GR 9: Classical theory of General Relativity I

Time: Tuesday 11:15–12:35 Location: SPA SR220

GR 9.1 Tue 11:15 SPA SR220

Analytic timing formula for a pulsar orbiting a Schwarzschild Black Hole — •Melanie Vogelsang, Eva Hackmann, and Claus Lämmerzahl — ZARM, Bremen, Deutschland

The timing formula of pulsars describe the pulse phase as a function of time with the goal to accurately predict the future pulse arrival times.

For the analytic calculation we consider pulsars around a supermassive black hole, whose gravitational field is described by the Schwarzschild metric. Therefore, the pulsars can be treated as test particles and their motion can be calculated analytically. The equation of motion of the light pulses can also be solved analytically, so that the time of arrival of a pulse can be calculated from its given time of emission. The crucial point in the calculation is to find the observed light ray, as the used pulsar model contains light emission in every direction.

The results of certain systems are compared to those of the post-Newtonian timing formula.

GR 9.2 Tue 11:35 SPA SR220

Test particle motion in a regular black hole spacetime — •Eva Hackmann — ZARM, Universität Bremen

We consider the motion of test particles in the regular black hole spacetime given by Ayón-Beato and García in Phys. Rev. Lett. 80:5056 (1998). The complete set of orbits for neutral and weakly charged test particles is discussed, including for neutral particles the extreme and over-extreme metric. We also derive the analytical solutions for the equation of motion of neutral test particles in a parametric form.

GR 9.3 Tue 11:55 SPA SR220

Non-perfect-fluid space-times in thermodynamic equilibrium and generalized Friedmann equations — •Konrad Schatz, Horst-Heino von Borzeszkowski, and Thoralf Chrobok — Institut für Theoretische Physik, TU-Berlin, Germany

Assuming homogeneous and parallax-free space-times, in the case of thermodynamic equilibrium, we construct the energy-momentum tensor of non-perfect fluids. To this end, first, we integrate the propagation equations for the matter functions, i.e., for energy density, isotropic and anisotropic pressures, and heat-flux. This provides these functions in terms of the structure constants of the three-dimensional isometry group of homogeneity and, espectively, of the kinematical quantities, expansion, rotation and acceleration. Second, the matter functions are combined to the energy-momentum tensor. Using Einstein's equations, the constants of integration can be determined such that one gets bounds on the kinematical quantities and finds a generalized form of the Friedmann equations. Finally, it is shown that, for a perfect fluid, the Friedmann and Gödel models can be recovered. All this is derived without assuming any equations of state or other specific thermodynamic conditions.

GR 9.4 Tue 12:15 SPA SR220

Rotating Wormholes — •Burkhard Kleihaus — Universität Oldenburg

Wormholes are solutions of the Einstein equations discribing spacetimes with two asymptotically flat regions connected by a throat. A textbook example is the Ellis wormhole supported by a scalar phantom field. In the static case this solution is known since long a time.

Here we present the stationary rotating generalizations of the Ellis wormhole in four and five dimensions and discuss their physical properties. These solutions are asymptotically flat and free of sigularities. For a fixed size of the throat the angular momentum is bounded from above. The domain of existence is bounded by the extremal black hole solutions. We derive a Smarr-like relation between mass and angular momentum. Also astrophysical implications are considered in the four dimensional case. We address the question of stability and argue that wormholes might be stabilized by rotation.