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Observations of Extreme Solar Transient Events by MAG Payload onboard Aditya-L1 Spacecraft around L1 Point

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Aditya-L1 is the first Indian spacecraft placed in a halo-orbit around the first Lagrangian (L1) point to continuously observe the Sun [1]. A fluxgate magnetometer (MAG) is also onboard with other in-situ [2] and remote sensing payloads to measure the interplanetary magnetic field (IMF) coming from the Sun towards the Earth which is an important parameter in monitoring the near Earth space weather [3]. The MAG is a dual triaxial sensor set mounted on a 6 m long boom, deployed along the negative roll direction of Aditya-L1, with one set at the tip of boom and the other set at the centre of the boom around 3 m away from the spacecraft towards the boom-tip on the sun-viewing panel deck [4]. The MAG boom was deployed on January 11, 2024 and since then MAG is measuring the IMF which is compared with data from other spacecrafts around the L1 point such as DSCOVR from NOAA, USA and both these observations agree very well. During its continuous operations since then MAG has observed several extreme solar transient events such as the Coronal Mass Ejections (CMEs) and Magnetic Clouds when the IMF gets enhanced from its normal value of ≈ 5 nT. One such event was observed during March 22-25, 2024. The IMF reached up to 17 nT during this event. The maximum variation of B_z is ≈ 15 nT. Another such event was recorded during May 10-13, 2024 [5]. The IMF reached up to 38 nT during this event. The maximum variation of B_z is ≈ 36 nT. Several CMEs were generated from the solar surface on May 08, 2024 and reached the L1 point on May 10, 2024 and generated a severe geomagnetic storm (Dst ~ 406 nT) after reaching the Earth. Another CME was observed during August 11-15, 2024 during which the IMF reached up to 25 nT and the peak-to-peak variation of the B_z component was more than 45 nT.

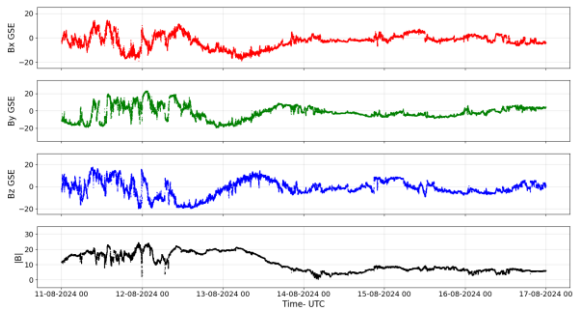

Figure 1: CME observed by MAG onboard Aditya-L1 during August 11-15, 2024.

The magnetic field measurements from the ground based observatories confirm the triggering of a geomagnetic storm (SymH < -200 nT) due to this CME.

The event during October, 2024 is the passage of a magnetic cloud through L1 point as shown in Figure 2. The IMF reached up to ≈ 50 nT during this event. The maximum variation of B_z is ≈ - 40 nT.

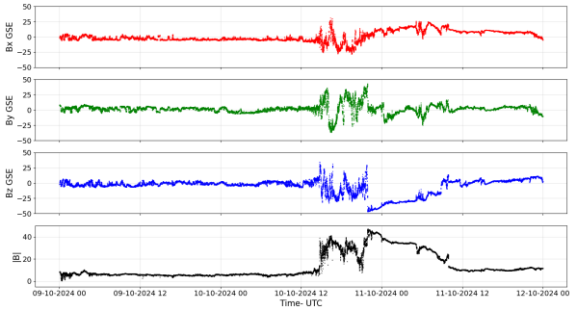

Figure 2: The CME observed by MAG onboard Aditya-L1 during 09-11 October, 2024.

In this paper, the one year observations of IMF by MAG payload; its variation during the extreme solar transient events and their effect on the Earth's magnetosphere are presented.

References

[1] D. Tripathi, …, and V. K. Yadav, "The Aditya-L1 Mission of ISRO", *The Era of Multi-Messenger Solar Physics*, Proc. IAU Symp. No. 372, 2023, Eds. G. Cauzzi & A. Tritschler, doi: 10.1017/S1743921323001230
[2] P. Janardhan, … , Vipin K. Yadav, et al., "Probing the heliosphere using *in-situ* payloads on-board Aditya-L1", *Current Science*, 113 (4), 2017, 620-624, doi:10.18520/cs/v113/i04/620-624.
[3] Vipin K. Yadav, et al., "Science objectives of the Magnetic Field Experiment onboard Aditya-L1 Spacecraft", *Advances in Space Research*, 61 (2), January 2018, 749-758, doi:10.1016/j.asr.2017.11. 008
[4] Vipin K. Yadav, et al., "The Fluxgate Magnetometer (MAG) onboard Aditya-L1 Spacecraft", *Solar Physics*, 300 (3), 33, 2025 doi:10.1007/s11207-025-02440-0
[5] Vipin K. Yadav, Y. Vijaya, P.T. Srikar, et al., "First Results of Magnetometer (MAG) Payload onboard Aditya-L1 Spacecraft", URSI-RCRS 2024; doi:10.46620/URSI_RSRC24/0049 MXN3595