GR 101 Eigenschaften von klassischen Lösungen

Zeit: Montag 14:00–16:00 Raum: K

Hauptvortrag

GR 101.1 Mo 14:00 K

Ernst Equation and Riemann Surfaces — •Christian Klein[1] and Olaf Richter[2] — [1]MPI für Mathematik in den Naturwissenschaften, Inselstr. 22-26, 04103 Leipzig — [2]Institut für Theoretische Physik, Universität Leipzig, Postfach 100 920, 04009 Leipzig

In a general relativistic framework stars and galaxies in thermodynamical equilibrium lead to stationary axisymmetric spacetimes. Therefore it is of special physical interest that the Einstein equations in this case are equivalent to the completely integrable Ernst equation. The integrability of the Ernst equation implies the knowledge of many explicit exact solutions , the most prominent being the Kerr solution which describes the exterior of a rotating black hole. We discuss applications of the Ernst equation in various field of physics and mathematics as in the context of Yang-Mills-Higgs monopoles and Bianchi surfaces. Rich classes of solutions to integrable equations can be constructed with methods from the theory of Riemann surfaces which were originally introduced to generate periodic solutions to integrable wave equations such as the Korteweg-de Vries equation. The corresponding solutions to the Ernst equation, which contain the Kerr solution as a limit, are not periodic and are related to deformations of the underlying Riemann surface. We study these solutions to the Ernst equation in detail and discuss physical properties of this class.

GR 101.2 Mo 14:40 K

Slowly Rotating Homogeneous Stars and the Heun Equation — •David Petroff — Friedrich-Schiller-Universität Jena

The scheme developed by Hartle for describing slowly rotating bodies in 1967 was applied to the simple model of constant density by Chandrasekhar in 1974. The pivotal equation one has to solve turns out to be one of Heun's equations. After a brief discussion of this equation and the chances of finding a closed form solution, I will present quickly converging series solutions of it. A comparison with numerical solutions of the full Einstein equations allows one to truncate the series at an order appropriate to the slow order approximation.

GR 101.3 Mo 15:00 K

The Transition from Quark Matter to a Black Hole — •Hendrick Labranche and David Petroff — Theoretisch-Physikalisches Institut der Friedrich-Schiller-Universität Jena

It has recently been proved that the only permissible quasi-stationary transition from a fluid body to a (Kerr) Black Hole necessarily results in the extreme Kerr Black Hole. In this talk I will consider such a transition for quark matter using numerical methods. Particular attention will be paid to the behaviour of the multipole moments at infinity and to the gradual appearance of the "throat geometry".

GR 101.4 Mo 15:20 K

The Extreme Distortion of Black Holes due to Matter — •Marcus Ansorg[1] and David Petroff[2] — [1]Max Planck Institute for Gravitational Physics (Albert Einstein Institute), Am Muehlenberg 1, D-14476 Potsdam, Germany — [2]Theoretisch-Physikalisches Institut, Friedrich-Schiller-Universitaet Jena, Max-Wien-Platz 1, D-07743 Jena

A highly accurate computer program is used to study axially symmetric and stationary spacetimes containing a Black Hole surrounded by a ring of matter. It is shown that the matter ring affects the properties of the Black Hole drastically. In particular, the absolute value of the ratio of the Black Hole's angular momentum to the square of its mass not only exceeds one, but can be greater than ten thousand ($|J|/M^2 > 10^4$). Indeed, the numerical evidence suggests that this quantity is unbounded.

GR 101.5 Mo 15:40 K

Zur Gravitationslinsenwirkung eines geladenen rotierenden Schwarzen Lochs — •Volker Perlick und Wolfgang Hasse — TU Berlin, Sekr. PN 7-1, Institut für Theoretische Physik, 10623 Berlin

M_+ sei der Außenraum eines geladenen rotierenden Schwarzen Lochs, d.h., der Bereich außerhalb des äußeren Horizonts in einer Kerr-Newman-Raumzeit. Wir fixieren einen Punkt $p \in M_+$ (Beobachtungsereignis) und eine zeitartige Kurve γ in M_+ (Weltlinie einer Lichtquelle). Wir setzen voraus dass γ (i) in der Vergangenheitsrichtung maximal ist, (ii) in der Vergangenheit weder zum Horizont noch in's Unendliche geht und (iii) nicht die Kaustik des Vergangenheitslichtkegels von p trifft. Unter diesen sehr milden Voraussetzungen zeigen wir mithilfe von Morse-Theorie, dass der Beobachter in p abzählbar unendlich viele Bilder der Lichtquelle γ sieht. Außerdem machen wir deutlich, dass es in der Kerr-Newman-Raumzeit einen Zusammenhang zwischen dem Auftreten unendlich vieler Bilder und der Umkehr von Zentrifugal-plus-Coriolis-Kraft gibt.