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Conditions at planetary magnetopauses further from the Sun are probably less favorable for magnetic reconnection

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Abstract

Although magnetized planets are each surrounded by a magnetospheric cavity in the solar wind flow, magnetic reconnection at the magnetopause boundary of such cavities allows solar wind energy into the system. Previous authors have suggested that a higher Mach number planetary bow shock leads to less favorable conditions for magnetopause reconnection. Here, simple models are used to expand on this hypothesis. Evaluating the shock jump conditions across a model planetary bow shock suggests that higher Mach numbers produce higher plasma β (ratio of plasma to magnetic pressure) conditions in the magnetosheath (between the bow shock and magnetopause). A model of conditions at a planetary magnetopause is used to examine the influence of magnetosheath β on magnetopause reconnection. Applying current understanding of the conditions required for reconnection onset suggests that higher magnetosheath β conditions place increasingly severe restrictions on the fraction of the dayside magnetopause surface where reconnection can occur. Since typical planetary bow shock Mach numbers increase the further a planet orbits the Sun, conditions at a planetary magnetopause probably become less favorable for magnetic reconnection with increasing heliocentric distance. Conditions at Jupiter's magnetopause are most likely to violate this proposed variation.