Numerical tools for the simulation of core-collapse supernovae

R. Käppeli[1], M. Liebendörfer[1], A. Perego[1], S. Scheidegger[1], S. C. Whitehouse[1] [1]Department of Physics, University of Basel, Klingelbergstrasse 82, CH-4056 Basel,

roger.kaeppeli@unibas.ch

1 Abstract

Core-collapse supernovae herald the spectacular death of massive stars by an energetic explosion. The gravitational collapse of the innermost stellar core leads to the transport of a tremendeous amount of neutrinos through hot accumulated stellar layers. The complexity of the arising fluid instabilities in multiple dimensions can only be tackled by numerical means. The physical system can be described by the equations of radiation- magnetohydrodynamics which form a non-linear system of conservation laws with source terms. We will outline the solution methods of this non-linear set of PDEs with the focus on our contribution to the algorithms. The magnetohydrodynamic equations are solved with a Riemann solver free central method, where the magnetic field is guaranteed to be solenoidal by a dimensionally split constrained transport method and a newly developed general method for the treatment of balance laws near steady states [**?**]. The spectral radiation transport is handled by the newly developed isotropic diffusion source approximation (IDSA) method [**?**], which efficiently captures the asymptotic limits of diffusive and transparent regimes. Further we detail on our parallelisation strategies of the algorithm for distributed and shared memory architectures.

References

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