Relating a Prominence Observed from the Solar Optical Telescope on the Hinode Satellite to Known 3-D Structures of Filaments

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Abstract. We address only a first step in relating limb and disk observations by illustrating and comparing the spines and barbs of three different quiescent prominences and filaments observed in Hα by three different telescopes. Although the appearance of the three quiescent prominences is quite different, we show that each consists of a spine, barbs extending from the spine, and arcs at the base of some of the curtains of barb threads.

1. Similarities Among Different-Appearing Quiescent Prominences

If we verify that we are comparing the same type of prominence, we can apply what we have learned from ground-based observations and other space-based observations to the Hinode Solar Optical Telescope (SOT) images and vice-versa. The three quiescent prominences (or filaments against the disk) that we compare are shown in Figure 1. The SOT image on 2007 Apr 25 is in the lower right. Across the top are shown three images of the prominence observed from the east limb to the west limb at Helio Research for the dates 2001 Sep 30, Oct 2 and Oct 3. The third quiescent prominence in the lower left was observed in high resolution at the Swedish Solar Telescope (SST) on 2003 Aug 25-26. All three of the prominences were taller than 50,000 km and over 200,000 km long. The appearance of the three prominences is quite different. The purpose of this poster paper was to point to the reasons for these differences and to provide evidence that the basic structure of these prominences is similar. They all have a spine, barbs which extend to the sides of the spine, and dynamic arcs at the base of some of the barbs. Each of these structural elements consists of fine threads of similar dimensions (Lin et al. 2005).

2. Comparison of Spines

We demonstrated that all three prominences have a spine partially seen in Hα in differing degrees in the three prominences. Most of the spine of the SOT prominence is invisible against the disk as found in the Mauna Loa full disk images. However, in STEREO Ahead images in 304A from EUVI/SECCHI, the
spine is visible against the disk three or more days prior to the SOT image. The spine was oriented nearly east-west and thus, when the prominence was observed by SOT, it is viewed from its east end and slightly from the north side as it passes beyond the limb. The large vertical structure in SOT cannot be the spine. However, if some threads of the spine were visible, they would appear to be vertical from our end view of the prominence.

What we mainly see in the SOT image is the threads of two tall barbs of the prominence above and beyond the limb. In Figure 2, the two barbs without a connecting spine can be seen against the disk in the Hα images from Mauna Loa on Apr 25. We verified that these are barbs from the STEREO Ahead images showing the prominence against the disk on Apr 25. The end view of two filament barbs, one on each side of the spine, yields a conical structure (see example in Lin, Martin and Engvold 2008). However, without the spine being visible above the limb, one cannot distinguish the barb on the left side of the spine from the one on the right side.

Some threads of the horizontal spine are visible in 304Å equatorward and much lower than the tall dominant structure in SOT image in Figure 1. The SOT image similarly reveals a few horizontal threads already over the limb that appear to be part of the spine. For an explanation of the reasons why the spine
Figure 2. Images of the *Hinode* / SOT prominence in Fig.1 before and at the west limb on 2007 April 23 and 25. The left column contains sections of Hα images from the Mauna Loa Solar Observatory Hα full disk telescope. The right column shows sections of 304Å images from the SECCHI/EUVI instrument on *STEREO*. The spine of the filament is seen at 304Å but only two barbs of the filament are visible in Hα. The arrows span the zone where the dark part of the prominence in 304Å crosses the limb.

is mostly invisible in Hα and visible in 304Å, we refer the reader to Master’s thesis of Yong Lin (2000).

The spine of the filament observed at Helio Research is visible in Figure 1. We include three images to show the longevity of the spine and barbs of this prominence. However, very little of the spine is seen in this prominence against the disk. The spine is a vertical sheet and our view of it from above is unfavorable for viewing a thin ribbon of mass except where it bends eastward. Second, the density of the spine is too low for much of it to be seen.

The spine in our third example is much more conspicuous because it contains more threads in Hα in our line-of-sight and this makes the spine darker. The darkness of filaments and the visibility of their structures are also strongly dependent upon the height of filaments (Lin 2000) and the magnetic flux density of the network magnetic fields in the photosphere surrounding the filament.

### 3. Comparison of Barbs

The images in Figure 1 are rotated relative to the Helio Research images such that the threads of the barbs are nearly aligned. This arrangement allows us to better compare the threads of barbs which are characteristic of the fine structure of all quiescent prominences (Engvold 1976; Martin, Lin and Engvold 2008). The SST image of the barb on the right of the spine reveals how the threads of barbs typically connect to the spine while in the barb on the left, parts of some threads (dashed line), are invisible where they connect to the spine. In the SOT image,
the view of the barbs is from the east end of the filament (Fig 2). For a similar end view of the SST and Helio Research images as from SOT, one would have to be standing on the chromosphere facing the barb structure at the position of the black arrows on the images. From this vantage point, all the threads in the barbs would appear vertical as in the SOT image.

4. Comparison of Arcs

Each of the arrows in Figure 1 also points to an arc at the base of the barbs. The arcs generally rise slowly with time but less rapidly than the magnetic bubbles studied by Berger et al. (2008). They might or might not be the same physical phenomena as the faster moving bubbles. One sees generally a downflow above the arcs rather than counterstreaming which is nearly everywhere in the spines and barbs of quiescent prominences and filaments. Below the arcs there appears to be a void of mass. The contrast of the structure above and the absence of structure below the arcs cause them to stand out even when other structures are sometimes superposed in the line-of-sight. The arcs represent a change in the direction of downflows from the threads above. The arcs have a wide range of sizes and they are common. We suggest that at least some of the more slowly changing arcs represent the magnetic interface between prominence magnetic fields and the intranetwork magnetic fields within supergranules immediately below the barb threads that appear to terminate at the arcs.

5. Conclusion

We have shown that in spite of large apparent differences between quiescent prominences and filaments, all are composed of the same fine thread structure and this fine structure takes the form of three basic structures: spines, barbs which branch from a spine and arcs which form and change at the lower apparent endpoints of many barbs.

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References