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Fine Magnetic Structure and Formation Mechanism of Solar Filaments

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Filaments or prominences are cold and dense plasma supported by coronal magnetic fields in the hot and tenuous corona. The eruption of filaments is an important solar source for producing coronal mass ejections in interplanetary space and causes geomagnetic storms. In historical literature, problems with the fine structures, formation, and eruption mechanisms of soar filaments and prominences are still unclear [1,2]. Therefore, the study of solar filaments is the most important topic in solar physics and has been studied intensively over the past several decades. High spatiotemporal resolution observations have achieved significant advances in this field of study. In this talk, I will introduce our recent studies on the formation, magnetic structure, and eruption mechanisms based on multi-wavelength and multi-angle high-resolution ground-based and space-borne solar telescopes, and these results might shed some light on the full understanding of solar filaments [3].

On the magnetic structure of prominences, high spatiotemporal observations reveal that there are many complex fine structures in a typical prominence, for example, the co-existence of vertical and horizontal fine magnetic threads and curious phenomena including prominence bubbles, plumes, and mass flows inside the prominence body (see Figure 1 for example). These new observational results raised new questions about our understanding of the magnetic structure of prominences.

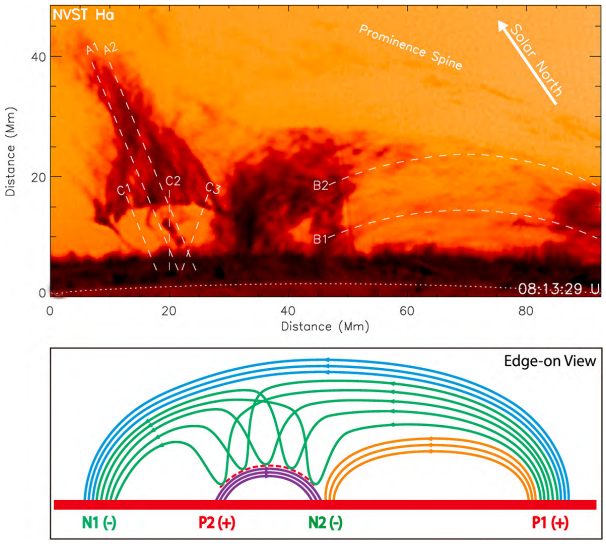

Figure 1. The top is a prominence observed by the New Vaccum Solar Telescope, which shows horizontal and vertical threads, bubble and plume structures. The bottom is a cartoon showing the edge-on view of the prominence's magnetic structures [3].

Besides the fine structures observed in prominences, some filaments seem composed of two distinct branches separating in height [4]. Such a new structure means we should re-understand the traditional filament and coronal mass ejection models. Many authors are interested in the formation of such a strange magnetic flux rope structure. It was first proposed that there are two types of double-decker filament structures. One comprises two separated flux ropes, while the other comprises a flux rope above a shear arcade. Some previous observations found that the formation of a double-decker filament can be due to the separation of an original single flux rope or by an emerging flux rope from below an original one [4,6].

We recently reported that a double-decker filament can be formed by two successive tether-cutting eruptions, as the cartoon model shown in Figure 2. The proposed model is based on true observations, in which we observed the successive formation of two flux ropes from the same polarity inversion line due to the converging and shearing motion of the opposite polarities on the two sides of the polarity inversion line [7,8]. These new findings greatly advanced our understanding of filaments and prominence, and more observational and theoretical studies are desirable in the future.

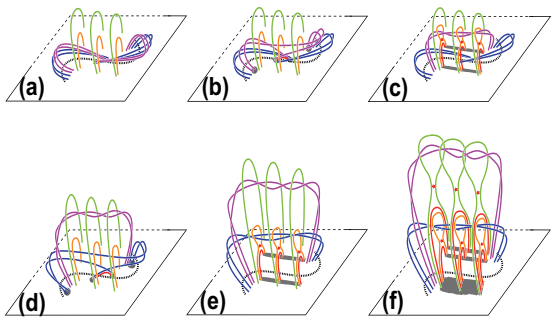

Figure 2. The cartoon model illustrates the formation mechanism of a double-decker filament via two successive tether-cutting eruptions [7,8].

References

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