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Filament Channels: Contrasting Their Structure in Hα and He I 1083 nm

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Abstract. From a direct comparison, we find that filament channels are more easily detected in He I λ1083 than in Hα, particularly for polar crown filaments. He I 1083 nm filament channels appear to coincide with the outer boundaries of *Yohkoh*/SXT X-ray cavities.

1. Filament Channels in He I λ1083

Filament channels occur along polarity inversions that separate magnetic fields of opposite magnetic polarity. They may or may not have a filament within their boundaries, but their existence is a necessary condition for the formation of a filament. In He I λ1083 nm images, filament channels are observed as brighter, elongated structures. As shown in Figure 1, they are easily distinguished from the similar-appearing coronal holes by the characteristics of the underlying magnetic field.

This paper compares the properties of He I 1083 nm filament channels in relation to those in Hα and to coronal cavities that surround filaments/prominences. We make use of five data sets: the National Solar Observatory at Kitt Peak (NSO/KP) daily high-resolution (1–2 arc-sec pixels), full-disk observations of the line-of-sight photospheric (λ868.8 nm) and chromospheric (λ854.2 nm) magnetic fields and He I λ1083 nm equivalent width; the Ottawa River Solar Observatory (ORSO) daily center-line and off-band Hα high-resolution ($\leq$ 0.5 arc-sec pixels), limited-field surveys of the entire solar disk; the *Yohkoh*/Soft X-ray Telescope (SXT) full-disk X-ray images taken in the thin Al and AlMg filter with a pixel size of 5 arc-sec.

2. Comparison of Filament Channels in He I λ1083 and Hα

A comparative study of filament channels in He I λ1083 nm and Hα was made for several days in 1978, 1979 and 1992. Figure 1 shows one example of an area of the northern hemisphere on July 14, 1979. This area of the Sun includes a polar-crown filament (N47E41 to N67W22) and two segmented filaments in the latitude range N20 to N30. Several smaller filaments are also seen in the Hα

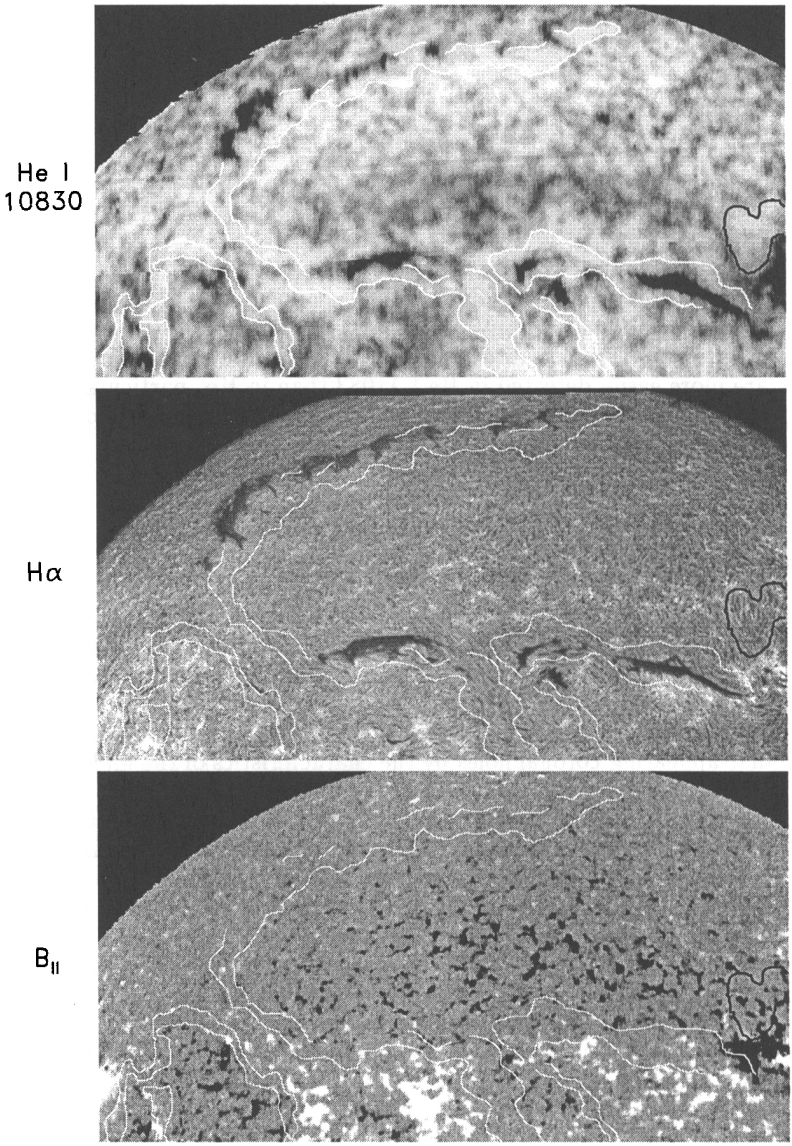

Figure 1. *Top:* NSO/KP He I λ1083 nm spectroheliogram on an inverse equivalent width scale (1741 UT). *Middle:* ORSO Hα filtergram (1412 UT). *Bottom:* NSO/KP magnetogram (1630 UT) of a portion of the northern hemisphere on July 14, 1979. The He I 1083 filament channels are outlined in *white* and a coronal hole in *black* in all three panels. North is at the top and East to the left.

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filtergram.

The He I 1083 nm filament channels, outlined in Figure 1 and as described above, are elongated structures along almost every polarity inversion in Figure 1. The mean equivalent width of the channels is 29–35 mÅ, comparable to that of the interiors of supergranular cells, which are partially or completely enclosed by enhanced He I 1083 nm absorption associated with magnetic network fragments at the edges of the cells, and to that of coronal holes.

Many of the He I 1083 filament channels located in stronger magnetic flux of decaying active regions exhibit a corridor of Hα fibrils that are nearly aligned with the polarity inversion (Figure 1, middle panel), an Hα characteristic first noted by Foukal (1971) and later by Martin, Bilimoria and Tracadas (1994). The width of the He I 1083 filament channel across the polarity inversion corresponds to the width of the pattern of aligned Hα fibrils. These properties are observed whether or not the channel is occupied by a filament.

In the area of the polar-crown filament at higher latitudes, there is no obvious alignment of the Hα fibrils along the polarity inversion, although the polar-crown filament channel is easily detected in the He I 1083 image. Since polar-crown filaments extend to a greater height than those filaments in stronger fields, it may be that the alignment of Hα fibrils along a polarity inversion is related to the height of a filament or its corresponding magnetic structure.

3. Comparison of a Filament Channel in He I λ10830 and an X-ray Prominence Cavity

A persistent coronal cavity was observed by *Yohkoh*/SXT on several successive limb crossings during June–August 1997 (Hudson, Acton and Harvey 1998). This X-ray cavity is compared on July 4, 1997 in Figure 2 with the corresponding NSO/KP He I 1083 spectroheliogram. The filament associated with this cavity can be seen on the disk and at the limb in both He I 1083 nm and Hα extending to 59,000 km above the limb at 0100 UT. Although there is a 15-hour time difference between the He I 1083 and X-ray observations, we do not expect the relative positions of the channel and the X-ray emission to change, because of the east-west orientation of the filament channel. It appears from this comparison, as well on other limb crossings, that the boundaries of the filament channel coincide with the outer boundaries of the X-ray cavity. This correspondence hints that the appearance of the He I 1083 channel may be related to the lower density and X-ray emission that is typically observed in the overlying cavity (Tandberg-Hanssen 1974 and references therein, Serio et al. 1978).

The prominence, similar in height and structure in Hα, He I 1083 nm, and the SOHO/EIT He II 30.4 nm images, is centered below the enhanced X-ray emission structure located within the cavity. The top of the prominence at the time of the X-ray image extends just inside of the bottom of this structure, as shown in Figure 2.

4. Conclusions

He I λ1083 nm filament channels, which appear bright and almost devoid of structures, correspond to the corridor of Hα fibrils aligned along polarity in-

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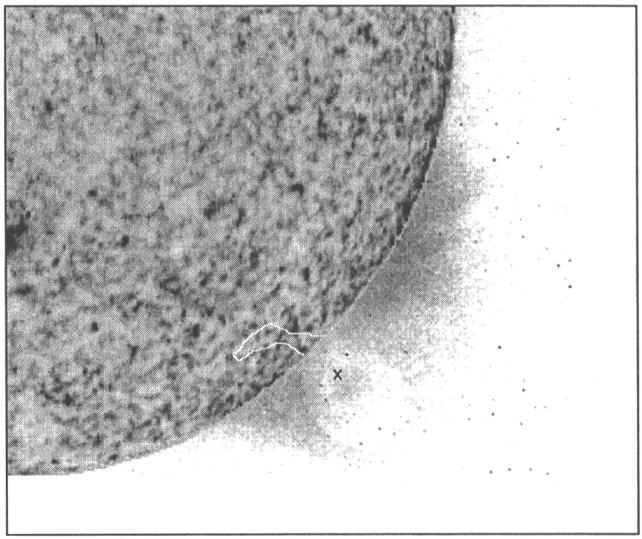

Figure 2. The southwest quadrant of the NSO/KP He I λ1083 nm spectroheliogram (1520 UT) superimposed on a *Yohkoh*/SXT image (0002 UT) on July 4, 1997. The filament channel at the base of the X-ray cavity is outlined in white. An × marks the top of the prominence observed on the limb at 0108 UT.

versions in stronger magnetic field regions. However, in weaker field regions, such as the polar crown, filament channels are clearly visible in He I 1083 nm images, but generally not in Hα. This result suggests that He I 1083 nm is a more sensitive indicator of a filament channel. The fibril alignment seen in Hα may be related to the height of a filament and its magnetic structure; the higher the filament, the less evidence of fibrils aligned with the polarity inversion. The boundaries of the He I 1083 nm appear to coincide with the outer boundaries of *Yohkoh*/SXT X-ray cavities.

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