

Numerical hydrodynamic and MHD benchmarks

A. Jackson, P. Marti, A. Sheyko and the benchmark teams

There is a need to perform numerical simulations of hydrodynamical flow and dynamo action in more and more complex geometries such as spheroids and ellipsoids. We recently coordinated two benchmark exercises in both spherical shell and full-sphere geometries. These are designed to provide precise solutions for realistic physical problems, against which new codes can be checked.

The first exercise in a spherical shell is a thermally-driven dynamo problem which uses the so-called pseudo-vacuum boundary conditions, requiring that the magnetic field be purely radial on the boundary. This boundary condition is much easier for the new breed of finite difference/finite volume or finite element codes, since it is not necessary to solve for the field in the exterior (as is required when an exterior vacuum condition is used).

The second exercise is in a full sphere and consists of three benchmarks: convection, a thermally driven dynamo, and mechanically driven hydrodynamical flow. Participants used a variety of spectral and local codes for the hydrodynamical problems, and only spectral methods were used for the dynamo problem, as it is set in an insulating exterior. We report on the successes of different approaches to these problems.