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Evidence of a Non-Orthogonal X-Line in Guide-Field Magnetic Reconnection

We will present compelling evidence suggesting the X-line of guide-field magnetic reconnection is not necessarily orthogonal to the plane in which magnetic reconnection occurs. The plane of magnetic reconnection is often referred to as the L-N plane, where L is the direction of the reversing and reconnecting magnetic field and N is normal to the current sheet. The X-line is often assumed to be orthogonal to the L-N plane (defined as the M direction) in the majority of theoretical studies and numerical simulations. The four-satellite Magnetospheric Multiscale (MMS) mission, however, observes a moderate guide-field magnetic reconnection event in Earth's magnetotail in which the X-line is significantly and credibly oblique to the L-N plane. This finding is somewhat opportune as two of the MMS satellites in the same N location report nearly identical observations in the electron diffusion region (EDR) even though they have substantial separation in L. A minimum directional derivative analysis, which suggests that the X-line is nearly 60° from M, adds support that the X-line is oblique. Furthermore, the measured ion velocity is inconsistent with the apparent motion of the MMS spacecraft in the L direction through the EDR, which can be resolved if one assumes a strong shear of the L-N plane and motion in the M direction. A non-orthogonal X-line, if somewhat common, would call for revisiting theory and simulations of guide-field magnetic reconnection and a reexamination of how the reconnection electric field may be supported in the EDR.

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Theme

Energetic Phenomena

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