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Current Sheet Instabilities and Parallel Electric Fields Associated with Magnetic Reconnection

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Magnetospheric Multiscale (MMS) mission observations of magnetic reconnection at the Earth's magnetopause often show strong parallel electric fields associated with magnetic field (B) turbulence. The parallel electric fields and the B turbulence are in the magnetopause current sheet near the electron diffusion region (EDR). The B turbulence is most intense at frequencies that are above the ion cyclotron frequency and below the lower hybrid frequency. It is consistent with a thin, oscillating magnetopause current sheet that is corrugated along the direction of the current (along the X-line). The oscillating current sheet may cause a low-frequency displacement of the EDR, which, in the linear state, should not disrupt the reconnection process. However, if the displacement is sufficiently large, the inertia of ions may result in strong parallel electron currents and strong turbulence, which may disrupt the reconnection process and result in a discontinuous X-line. We analyze MMS observations of confirmed EDR regions to understand the nature of the current sheet instabilities and the impact that such instabilities may have on magnetic reconnection.