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MESSENGER observations of Mercury's bow shock and magnetopause

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Abstract

The MESSENGER spacecraft made the first of three flybys of Mercury on January 14, 2008 (1). New observations of solar wind interaction with Mercury were made with MESSENGER's Magnetometer (MAG) (2,3) and Energetic Particle and Plasma Spectrometer (EPPS) – composed of the Energetic Particle Spectrometer (EPS) and Fast Imaging Plasma Spectrometer (FIPS) (3,4). These MESSENGER observations show that Mercury's magnetosphere has a large-scale structure that is distinctly Earth-like, but it is immersed in a comet-like cloud of planetary ions [5]. Fig. 1 provides a schematic view of the coupled solar wind – magnetosphere – neutral atmosphere – solid planet system at Mercury.

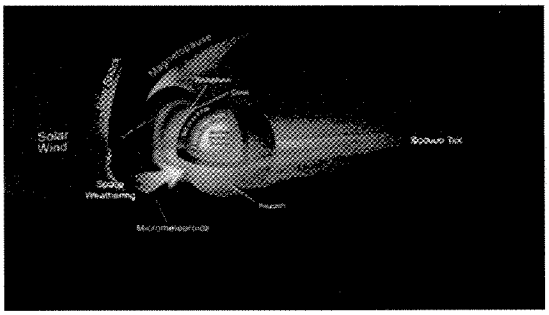

Fig. 1. MESSENGER measurements from its first flyby suggest a coupling between the incident solar wind, the magnetosphere, the neutral atmosphere, and the solid planet.

Here we present new models of bow shock and magnetopause shape and location that incorporate both the MESSENGER and earlier Mariner 10 measurements of these boundaries. A fast magnetosonic Mach number for the solar wind at Mercury's distance from the Sun of ~ 3 is derived from the shape of the bow shock. This value is consistent with earlier observations at these distances from the Sun by the Helios mission. The shape of Mercury's magnetopause and the thickness of the magnetosheath are found to be similar to that of the Earth, suggesting that the solar wind interaction is dominated by its dipolar magnetic field.

MESSENGER measurements near the magnetopause do, however, indicate that internal plasma pressure does contribute to the pressure balance across this boundary. MAG and FIPS measurements are used to estimate the ratio of plasma thermal pressure to magnetic pressure at the dusk flank of the plasma sheet and dawn terminator regions, under the assumption that pressure is balanced across the inbound and outbound magnetopause crossings. To investigate the possible origins of the plasma ions in these regions, we utilize a combination of FIPS measurements and the results of 3-D hybrid [6] and magnetohydrodynamic simulations of the solar wind interaction with Mercury for the upstream conditions believed to exist at the time of the MESSENGER flyby.

References

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