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The magnetic structure of Saturn's magnetosheath

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Abstract

A planet's magnetosheath extends from downstream of its bow shock up to the magnetopause where the solar wind flow is deflected around the magnetosphere and the solar wind embedded magnetic field lines are draped. This makes the region an important site for plasma turbulence, instabilities, reconnection and plasma depletion layers. A relatively high Alfvén Mach number solar wind and a polar-flattened magnetosphere make the magnetosheath of Saturn both physically and geometrically distinct from the Earth's. The polar flattening is predicted to affect the magnetosheath magnetic field structure and thus the solar wind-magnetosphere interaction. Here we investigate the magnetic field in the magnetosheath with the expectation that polar flattening is manifested in the overall draping pattern. We compare an accumulation of Cassini data between 2004 and 2010 with global magnetohydrodynamic (MHD) simulations and an analytical model representative of a draped field between axisymmetric boundaries. The draping patterns measured are well captured and in broad agreement for given upstream conditions with those of the MHD simulations (which include polar flattening). The deviations from the analytical model, based on no polar flattening, suggest that non-axisymmetry is invariably a key feature of the magnetosphere's global structure. Our results demonstrate the impact of non-axisymmetry on the overall configuration of the magnetic field in the magnetosheath which ultimately prescribes the magnetic shear angle – a parameter widely theorized to influence momentum and energy transfer. We anticipate our assessment to provide an insight to this barely studied interface between a high Alfvénic bow shock and a very dynamic magnetosphere.