GR 1: Schwarze Löcher I

Zeit: Montag 14:00–16:00 Raum: HS 6

GR 1.1 Mo 14:00 HS 6

Tidally distorted black holes — •Norman Gürlebeck — ZARM, University of Bremen, Germany

Planets, stars and black holes are deformed due to an external gravitational field generated by e.g. a moon or a companion in a binary system. This deformation is in Newtonian theory characterized by the first and second Love numbers. These measure the deformation of the surface and the induced multipole moment produced by a specific external field. Similar definitions were employed in General Relativity in [T. Damour & O. M. Lecian, PRD, **80**,044017 (2009); T. Binnington & E. Poisson, PRD, **80**, 084018 (2009)]. However, these approaches require necessarily some linearizations and approximations. We employ here the source integrals for the asymptotic multipole moments, which we found recently in [N. Gürlebeck, gr-qc/arXiv:1207.4500], to show that the induced multipole moments and, thus, the second Love numbers for static and axially symmetric black holes always vanish, thereby corroborating existing results in the aforementioned papers without resorting to any approximations. Hence, the contributions of the distorted black hole to the asymptotic multipole moments turn out to be exactly those of an undistorted Schwarzschild black hole. This can be seen as a generalization of the no-hair theorem to the case where additional matter is present. Nonetheless, the internal geometry of the horizon changes, which is characterized by the first Love numbers.

GR 1.2 Mo 14:15 HS 6

Gauss-Bonnet solitons and black holes in 5d Anti-de Sitter spacetime — •Sardor Tojiev[1], Betti Hartmann[1], and Yves Brihaye[2] — [1]School of Engineering and Science, Jacobs University Bremen, 28759 Bremen, Germany — [2]Physique-Mathematique, Universite de Mons-Hainaut, 7000 Mons, Belgium

We have studied 5-dimensional solitons and black holes in Gauss-Bonnet gravity coupled to electromagnetic and scalar fields. We find that the presence of the Gauss-Bonnet term has an influence on the pattern of soliton solutions for small enough values of the electric charge. We also present new results for rotating Gauss-Bonnet black holes with and without scalar hair. We find that although solitons cannot be made rotating properly with non-vanishing angular momentum, the hairy black holes can be generalized to rotating solutions characterized by the angular velocity on the horizon. Our numerical results show that some branches of soliton solutions disappear when the Gauss-Bonnet coupling constant is large enough.

GR 1.3 Mo 14:30 HS 6

Black holes, classicalization, dimensional reduction and holography — •Piero Nicolini[1], Jonas Mureika[2], and Euro Spallucci[3] — [1]Goethe University Frankfurt — [2]Loyola Marymount University, Los Angeles — [3]University of Trieste

In this contribution we address two issues related to the black hole classicalization (also known as gravity self completeness) i.e., the recently conjectured black hole semi-classical regime one obtains by compressing particles at transplanckian energies.

We showed that the supposed mechanism of space-time spontaneous dimensional reduction - one experiences by probing the space-time at energies close to the Planck scale - might be in conflict with the expected gravity self completeness. Specifically for (1+1)-dimensional dilaton gravity models black hole formation can occur with no mass lower bound.

In the second part of the talk, we present a new static, neutral, non-rotating black hole metric, admitting an extremal configuration with both mass and radius equalling the Planck units. We identify this object as the space-time fundamental building block, whose interior is physically inaccessible and cannot be probed even during the Hawking evaporation terminal phase. This metric overcomes the difficulties presented in the first part of the talk. Thermodynamics and holographic considerations are presented as a conclusion of the contribution.

GR 1.4 Mo 14:45 HS 6

Van der Waals behavior and gauge/gravity duality — •Antonia Micol Frassino — Frankfurt Institute for Advanced Studies, Goethe University, Frankfurt am Main

We study a specific solution of the Einstein's equations generated by a self–gravitating, anisotropic fluid type matter. We analyse the critical behaviour of this Schwarzschild–like solution in Anti–de Sitter space spacetime showing that exists an extension of the Hawking–Page transition into a van der Waals–like phase diagram. In this analysis we consider the cosmological constant as a dynamical quantity and its variation is included in the first law of black hole thermodynamics. We do explicit calculations in the case of space dimensions $n = 3$. Then we generalize to generic n dimensions.

GR 1.5 Mo 15:00 HS 6

Geometrothermodynamics of Kerr-Newman Black Hole with Cosmological Constant as Thermodynamic Varible — •Mojica Sindy[1] and Larrañaga Alexis[2] — [1]Institut Für Physik, Universität Oldenburg, Germany — [2]Universidad Nacional de Colombia, Colombia, Bogotá

The thermodynamics of the Kerr-AdS black hole is reformulated within the context of the formalism of geometrothermodynamics(GTD), developed by Hernando Quevedo. We use the Quevedo's invariant metric G associated to thermodynamics phase space τ and the metric g corresponding to space of a thermodynamics state of equilibrium ϵ, induced from τ through a Legendre transformation in order to study the possible phase transitions as a divergence of curvature scalar which is compared with the heat capacity. We show is possible find phase transitions. However, considering the cosmological constant like a variable state does not generated a new phase transitions.

GR 1.6 Mo 15:15 HS 6

Orbits around a charged doubly spinning black ring — •Saskia Grunau, Valeria Kagramanova, and Jutta Kunz — Carl von Ossietzky Universität Oldenburg

We analyze the geodesics of test particles and light in the five dimensional charged doubly spinning black ring spacetime. Apparently it is not possible to separate the Hamilton-Jacobi-equation for charged doubly spinning black rings in general, so we concentrate on special cases: null geodesics in the ergosphere and geodesics on the two rotational axes of the charged doubly spinning black ring. We present analytical solutions to the geodesic equations for these special cases. Using effective potential techniques we study the motion of test particles and light and discuss the corresponding orbits

GR 1.7 Mo 15:30 HS 6

Photonenregionen in Raumzeiten kompakter Objekte — •Arne Grenzebach, Claus Lämmerzahl und Volker Perlick — ZARM, Universität Bremen, 28359 Bremen

In diesem Vortrag werden physikalische Effekte untersucht, die mit der Photonenregion der Kerr-Raumzeit verknüpft sind. Grund für diese Überlegungen sind die aktuellen Versuche, den Schatten eines Schwarzen Loches zu beobachten. Unter anderem interessiert hier die Frage, wie sich Photonen im Bereich der Photonenregion akkumulieren. Die Beschreibung der auftretenden Phänomene ist jedoch nicht nur auf Schwarze Löcher ($a \leq m$) beschränkt, sondern eignet sich auch für nackte Singularitäten ($a > m$). Ähnliche Rechnungen können auch für allgemeinere Raumzeiten, für die eine solche Photonenregion existiert, durchgeführt werden, wie z.B. für die Kerr-NUT Raumzeit.

GR 1.8 Mo 15:45 HS 6

Photon distribution near a static black hole — •Dennis Philipp[1] and Volker Perlick[2] — [1]Fachbereich Physik, Universität Bremen, 28359 Bremen — [2]ZARM, Universität Bremen, 28359 Bremen

We consider the distribution of photons in die vicinity of a Schwarzschild black hole. As the initial condition, we assume that at each point of the sphere of radius $r = R$ (for some large R) a monochromatic and isotropic flash of light is emitted at $t = 0$. We use the concepts of kinetic theory, describing the photons in terms of a distribution function on 8-dimensional phase space P with coordinates (x^μ, p_μ). The resulting distribution function, which satisfies Liouville's equation (the collisionless Boltzmann equation), is implicitly given by an equation that involves elliptic integrals. By integration over the momentum space we calculate the distribution function explicitly, in terms of elementary functions, in the limit $t \to \infty$, and we show that it has a singularity at $r = 3m$. We argue that every Schwarzschild black hole in Nature is surrounded by a sphere of very high photon density near $r = 3m$ which could be detrimental to the health of any observer that comes close to it.