

## Modeling of planetary dynamos

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In the past ten years self-consistent numerical simulations of the geodynamo have had a remarkable success. In many of these models the magnetic field properties closely match those of the Earth in terms of spatial spectra and magnetic field morphology. Some models exhibit dipole reversals whose temporal behavior agrees with what is known for geomagnetic reversals from the paleomagnetic record. While the modern geodynamo models rely only on the fundamental laws of magnetohydrodynamics, some conditions differ strongly from those in the Earth's core. Viscosity is fixed to values far in excess of realistic ones in order to suppress small-scale turbulence of the flow, which cannot be resolved with present computational means. Whether this seriously corrupts the essential physics of the dynamo process is an open question. It is not fully understood why the magnetic field is dipole-dominated in some models and not in others. Attempts for improving this situation consist of pushing the model parameters in the direction of Earth values and to quantify the dependence of key properties of the dynamo solution on the control parameters. The first results on such scaling laws are encouraging and may suggest that current models do in fact capture the essential physics of the geodynamo.

The magnetic fields of the various planets in the solar system differ greatly in strength and morphology. A general theory of planetary dynamos is still in its infancy and perhaps a case-by-case treatment is necessary. The weakness of Mercury's magnetic field, which has only 1% of Earth's field strength, is difficult to explain by a geodynamo-like model. The outer part of Mercury's liquid core may be stably stratified and a dynamo would operate only in a deep convecting sublayer. Model simulations show that here a strong magnetic field is generated. It varies rapidly with time and is therefore severely attenuated when diffusing through the stagnant conducting layer in the upper core. The model can explain the observed strength and large-scale structure of the observed field.