GR 8: Quantum field theory in curved spacetimes

Time: Thursday 12:00–12:30 Location: H9

GR 8.1 Thu 12:00 H9

Quantum fields near Cauchy horizons of charged black holes
— •Christiane Klein, Jochen Zahn, and Stefan Hollands — Institut für theoretische Physik, Universität Leipzig, Germany

Reissner-Nordström-de Sitter spacetimes contain a Cauchy horizon: beyond it, the evolution of the spacetime is no longer governed solely by the initial data. A combination of analytical and numerical results indicate that there is a range of the physical parameter space for which the metric can be extended across the Cauchy horizon even when considering generic classical perturbations of the initial data. This is a violation of Penrose's strong cosmic censorship conjecture. However, it has been demonstrated by Hollands et.al., that in these cases the energy flux of a real scalar quantum field will diverge quadratically at the Cauchy horizon for any Hadamard state, rendering the metric inextendible. In this talk we present numerical results indicating that the described quadratic divergence of the energy flux is present for a wide range of parameters, and that it can change its sign. In addition, we extend the results by considering charged scalar fields. Apart from the energy flux, we derive and study the current of these fields. We demonstrate that the current diverges at the Cauchy horizon and that its leading divergence can have either sign, in contrast to naive expectations.

The talk is based on Phys.Rev.D 102 (2020) 8, 085004, arXiv:2104.06005 and arXiv:2103.03714, which is joint work with S. Hollands and J. Zahn.

GR 8.2 Thu 12:15 H9

Effective Quantum Dust Collapse via Surface Matching —
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The fate of matter forming a black hole is still an open problem, although models of quantum gravity corrected black holes are available. In loop quantum gravity (LQG) models were presented, which resolve the classical singularity in the centre of the black hole by means of a black-to-white hole transition, but neglect the collapse process. The situation is similar in other quantum gravity approaches, where eternal non-singular models are available. A strategy is presented to generalise these eternal models to dynamical collapse models by surface matching. Assuming 1) the validity of a static quantum black hole spacetime outside the collapsing matter, 2) homogeneity of the collapsing matter, and 3) differentiability at the surface of the matter fixes the dynamics of the spacetime uniquely. It is argued that these assumptions resemble a collapse of pressure-less dust and thus generalises the Oppenheimer-Snyder-Datt model. The junction conditions and the spacetime dynamics are discussed generically for bouncing black hole spacetimes, as proposed by LQG, although the scheme is approach independent. A global spacetime picture of the collapse for a specific LQG inspired model is discussed.