GR 11: Classical General Relativity II

Zeit: Donnerstag 13:45–16:05 Raum: VMP6 HS A

Hauptvortrag GR 11.1 Do 13:45 VMP6 HS A
Fresnel-Kummer wave surfaces in transparent (meta)materials, the Kummer tensor in general relativity, and beyond — Alberto Favaro[1] and •Friedrich W. Hehl[2] — [1]Imperial College London — [2]Univ. of Cologne and Univ. of Missouri, Columbia

The premetric Maxwell equations are expressed in terms of the excitations (D, H) and field strengths (E, B). A material with local and linear constitutive law carries, besides permittivities and permeabilities, magnetoelectric terms. In a spacetime description, this yields a 4th rank constitutive tensor χ with $36 = 20+15+1$ independent components. We restrict ourselves to the reversible case with 21 components. The light propagation in such a material is described by quartic Fresnel surfaces, which are determined by a 4th rank tensor $\mathcal{G}$ cubic in χ, that is, $\mathcal{G} \sim \chi^3$. We show that these Fresnel surfaces are Kummer surfaces (from algebraic geometry) and study some of their singularities. — In general relativity, we can define analogously a 4th rank Kummer tensor $\mathcal{K}$ that is cubic in the 20 compoment Riemann tensor R, that is, $\mathcal{K} \sim R^3$. The Kummer tensor is related to the Petrov classification of the gravitational field. We generalize these results to the Poincaré gauge theory of gravity with a 36 components curvature tensor.

See Baekler, Favaro, Itin, fwh, Ann. Phys. (NY) 349, 297 (2014); Favaro, fwh, arXiv:1510.05566v1

Hauptvortrag GR 11.2 Do 14:25 VMP6 HS A
Influence of a plasma on gravitational lensing by compact objects — •Volker Perlick — ZARM, University of Bremen, Germany

I discuss light bending by compact objects (black holes, wormholes, ultracompact stars, etc.) that are surrounded by a plasma. The plasma is assumed to be pressureless ("cold"), non-magnetised and optically thin. After deriving the general formula for the bending angle in a plasma under the assumption of spherical symmetry and staticity, I discuss in some detail the angular diameter of the shadow of a compact object in a plasma, again under the same symmetry assumptions. The Schwarzschild spacetime and the Ellis wormhole are treated as particular examples. In the last part, I consider a plasma on the Kerr spacetime. The perspectives of actually observing the discussed effects with supermassive black holes will be addressed as well. - The talk is largely based on joint work with Oleg Tsupko and Gennady Bisnovatyi-Kogan (Space Research Institute, Russian Academy of Science, Moscow).

GR 11.3 Do 15:05 VMP6 HS A
Spielzeugmodel eines relativistischen Akkretionsflusses in Kerr-Newman Raum-Zeit — •Kris Schroven, Eva Hackmann und Claus Lämmerzahl — ZARM, University of Bremen, Am Fallturm, 28359 Bremen, Germany

Wir stellen ein relativistisches Spielzeugmodel vor, welches den stationären Akkretionsfluss einer rotierenden Wolke aus nicht wechselwirkenden Teilchen beschreibt, die auf ein Kerr-Newman Schwarzes Loch fallen. Zur Beschreibung der Stromlinien verwenden wir zeitartige Geodäten, die durch Jacobi-elliptische Integrale ausgrdrückt werden können. Des weiteren wird das zugehörige lokale Geschwindigkeitsfeld bestimmt. Es kann ein analytischer Ausdruck für die äußere Kante der Akkretionscheibe gefunden werden, die sich während des Prozesses der Akkretion bildet. Dieses Spielzeugmodell bietet eine gute Mölichkeit, die Auswirkungen des spezifischen Drehimpulses und die Ladung des schwarzen Loches auf den Verlauf des Akkretionsflusses und die äußere Kante der Akkretionsscheibe in starken Gravitationsfeldern darzustellen.

GR 11.4 Do 15:20 VMP6 HS A
Initial data for an black hole universe — •Michael Fennen[1] and Domenico Giulini[1,2] — [1]ZARM, Universität Bremen — [2]ITP, Universität Hannover

The standard model of cosmology describes the universe as a homogeneous and isotropic fluid on the largest scales very well. But if we consider smaller scales, the matter is actually concentrated in small regions within an almost empty universe. Therefore we construct vacuum intitial data for an inhomogeneous spherical universe where the matter is modelled by black holes. We want to investigate if and how these models resemble a Friedmann universe at the moment of maximal expansion to get a better understanding of the averaging and backreaction problem.

GR 11.5 Do 15:35 VMP6 HS A
General-relativistic ray optics in a nonmagnetized, pressureless two-fluid plasma — •Karen Schulze-Koops[1], Volker Perlick[2], and Dominik Schwarz[3] — [1]Uni Bielefeld/ ZARM — [2]Uni Bremen/ ZARM — [3]Uni Bielefeld

We investigate the influence of a plasma on the propagation of light in a general-relativistic spacetime. We restrict to the simple plasma model of a nonmagnetized, pressureless two-fluid plasma. Applying the Hamilton formalism to light rays we describe how Sachs equations, reciprocity theorem, and distance measures have to be modified when the influence of the plasma is considered. We briefly discuss applications to Robertson-Walker universes.

GR 11.6 Do 15:50 VMP6 HS A
Conformal (Weyl) Gravity — •Patric Hölscher — Bielefeld University, Bielefeld, Germany

Conformal (Weyl) Gravity is a theory which is an alternative to the standard theory of gravity by Albert Einstein. Opposed to the standard theory, which has to impose dark matter and dark energy to agree with the observational data, Conformal Gravity is based on an invariance principle, which leads to a unique action for gravity. By exploiting this invariance principle one is able to tackle astrophysical and cosmological problems like the flattening of rotation curves of galaxies or the cosmological constant problem. Furthermore, this theory provides an approach for a unification of gravity and quantum mechanics. Unfortunately, this theory contains some unsolved problems like the gravitational wave solutions, which could lead to energy conservation being violated.