SORTING CATEGORY: L1 (Simulation Methods and Implementation)
CATEGORY TYPE: Computational Physics

TITLE: A Discontinuous Galerkin Method for General Relativistic Hydrodynamics

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ABSTRACT:

Core-collapse supernovae (CCSNe) are multi-physics phenomena; the study of which provides insight into, among other things, the origin of the elements. To simulate supernova hydrodynamics we are developing a new code for solving the general relativistic (GR) hydrodynamics equations, using the discontinuous Galerkin (DG[1]) method combined with Runge-Kutta (RK) time-stepping. The RK-DG method is high-order accurate and local in space, and can therefore achieve high spectral bandwidth in regions with unsteady smooth flows (e.g., turbulence). At the same time it can capture discontinuities, such as in the nonlinear phase of the standing accretion shock instability (SASI[2]). Many current simulations point to the crucial role played by the SASI in aiding the neutrino-driven CCSN explosion mechanism. The first scientific target of our new code is to further understand the SASI's development in compact GR environments. We present the initial conditions and show preliminary results. Numerically, key questions are: How well does the RK-DG method handle shocks and resolve the turbulent flows that develop from the SASI? We address these questions as well.

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[1]Cockburn, B., & Shu, C.-W. (2001). Runge–Kutta Discontinuous Galerkin Methods for Convection-Dominated Problems. Journal of Scientific Computing, 16(3), 173–261. http://doi.org/10.1023/A:1012873910884

[2]Blondin, J. M., Mezzacappa, A., & DeMarino, C. (2003). Stability of Standing Accretion Shocks, with an Eye toward Core-Collapse Supernovae. The Astrophysical Journal, 584(2), 971–980. http://doi.org/10.1086/345812