GR 202: Numerische Simulationen

Zeit: Dienstag 14:00–15:30 Raum: KIP Kl. HS

GR 202.1 Di 14:00 KIP Kl. HS

Motion around gravitating monopoles — •Valeria Kagramanova[1], Jutta Kunz[1], and Claus Lämmerzahl[2] — [1]Institut für Physik, Univ. Oldenburg — [2]ZARM, Univ. Bremen

Magnetic monopoles arise as globally regular solutions of Einstein-Yang-Mills-Higgs theory. The singly charged magnetic monopole is static and spherically symmetric. Magnetic monopoles with higher charges possess only axial symmetry or discrete symmetries. Beside focussing primarily on properties of the metric it is certainly of interest to characterize solutions of gravitational field equations in terms of the properties of the possible test particle motions, since only matter and light give observational insight into a given gravitational field. In the case of magnetic monopoles, the particle motion is given by an effective potential which depends on the angular momentum as well as on the energy of the particle. We obtain scattering states, various classes of bound states as well as limiting states. Characteristic features of the orbits like scattering angles and periods of the motion, both related to the coupling strength, are obtained.

GR 202.2 Di 14:15 KIP Kl. HS

Calibration of Moving Puncture Simulations — •Bernd Brügmann[1], Jose Gonzalez[1], Mark Hannam[1], Sascha Husa[1], Ulrich Sperhake[1], and Wolfgang Tichy[2] — [1]University of Jena, Germany — [2]Florida Atlantic University, USA

We present single and binary black hole simulations that follow the moving puncture paradigm of simulating black-hole spacetimes without excision, and use moving boxes mesh refinement. Focussing on binary black hole configurations where the simulations cover roughly two orbits, we address five major issues determining the quality of our results: numerical discretization error, finite extraction radius of the radiation signal, physical appropriateness of initial data, gauge choice and computational performance.

GR 202.3 Di 14:30 KIP Kl. HS

Total recoil: the maximum kick from nonspinning black-hole binary inspiral — Jose Gonzalez, •Ulrich Sperhake, Bernd Brügmann, Mark Hannam, and Sascha Husa — TPI, University of Jena, Germany

When unequal-mass black holes merge, the final black hole receives a "kick" due to the asymmetric loss of linear momentum in the gravitational radiation emitted during the merger. The magnitude of this kick has important astrophysical consequences. Recent breakthroughs in numerical relativity allow us to perform the largest parameter study undertaken to date in numerical simulations of binary black hole inspirals and evaluate the kick resulting from mass ratios ranging from 1:1 to 1:4.

GR 202.4 Di 14:45 KIP Kl. HS

Discrete action functionals and symplectic integrators — •Ralf Peter and Jörg Frauendiener — Universität Tübingen, Abteilung Theoretische Astrophysik, Auf der Morgenstelle 10, 72076 Tübingen

We present our results for discrete action functionals (analogous to [1]) and for the symplectic time integrator Rattle [2], applied to relativistic field theories with constraints. As test objects, we use in both cases a 1+1-dimensional wave map.

[1] Stephen L. Adler, Tsvi Piran: Relaxation methods for gauge field equilibrium equations, Rev. Mod. Phys. **56**, 1–40 (1984)
[2] Hans C. Andersen: Rattle: A "Velocity" Version of the Shake Algorithm for Molecular Dynamics Calculations, J. Comp. Phys. **52**, 24–34 (1983)

GR 202.5 Di 15:00 KIP Kl. HS

Application of Discrete Differential Forms in numerical General Relativity — •Ronny Richter — Universität Tübingen: Institut für Astronomie und Astrophysik — Mathematisches Institut

We discuss a way to apply Discrete Differential Forms in numerical General Relativity. The method was used for the space-time discretisation of systems with large symmetry groups, like spherically symmetric ones. The results of numerical tests are quite promising. In particular the error converges quadratically to zero with the discretisation parameter.

GR 202.6 Di 15:15 KIP Kl. HS

Relativistic Simulations of Neutron Star Mergers — •Roland Oechslin — Max-Planck-Institue fuer Astrophysik, Garching, D

An extended set of binary neutron star merger calculations is presented. The relativistic hydrodynamics simulations are based on the conformally flat approximation to GR and are performed with a Smoothed Particle Hydrodynamics code for the gas treatment. We use the two physical finite temperature equations of state (EoS) of Shen and Lattimer&Swesty, an ideal-gas EoS and the cold EoS of Akmal et al. extended with an ideal gas-like thermal contribution.

From the calculations, we extract torus masses, ejecta masses and gravitational waves. We assess the dependence of these obervables on the neutron star masses, their spins and the EoS.