# "Dandelion" Filament Eruption and Coronal Waves Associated with a Solar Flare on 2011 February 16

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Coronal disturbances associated with solar flares, such as H$\alpha$ Moreton waves, X-ray waves, and extreme ultraviolet (EUV) coronal waves are discussed herein inrelation to magnetohydrodynamics fast-mode waves or shocks in the corona. To understand the mechanism of coronal disturbances, full-disk solar observations with high spatial and temporal resolution over multiple wavelengths are of crucial importance.

We observed a filament eruption, whose shape is like a "dandelion", associated with the M1.6 flare that occurred on 2011 February 16 in H$\alpha$ images taken by the Flare Monitoring Telescope at Ica University, Peru. We derive the three-dimensional velocity field of the erupting filament.

We also identify winking filaments that are located far from the flare site in H$\alpha$ images, whereas no Moreton wave is observed. By comparing the temporal evolution of the winking filaments with those of the coronal wave seen in the extreme ultraviolet images data taken by the Atmospheric Imaging Assembly on board the *Solar Dynamics Observatory* and by the Extreme Ultraviolet Imager on board the *Solar Terrestrial Relations Observatory-Ahead*, we confirm that the winking filaments were activated by the EUV coronal wave.

Keywords: Sun: chromosphere, Sun: corona, Sun: filament

 

# Increase in the amplitude of line-of-sight velocity of the small scale motion as the precursor of filament eruptions

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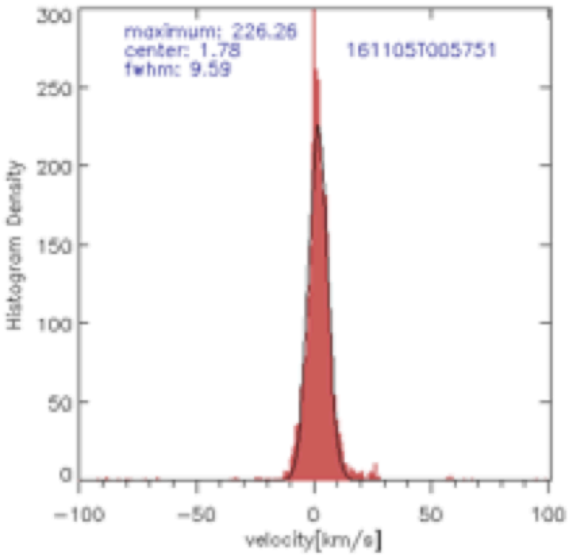
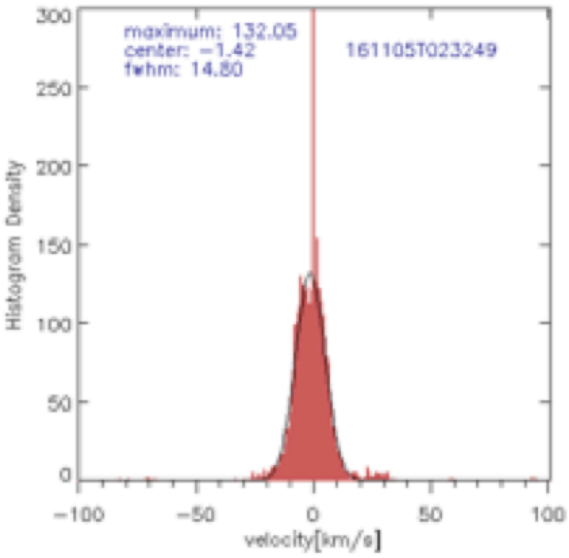
Filaments, the dense cooler plasmas in the solar corona, often become unstable and erupt into the interplanetary space as coronal mass ejections (CMEs). The CMEs may cause geomagnetic storms that result in various societal and economical impacts such as blackouts and satellite anomalies, so that it is important to predict when filament eruptions will occur. From the space weather point of view, monitoring filaments as the progenitor of CMEs has a following advantage that we can monitor not only flares from active regions but also the eruptions from quiet regions that may also cause severe geomagnetic storms. The aim of this study is to investigate the characteristics of eruptive filaments that can be used as the precursor of eruptions.

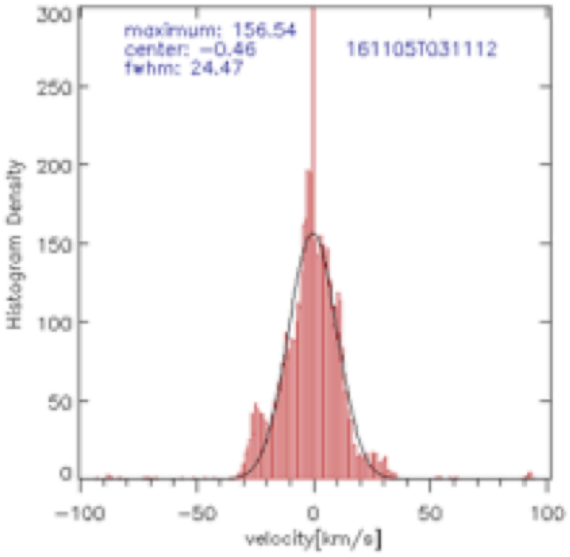
For this purpose, we analyzed the solar full disk images captured by Solar Dynamics Doppler Imager(SDDI) installed on Solar Magnetic Activity Research Telescope(SMART) at Hida Obser- vatory, Kyoto University. SDDI can obtain solar full disk images in 73 wavelengths between H$\alpha$ center-9A and H$\alpha$ center+9A per 0.25A with the time resolution of about 15 seconds. Therefore this instrument can observe unprecedented detailed line-of-sight velocities of filaments. Focusing on this feature, we calculated the filament's line-of sight velocities for each pixel of the images by utilizing Beckers' cloud model from before the eruption, and making histograms of the number of pixels and line-of-sight velocities for each pixel. As the result, we found an increase in the amplitude of line-of-sight velocity of the small scale motions in the filament about one hour before the onset of the eruption, i.e. the FWHM of the fitted gaussian increased. This result can be possibly used as the precursor of filament eruptions

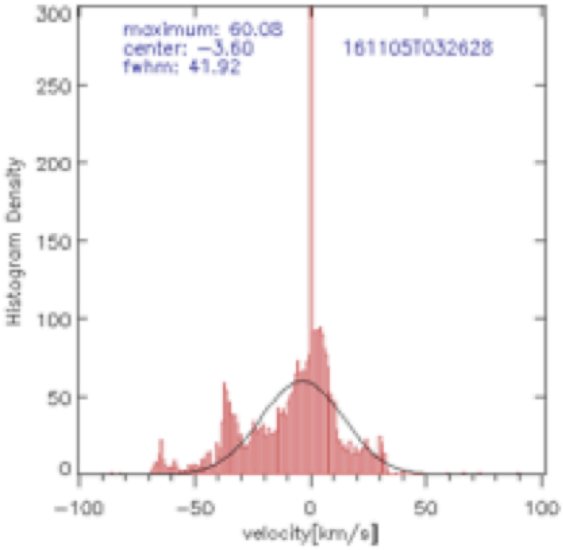
Keywords: prominence, filament activation, line-of-sight velocity



# Study of the occurrence condition of eruptive flares and CMEs based on non-linear force-free field model

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The solar flares and CMEs sometimes largely disturb the Earth's electromagnetic environment and may impact various social systems. In particular, large magnetic storms (Dst < -100nT) are caused by CMEs. Therefore, the prediction of CMEs occurrence is an important issue for space weather forecast. The SOHO observations indicated that, although solar flares often occurred under CMEs, CMEs do not always occurred associated with all solar flares (Yashiro et al, 2006). Solar flares accompanying CMEs are called “eruptive flare”, other solar flares are called “non-eruptive flares”. The occurrence condition of eruptive/non-eruptive has not been yet well-understood.
Recently, Toriumi et al. (2017) pointed out that the ratio of flare ribbons flux to the total flux of active region tends to be larger for the eruptive flare compared to the non-eruptive flares. On the other hand, Inoue et al. (2016) suggested that there is a correlation between the shape of the ribbon and the region of high magnetic twist using the non-linear force free field (NLFFF) model. In this study, we investigated the relationship between the area fraction of high magnetic twist region and the property of whether flare is eruptive or not using the SDO/HMI data and the NLFFF model. The result suggests that the area fraction of highly twisted flux of the active region producing non-eruptive flares tends to be lower than that of the regions producing eruptive flares, although the number of sample is not yet enough to make a clear conclusion.

Keywords: Solar flare, Corona mass ejection (CME), Non-liner force free field, Space weather

 

# Forecast Coronal Mass Ejection Arrival at the Earth: An Integrated Automated System and Its Performance

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Coronal mass ejections (CMEs) are one of the most violent events in the interplanetary space. CMEs can produce geomagnetic storms and other space weather phenomena when propagating near the Earth. Therefore, it is an important task to forecast whether or not a CME will arrive at the Earth. We develop an integrated CME arrival forecasting (iCAF) system, which consists of the modules of CME detection, three-dimensional (3D) parameter derivation and trajectory reconstruction based on coronagraph observations, to predict the Earth-arrival of a CME. The performance of iCAF is tested by comparing the 2D projected parameters with those in the catalog at the Coordinated Data Analysis Workshop (CDAW) Data Center, comparing the 3D parameters with those of the gradual cylindrical shell (GCS) model and estimating the success rate of the CME Earth-arrival predictions based on in-situ observations. It is found that the 2D parameters provided by both iCAF and the CDAW catalog are consistent with each other, but the iCAF angular widths are 20% smaller than those of the CDAW catalog because the automatic CME detection could not detect the faint edge of a CME. The ice cream cone model is found to be appropriate to be used to fit the CME 3D parameters when there are only single-view observations. Moreover, the success rate of the arrival predictions with deflection in iCAF is about 82%, which is 19% higher than that without deflection. iCAF is a worthwhile attempt since it is a completely automatic system with CME deflection in the interplanetary space, i.e., a key issue for the space weather forecasting, taken into account.

Keywords: Coronal mass ejection, Earth arrival, Integrated automated forecasting system

 

# Statistical analysis for CME topology in the low corona

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The direction of magnetic vectors within coronal mass ejections, CMEs, has significant importance for forecasting terrestrial behavior. We have developed a technique to estimate the time-varying magnetic field at Earth for periods within CMEs (Savani et al 2015, 2016). The technique can be regarded as the aggregate from two significant contributions: 1) Estimating the initial topological structure of the CME and 2) Estimating the hypothetical Earth-trajectory after CME evolutionary effects have been considered. In this presentation, we study the applicability of using a simplified scheme to estimate the CME topology from two parameters; the solar cycle and solar hemisphere. We show that statistical improvements for estimating the CME topology can be made by including additional parameters for more complex events that occur less frequently. We describe how identifying the polarity of the leading edge from post flare arcades at the source of the CME is an example of one of these parameters.

Keywords: Coronal mass ejections, magnetic field, Bz forecasting

 