

FINE STRUCTURE OF THE SOLAR CHROMOSPHERE: LIMB - CROSSING SPICULES

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ABSTRACT

From limb observations obtained at the Sacramento Peak Observatory at $H\alpha \pm 0.75 \text{ \AA}$, we studied the $H\alpha$ chromospheric mottles crossing the solar limb. Apart for the individual dark and bright mottles crossing the solar limb, we observed bushes, as parts of the chromospheric network (rosettes) crossing the solar limb and structures on the limb indicating probably arch shaped mottles.

OBSERVATIONS AND IMAGE PROCESSING

The observations were obtained with the Vacuum tower telescope of the Sacramento Peak Observatory at $H\alpha \pm 0.75 \text{ \AA}$, on April 8, 1995, near the solar limb (S 10.6° , E 74.3°), with the Universal Birefringent Filter and a 1024 X 1024 pixel CCD camera. The field of view is 200" X 240" and the time difference between the two $H\alpha$ wings is 15 sec, while the time difference between consequent pictures of the same wavelength is one minute.

The CCD images were corrected for the dark current and the flat field. Moreover we corrected the images for limb darkening in order to see the fine structure of the chromosphere near and beyond the solar limb.

RESULTS

Although spicules are one of the most studied phenomena of the solar chromosphere, many problems related to them still remain unanswerable and controversial. An old controversy is whether the dark mottles which cross the solar limb appear as spicules, since the conditions in the vicinity of the limb do not permit the observer to see both features, on the disc and beyond the limb at the same time (Bhavilai, 1965; Koutchmy and Macris, 1971; Macris, 1956, 1957; de Jager, 1957).

The method of correction we used allows us to study the chromospheric structures simultaneously above the limb and on the disk.

April 8 1995 17:07:50 124" x 37"



Figure 1. Images of the solar limb at $H\alpha + 0.75 \text{ \AA}$. (a), (b) before and after the correction for the limb darkening and (c) the image (a) processed using a high pass filter (Johannesson and Zirin, 1997). The inner limb continue to be clear in all processed images.

In figure 1 we present three different views of one of the images of the solar limb, before (a) and after (b) the correction for limb darkening, as well as after processing with a high pass filter (c). The correction shows very clearly the spicules and improves the appearance of the near the limb disk structures. It is remarkable that a significant number of spicules cross the limb. In figures 2, 3 and 4 we present some characteristic cases. The limb-crossing spicules are marked by arrows. The dopplergrams which accompany the $H\alpha$ images show line of sight velocities for the majority of limb-crossing spicules with directions towards and away from the observer.

In figure 4 one can see the evolution of a small chromospheric network cell which is at a sort distance from the solar limb (63 000 km), in different phases of its evolution. Some of the mottles which originate in the bush cross clearly the limb.

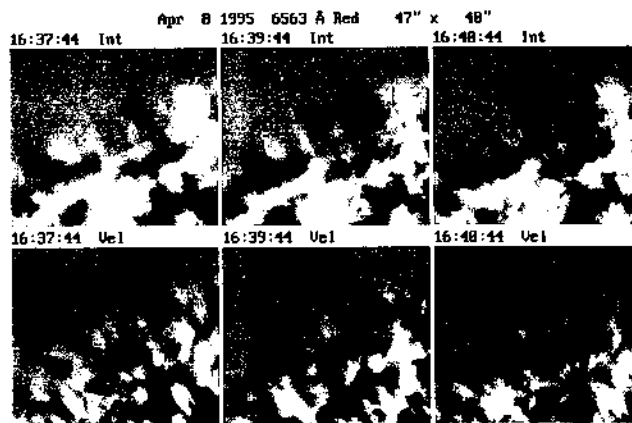


Figure 2. $H\alpha + 0.75 \text{ \AA}$ Intensity (top) and Velocity (bellow) images of the limb. There is a significant number of dark mottles crossing the limb. Some of them are indicated by arrows.

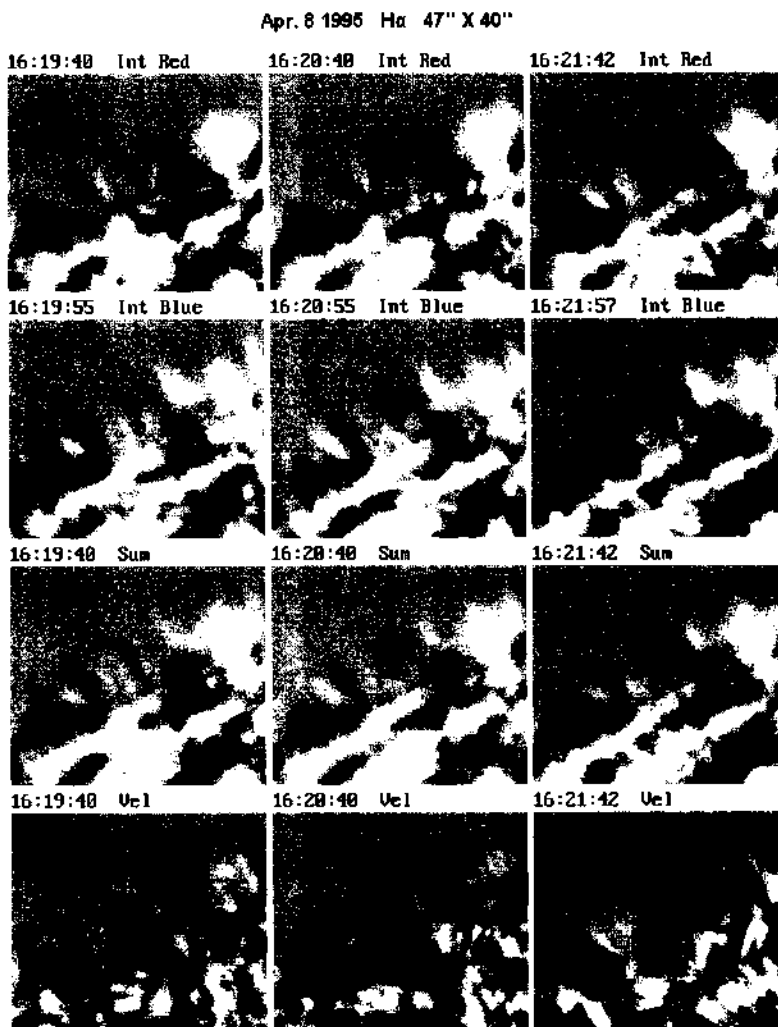


Figure 3. A pair of spicules develops and crosses the limb. One of the spicules of the pair has a line of sight velocity away from the observer.

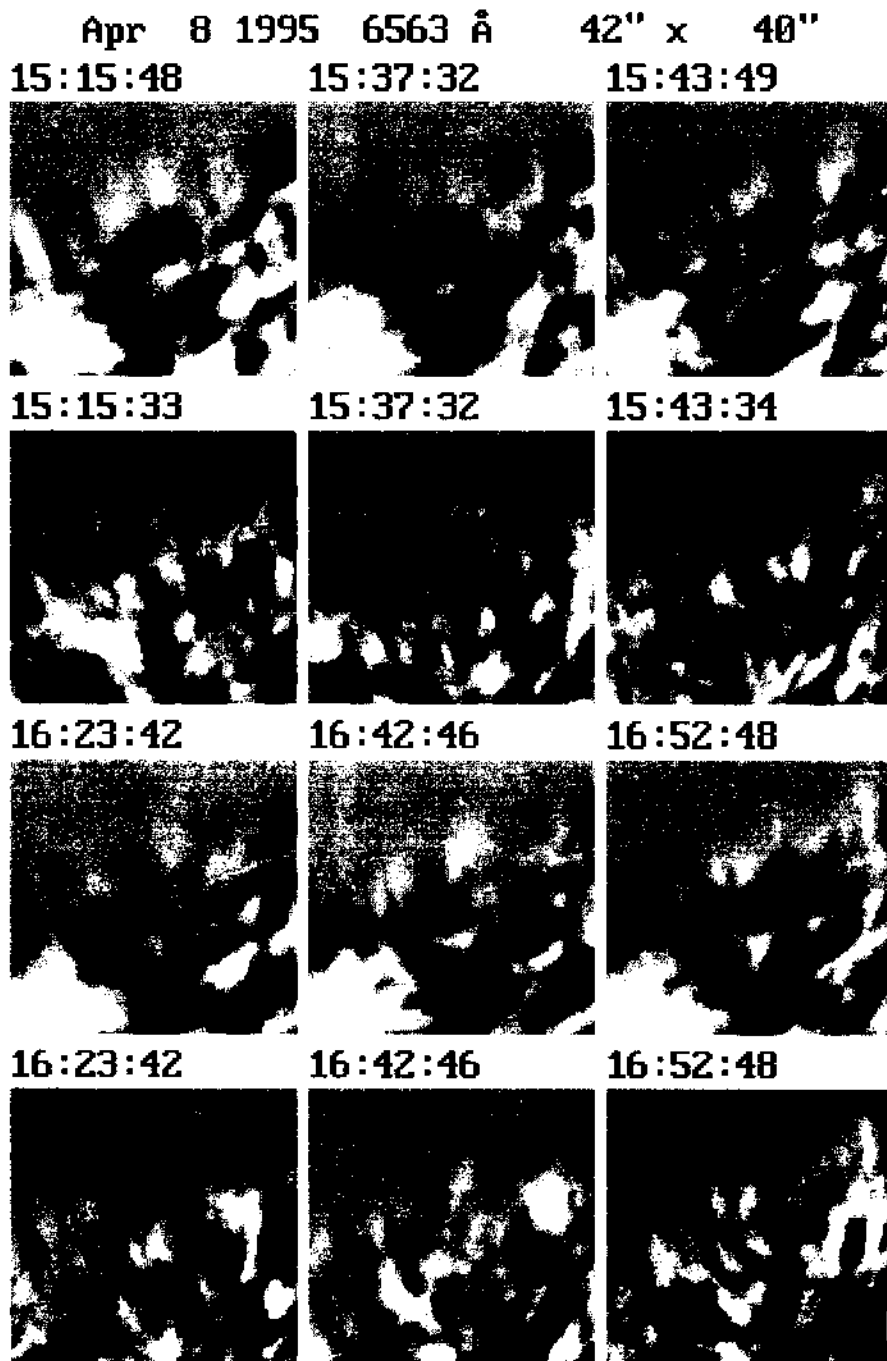


Figure 4. Chromospheric network cells crossing the limb. $H\alpha + 0.75 \text{ \AA}$ and $H\alpha - 0.75 \text{ \AA}$ (first and third rows) and velocity (second and fourth rows).

In figure 5 we give a possible arch-shaped configuration of dark and bright spicules on the limb. The upper part of the arch is not clearly distinguished, but the shape is

the same as the arch shape mottles which bridge adjacent bushes of chromospheric network near the solar limb (Bhavilai, 1965, Zachariadis et al., 1999).

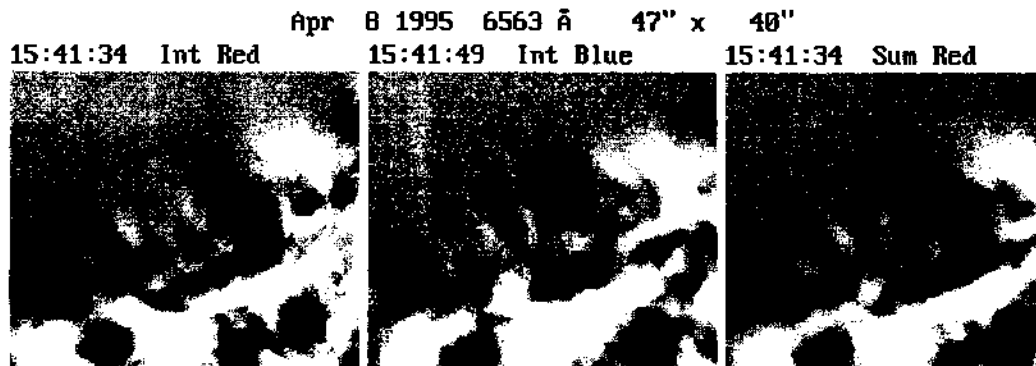


Figure 5. Arch shaped mottles at the chromospheric limb, bridging adjacent bushes of the chromospheric network; (a) $H\alpha - 0.75 \text{ \AA}$, (b) Intensity and (c) $H\alpha + 0.75 \text{ \AA}$.

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