GR 18: Black Holes

Time: Friday 11:10–13:10 Location: H 2013

GR 18.1 Fri 11:10 H 2013

On wave propagation in Schwarzschild spacetime — •Dennis Philipp and Volker Perlick — ZARM, Universität Bremen, 28359 Bremen

The propagation of (massless) scalar, electromagnetic and gravitational waves on fixed Schwarzschild background spacetime is described by the general time-dependent Regge-Wheeler equation. We transform this wave equation to usual Schwarzschild, Eddington-Finkelstein and Painlevé-Gullstrand coordinates. After separating a harmonic time-dependence the resulting radial equations belong to the class of confluent Heun equations, i.e., we can identify two regular and one irregular singularities. Using the generalized Riemann-scheme we collect properties of all singular points and construct (local) solutions in terms of the standard confluent Heun function HeunC, Frobenius- and asymptotic Thomé series.

We study the Eddington-Finkelstein and Painlevé-Gullstrand cases in detail and obtain in each case a solution that is regular at the black hole horizon. This solution is connected to causal boundary conditions, i.e., purely ingoing radiation at $r = 2M$. To construct solutions on the entire open interval $r \in]0, \infty[$ we give an analytic continuation of local solutions around the horizon. Black hole scattering and quasi-normal modes are briefly considered as possible applications.

GR 18.2 Fri 11:30 H 2013

Shadows of Black Holes — •Arne Grenzebach, Volker Perlick, and Claus Lämmerzahl — ZARM, Universität Bremen, 28359 Bremen

In this talk I present how to calculate the shadow of a Kerr-Newman-NUT black hole with a cosmological constant analytically. For this, the existence of (unstable) spherical light rays in a region $\mathcal{K}$ is essential because these determine the boundary of the shadow. After transformation to celestial coordinates on the observer's sky, the shadow is viewed via stereographic projection as usual. The observer is located at arbitrary Boyer-Lindquist coordinates outside of the horizon.

GR 18.3 Fri 11:50 H 2013

Composite localized field solutions in the Einstein-Yang-Mills theory in AdS spacetime — •Olga Kichakova[1], Jutta Kunz[1], Eugen Radu[2], and Yasha Shnir[3] — [1]Oldenburg University — [2]Aveiro University — [3]JINR, Dubna

We construct new finite energy both regular and black hole solutions in Einstein-Yang-Mills-SU(2) theory. They are static, axially symmetric and approach at infinity the anti-de Sitter spacetime background. These configurations are characterized by a pair of integers (m,n), where m is related to the polar angle and n to the azimuthal angle, being related to the known flat space monopole-antimonopole chains and vortex rings. Generically, they describe composite configurations with several individual components, possesing a nonzero magnetic charge, even in the absence of a Higgs field. Such Yang-Mills configurations exist already in the probe limit, the AdS geometry supplying the attractive force needed to balance the repulsive force of Yang-Mills gauge interactions. The gravitating solutions are constructed by numerically solving the elliptic Einstein-DeTurck–Yang-Mills equations.

GR 18.4 Fri 12:10 H 2013

Rotating black holes in Einstein-Maxwell-Chern-Simons theory with negative cosmological constant — •Jose Luis Blazquez Salcedo — Oldenburg University, Oldenburg, Germany

We study 5-dimensional black holes in Einstein-Maxwell-Chern-Simons theory with negative cosmological constant, and free Chern-Simons coupling parameter. We consider topologically spherical black holes, with both angular momenta of equal magnitude. In particular, we study extremal black holes, which can be used to determine the boundary of the domain of existence. We compare the results of asymptotically flat solutions with the asymptotically Anti-de Sitter case. Several branches of black holes are found depending on the coupling parameters. The near horizon formalism is used to obtain some analytical results.

GR 18.5 Fri 12:30 H 2013

On gravity self-completeness in higher dimensions — •Sven Köppel[1,2], Euro Spallucci[3,4], Piero Nicolini[1,2] und Marcus Bleicher[1,2] — [1]Institut für theoretische Physik, Goethe-Universität Frankfurt am Main, Deutschland — [2]Frankfurt Institute for Advanced Sciences, Frankfurt am Main, Deutschland — [3]Dipartimento di Fisica, Sezione di Fisica Teorica, Università degli Studi di Trieste, Italy — [4]INFN, Sezione di Trieste, Strada Costiera 11, Trieste, Italy

There is a great expectation about the possibility for gravity of being self-complete, i.e., able to prevent the access to scales smaller of the Planck scale. According to such a paradigm, we propose black hole geometries with an improved short scale behavior. Specifically such models have a regular center and a stable cold evaporation end-point (remnant). We show that the proposed geometries can be derived by a non-local deformation of the Einstein-Hilbert action and are compatible with the large spatial extradimension scenario.

GR 18.6 Fri 12:50 H 2013

Generalized Uncertainty Principle and Black Holes — •Marco Knipfer[1,2], Sven Köppel[1,2], Maximiliano Isi[3], Jonas Mureika[4], Piero Nicolini[1,2], and Marcus Bleicher[1,2] — [1]Institut für Theoretische Physik, Johann Wolfgang Goethe-Universität, Frankfurt am Main, Deutschland — [2]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Deutschland — [3]Physics Department, California Institute of Technology, Pasadena, CA, United States — [4]Department of Physics, Loyola Marymount University, Los Angeles, CA, United States

Many of the current endeavors of finding a quantum theory of gravity introduce two basic adjustments: Additional space dimensions and the existence of a minimal length of about the *Planck length* $\ell_{\mathrm{p}} \approx 1.6 \times 10^{-36}\mathrm{m}$. According to this line of reasoning we modify the *Heisenberg uncertainty relation* into the *generalized uncertainty principle* (GUP) $\Delta x \Delta p \geq \frac{\hbar}{2}\left[1+\beta(\Delta p)^2\right]$. To evaluate the effects of the GUP in curved space, we consider a non-local gravity Lagrangian. The resulting field equations depend on a non-local operator not known *a priori*. We show that a particular profile of such an operator can reproduce GUP effects. Specifically we derive a GUP improved Schwarzschild metric. Even if the curvature singularity is just smoothened, the thermodynamics becomes regular, *i.e.*, the temperature no longer diverges in the final evaporation stage and a cold black hole remnant forms.