Normalized Reconnection Rate and X-Line Location at the Magnetopause

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Résumé

Magnetic reconnection at the magnetopause governs the coupling between the solar wind and the
Earth's magnetosphere, yet two of its most fundamental aspects remain poorly understood: the
normalized reconnection rate and the spatial location of the reconnection line. Addressing the first, we
introduce a new statistical method based on more than one million in-situ subsolar magnetopause
measurements to estimate the normal magnetic field and plasma inflow velocity as a function of the
interplanetary magnetic field (IMF) clock angle. Both quantities increase with clock angle, consistent
with ongoing reconnection, and their ratios to tangential components - corresponding to the normalized reconnection rate - converge to a remarkably stable value of 0.14 ± 0.05 for clock angles
exceeding 60∘, indicating that the reconnection rate is independent of the guide field at the magnetopause. Addressing the second challenge, we present a new X-line model that identifies the
dominant reconnection line by maximizing the reconnection rate on both a local and a global scale.
Validated against four global MHD simulations spanning diverse dipole tilts and IMF orientations, the
new model consistently performs better than both the maximum magnetic shear and global rate
maximization approaches in predicting the magnetic separator location.

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