GR 3: Classical General Relativity

Time: Monday 15:40–17:30 Location: H 2013

GR 3.1 Mon 15:40 H 2013

Progress in the evolution of collapsing gravitational waves — •DAVID HILDITCH — TPI Jena

I will present simulations of collapsing gravitational waves obtained using two methods. First, using the moving puncture gauge, I show that it is possible to evolve certain types of initial data through apparent horizon formation. Secondly I will present a new pseudo-spectral code which we are using to tackle the same initial data.

30 min. break

GR 3.2 Mon 16:30 H 2013

Plebański-Demiański solutions of General Relativity and their expressions quadratic and cubic in curvature: analogies to electromagnetism — •JENS BOOS — Institute for Theoretical Physics, University of Cologne, 50923 Köln, Germany

An electromagnetic field represented by the field strength 2-form F has two invariants: the scalar $\mathbf{B}^2 - \mathbf{E}^2$ and the pseudo-scalar $\mathbf{E} \cdot \mathbf{B}$. These relations taken from (linear) vacuum electrodynamics persist up to the full non-linear case of Einstein's General Relativity as applied to the exact seven parameter solution of Plebański and Demiański (PD).

The vacuum energy density $\mathbf{B}^2 + \mathbf{E}^2$ corresponding to an electromagnetic field can be deduced from the square of its symmetric energy momentum tensor. The square of the Bel-Robinson tensor gives the analogous expression in case of the PD solution.

We also determine the Kummer tensor, a tensor cubic in curvature, for the PD solution for the first time, and calculate the pieces of its irreducible decomposition.

The calculations are carried out in two coordinate systems: in the original polynomial PD coordinates, and in a modified Boyer-Lindquist-like version introduced by Griffiths and Podolský (GP) allowing for a more straightforward physical interpretation of the free parameters.

GR 3.3 Mon 16:50 H 2013

Visualization of finite-sized objects in General relativity — •THOMAS MÜLLER[1], SEBASTIAN BOBLEST[1], and DANIEL KRÜGER[2] — [1]Visualisierungsinstitut der Universität Stuttgart — [2]1. Institut für Theoretische Physik, Universität Stuttgart

In the visualization of general-relativistic scenarios one usually defines finite-sized test objects in a local tetrad and neglects the curvature of spacetime. As a first step towards a more detailed representation of extended objects, we define the surface of a sphere as the set of points resulting from the integration of space- and lightlike geodesics up to a certain value of the affine parameter. We analyze the effects of this definition on the visual impression of a sphere in several general-relativistic spacetimes, with special focus on the Reissner-Nordstrøm dihole metric.

GR 3.4 Mon 17:10 H 2013

General Relativity with a Variable Speed of Light — •ALEXANDER UNZICKER[1] and JAN PREUSS[2] — [1]Pestalozzi-Gymnasium München — [2]Technische Universität München

Einstein's first idea of how to describe curved paths of light, outlined in his 1911 paper on a variable speed of light, has a much closer similarity to general relativity than commonly perceived. The geodetic in a curved spacetime or the fastest path in a Euclidean space with variable c are actually two equivalent formulations of the same physics. Though this has been occasionally recognized in the literature, there seemed to be little need to change perspective. However, in 1957 Robert Dicke first pointed out that a variable speed formulation of general relativity could encompass Mach's principle, an idea with which Einstein had always been intrigued. Here, Dicke's idea is presented in a new form, using the Poisson equation. The relation to the usual Einstein equations is discussed.