AGPhil 3: Black Holes I

Time: Tuesday 11:30–13:00 Location: AGPhil-H14

AGPhil 3.1 Tue 11:30 AGPhil-H14

No membrane at the black hole horizon? — •Marco Sanchioni — Via Timoteo Viti 10, Department of Pure and Applied Sciences, University of Urbino, Italy

Since the discovery of Hawking radiation (Hawking, 1976), it has been ac- accepted among physicists, and later on also by philosophers (Wallace, 2018), that black holes are thermodynamic objects in the total sense. To have a statistical mechanical underpinning of black hole thermodynamics, as is the case for thermodynamics of ordinary things, it has been argued that a quantum membrane should be posited at the black hole horizon. This paper is an inquiry on the status of the quantum membrane paradigm in light of recent theoretical results on black hole physics obtained within the research program of semiclassical gravity (Penington et al., 2019; Almheiri et al., 2020) and ultimately grounded on the ER=EPR proposal (Maldacena and Susskind, 2013). However, we do not discuss the problematic aspect of such a research program, which would be a project on its own, and our result is thus conditional to its validity. In particular, the paper starts an investigation on the picture of black holes that underlies these new calculations. The main result of this paper is that, within the central assumption on the validity of semiclassical gravity, the quantum membrane paradigm should be abandoned.

AGPhil 3.2 Tue 12:00 AGPhil-H14

Stellar gravitational collapse, singularity formation and theory breakdown — •Kiril Maltsev — Heidelberg Institute for Theoretical Studies / University of Heidelberg

A critical examination of the main physical arguments against the prediction of gravitational singularity formation in stellar core collapse is given, restricted in scope to a historically oriented survey of the decades spanning in between the Schwarzschild 1916 solution and the Penrose 1965 theorem. We first review the 3 definitions (missing point(s), infinite curvature, and geodesic incompleteness) of what a singularity is, and argue that its prediction is problematic for GR, indicating breakdown of Lorentzian geometry, only insofar as infinite curvature is concerned. In contrast, geodesic incompleteness is its innovating hallmark, which is not meaningfully available in Newtonian gravity formulations (infinite density, and infinite gravitational force) of what a gravitational singularity is. The Oppenheimer-Snyder 1939 solution derives the formation of locally infinite curvature and of incomplete geodesics, while Penrose's 1965 theorem concerns the formation of incomplete (null) geodesics only. We assess as the most robust curvature pathology formation counter-argument Markov's derivation of an upper bound on the quadratic curvature invariant from a ratio of natural constants, in connection with Wheeler's conjecture that the Planck scale is ultimate. Finally, we recall Landau's objection to fermionic infinite density point mass formation, which still provides strong reasons to believe that by the least an intermediate state towards the final fate of gravitational collapse must be a bosonic configuration.

AGPhil 3.3 Tue 12:30 AGPhil-H14

Alice meets Bob! or: The association of infinity and finiteness within the Schwarzschild metric — •René Friedrich — Strasbourg

The Schwarzschild metric is the basic description of a gravitational field, but it is more than that: It provides us with some hints about the way how the universe is working. One main feature of the Schwarzschild metric is the association of finite and infinite time structures, and it includes even proposals for the solution of the so-called "information paradox" of black holes and the supposed "breakdown of general relativity" near singularities.