In the search of magnetic reversals in a geodynamo model with a stably-stratified layer

Nicolás P. Müller[1], François Pétrélis[1] & Christophe Gissinger[1,2]

[1] Laboratoire de Physique de l'École normale supérieure, ENS, Université PSL, CNRS, Sorbonne Université, Université Paris Cité, F-75005 Paris, France
[2] Institut Universitaire de France (IUF), Paris, France
nicolas.muller@phys.ens.fr

Recent seismic, mineral physics, and geomagnetic investigations have indicated the existence of a stably-stratified layer (SSL) beneath the core-mantle boundary of Earth. This layer, potentially present in other celestial bodies such as Mercury and Saturn, may originate from thermal or compositional influences. In the case of Earth, its depth ranges from 0 to 300 km, exhibiting a stratification strength denoted as $N/\Omega \in (0, 50)$, where N represents the Brunt-Väisälä frequency and Ω the rotation rate [1]. The presence of the SSL on Earth remains a topic of debate, evidenced by the diverse range of parameters yielded by various models. An important aspect of the SSL is its influence on the overall configuration of the magnetic field and on the occurrence of magnetic polarity reversals on a large scale.

In this work, we conduct an extensive study performing numerical simulations of a kinematic geodynamo model within a spherical shell, employing the codensity approximation. The SSL is introduced by assuming a background temperature gradient that undergoes a sign change, being negative near the inner-core boundary and positive in proximity to the core-mantle boundary. Our analysis reveals a transition from dipolar to multipolar dynamo solutions, governed by the magnetic Reynolds number. This transition is found to be influenced not solely by hydrodynamical processes but also by magnetic effects. Furthermore, we explore the modifications imposed by the SSL on this transition.

References

1. T. Gastine, J. Aubert & A. Fournier, Dynamo-based limit to the extent of a stable layer atop Earth's core, *Geophys. J. Int*, (2020) **222**, 1433-1448.