GR 1: Black Holes

Time: Monday 9:00–11:00 Location: GR-H2

GR 1.1 Mon 9:00 GR-H2

Photon spheres and shadows of time-dependent black holes — Jay Solanki[1] and •Volker Perlick[2] — [1]Sardar Vallabhbhai National Institute of Technology, Surat, 395007 Gujarat, India — [2]ZARM, University of Bremen, 28359 Bremen, Germany

The Vaidya spacetimes are a class of time-dependent and spherically symmetric solutions to Einstein's field equation with a null dust as the source. They describe the gravitational field around a spherically symmetric body that either gains mass by absorbing the null dust or loses mass by emitting it. Here we consider a subclass of the Vaidya spacetimes where the source is a black hole and the metric is conformally static. We demonstrate that there is an unstable photon sphere and we calculate the shadow of such black holes, first as seen by conformally static observers and then as seen by moving observers. The considered spacetimes may be viewed as simple models of black holes that are either accreting or (Hawking) radiating.

GR 1.2 Mon 9:20 GR-H2

Gravitational Lensing in the NUT Spacetime — •Torben C. Frost — ZARM, University of Bremen, 28359 Bremen, Germany — Institute for Theoretical Physics, Leibniz University Hannover, 30167 Hannover, Germany

The existence of a gravitomagnetic charge, the gravitational analogon to a hypothetical magnetic charge in electrodynamics, is a long-standing open question in physics. In my talk I will discuss how we can use gravitational lensing to identify if a black hole in nature carries a gravitomagnetic charge. For this purpose I will assume that they are described by the NUT metric. We will solve the geodesic equations using Legendre's elliptic integrals and Jacobi's elliptic functions. Then we will rederive the angular radius of the shadow, formulate a lens equation, derive redshift and travel time.

GR 1.3 Mon 9:40 GR-H2

A global view on Kerr spacetime – First person visualization of general relativity — •Thomas Reiber — Universität Hildesheim, Germany

The maximal analytic extension of slow Kerr spacetime contains an infinity of asymptotically flat "exterior" regions connected by a strongly curved "interior" region. An observer may stay in one of the exterior regions or – crossing event horizons – pass through the strongly curved region to reach one of the other asymptotically flat regions. We calculate videos of what an observer would see on different journeys through Kerr spacetime by using general relativistic ray tracing. For that purpose we use a covering of Kerr spacetime by an atlas consisting of Kerr-Schild and Kruskal-like coordinate patches.

GR 1.4 Mon 10:00 GR-H2

Non-teleology and motion of a tidally perturbed Schwarzschild black hole — •Zeyd Sam — School of Mathematical Sciences and STAG Research Centre, University of Southampton, United Kingdom — Institute for Physics and Astronomy, University of Potsdam, Germany

The prospect of gravitational wave astronomy with EMRIs has motivated increasingly accurate perturbative studies of binary black hole dynamics. Studying the apparent and event horizon of a perturbed Schwarzschild black hole, we find that the two horizons are identical at linear order regardless of the source of perturbation. This implies that the seemingly teleological behaviour of the linearly perturbed event horizon, previously observed in the literature, cannot be truly teleological in origin. The two horizons do generically differ at second order in some ways, but their Hawking masses remain identical. In the context of tidal distortion by a small companion, we also show how the perturbed event horizon in a small-mass-ratio binary is effectively localized in time, and we numerically visualize unexpected behaviour in the black hole's motion around the binary's center of mass.

GR 1.5 Mon 10:20 GR-H2

Black hole temperature in Horndeski gravity — •Kamal Hajian[1], Stefano Liberati[2], Mohammad Mehdi Sheikh-Jabbari[3], and Mohammad Hasan Vahidinia[4] — [1]Carl von Ossietzky University of Oldenburg Department of Physics D-26111 Oldenburg — [2]3SISSA, Via Bonomea 265, 34136 Trieste, Italy and INFN, Sezione di Trieste — [3]5School of Physics, Institute for Research in Fundamental Sciences (IPM), P.O.Box 19395-5531, Tehran, Iran — [4]Department of Physics, Institute for Advanced Studies in Basic Sciences (IASBS), P.O. Box 45137-66731, Zanjan, Iran

In Horndeski gravities, which are the most generic scalar-tensor theories without ghosts, the speed of graviton can be different w.r.t other massless particles/waves such as photons. We will show that this leads to a black hole temperature which is different from the standard Hawking temperature by an overall factor. The factor depends on black hole properties as well as the Lagrangian. Using this modified temperature, the first law of thermodynamics for black holes in Horndeski gravities is recovered.

GR 1.6 Mon 10:40 GR-H2

Black hole shadows enlightening quantum gravity — •Michael Florian Wondrak, Kolja Kuijpers, Jesse Daas, Frank Saueressig, and Heino Falcke — Institute for Mathematics, Astrophysics and Particle Physics (IMAPP), Radboud University, Nijmegen, The Netherlands

With the advent of the Event Horizon Telescope, the shadow of supermassive black holes could be resolved for the first time. Tests of the general theory of relativity at this strong-field regime come into reach. Probing quantum gravity is particularly interesting.

In this talk, we focus on extending the Einstein–Hilbert action by higher curvature terms which necessarily arise as counterterms upon quantization. We numerically solve the equations, find solutions with and without horizons, and extract the corresponding shadow radii. The results are discussed regarding observability.