AGPhil 9: General Relativity and Black Holes

Time: Thursday 16:30–18:00 Location: H7

AGPhil 9.1 Thu 16:30 H7

The History and Interpretation of Penrose's Singularity Theorem — •Dennis Lehmkuhl — Lichtenberg Group for History and Philosophy of Physics, University of Bonn

The Nobel Prize of 2020 was awarded to Roger Penrose for his singularity theorem of 1965, which the Nobel foundation interpreted as "the discovery that black hole formation is a robust prediction of the general theory of relativity." However, the 1965 paper does not mention the term "black hole" but speaks of gravitational collapse and spacetime singularities, starting with remarks on Schwarzschild's 1916 solution to the Einstein field equations. In this talk, I will put Penrose's singularity theorem in its historical context, starting with Einstein's and Schwarzschild's interpretation of the Schwarzschild metric in the late 1910s and 1920s, and discuss how the metric was linked to the question of gravitational collapse by Oppenheimer and Snyder in the late 1930s, and reconsidered by Wheeler and others in the 1950s and 1960s; and how Penrose drew on all these developments. I will describe which conceptual and technical advances Penrose had to invent and combine in order to come up with his singularity theorem to go beyond considerations of specific spacetimes like that of Schwarzschild, and show why the theorem was such a game-changer. Finally, I will discuss different possible interpretations of the theorem.

AGPhil 9.2 Thu 17:00 H7

Operational vs Descriptive Black Hole Complementarity — •Siddharth Muthukrishnan — Department of History and Philosophy of Science, University of Pittsburgh, Pittsburgh PA 15260 USA

To what extent does the black hole information paradox lead to violations of quantum mechanics? Black hole complementarity has emerged as an influential framework to prevent any such violations from being empirically problematic. I distinguish between an operational and a descriptive principle of black hole complementarity. Recent results applying quantum information theory and quantum computational complexity theory to black holes then imply that the operational principle is successful where the descriptive principle is not. Keeping this distinction in mind helps clarify why one seeks a solution to the information paradox, and what such a solution needs to explain. In particular, if the operational principle is accepted, then the black hole information paradox is no longer pressing.

AGPhil 9.3 Thu 17:30 H7

Why Einstein may have had good reason to oppose the geometrization of gravity in general relativity. — •Femke Kuiling — University of Minnesota, Minneapolis, USA

Using Einstein's Methodological Realism (Lehner 2014), I strengthen Lehmkuhl's argument for why Einstein refused to conclude (as most others have) that General Relativity somehow reduces gravity to geometry.