On the use of boundary layer compatibility conditions for geodynamo modeling

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There are several successful numerical MHD geodynamo models which can reproduce Earth-like magnetic field spatial spectra and time variations such as the westward drift and reversals. However, some of the parameters, especially the Ekman number, are far from those of the Earth's core. Small Ekman number introduces small-scale phenomena such as turbulence and boundary layers into the problem. It may not be possible to resolve them in direct numerical calculations of the geodynamo for some time, and techniques which may take those effects into account for the model calculations are desired. The dynamical effect of the turbulence may be quantified or parameterized by considering models of subgrid-scale phenomena such as turbulent viscosity or similarity model, and a number of researches are going on along this line. On the other hand, method to include the boundary layer seems to be left and the problem needs more attention. In this paper, we will consider the use of boundary layer compatibility conditions as a candidate to include the boundary layer effect into numerical geodynamo models.

Some of the requirements for the use of boundary layer compatibility conditions may be listed as the following. (1) Boundary layers that may exist in the core are identified and the conditions to have the layers are known. (2) The time to establish the boundary layers is sufficiently shorter than the time of interest of the main body of the flow and magnetic field. (3) The boundary layers are stable, i.e., break downs of the boundary layers do not occur by instability. In this paper, we will focus on (3), and discuss potential of using boundary layer compatibility conditions for geodynamo modeling by showing the stability conditions of the Ekman-Hartmann layer.