Abstract Submitted
for the APR18 Meeting of
The American Physical Society

SENR/NRPy+: Numerical Relativity in Singular Curvilinear Coordinate Systems ZACHARIAH ETIENNE, IAN RUCHLIN, West Virginia University, THOMAS BAUMGARTE, Bowdoin College — We report on a new open-source, user-friendly numerical relativity code package called SENR/NRPy+. Our code extends previous implementations of the BSSN reference-metric formulation to a broad class of curvilinear coordinate systems, making it ideally-suited for modeling physical configurations with approximate or exact symmetries. It is orders of magnitude more efficient than other widely used, open-source numerical relativity codes when simulating black hole dynamics. The formulation addresses coordinate singularities in the computational domain via cell-centered grids and a simple change of basis that analytically regularizes tensor components with respect to the coordinates. NRPy+ provides a Python-based interface in which equations are written in natural tensorial form and output at arbitrary finite difference order as highly efficient C code, and SENR consolidates the source generated by NRPy+ into an OpenMP-parallelized numerical relativity code. In the context of head-on puncture black hole evolutions, we demonstrate nearly exponential convergence of constraint violation and gravitational waveform errors to zero as the order of spatial finite difference derivatives is increased, while holding the coordinate grids fixed at moderate resolution.

Zachariah Etienne
West Virginia University

Date submitted: 12 Jan 2018 Electronic form version 1.4