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Mercury intrinsic magnetic field : Limits of the offset-dipole representation

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The interaction of the solar wind (SW) with the magnetic field of The analysis of MESSENGER orbital observations led Anderson et al (2011) to propose a dipole centered on the spin axis of the planet with a northward offset equal to 484$\pm$11 km to represent the intrinsic magnetic field of Mercury at northern latitudes higher than 30°. The magnetic moment has a magnitude of 195$\pm$10nT, points southward and is tilted by less than 3° with respect to the spin axis. The restriction to northern latitude comes from the lack of low altitude measurements of the magnetic field at southern latitudes due to MESSENGER orbit. Hence for the moment being there is no observation to constrain the representation of the southern planetary field. The suggested offset is equal to about 20% of the planetary radius which is quite a large value by comparison to 8.5% in the terrestrial case although with a lateral offset. This representation of the intrinsic field by an offset dipole suggests that the southern polar cap should be much wider than the northern one, leading to important consequences for magnetospheric dynamics. Nevertheless the offset dipole is just a convenient representation that can be fitted by the first terms of the multipolar development. The surface field of the planet produced by the offset dipole (OD) proposed by Anderson et al (2011) is thus fitted by the sum of a dipolar and a quadrupolar field (DQ) for northern latitudes higher than 50°. The resulting field differs slightly from the offset dipole field at northern latitudes but a separatrix exists at southern latitudes between dipolar-like and quadrupolar like field lines. This separatrix begins on the polar axis at an altitude RS equal to three times the ratio of the quadrupolar to the dipolar moment. When the relative axial offset of the dipole becomes larger than 16% then RS becomes larger than the planetary radius leading to important topological changes of the southern field. Global hybrid simulations of the Hermean magnetosphere for the two models OD and DQ demonstrate that the southern magnetosphere produced by the DQ model differs greatly from what is expected using the OD model (Richer et al 2012).

Reference:
Anderson et al., Science, 333 , 1859, (2011)
Richer, E., R. Modolo, G. M. Chanteur, S. Hess, and F. Leblanc (2012), A global hybrid model for Mercury's interaction with the solar wind: Case study of the dipole representation, J. Geophys. Res., 117, A10228, doi:10.1029/2012JA017898.