Challenges of modeling astrophysical MHD

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Abstract

Most of the visible matter in the Universe is a plasma, that is a dilute gas of electrons, ions, and neutral particles. Studying multidimensional, time-dependent and/or highly nonlinear processes in astrophysical plasmas usually requires numerical methods. While numerical algorithms for compressible MHD are now widely available, the challenge for the future is to extend these methods with additional physics important in astrophysical systems. This includes non-ideal MHD effects in weakly ionized plasmas, the addition of anisotropic transport coefficients in weakly collisional plasmas, and perhaps most challenging, the addition of radiation transport to include both energy and momentum transport by photons. I will describe some problems in astrophysics which motivate the development of such methods, describe recent advance in numerical algorithms for MHD and their implementation on parallel processors, and briefly describe some of what we have learned from application of the methods.