

## Energy-consistent finite difference method for compressible magnetohydrodynamic simulations

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We propose a finite difference scheme for solving the fully compressible magnetohydrodynamic equations with the energy consistency in the discrete sense. One notable advantage of this scheme is that the conservation properties of the internal, kinetic, and magnetic energy equations can be satisfied in the discrete level without solving the total energy equation. This characteristic of the proposed scheme is achieved by carefully choosing the differentiated variables of the basic equations. The predicted conservation properties are demonstrated with linear and nonlinear numerical tests. We found that the proposed method can handle the extremely stringent problems, such as the propagation of shock wave in the ambient plasma beta of  $10^{-6}$  or less.

Keywords: Magnetohydrodynamics (MHD), Numerical simulation, Computational fluid dynamics (CFD)