Magnetospheric Magnetic Field Observations and Modeling at Mercury

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The external field arising from Mercury’s interaction with the solar wind, relative to the internal field at the planet’s surface, is two orders of magnitude larger than at Earth. The flyby observations from Mariner 10 in 1974 and 1975, and from MESSENGER on 14 January and 6 October 2008, provide the basis for our knowledge of Mercury’s magnetic field. The second MESSENGER flyby occurred over the opposite hemisphere from the other flybys, and these data constrain the tilt of the planetary moment from the planet’s spin axis to be less than 5º. For a purely dipolar internal field, the moment is in the range 240 to 270 nT-$R_M^3$, where $R_M$ is Mercury’s radius. Multipole solutions for the planetary field yield smaller dipole moments, 180 to 220 nT-$R_M^3$, and higher-order terms that together yield an equatorial surface field from 250 to 290 nT. The residuals indicate a radially outward field, which a centered dipole field cannot give. The equatorial fields are also less strongly northward than required by a centered dipole consistent with the field over the pole. Moreover, the residuals are not largest close to the planet, and when considered in magnetospheric coordinates they indicate a cross-tail current with a density of 0.1 $\mu$A/m² extending to within 0.5$R_M$ altitude on the nightside. The plasma observations demonstrate that solar wind plasma is present below 500 km altitude, consistent with magnetospheric currents close to the planetary surface. Observations from orbit are required to reliably resolve structure in the internal field.