Master 2: ***International Centre for Fundamental Physics***

INTERNSHIP PROPOSAL

Laboratory name: Laboratoire de Physique Statistique
CNRS identification code: UMR8550
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webpage : http://www.phys.ens.fr/~gissinger/index.html
Internship location: Ecole Normale Superieure PARIS
Thesis possibility after internship: YES Funding: NO

Electromagnetically-driven interface between two liquid metals

Magnetohydrodynamics (MHD), i.e. the study of the dynamics of electrically conducting fluids, is a very broad research field, ranging from the study of stellar magnetic fields, to plasma stability in nuclear fusion and numerous industrial applications using liquid metals. It is also an interesting example of **energy conversion:** in presence of an electrically conducting fluid, it is possible to generate magnetic energy from the kinetic energy of the fluid.
An interesting example is **liquid metal batteries**, which are currently discussed as a promising option for electric grid stabilization: *a liquid metal battery comprises two liquid metal electrodes (separated by a molten salt electrolyte) that self-segregate into three layers based upon density and immiscibility.* Under some circumstances however, induced currents can destabilize the interface between the liquids and therefore short-circuit the battery.

A full understanding of the mechanisms by which an MHD interface initially at rest becomes unstable is still missing. More surprisingly, no experimental investigation of the MHD regimes produced in a two-fluid electromagnetically-driven flow has been proposed so far.
The internship proposed here therefore relies on the **experimental investigation of an electromagnetically-driven MHD interface between two liquid metals.** *It will involve two different liquid metals superposed on top of each other inside a vessel subjected to strong electrical currents and magnetic fields. A temperature gradient may also be imposed on the experimental setup.*

By means of measurements of the interface motions, the induced currents, the thermal flux and the velocity field in the liquids, several questions will be addressed:
- what are the conditions for instability of an MHD interface?
- what types of secondary flow are generated in such two-fluid cells?
- once the interface starts to destabilize, what controls the saturation of this instability-driven energy conversion?

Using the temperature control, it is also possible to study the effect of magnetic field and electrical currents on thermal convection, and the existence of *hydrodynamic* thermo-electrical effects.