Mariehamn Summer School Incompressible MHD Project Task

While the numerical solution of the compressible MHD equations is straightforward (but still tedious), the solution of the incompressible MHD equations is hindered by the additional constraint of incompressibility. There are different methods on the market to get around this obstacle, we will study the pseudospectral method in detail. Here the MHD equations are solved in the Fourier space, turning the PDE into an ODE and the incompressibility constraint into a simple projection. Still the nonlinear terms have to be evaluated in real space.

For the project work the pseudospectral method will be applied to the Navier-Stokes equation in 3D. Even though the magnetic field is missing, the extension to MHD is trivial and will be discussed in the course. Topics of the course will be the properties of Fourier transforms, the implementation of pseudospectral methods, stability and dissipation in incompressible MHD.

Task: Use pseudospectral methods to simulate the incompressible Navier-Stokes-equation

Before the course: Become acquainted with Fourier transforms and their numerical implementation (favorably FFTW-3)

Suggested reading: <u>http://esoads.eso.org/cgi-bin/nph-data_query?</u> <u>bibcode=2001ApJ...</u> <u>554.1175M&db_key=AST&link_type=ABSTRACT&high=4a490f689e</u> <u>12128</u>