Long-Term Datasets for the Understanding of Solar and Stellar Magnetic Cycles
Proceedings IAU Symposium No. 340, 2018
D. Banerjee, J. Jiang, K. Kusano & S. Solanki, eds.

doi:10.1017/S1743921318002028

Propagation of MRT Unstable Plasma Spikes in the Inter-planetary Space

Sudheer K. Mishra[1], Talwinder Singh[2], P. Kayshap[3] and A. K. Srivastava[1]

[1]Department of Physics, Indian Institute of Technology (BHU), Varanasi-221005, India.
email: sudheerkm.rs.phy16@itbhu.ac.in

[2]Department of Space Science, University of Alabama in Huntsville, Huntsville, AL 35899, USA

[3]UMCS, Group of Astrophysics, UMCS, ul. Radziszewskiego 10, 20-031, Lublin, Poland

Abstract. We have used the Coronagraphic and Heliospheric Imaging data from Solar TErrestrial RElations Observatory (STEREO) to observe a prominence which is erupted on June 7^{th} 2011. This prominence is subjected to the morphological evolution of MRT instability from the lower solar corona upto the inter-planetary space. The unstable structures are converted into the bunch of localized plasma spikes due to the turbulent mixing, and propagate in the inter-planetary space upto 1 A.U.

1. Introduction

The formation of plumes and fragmentation in an eruptive prominence may be occurred due to the magnetic Rayleigh-Taylor instability (Hillier 2018). A prominence eruption occurred on June 7^{th} 2011 as observed by Solar TErrestrial RElations Observatory (STEREO). It is observed that the eruptive prominence is magnetic Rayleigh-Taylor unstable from the inner corona to the low interplanetary space (Innes *et al.* 2012; Carlyle *et al.* 2014; Mishra *et al.* 2018). We demonstrate that the eruptive prominence eruption moves in form of the MRT unstable plasma spikes into the inter-planetary space reaching upto 1 A.U. (Wood *et al.* 2015).

2. Observational Data and Analysis

Coronagraphs (COR-1A & COR-2A, Howard *et al.* 2008) and Heliospheric Imagers (HI-1A & HI-2A, Howard *et al.* 2008) onboard STEREO have been used to observe the prominence eruption occurred from the NOAA AR 11226/11227 on June 7^{th} 2011 from 1.4 solar radii to 1 A.U. The MRT unstable plasma structures have been observed from inner corona upto the low interplanetary space (Innes *et al.* 2012; Mishra *et al.* 2018). Here, we extend the study of Mishra *et al.* (2018) and report that MRT unstable plasma spikes associated with prominence eruption propagate into an outer inter-planetary space.

3. Result and Discussion

A prominence has been erupted on June 7^{th} 2011 and some of the associated plasma have been reached upto 1 A.U. on June 9^{th} 2011 (Wood *et al.* 2015). The magnetic Rayleigh-Taylor unstable finger structures have been observed into the intermediate corona using STEREO/COR-1 (Fig. 1; right panel). Schematic in Fig. 1 (left-panel)

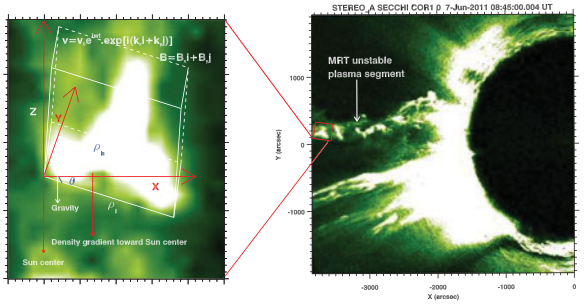

Figure 1. Right: Partial field of view of COR-1 onboard STEREO-A that shows the MRT unstable fingers in the eruptive prominence at June 7^{th} 2011. Left: A schematic representation of a MRT unstable finger structure.

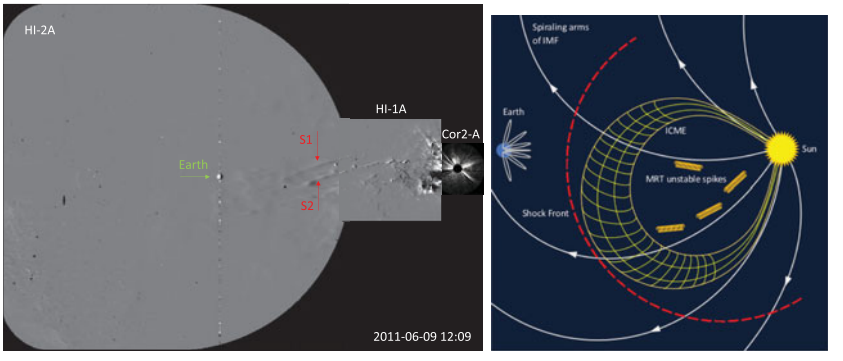

Figure 2. Left: The aligned and composite images of STEREO/COR-2A (2.5 to 15 solar radii), Heliospheric Imager (HI)-1A (15 to 80 solar radii), and Heliospheric Imager (HI)-2A (upto 4 A.U.) onboard Solar TErrestrial Relations Observatory (STEREO) on 9 June 2011 at 12:09 UT, display the formation of plasma spikes impinging in and around the Earth. Right: A schematic showing the propagation of MRT unstable plasma spikes in the inter-planetary space.

shows a planer magnetic interface ($B = B_x\hat{\mathbf{i}} + B_y\hat{\mathbf{j}}$) developed between the finger structure and corresponding below lying dark region. The magnetic interface is parallel to the wave velocity perturbation triggering MRT instability. A density gradient works towards the Sun center in the direction of the gravity (Fig. 1; left panel). The tension component of the Lorentz force accelerates the MRT unstable plasma segment against the gravity and density gradient (Fig. 1; left panel). It is observed that these MRT unstable finger structures further change there morphological shape i.e., fingers→ mushroom-like → plasma spikes, with the decreasing magnetic field into the outer solar atmosphere. (Mishra *et al.* 2018).

The plasma spikes are evolved in the low-interplanetary space due to turbulent mixing of the MRT unstable plasma structures erupting from the Sun (Mishra *et al.* 2018). The transport of this eruptive prominence upto 1.0 A.U. has reported by Wood *et al.* (2015). In the present paper, we find that the eruptive prominence is MRT unstable which propagates in form of plasma spikes into the inter-planetary space (cf., Figs 2, left-panel, spikes S1& S2). The schematic (Fig. 2, right-panel) demonstrates the modified scenario of the propagation of various ejecta in the interplanetary space. It includes the formation of localized MRT unstable plasma spikes that can slide along the inter-planetary magnetic field and can carry their own magneto-plasma system. These unstable plasma spikes imping around the Earth at 1 A.U. (Fig. 3). If such MRT unstable plasma structures

https://doi.org/10.1017/S1743921318002028 Published online by Cambridge University Press

move collectively and interact with the Earth's outer atmosphere then they can generate the episodic geomagnetic storm and can act as a new space weather candidate.

References

Carlyle J., Williams D. R., van Driel-Gesztelyi L., Innes D., Hillier A., Matthews S., 2014, *ApJ*, 782, 87
Hillier A., 2018, RvMPP, 2, #1
Howard R. A., *et al.*, 2008, SSRv, 136, 67
Innes D. E., Cameron R. H., Fletcher L., Inhester B., Solanki S. K., 2012, A&A, 540, L10
Mishra S. K., Singh T., Kayshap P., Srivastava A. K., 2018, *ApJ*, 856, 86
Wood B. E., Howard R. A., Linton M. G., 2016, *ApJ*, 816, 67

https://doi.org/10.1017/S1743921318002028 Published online by Cambridge University Press