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Line broadening of EUV lines across the solar limb observed by SUMER/SOHO

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Abstract. We analyze time series scans of the solar limb performed by the spectrometer SUMER on-board the SoHO satellite. The analyzed dataset consists of observations obtained in the C III 977Å line. After applying the standard SUMER data reduction procedure, we perform a one line Gaussian fit to the profiles to obtain different parameters for each pixel within the scans. Studying the variations of the line width from the disk to the limb and off-limb we find that it increases off-limb and shows a peak at $\sim 15''$ above the limb. We suggest that this increase is due to the random directions of several spicules found along the line of sight.

Keywords. Sun: solar limb; spicules; line broadening

1. Introduction

Broadening of line profiles has been investigated by numerous authors, since it can provide important information concerning ion temperatures, sub-resolution turbulent motions, velocity fluctuations associated with MHD waves and, if coronal lines are involved, information on coronal heating. Line broadening, when observed in solar transition region lines, peaks at about $10''$–$15''$ above the limb (Mariska *et al.* 1979, Peter *et al.* 2003). The physical origin of this excessive broadening still remains controversial. A possible correlation between this behavior and solar spicules is given by Doyle *et al.* (2005).

2. Observations and data reduction

The data set used in this study was obtained with the SUMER spectrometer on-board the SoHO satellite. It consists of a time series obtained at the south polar coronal hole (PCH) taken on February 21, 1997 from 01:20 to 01:36 UT. The targeting of the instrument was at a fixed position with Solar X at $0''$ and Solar Y at $-984.75''$. Slit 3 (i.e. $1'' \times 300''$ top) and detector B were used for taking the 15s exposures. Various corrections have been applied to the data using the standard SUMER reduction software. An automated one line Gaussian fit was applied giving a set of parameters (i.e. line intensity, line center position and FWHM) for each pixel within the dataset.

3. Time series data at the south polar coronal hole

In figure 1 (left) the time evolution of the C III 977Å line intensity in the observed region is displayed. Although this time series lasts for only $\sim$15 min, an intense spicule activity can be detected, which is more clearly seen in the dopplergram in figure 1 (right) as alternating red (tones of white) and blue shifts (tones of black) with respect to time.

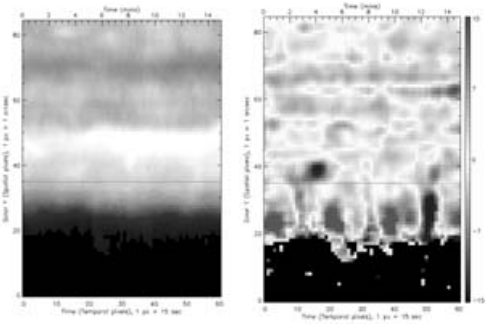

Figure 1. *Left:* Time series of the C III 977Å line intensity. *Right:* Dopplergram of the C III 977Å time series. The bar on the right represents Doppler shifts in $\mathrm{km\,s^{-1}}$, (redshifts in tones of white and blueshifts in tones of black). The horizontal line shows the continuum limb.

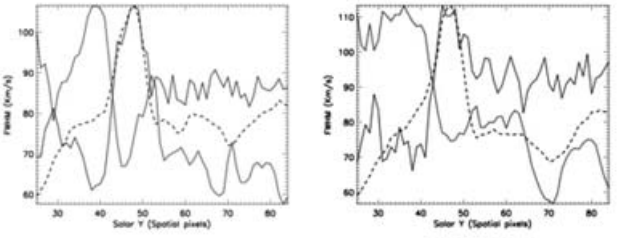

Figure 2. FWHM variations. Line intensity and continuum normalized to the non-thermal velocity range of values and peaking at $\sim 48''$ are also shown.

In figure 2 (left) the variations of the FWHM in the region observed from 4.5 to 6.5 mins corresponding to a red-shifted area and in figure 2 (right) the variations of the FWHM in the region observed from 11.5 to 13 mins corresponding to a blue-shifted area are shown. In both regions the FWHM peaks at $\sim 10''$ - $15''$ above the line continuum limb (shown by the horizontal line in figure 1). Notice, that in both regions, even though we are far above the limb at heights where there is no evidence for a significant plasma presence we still observe line shifts and line width broadenings. This means that low intensity spicules are present and can contribute to the broadening of a line's profile.

4. Conclusions

We suggest that the observed increase of line broadening off-limb is due to spicules. This broadening could be due to (a) the random directions of many spicules observed along the line-of-sight which can give a wide line profile as a result and/or (b) the non-thermal motions within spicules.

Acknowledgements

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