Asymptotic models of rotating flows in ellipsoidal planets

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Résumé

Global spherical models of convection have succeeded in reproducing the main features of the large-scale magnetic field observed at the Earth's surface (e.g. Schaeffer et al, 2017). Planetary magnetic fields are thus often believed to be generated by turbulent convection in planetary liquid interiors. However, the recorded paleomagnetic fields of both the Early Earth and the Moon (which were generated billions years ago) may be incompatible with the convection scenario for the possible planetary conditions at that time (e.g. Landeau et al., 2022). Other dynamo scenarios are thus worth considering to explain such puzzling observations, such as turbulent flows driven by large-scale tidal deformations in non axisymmetric geometries. Planetary core boundaries are indeed rather ellipsoidal at the leading order (due to the combined action of global rotation and tidal deformation), but the effects of large-scale topography have been largely overlooked in current models. Motivated by such planetary applications, we present a novel reduced model of rapidly rotating flows enclosed in ellipsoidal geometries, which is asymptotically valid in the low-viscosity planetary regime. We first explore the properties of the rotation eigenmodes of the fluid (Vidal & Cébron, 2020), which can provide direct physical insights into the planetary flow dynamics, and then discuss pioneering dynamo computations in non-spherical geometries (Vidal & Cébron, 2021).

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