Subject offered for a contract starting october 2014

SUBJECT TITLE:

Mechanisms of magnetic field amplification in numerical models of the geodynamo

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Presentation of the subject: (1 or 2 pages)

In the last few years a wide variety of numerical models have been produced, solving the equations of magnetohydrodynamics in a rotating spherical shell, in order to investigate the origin of the Earth magnetic field. Although the equations and the physical setup offer a sensible model for the Earth code, the parameter regime in which these models are run is necessarily very remote from the geophysically relevant one. This originates in the extreme parameters associated with the wide variety of length scales and timescales at work in the Earth liquid core. The resulting system of equation is stiff and cannot be solved as such, even in present day state-of-the-art simulations. For this reason the available models operate in a limit that is different to that expected for the Earth core. Despite these obvious limitations, numerical models appear to produce magnetic fields with many Earth like properties, and it is thus critical to understand which aspects of the models are reliable and which are not.

The key question then is to understand the forces balance at work in these models, depending on the regions of the parameter space in which they are performed. This will provide essential information on their applicability to the geodynamo. Recent works have highlighted the role of viscous effects as well as he role of inertial for excessive forcing. The next step will then be to identify the mechanisms of magnetic amplification. Besides meanfield formalism (which is usually relied on for such interpretations) other well known mechanisms deserve investigation. For example the Ponomarenko helicoïdal shear, which could be associated to a convection column. The question of whether the time dependence of the flow is important for dynamo action is also critical ("Would a snapshot of the flow also produce a dipolar field?"). A detailed investigation of 3D models available to date is needed and timely, as it will help to identify the different mechanism at work depending of the dominant force balances and their relevance to the Geodynamo.

This thesis can be hosted in the MAG extension of the Geomagnetism group, based at ENS. It has potential important consequences in Earth sciences as it will help understand to what extend and in which part of the parameter space can direct numerical simulations shed light on the Earth core dynamics.