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An Open Hybrid Plasma Solver

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Abstract

We present a hybrid plasma solver (particle ions, fluid mass-less electrons). The software is built on the public available FLASH software, developed at the University of Chicago [1], that provide adaptive grids and is fully parallelized. FLASH is a general parallel solver for compressible flow problems. It is written in Fortran 90, well structured into modules, has good support, and is open source. The parallelization is done using a block-structured adaptive cartesian grid with the Message-Passing Interface (MPI) library as the underlying communication layer.

The hybrid solver in FLASH uses cell centered finite differences [2] and conserves energy well [3]. Recently we have added to the hybrid solver the capability of handling vacuum regions, non-uniform resistivity, external fields, and hyperresistivity.

We also present an application of the solver to the interaction between the Moon and the solar wind [4], as illustrated in Fig. 1.

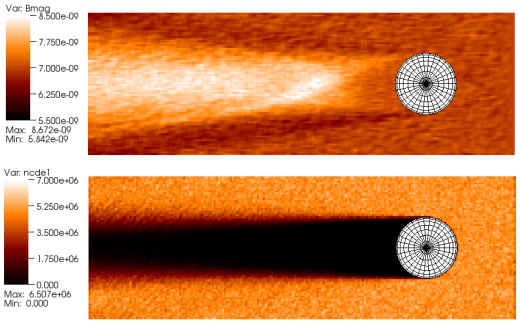

Figure 1: An example of the solar wind interaction with the Moon computed by the three-dimensional hybrid solver. Cuts in the ecliptic plane showing magnetic field magnitude [T] (upper panel), and proton number density [m^{-3}] (lower panel). The solar wind flows from the right with the IMF in the ecliptic plane, perpendicular to the solar wind flow direction. For this run the grid has more than 1 million cubic cells of size 115 km, and 64 million particles were used. The run time to steady state was 6 hours on 64 cores.

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