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Adaptive discontinuous Galerkin methods for numerical relativity.

Astrophysical phenomena such as the interaction of two black holes can be modeled via the Einstein equations from general relativity. These equations form a system of nonlinear PDEs that describe how spacetime geometry interacts with matter. Solving the Einstein equations numerically poses several challenges including: (1) there exist numerous formulations – numerical discretizations should be modified to take advantage of a given formulation; (2) a subset of the equations are constraints that must be carefully handled in a numerical discretization; and (3) discontinuous solutions are generally admissible – some of these may be true physical discontinuities, others may only be artifacts of a specific choice of coordinates.

After giving a brief overview of the equations and the various numerical challenges, we will present in this talk some preliminary results on developing high-order, solution-adaptive, discontinuous Galerkin methods for the solution of the Einstein equations. In particular, we will show spherically symmetric simulations of critical collapse of a minimally-coupled scalar field. We will describe several strategies for adapting the underlying mesh and for accurately handling the interfaces between coarse and fine grids. (Received August 08, 2007)