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Paleomagnetospheric Modelling of the Hermean Magnetosphere

Daniel Heyner
TU Braunschweig, Institut für Geophysik und extraterrestrische Physik, Braunschweig, Germany (d.heyner@tu-bs.de)

Mercury possesses a very weak internally generated global magnetic field. The surface field strength at the equator is about 190 nT which is ca. 160 times weaker than the terrestrial value. In-situ magnetic field measurements from the MESSENGER probe in the low-altitude campaign shortly before the end of mission indicate the possibility of a much stronger dipole moment in ancient times, allowing even a field of comparable surface field strength as the terrestrial value. This would imply a much stronger dynamo process in the past.

On the other hand, Mercury is also subject to an intense inflow of solar wind plasma due to its proximity to the Sun. The impinging solar wind flow is not steady having intrinsic natural variations as well as the variation due to the changing heliocentric distance along the Hermean orbit around the Sun. In a comparison of our Sun to similar stars, it is found that the solar wind dynamic pressure is also exponentially decaying over time.

The solar wind plasma flow exerts an inward pressure on the magnetopause, the outermost boundary of the magnetosphere. The internal magnetic field pressure by the planetary dipole acts against the inward push of the solar wind. Thus, pressure equilibrium defines the spatial scale of the magnetopause and thus the spatial magnetospheric extent. The electric currents in the magnetopause induce a magnetic field acting on the planet, driving e.g. induction currents in the interior and maybe even quench the internal dynamo process. In this paper it is demonstrated, how the magnetopsheric spatial scale changes with a time-dependent internal dipole moment as well as a time-dependent solar wind pressure using a semi-empirical magnetospheric modeling approach. From this, the resultant magnetopause fields acting on the planet are computed and discussed.