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Off-pointed SWAP Obs.

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Abstract

Keywords: Coronal Mass Ejections, Low Coronal Signatures, Initiation and Propagation

1. Introduction

In this paper, relatively unique observations of a solar eruptive event are studied with a combination of multiple, overlapping EUV and white-light image data. In Section 2 we describe the observations and use of multiscale image processing methods. In Section 3 we describe the event, that occurred on 26 July 2013, and how the combination of observations and techniques can provide deeper insight into the initiation phase of CMEs. A discussion of the interpretation of this study is presented in Section 4, and final conclusions in Section 5.

2. Observations and Techniques

Data from solar-disk imagers may be combined with coronagraph observations, in order to connect CMEs to their source regions and study their initiation phase. The *Sun Watcher using Active Pixel System Detector and Image Processing* (SWAP: Seaton *et al.*, 2013, Halain *et al.*, 2013) on board the second *Project for Onboard Autonomy* (PROBA2: Santandrea *et al.*, 2013), has a spectral bandpass centered on 174 Å, with 3.2 arcsec pixels over a 54×54 arcmin field-of-view, and a cadence of ≈ 2 minutes. It can be off-pointed to observe the extended EUV corona up to ?arcsecs, or ?$R_\odot$, which can overlap the white-light coronal observations to provide new insight to the initiation phase of CMEs.

Extreme Ultraviolet Imager (EUVI: Wuelser *et al.*, 2004) on board the *Solar Terrestrial Relations Observatory* (STEREO: Kaiser *et al.*, 2008), the *Atmospheric Imaging Assembly* (AIA: Lemen *et al.*, 2012) on board the *Solar Dynamics Observatory* (SDO: Pesnell, Thompson, and Chamberlin, 2012); and the *Large Angle Spectrometric Coronagraph* (LASCO: Brueckner *et al.*, 1995)

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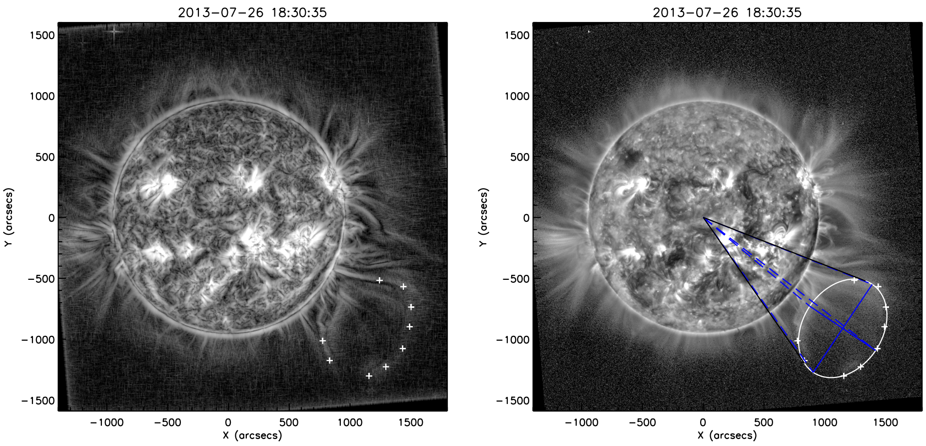

Figure 1. SWAP images of a prominence eruption at 18:30 UT on 26 July 2013 during a PROBA2 off-pointing campaign. The left image shows the results of a multiscale edge-detection algorithm, allowing a point-and-click characterization of the erupting structure. The right image shows the resulting ellipse fit overlaid on the original SWAP image (with a long-term background subtracted to highlight the faint EUV corona).

on board the *Solar and Heliospheric Observatory* (SOHO: Domingo, Fleck, and Poland, 1995), and coronagraphs of the *Sun-Earth Connection Coronal & Heliospheric Imagers* (SECCHI: ,) on board STEREO. While there are difficulties in the interpretation of observations from the varying instruments (having different fields of view, image passbands, and cadences), the multiple viewpoints can complement each other to allow a determination of the true morphology of the system.

Methods of multiscale image processing have been developed in recent years for use on solar image data to enhance the underlying structure (Stenborg, Vourlidas, and Howard, 2008; Young and Gallagher, 2008; Gallagher *et al.*, 2011; Morgan and Druckmüller, 2014). The fundamental idea behind these methods is to highlight details apparent on different scales within the data. Therefore, multiscale techniques provide an ability to remove small-scale features in images, essentially suppressing the noise such that the structures of interest can be revealed in greater detail. By applying them to coronagraph images, the morphology of CMEs as they propagate through the corona in a sequence of observations can be determined with better accuracy than previously possible, and can allow a characterization of the erupting structure to determine various properties in their evolution (Byrne *et al.*, 2009, 2010, 2012).

Here, multiscale methods are used on observations from the disk imaging instruments of SDO/AIA, STEREO/SECCHI-EUVI, and SWAP EUV imager, to provide insight into the low-coronal morphology of erupting structures that form CMEs. Details on the fundamental techniques are outlined in Young and Gallagher (2008) wherein the magnitude of the multiscale gradient is used to show the relative strength of the detected edges in the image structure at a particular scale of the multiscale decomposition (*i.e.*, the strongest edges appear

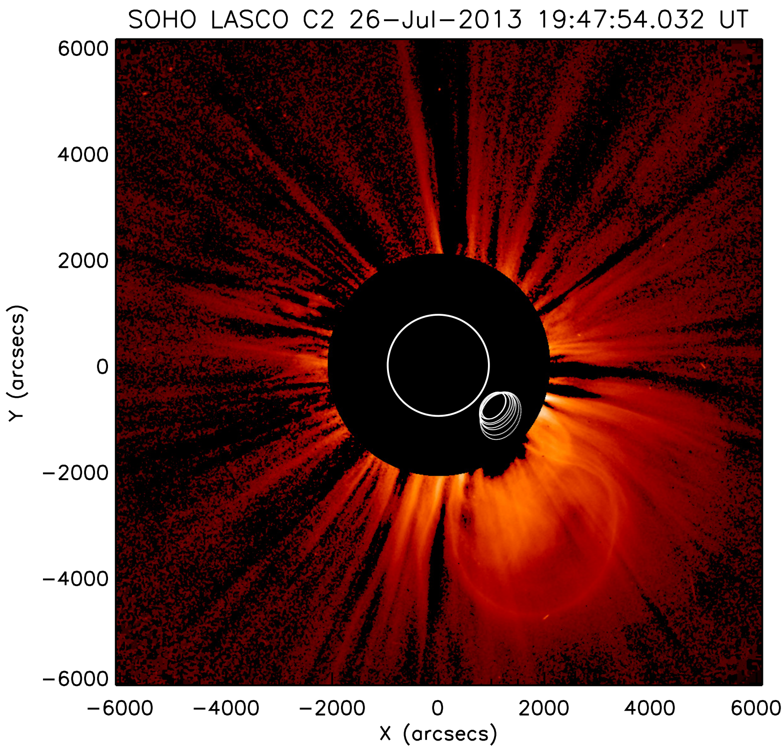

Figure 2. LASCO/C2 base-difference image of the CME at 19:47 UT on 26 July 2013, with the ellipse characterizations from the SWAP observations of the associated prominence, overlaid on the plane-of-sky for comparison. It appears that the CME underwent a southward deflection or asymmetric expansion in its propagation.

brightest). To further increase the signal-to-noise ratio of the edge detections, the magnitude information from the scales most relevant to the coronal structures of interest may be multiplied together, neglecting the largest scales that smooth out the coronal signal, and the smallest scales that reveal the finer structure and noise (see Byrne *et al.*, 2012, for details). Thus the magnitude of the multiscale gradient across the dominant edges of coronal loops and CMEs is further enhanced for subsequent characterization of their morphology.

Byrne *et al.* (2014) show the effectiveness of the multiscale techniques for detecting the structure of an ejection in SWAP images. These multiscale methods are applied to the SWAP data here, for this event seen during the off-pointing campaign on 26 July 2013, in order to highlight the structures in the image and perform a point-and-click characterization of the erupting prominence. This allows, for example, an ellipse fit to the outward propagating fronts, to obtain kinematical and morphological information as described in Byrne *et al.* (2009). Figure 1 shows two images of the SWAP observations of the erupting prominence at 18:30 UT on 26 July 2013:

3. Solar Eruptive Event

4. Discussion

5. Conclusions

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