A New Hermean Magnetic Field Model

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Abstract

MESSENGER spacecraft MAG measurements provide crucial information on the magnetic field of Mercury. Due to the spacecraft eccentric orbit and the small magnetosphere of Mercury, measurements close enough to the planet's surface and therefore suitable for internal magnetic field studies are acquired only over the northern hemisphere. This configuration is a limitation to standard global modeling methods such as Spherical Harmonics. We use a local modified Equivalent Source Dipole method to model the magnetic field above the surface from measurements partially distributed. Here, the dipoles are placed deep inside the planet. This method is first applied to single sidereal day data periods. We find small-scale features varying in time which may be interpreted as fields of external origin. Note that in this study, we do not attempt to model explicitly the external field. As the planet is in 3:2 resonance the Sun does not cover all local longitudes during one sidereal day. We therefore consider only one-solar-day models because most external features tend to be averaged out. We find a dominantly axisymmetric field for each solar-day models. However, comparing successive models we observe a strong large-scale variability of the field. This is probably due to some large-scale external sources. Further studies are needed to confirm whether these differences are due to spatial or temporal variability. We finally compute a unique model with all the data considered above (about three terrestrial years) to describe the Hermean magnetic field. This model confirms the large-scale and close-to-axisymmetry structure of the internal magnetic field of Mercury. It also displays the northward offset magnetic equator crossings previously detected. However, our magnetic equator latitude varies with altitude in contrast with the altitude-independent equator latitude of the purely dipole offset hypothesis. Fitting SH coefficients to our model we obtain an axial quadrupole to axial dipole ratio up to 0.48 that decreases to _˜0.2 if the poorest data coverage are not considered. These results suggest that the magnetic field of Mercury may be explained by a range of possible hemisphericities enlarging the domain of possible dynamical regimes for Mercury's dynamo.

Keywords: Planetary magnetic field, Mercury, MESSENGER mission, Axisymmetric field

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