Contribution ID: **30** Type: **Oral Contribution**

General Relativistic Multidimensional Flux-Limited Diffusion Scheme for Neutrino Transport

Monday, 12 August 2019 11:00 (20 minutes)

We present the new code NADA-FLD to solve multi-dimensional neutrino-hydrodynamics in full general relativity (GR) in spherical polar coordinates. The neutrino transport assumes the flux-limited diffusion (FLD) approximation and evolves the neutrino energy densities measured in the frame comoving with the fluid. Operator splitting is used to avoid multi-dimensional coupling of grid cells in implicit integration steps involving matrix inversions. Terms describing lateral diffusion and advection are integrated explicitly with the Allen-Cheng or the Runge-Kutta-Legendre method, which remain stable even in the optically thin regime. We discuss several toy-model problems in one and two dimensions to test the basic functionality and individual components of the transport scheme. We also perform fully dynamic core-collapse supernova (CCSN) simulations in spherical symmetry. For a Newtonian model we find good agreement with the M1 code ALCAR, and for a GR model we reproduce the main effects of GR in CCSNe already found by previous works.

Keywords

Neutrinos

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Session Classification: Neutrinos