GR 5: Classical General Relativity I

Zeit: Dienstag 13:45–15:55 Raum: VMP6 HS A

Hauptvortrag GR 5.1 Di 13:45 VMP6 HS A

Static vacuum photon spheres have no hair — •Carla Cederbaum — University of Tübingen, Germany

We will present two different mathematical proofs showing that the Schwarzschild spacetime is the only static vacuum asymptotically flat general relativistic spacetime that possesses a suitably geometrically defined photon sphere. In other words, we will show that static (vacuum) photon spheres have no hair. We will also discuss generalizations to the electrovacuum case as well as to higher spacetime dimensions.

The proofs extend classical static black hole uniqueness results. Part of this work is joint with Gregory Galloway.

GR 5.2 Di 14:25 VMP6 HS A

Deviation equations and measurement of the gravitational field in General Relativity — •Dirk Puetzfeld — ZARM, U Bremen

In General Relativity, the comparison of test bodies moving along adjacent world lines is of direct operational significance. The observation of a suitably prepared set of test bodies allows for the determination of the components of the curvature. We present some recent results on generalized deviation equations for test bodies and the measurement of the gravitational field by means of these equations.

GR 5.3 Di 14:40 VMP6 HS A

Null geodesics in accelerating black hole spacetimes — •Eva Hackmann — ZARM, Universität Bremen

The accelerating black hole spacetime, also known as C-metric, is a two parameter solution of the vacuum field equations with conical singularities on the z-axes. We discuss null geodesics in the C-metric using spherical-type coordinates as introduced by Griffith and Podolsky (Class. Quantum Grav. 23:6745, 2006), which reduce to the familiar form of the Schwarzschild metric in Boyer-Lindquist coordinates for vanishing acceleration. The characteristic features of null geodesics in this spacetime are studied and an analytical solution of the equation of motion will be presented. We also discuss possible locations of timelike stable circular orbits and the observation of light emitted from there.

GR 5.4 Di 14:55 VMP6 HS A

Circular motion in NUT spacetime — •Pavel Jefremov and Volker Perlick — ZARM, Bremen, Deutschland

For the geodesic motion we find the surface where circular motion takes place as well as characteristic radii of the spacetime (last stable and marginally bound orbits). For the fluid motion we investigate the model of geometrically thick tori ("Polish Doughnuts") and discuss how their structure is influenced by the parameters of the metric. For ultrarelativistic motion in a general anxially symmetric spacetime we derive formula for the potential lines of centrifugal and Coriolis forces and discuss the results in the NUT spacetime.

GR 5.5 Di 15:10 VMP6 HS A

On relativistic geodesy and orbit deviations — •Dennis Philipp[1], Claus Laemmerzahl[1,2], Volker Perlick[1], and Dirk Puetzfeld[1] — [1]ZARM, University of Bremen, Bremen, Germany — [2]University of Oldenburg, Oldenburg, Germany

For metrology, geodesy and gravimetry in space, satellite based instruments and measurement techniques are used and the orbits of the satellites as well as possible deviations between nearby ones are of central interest. The measurement of this deviation itself gives insight into the underlying structure of the spacetime geometry, which is curved and therefore described by the theory of general relativity. We investigate the deviation of nearby orbits that can be modeled using the relativistic deviation equation (Jacobi equation for first order deviations) and we comment on the applicability and physical effects that can be described within this framework.

GR 5.6 Di 15:25 VMP6 HS A

A general pseudo-Newtonian limit of geodesic motion — •Vojtech Witzany — ZARM, Universität Bremen, Am Fallturm, 28359 Bremen, Germany

Almost from the very first investigations into the nature of black-hole accretion, astrophysicists have used "pseudo-Newtonian" potentials to describe the dynamics of accretion discs. These potentials seamlessly reduce to the Newtonian gravitational potential in the far-field limit, but posses simple modifications in the close field to mimic some of the key features of particle motion near a black hole.

Recently, a new class of elegantly derived and accurate velocity-dependent potentials emerged in the literature raising the question whether there is a general pseudo-Newtonian description for any spacetime. In this talk, I will show that there is such a description both for massive and massless particle motion, and that this description can give exact coordinate-time-parametrized null geodesics in stationary space-times. Futhermore, I will demonstrate the effectivity of this description in the Kerr space-time.

GR 5.7 Di 15:40 VMP6 HS A

Parameterized post-Newtonian limit of Horndeski's gravity theory — •Manuel Hohmann — Physikalisches Institut, Universität Tartu, Estland

We discuss the parameterized post-Newtonian (PPN) limit of Horndeski's theory of gravity, also known under the name generalized G-inflation or G^2-inflation, which is the most general scalar-tensor theory of gravity with at most second order field equations in four dimensions. We derive conditions on the action for the validity of the post-Newtonian limit. For the most general class of theories consistent with these conditions we calculate the PPN parameters $\gamma(r)$ and $\beta(r)$, which in general depend on the interaction distance r between the gravitating mass and the test mass. For a more restricted class of theories, in which the scalar field is massless, we calculate the full set of PPN parameters. It turns out that in this restricted case all parameters are constants and that the only parameters potentially deviating from observations are γ and β. We finally apply our results to a number of example theories, including galileons and different models of Higgs inflation.