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Core boundary layers and Earth normal modes

M. Delatre and B. Valette

L.G.I.T., Université de Savoie, France (bvale@univ-savoie.fr / Fax: +33 4 79758742)

Earth oscillations present both a jump in the displacements and a shear of the magnetic field lines at the core-mantle and inner core boundaries, which result in boundary layers linked to the viscous and magnetic properties of the outer core. In spite of their small thickness, these boundary layers play an important role in the coupling of the core with the mantle as it has been shown for the free core nutation. In this study we show how the effect of these visco-magnetic layers can be taken into account in the calculation of seismic normal modes with low harmonic degree. This is achieved through the perturbation of the weak formulation of the elastodynamic equations and the introduction of a kind of Dirichlet-to-Neumann (DtN) operator, which finally yields an expression of the frequency shift of modes. The computation of the DtN operator is conducted through a magneto-hydrodynamic model of the boundary layers in a manner similar to that now commonly used in free core nutation calculations. This study provides a new way for estimating upper bounds of viscosity and electrical conductivity at the outer core boundaries from normal mode data.