ADAPTIVE MULTIRESOLUTION METHODS FOR MAGNETOHYDRODYNAMICS WITH PARABOLIC-HYPERBOLIC DIVERGENCE CLEANING

ANNA K. F. GOMES, MARGARETE O. DOMINGUES, ODIM MENDES, SÔNIA M. GOMES, AND KAI SCHNEIDER

Abstract. A crucial aspects in the numerical resolution of magnetohydrodynamic equations is the enforcement of the divergence free constraint of the magnetic field. One methodology considers a modified system of conservation laws by introducing an extended generalized Lagrange multiplier (EGLM-MHD) proposed in [1]. This presentation considers an adaptive multiresolution (MR) technique, with local and controlled time stepping strategies [2, 3, 4] for the simulation of the EGLM-MHD model. The MR method is a combination of a finite volume scheme using explicit time discretization with a multiresolution representation of the numerical solution on dynamically adaptive grids, which are introduced by suitable thresholding of its wavelet coefficients. The purpose of MR schemes is to speed-up computations while preserving the accuracy given by the reference finite volume scheme. For the present study the main purpose is to evaluate the influence of adaptivity on the incompressibility of the magnetic field. We shall present numerical results for MR simulations, where the finite volume reference scheme used HLLD [5] numerical flux, and second Runge-Kutta scheme for time integration. Different thresholding strategies are studied and the comptutational efficiency and accuracy of these new numerical schemes are assessed.

Keywords: Multiresolution, adaptivity, MHD, divergence cleaning.

Mathematics Subject Classifications (2000): 65Mxx, 76W05, 65M50.

References

[1] A. Dedner and F. Kemm and D. Kröner and C.-D. Munz and T.Schnitzer and M. Wesenberg. Hyperbolic Divergence Cleaning for the MHD Equations. Journal of Computational Physics 175: 645-673, 2002.

[2] Domingues, M.O., Gomes, S.M., Roussel, O., Schneider, K.: An adaptive multiresolution scheme with local time stepping for evolutionary pdes. J. Comput. Phys. **227**(8), 3758–3780 (2008).

[3] Domingues, M.O., Gomes, S.M., Roussel, O., Schneider, K.: Space-time adaptive multiresolution methods for hyperbolic conservation laws: Applications to compressible euler equations. Appl. Num. Math. **59**, 2303–2321 (2009).

[4] M. O. Domingues, S. M. Gomes, O. Roussel, and K. Schneider. Adaptive multiresolution methods. ESAIM Proceedings, 34:1–98, 2011.

[5] T. Mioshi and K. A. Kusano. A multi-state HLL approximate Riemann solver for ideal magnetohydrodynamics. Journal of Computational Physics 208: 315–344, 2005.

Instituto Nacional de Pesquisas Espaciais, Brasil
E-mail address: margarete@lac.inpe.br, odim@dge.inpe.br

IMECC - Universidade Estadual de Campinas, Brazil
E-mail address: soniag@ime.unicamp.br

Faculté des Sciences, Aix Marseille Université, France
E-mail address: kschneid@cmi.univ-mrs.fr