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Dynamics of Earth's Magnetopause During Solar Storms: Insights from In-Situ Measurements of NASA's MMS Mission

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1 Extended Abstract

In this study we examine the impact of solar phenomena on Earth's magnetosphere using data from NASA's Magnetospheric Multiscale (MMS) mission for the period of December 2023 to July 2024 which gave us the opportunity to analyze the whole magnetopause X-Y(GSE) plane. We have analyzed the variations in the magnetopause under different solar storm conditions and during periods of solar quiescence. We employ various analytical techniques like minimum variance analysis [1] and four spacecraft methods [2] to determine the magnetopause's location, velocity, and thickness during storm and Non-Storm Periods, variation of the magnetopause and the different plasma values. The analysis includes observations during the May 2024 "Mother's Day" geomagnetic storm, which recorded one of the strongest IMF peaks in recent history and compares it to non-storm conditions. We identified 4.0Re shifts of the magnetopause location towards earth at time approximately 11:49,11-may-2024 , this magnetopause shifting analysis is done over the complete data of magnetopause X-Y(GSE) plane and during this period significant number of magnetopause crossing is observed by MMS Satellites which allows use to calculate the magnetopause location and its variation in the many other different solar activities. We also find the electron density, plasma temperature, and beta values, highlighting the dynamic interaction between solar activities and Earth's magnetospheric environment. This finding will increase the understanding of spaceweather dynamics and their implications for technological systems on Earth and in space.

In all four spacecraft, MMS has unique instrument sets. Each of the octagonal-shaped MMS observatories houses eleven scientific experiments composed of twenty-five different sensors. It has an accuracy and time resolution of milliseconds and measures electric fields, magnetic fields, charged velocities, and plasma movement [3]. For this study two instruments are used

- **Fast Plasma Investigation (FPI)**:- It measures the particles velocity space distribution. It is composed of four types of dual electron spectrometer (DES) and dual Ion Spectrometer (DIS) on each satellite . FPI adds data of all DES , DIS with time resolution of 30ms and 150ms respectivily in the energy range 10eV-30keV.
- **Flux gate Magnetometer (FGM)**:- It measures magnetic field with the frequency 128 sample/s and accuracy of 0.1nT.

References

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