Solar and Stellar Magnetic Fields: Origins and Manifestations
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On the Role of Magnetic Fields in an Erupting Solar Filament

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Abstract. A filament eruption may lead to a coronal mass ejection (CME), which is one of the main driving mechanisms of space weather. This work analyses a slow and flareless CME event associated with an erupting quiescent filament. By using the extreme ultraviolet images of the Atmospheric Imaging Assembly onboard the Solar Dynamics Observatory, we trace the evolution of the filament in detail, and present the manifestations of the role of magnetic fields in the low corona. The results suggest the existence of a magnetic flux rope in the pre-eruption structures. Our study of this complex magnetic system may lead to a better understanding of CMEs and their impact on the space weather.

Keywords. Sun: filaments, Sun: magnetic fields, Sun: coronal mass ejections (CMEs)

1. Introduction

A coronal mass ejection (CME) is a significant release of magnetized plasma from the solar corona into the interplanetary space. It is one of the main driving mechanisms of space weather events that may lead to major geomagnetic storms. Solar quiescent filaments are dark curves-like structures that sometimes appear in the quiet Sun. When the dark filaments are above the limb of the Sun, they will turn to bright and significant, so they are also called solar prominences. The magnetic field is the controlling force in the solar corona and it dominates the formation, evolution and eruption of filaments. The magnetic structure of filaments can provide gravitational support and thermal isolation (see Gibson 2018 and references therein). The flux rope, the sheared-arcade and other magnetic structural models provide a framework for understanding the evolution of the filament in the solar corona.

2. Data

This work uses the extreme ultraviolet (EUV) images of the Atmospheric Imaging Assembly (AIA) onboard the Solar Dynamics Observatory (SDO), because of its excellent temporal coverage and spatial resolution (Lemen *et al.* 2012). The data set is processed by using the standard routines in the Solar SoftWare.

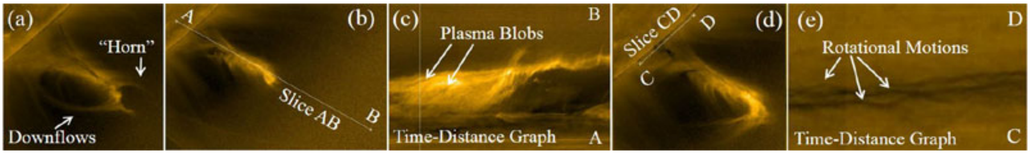

Figure 1. Dynamic features of an evolving filament in SDO/AIA 171 Å channel.

3. Results

A quiescent filament appeared on the western limb of the Sun around June 13, 2018. Although the overall evolution of the filament was slow, it was full of highly dynamic features in small-scale. Inside a coronal cavity, the filament slowly extends outward, and becomes bright on its top in the EUV images of the SDO/AIA. There was a horn-like structure on the top of the filament (Fig. 1), and it may relate to a magnetic flux rope. The horn-like structure appeared bifurcation and brightening which may suggest that it had a magnetic reconnection and lead to downflows back to the solar surface. As we can see from the time-distance graph of slice AB, some magnetized plasma blobs were moving upward and they may accumulate magnetic fields for the final eruption of the filament. We also analyses rotational motions in the filament. A slice (CD) is made at the location near the feet of the filament, and the dark materials in the middle of the slice appear a wave-like pattern in the time-distance graph. It may indicate that these materials have rotational motions which may be involved to the final eruption.

After a long period of evolution, the filament finally erupted and caused a slow CME. The erupting structure moved to the sides and outward. In the SDO/AIA 211 Å waveband image, we can see a long bright line that are nearly perpendicular to the solar surface, while there is no such bright line in the AIA 171 Å waveband images. The different observations in these different wavebands may indicate that this long line structure has a high temperature and it may be a current sheet produced by the magnetic reconnection of the eruption. The eruption was without significant X-ray enhancement, but had growing post-eruption arcades which are similar to the post-flare loops (Song *et al.* 2016) and can be explained by the standard flare model. A CME can be observed from the image of SOHO/LASCO and it may cause disturbance to the interplanetary space.

4. Summary

This work investigated the evolution of a solar quiescent filament and its final eruption. Coronal cavity, horn-like structure, downflows, plasma blobs and other fine structures are observed during its evolution. It suggests that the magnetic flux rope plays an important role for the erupting filament, the CME and the space weather.

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References

Gibson, S. E. 2018, *Living Rev Sol Phys*, 15, 7
Lemen, J. R., Title, A. M., Akin, D. J., *et al.* 2012, *Sol Phys*, 275, 1–2, 17
Song, Q., Wang, J. S., Feng, X. S., & Zhang, X. X. 2016, *ApJ*, 821, 2, 83

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