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An induced magnetosphere without an atmosphere: The solar wind interaction with Iapetus

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Venus and Mars are the prototypes of the interaction of a flowing magnetized plasma with a planetary body possessing an ionosphere, forming what has been called an induced magnetosphere. The atmosphere supports the ionosphere and the ionosphere in turn deflects the solar wind flow without the assistance of an intrinsic magnetic field. The deflection occurs because an induced current arises in the ionosphere that shields the planet from the time-varying magnetic field in the solar wind. Saturn's moon Iapetus has no ionosphere to electrically connect with the solar wind, but Iapetus still deflects the supersonic solar wind because the IMF is time varying. We illustrate this behavior with data obtained by Cassini on its flyby of Iapetus in September 2007, demonstrating the flow deflection by what must be the conductivity of the moon's interior. Another important lesson from this encounter is the presence of a bow wave and not a bow shock despite the supersonic nature of the flow. This is consistent with the large ion gyroradius in the solar wind at 10 AU resulting in the breakdown of the MHD limit when the obstacle size is smaller than the ion kinetic scale. Iapetus is not the only body capable of such an interaction. Other bodies include Vesta and Ceres and Pluto and Charon, but the present missions to these bodies (Dawn and New Horizons, respectively) carry no magnetometers.