MHD Numerical Simulations on Tetrahedral Grids with MH4D

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Abstract

MH4D (Magnetohydrodynamics on a TETRAhedral Domain) is a massively-parallel, device-independent numerical code for the solution of the resistive and viscous MHD equations on an unstructured grid of tetrahedra. The unstructured grid allows the computational domain to be of arbitrary shape and the resolution to be increased in the regions of physical interest. Consequently, plasma confinement devices of complex shape (e.g. stellerators) can be modeled and problems with a wide range of spatial scales can be studied. A variational formulation of the differential operators ensures accuracy and the preservation of the analytical properties of the operators ($\nabla \bullet \mathbf{B}=0$), and self-adjointness of the resistive and viscous operators. The combined semi-implicit treatment of the waves and implicit formulation of the diffusive operators can accommodate the wide range of time scales present in the solar corona. The capability of mesh refinement and coarsening is also included. MH4D is capable of solving the full resistive and viscous MHD equations both explicitly and semi-implicitly. We will present new results obtained with the full MHD code such as a simulation of the nonlinear kink in the line-tied Gold-Hoyle equilibrium [1,2] and a solution of the coplanar MHD Riemann problem of Brio and Wu (1988) [3].

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