

Pinching of ICME Flux Rope: Unprecedented Multipoint Observations of Internal Magnetic Reconnection during Gannon's Superstorm

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The solar storm of May 10, 2024, during solar cycle 25, stands out as one of the most extreme space weather events of recent decades. Its exceptional intensity, combined with modern spacecraft positioned at different vantage points in the interplanetary medium, created a rare opportunity to investigate the dynamics of interplanetary coronal mass ejections in unprecedented detail.

By utilizing multipoint observations from NASA's Wind, ACE, DSCOVR, ARTEMIS-P2, STEREO-A, MMS, and ISRO's newly operational Aditya-L1 mission, we examined the evolution of plasma and magnetic field conditions associated with this storm. Our analysis suggests that large-scale, quasi-steady magnetic reconnection occurred deep inside the ICME flux rope. This reconnection was likely triggered by interactions between multiple ICMEs that merged during their transit from the Sun to Earth, forming a current sheet (CS) embedded within the flux rope. This process resulted in a dramatic reversal of the interplanetary magnetic field (IMF) B-y and B-z components observed at the L1 point. At the same time, reconnection exhausts accompanied by pronounced enhancements in both electron and ion fluxes were detected along the CS, which extended more than 200 RE (approximately 1.3 million kilometers) across the GSE-y direction. These findings demonstrate that internal reconnection can play a crucial role in restructuring the magnetic topology of ICMEs. This restructuring not only altered the flux-rope morphology but also amplified the ICME's geoeffectiveness, intensifying its space weather impact on Earth.