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Evaluating Spectral Techniques in Numerical Relativity[1]
MICHAEL BOYLE, LEE LINDBLOM, HARALD PFEIFFER, MARK SCHEEL, California Institute of Technology, LAWRENCE KIDDER, Center for Radiophysics and Space Research, Cornell University — We analyze the behavior of a pseudo-spectral code evolving the KST formulation of Einstein's equations. In an effort to better compare different analytical formulations of Einstein's equations and numerical techniques for implementing them, a set of standardized tests for numerical relativity codes has been suggested by the "Apples with Apples" collaboration. The tests involve simple, three-dimensional spacetimes with known analytic solutions evolved in a space without boundaries (a 3-Torus) with prescribed evolution parameters such as resolution and time step. We have implemented these tests with our code. We find that the exponential convergence of spectral spatial differentiation and the stability of the KST formulation allow us to evolve these spacetimes on low-resolution grids, limited most strongly by machine precision. We derive expressions to estimate the growth of errors due to machine precision in arbitrary spacetimes, and show that these limits are easily achieved by our code, with good stability of the analytical formulation and numerical implementation.

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Michael Boyle
California Institute of Technology

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