Title : **Numerical simulations & solar magnetism**

Acronym : A2

EU Coordinator : : Guillaume AULANIER, Observatoire de Paris

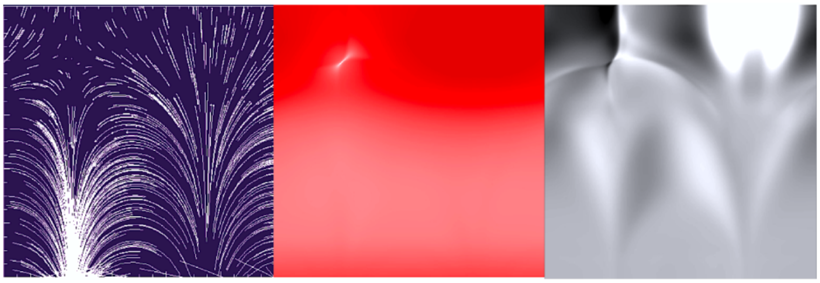
Teaching staff : Guillaume AULANIER

Pre-requisites : First year of MSc in Physics or Engineering Schools.

Credits : 3 ECTS

Language : French/English

Keywords : Space plasmas & Astrophysics. Magnetohydrodynamics. Numerical simulations. Project-based learning.



Exemple of a figure generated by a student group.
(Left:) field lines. (Middle:) plasma beta. (Right:) vertical velocities.

Goal. Numerical simulation is an investigation tool shared by many specialties in plasma physics. This aim of this course is to expose students to handling this tool. More specifically, students will achieve a preliminary practical training followed by one long project in computational fluid dynamics (CFD).

All the proposed projects imply the magnetohydrodynamic (MHD) modeling in two dimensions of some physical processes involved in the Sun's activity, being associated with magneto-convection at the interface between the star's internal and external layers.

Le goal of this course is *not* to do programming and code development – even if some lines will have to be typed and some parameters will have to be varied depending on the project. Instead, the principle is to use an operational code written in FORTRAN as well as a distinct visualization tool with GDL, so as to fine-tune, to test, and to *conduct numerical experiments* aiming at characterizing, understanding, and quantifying some physical mechanisms.

Organization. No preexisting expertise in FORTAN or GDL is required. However, some experience in using LINUX is strongly recommended, and some knowledge in MHD is essential.

The first session will be a course introducing general concepts, presenting some sensitive issues in CFD, and describing the OHM code that will be used in the projects. The second session will be a practical training on the identification of the threshold for the convective instability in stratified plasmas. These two first sessions are mandatory to continue. All the other sessions will be dedicated to the projects, with students working by pairs on one single topic of their choice.

Examples of projects

[P1] Dynamo effect and magneto convection with thermal forcing

[P2] Transport and tearing of magnetic flux tubes floating in a stratified medium

[P3] Coronal magnetic reconnection driven by remote thermal convection