ÉCOLE DOCTORALE SCIENCES DE LA TERRE

Subject offered for a contract starting october 2014

SUBJECT TITTLE: COUPLED DYNAMICS OF THE GEOMAGNETIC WESTWARD DRIFT AND THE EARTH'S INNER CORE SUPER-ROTATION.

Advisor: **AUBERT JULIEN, DR2 CNRS**

Second Advisor/ Supervisor: **FOURNIER ALEXANDRE, MCF IPGP**

Host lab/ Team : *please fill in and leave out meaningless information*
IPGP-Geological Fluid Dynamics

Financing: contrat doctoral sans mission

For more information go to http://ed109.ipgp.fr, section: Offres de these (PhD offer), You must apply on the Doctoral School website

Presentation of the subject: (1 or 2 pages)

The solid Earth is a system of dynamically coupled envelopes, comprising a solid mantle, a fluid outer core, and a solid inner core. The geomagnetic signal, created in Earth's electrically conducting and convecting core by a dynamo effect, is a valuable source of information constraining the structure, dynamics and history of this coupled system.

Numerical simulations of the geodynamo have recently improved to the point where they can account for the main properties of both the geomagnetic field and its temporal variation (known as the geomagnetic secular variation or GSV). An important part of the GSV is the geomagnetic westward drift, through which magnetic field features at the Earth's core-mantle boundary are perceived as drifting westward at a speed up to 20 kilometers per year.

Recent state-of-the art numerical models link the geomagnetic secular variation to the mechanical and thermo-chemical couplings existing between the Earth's inner core, outer core and mantle. Through this scenario, it has been envisioned that most of the important differential rotations existing in this system are in fact coupled together. The most tempting perspective is that the super-rotation of the inner core with respect to the mantle, the observational evidence of which has been debated for a long time, is in fact related to the westward drift below the core-mantle boundary, a robust feature which is observed to a very good accuracy.

The goal of this PhD. project is to numerically explore and document this scenario, using as a basis the recently published Coupled Earth Dynamo model (Aubert, Finlay, Fournier, 2013, Nature). This model includes realistic couplings between the core, inner core, and mantle, and will be used as a basis to perform a scaling analysis of the important rotations in the system. The scaling results will offer the possibility to infer how much of the shear present in the core corresponds to inner core super-rotation, how much corresponds to westward drift, as well as the links existing between the two.

A second part of the project will be dedicated to a fine analysis of the geomagnetic variations observed during the past few centuries, in order to rate the predictive power of each member of the series of models used in the first part. The emphasis will be put on the capability of a given model to explain the westward drift and its spatial/temporal variability, as seen in the geomagnetic record. This data-driven study will enable a refinement of the results obtained in the first part. Better constraints on the inner core super-rotation should finally be obtained through this two-step approach integrating numerical models and geomagnetic data. In particular, the candidate should be in a position to place a geodynamically-derived upper bound on the amount of super-rotation expected for Earth's inner core.

We seek a candidate with background and interest in Deep Earth Geophysics, Geomagnetism, Applied Mathematics and high-performance computing. A good level in English is a prerequisite for this project.