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Title: Numerical simulations of magnetohydrodynamics and applications in astrophysics

We introduce a finite volume code for ideal magnetohydrodynamics (MHD), which possesses excellent stability properties. Ingredients are: an approximate Riemann solver, extension to multidimensions via a Powell term, second order preserving positivity. The scheme's robustness is due to entropy stability, positivity and properly discretised Powell terms. Numerical tests demonstrate that the theoretical stability properties are valid in practice with negligible compromises to accuracy. The implementation takes the form of a modification of the MHD module in the FLASH code, an adaptive mesh refinement code. We compare the new scheme with the standard FLASH implementation for MHD. Results show comparable accuracy to standard FLASH with the Roe solver, but highly improved efficiency and stability, particularly for high Mach number flows and low plasma b. This code is then applied in an astrophysical context. Here we study aspects of the evolution of the universe, in particular star formation. Our code allows more accurate predictions than has been possible before.