GR 9: Quantum Field Theory in Curved Spacetime

Time: Tuesday 17:30–18:30 Location: HBR 14: HS 2

GR 9.1 Tue 17:30 HBR 14: HS 2

Particle Production by Gravitational Fields and Black Hole Evaporation — •Michael F. Wondrak[1,2], Walter D. van Suijlekom[2], and Heino Falcke[1] — [1]Department of Astrophysics/IMAPP, Radboud Universiteit, Nijmegen, The Netherlands — [2]Department of Mathematics/IMAPP, Radboud Universiteit, Nijmegen, The Netherlands

This talk presents a new avenue to black hole evaporation using a heat-kernel approach in the context of effective field theory analogous to deriving the Schwinger effect. Applying this method to an uncharged massless scalar field in a Schwarzschild spacetime, we show that spacetime curvature takes a similar role as the electric field strength in the Schwinger effect. We interpret our results as local pair production in a gravitational field and derive a radial production profile. The resulting emission peaks near the unstable photon orbit. Comparing the particle number and energy flux to the Hawking case, we find both effects to be of similar order. However, our pair production mechanism itself does not explicitly make use of the presence of a black hole event horizon and might have cosmological implications.

The presentation is based on Phys. Rev. Lett. 130 (2023) 221502.

GR 9.2 Tue 17:50 HBR 14: HS 2

Particle creation in Bianchi IX universe — •Tatevik Vardanyan and Claus Kiefer — University of Cologne, Faculty of Mathematics and Natural Sciences, Institute for Theoretical Physics, Cologne, Germany

Particle production due to the expansion of the universe is studied for the general Bianchi type IX model. The impact of anisotropies on created particles/antiparticles is presented. The results are compared to the closed FLRW model of the universe.

GR 9.3 Tue 18:10 HBR 14: HS 2

Wigner phase of photonic helicity states in curved spacetime — •Luis Adrian Alanis Rodriguez — Institute for Theoretical Physics, University of Cologne, Cologne, Germany — Institute for Quantum Computing (PGI-12), Forschungszentrum Jülich, Jülich, Germany

We study relativistic effects on polarized photons that travel in a curved spacetime. The considered scenario is one in which photons propagate in the gravitational field of the Earth on a closed path that starts at a terrestrial laboratory, is reflected at one or more satellites, and finally returns to the laboratory. A formalism that takes into account the propagation and the boundary conditions at the mirrors is introduced. We find that after propagating along a closed path as in the aforementioned scenario, a non-trivial Wigner phase is acquired by the photons already in the Schwarzschild spacetime, where previous studies have found a trivial Wigner phase.