MMS Observations of a Compressed, Highly Driven Magnetopause during the 2024 Mother's Day Storm

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Abstract

From 10-12 May, 2024, a series of coronal mass ejections led to the Mother's Day Storm, one of the strongest geomagnetic storms of the century. MMS's position on the dayside magnetosphere on 11 May allows us to report in situ observations of an extremely driven and compressed _~6 Re magnetopause boundary layer. In the boundary, MMS observed a magnetic reconnection exhaust far downstream of a primary X-line with an average normalized reconnection rate of 0.20 ± 0.05 and significant ion heating estimated to be _~ 30% of the available magnetic energy. The enhanced ion heating, 50% higher than generally expected for the driving conditions, indicates the complexity of the boundary layer where MMS not only encounters a magnetic hole and crosses the magnetopause multiple times, but also sees significantly enhanced O+ magnetospheric outflows. Together, these signatures highlight how kinetic-scale processes at the magnetopause boundary layer enable large-scale energy transfer throughout the magnetosphere.

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