime Conventionalism Revised: Tidal Forces and Weyl Curvature — •Karim Thébault and Ufuk Tasdan — University of Bristol

Our goal in this paper is to better understand the physical interpretation of tidal forces and Weyl curvature in general relativity by considering novel articulations of thesis of 'spacetime conventionality'. We will first consider a specific rendition of the conventionality thesis in the context of the debates regarding the status of energy conservation and the effects of tidal forces. This will then, in turn, motivate a discussion of the two most physically important forms of curvature - Ricci and Weyl - which can be isolated in general relativity, focusing upon the extent to which such formal distinction may be employed to articulate an entirely non-conventional analysis of the causal origin of tidal forces. We next consider the idea that the Ricci vs. Weyl curvature distinction can be further deployed to anchor a conventionalism-proof distinction between 'pure geometric' Weyl curvature and 'matter-energy-coupled' Ricci curvature. To foreshadow our main conclusion, what we find is that the complex of couplings between Ricci curvature and stress-energy, via the Einstein equation, and Weyl and Ricci curvature, via the Bianchi identity, leads us away from such attractively clean distinctions. Finally, we will outline some open questions and possible lines of future work as an envoi.

AGPhil 6.2 Wed 14:45 AGPhil-H14

Perturbing the hole argument — •John Dougherty — Munich Center for Mathematical Philosophy, LMU Munich

The recent literature on the hole argument has seen a reappraisal of its mathematical aspects. According to this reappraisal, as Halvorson and Manchak succinctly put it, there are two mathematical claims that might be thought to underwrite the hole argument, and neither in fact does. The claim that there are isomorphic but distinct Lorentzian manifolds is trivial, and the claim that there is a diffeomorphism that spoils the determinism is false. In this paper I argue that at least one version of the hole argument is underwritten by a third mathematical claim: that the configuration space of general relativity is "natural", which is to say that it depends functorially on the base manifold. This claim is nontrivial in the sense that it is not true in many theories, such as those containing spinor fields. But it is true in a tensorial theory like general relativity. And it underwrites the version of the hole argument that analogizes general covariance to the "gauge" nature of general relativity as it is used in perturbative contexts such as calculations concerning gravitational radiation and semiclassical effects.

AGPhil 6.3 Wed 15:15 AGPhil-H14

A Case for Further Inquiry into Spin and Gravity — •Zachary Hall — Stanford University

I present an undiscussed instance of the tension between the background-dependent formalism of quantum theory and the background-independence of classical general relativity. Notably, the issue is subject to empirical testing, for which reason it also holds interest for those who eschew background-independent methods or interpretations in gravitational theory. The issue is that the representations of spin-states in quantum theory depend prima facie on an embedding of those states in a flat background geometry. This raises the question of whether we should continue using a background geometry in representing spin-states in a world with gravitation. The empirical questions are apparent with knowledge of how experimentalists align (a) preparing and measuring devices of spin-states undergoing no non-gravitationally induced precession and (b) measuring devices in multiple wings of experiments on spin-entangled states. The aligning procedure is operational, meaning that the question of how the aligned measurement axes should be represented in the spacetime has been so-far uninvestigated. While some may be inclined to think that they should be represented with the Christoffel symbols and path information of the system, it is not clear that this is the only acceptable solution a priori.

AGPhil 6.4 Wed 15:45 AGPhil-H14

On the relation between Unruh and Hawking radiation — Ignacio Araya[1] and •Siddharth Muthukrishnan[2] — [1]ICEN, Universidad Arturo Prat, 1110939, Iquique, Chile — [2]HPS, University of Pittsburgh, Pittsburgh, PA, USA 15260

It is often said that Hawking radiation just is a kind of Unruh radiation. In this work, we clarify the ways in which Hawking radiation can and cannot be seen as a kind of Unruh radiation. Hawking radiation is analogous to Unruh radiation in that the Schwarzschild metric near the horizon is isomorphic to the Rindler metric, which allows us to employ the derivation of Unruh radiation to obtain Hawking radiation. But the isomorphism is restricted to the near-horizon region. This observation leads to the way in which Hawking radiation is not a kind of Unruh radiation: the analogy between them is not due to the equivalence principle. One might think that because observers near – but outside of – the horizon of a black hole are equivalent, via the equivalence principle, to an accelerating observer in empty space, Hawking radiation observed by a hovering observer outside a black hole just is the kind of Unruh radiation that an accelerating observer in empty space would see. We argue that this is an incorrect way of thinking of Hawking radiation. Indeed, this would imply that hovering observers outside gravitating bodies that are not black holes – such as stars and planets – would also observe Unruh/Hawking radiation, and this is not the case. Throughout we emphasize the ways in which Hawking and Unruh radiation can be seen as varieties of geometric radiation, i.e., radiation generated by the structure of a metric containing horizons.