Nature of Prominences and their role in Space Weather
Proceedings IAU Symposium No. 300, 2013
B. Schmieder, J.-M. Malherbe & S. T. Wu, eds.

doi:10.1017/S1743921313011289

Observations of Overlying Extreme-ultraviolet Arches confining the eruption of a Filament

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Abstract. Using the multi-wavelength data from AIA/SDO, we report a failed filament eruption, which was associated with an X1.9 flare, but without any distinct CME, coronal dimming or EUV wave. Some magnetic arches above the filament was observed distinctly in EUV channels, especially in 94 Å and 131 Å, before and during the filament eruption. Our results show that the overlying arcades expanded along with the ascent of the filament at first until they reached a projected height of about 49 Mm above the Suns surface, where they stopped. The following filament material was observed to be confined by the stopped EUV arches and not to escape from the Sun. These results support that the overlying arcades play an important role in preventing the filament to erupt outward successfully.

Keywords. Sun: activity — Sun: filaments, prominences — Sun: flares — Sun: UV radiation

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On 2011 November 3, a filament erupted in NOAA AR 11339. According to GOES-15 observations, the associated flare is an X1.9 class flare. However, no coronal dimming, EUV wave or CME was related to the event according to the observations of SECCHI/STEREOB. These results indicate that it is a failed filament eruption.

The AIA 171 Å images (the top panels of Fig. 1) show the main eruption process of the filament "A" (see Fig. 1(a)). During the eruption, A broke into two major segments – "Ab_1" and "Ab_2" (see Fig. 1(c) and (d)). At about 20:23 UT, Ab_1 reached its maximum projected height of about 49 Mm (see Fig. 2) and then moved laterally. As for Ab_2, it only reached a maximum projected height of about 35 Mm (also see Fig. 2) and then returned. The bottom panels of Fig. 1 show the failed eruption at 131 Å. Obviously, there existed some bright arch structures ("Ar") overlying the filament before the flare

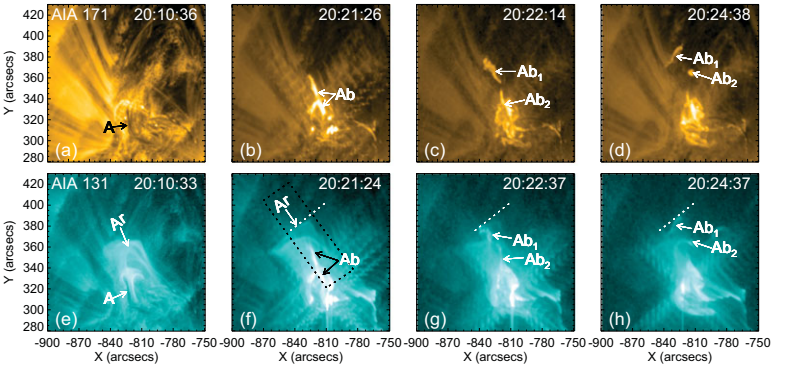

Figure 1. AIA 171Å and 131 Å images showing the filament eruption.

(see Fig. 1(e)). According to the observations in the other AIA passbands, it was found that these arches were only visible as emission in the 131 Å and 94 Å channels. As the flare commenced, Ar started to expand upwardly. After a rapid expanding for about 2 minutes, at 20:21 UT, the apex of Ar quickly stopped at a projected height of ∼49 Mm (indicated by the dotted lines in Fig. 1(f)-(g)). When the following filament Ab_1 reached the same altitude about one minute later, it did not keep rising but moved laterally under and along the apex of Ar, as shown in Fig. 1(g) and (h).

The detailed kinetics of Ar, Ab_1, and Ab_2 are shown in Fig. 2. Panels (a) and (b) are the time-slit maps along the wide slit (indicated by the dotted box in Fig. 1(f)) from the AIA 131 Å and 171 Å images, respectively. From these time-distance diagrams, we can clearly see that Ar was invisible at 171 Å, but present in the 131 Å wavebands. The time variations of the mean projected heights and the derived velocities of Ar (plus, dashed), Ab_1 (asterisk, dash dot), and Ab_2 (diamond, dash dot dot) are plotted in Fig. 2(c) and (d), respectively. During the rapid expanding phase, Ar was accelerated with an increased velocity from tens of km s^{-1} to more than 200 km s^{-1}. Then, the apex of Ar quickly stopped at a projected height of about 49 Mm. Ab_1 firstly erupted from the lower corona with a mean upward velocity of about 320 km s^{-1}. When it approached the apex of Ar, it was prevented to rise up by the overlying Ar, with a mean deceleration of about 2.7 km s^{-2}. This value is near to ten times that of the solar gravitational deceleration and is comparable to that reported by Ji *et al.* (2003). As for Ab_2, its velocity rapidly declined from more than 350 km s^{-1} to zero during a period of about 2 minutes, which derives a mean deceleration of about 2.9 km s^{-2} similar to that of Ab_1.

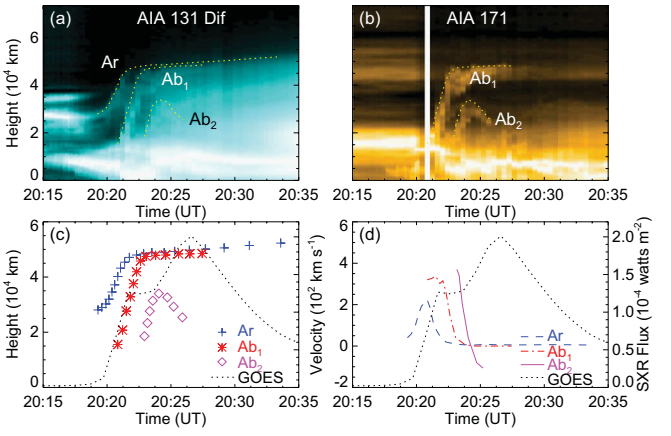

Figure 2. Time-slit maps from AIA 131 Å (a) and 171 Å (b) images; Time variations of the mean projected heights (c) and the derived velocities (d) of Ar, Ab_1, and Ab_2.

According to these results, it is very likely that the closed overlying EUV arches played a crucial role in preventing the successful eruption of the filament (e.g., Liu *et al.* 2009, Schmieder *et al.* 2013).

Acknowledgements

We thank the SDO/AIA and STEREO teams for data support. The work was supported by the NSFC (11103090, 41204124, 40825014 and 41331068), SPNSF (ZR2011AQ009) and CAS/NAO (KLSA201209).

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Schmieder, B., Démoulin, P., & Aulanier, G. 2013, *Adv. Sp. Res.*, 51, 1967

https://doi.org/10.1017/S1743921313011289 Published online by Cambridge University Press