ANALYSIS OF THE DOPPLER SHIFTS OF SPECTRAL LINES OBTAINED BY THE CDS/SOHO INSTRUMENT

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Abstract. SOHO/CDS measurements of the quiet Sun chromospheric He I 584.33 Å and transition region O V 629.73 Å spectral lines are used to study ability of the CDS instrument to detect the Doppler shifts of spectral lines in the supergranular network and internetwork using short exposures. Precise analysis has shown that the CDS instrument is not suitable for the detection of the mass motion in the internetwork, but in contrast, it is suitable for such detection in the network.

1. Introduction

The launch of SOHO in 1995 brought new opportunities to study the small-scale and short-time dynamical events. Explosive events were confirmed by the SUMER spectrometer (Innes *et al.*, 1997) and new types of eruptive events have been also revealed, e.g., blinkers by CDS (Harrison, 1997) and bright points by EIT (Zhang *et al.*, 2001). Now it is aimed to identify all these different types of eruptive events by the same instrument and to describe their dynamics. For this reason it is necessary to obtain not only information about line intensities but also information about Doppler shifts of spectral lines and their absolute calibration. In this contribution it is investigated whether data obtained by the CDS instrument are suitable for such task.

In particular, emission spectral lines of He I 584.33 Å (2.0×10^4 K) and O V 629.73 Å (2.5×10^5 K) were observed in the quiet Sun supergranular network

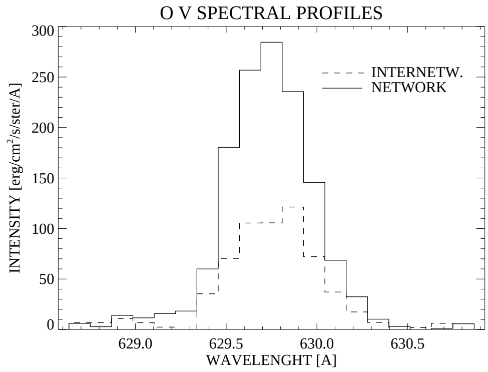

Figure 1. The characteristic spectral profiles of the O V 629.73 Å spectral line of the quiet Sun internetwork (dashed line) and network (solid line) obtained with the exposure time of 5 s.

and internetwork near disk center between 23:25 UT and 23:53 UT on May 14, 1998 by the CDS/NIS instrument (Harrison, 1995) using 'sit-and-stare' observational mode. 190 spectral images were obtained using the 2" $\times$240" slit with an exposure time of 5 s and with a cadence of 9.1 s. The spectra were corrected for the instrumental features of the CDS/NIS instrument[1] and converted to the physical units: intensity to erg $\mathrm{cm^{-2}s^{-1}sr^{-1}Å^{-1}}$ and the Doppler shifts to km $\mathrm{s^{-1}}$. The characteristic O V spectral profiles of the internetwork and network are displayed in Fig. 1. Single Gaussian profile with linear background was fitted to each spectral profile using relative weights of the data.[2] The wavelength scales were adjusted using the mean redshift of the transition region lines (Peter and Judge, 1999) and their laboratory wavelengths (Macpherson and Jordan, 1999). The resulting 2D maps of O V line intensities and Doppler shifts are given in Fig. 2.

2. Results

The absolute calibration of the Doppler shifts of spectral lines is very important for identification of the different small-scale eruptive events. Addressing this goal at first the mean spectral profiles for network (5" $\times$190 exposures) and for internetwork (7" $\times$190 exposures) of the He I and O V spectral lines were calculated as the first order approximation. The Doppler shifts of these mean spectral profiles showed that internetwork (He I $= 5.64 \pm 3.6$ km/s; O V $= 12.3 \pm$ 4.7 km/s) is more red-shifted than network (He I $= 4.62 \pm$ 2.1 km/s; O V $= 10.9 \pm 3.2$ km/s). After careful inspection it was found that

[1] Details: http://solg2.bnsc.rl.ac.uk/software/uguide/uguide.shtml
[2] CDS Software Note nr. 47: http://orpheus.nascom.nasa.gov/cds/home/swnotes

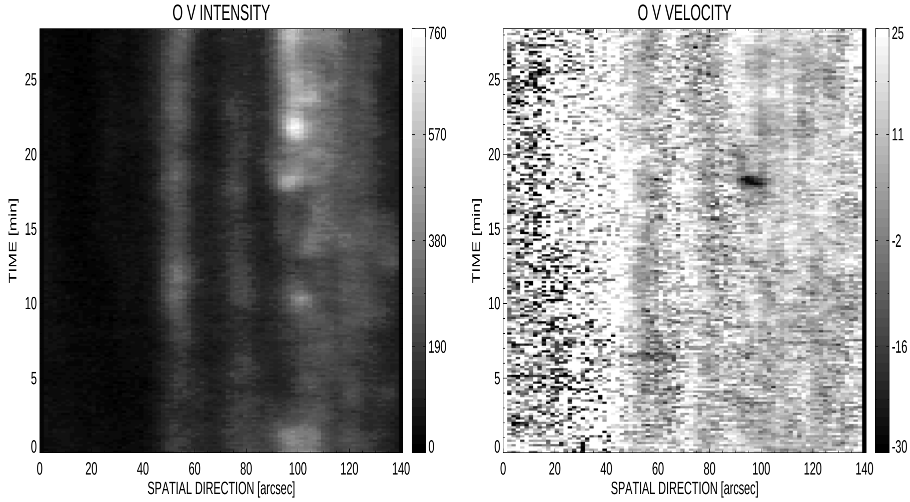

Figure 2. 2D space-time maps of the O V line intensities and the Doppler shifts. The horizontal axis describes spatial direction and the vertical axis describes time. The solar rotation was not compensated, so the vertical axis presents also the spatial extent of the observed solar features. Internetwork area was selected in the area between 62" and 69" and network area between 111" and 116". Intensities are given in erg cm^{-2}s^{-1}sr^{-1}Å^{-1} and the Doppler shifts in km s^{-1}. Positive values of the Doppler shifts are toward the solar surface and negative values toward the observer.

this contradictory result is probably caused by weak and noisy spectral profiles, which were included into averaging. Therefore we estimated the average network Doppler shift errors, which were found to be ± 2.1 km/s for He I and ± 3.2 km/s for O V lines respectively. Only the spectral profiles which had smaller errors of the Doppler shifts then the average network Doppler shift errors were selected from the whole data set for averaging. However there were no data with such small errors of the Doppler shift in the internetwork. The dependence of the relative cumulative number of exposures from internetwork and network on the Doppler shift errors for the O V line was constructed (Fig. 3; left panel) in order to confirm our idea. Values of the Doppler shifts of O V line in the internetwork and network as the function of the Doppler shifts errors are also shown (Fig 3; right panel). When only spectral data of very small error of the Doppler shift (only few in internetwork) were used then network was more red-shifted than internetwork. Very similar results were obtained also for the He I spectral line. Effect of binning was also studied to obtain more data with small error of the Doppler shift in internetwork. In particular, binning of area 6.7"$\times$ 10 s (4 pixels along the slit $\times$ 2 exposures) was made, but the number of applicable spectral profiles has not increased substantially.

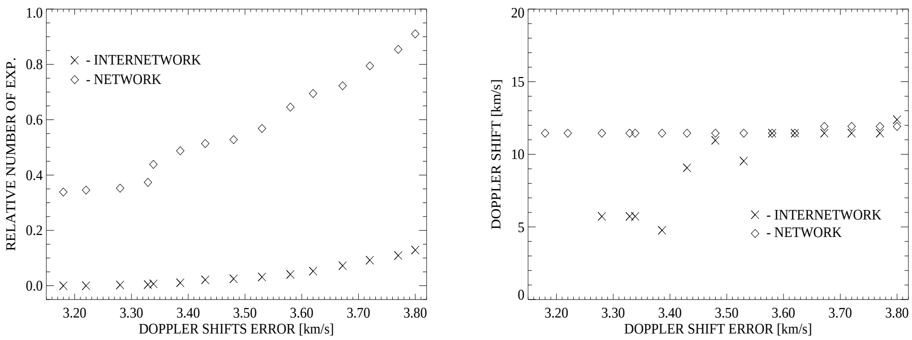

Figure 3. Left panel: Relative cumulative number of exposures from the internetwork and network as a function of the Doppler shift errors of O V line. Right panel: Doppler shifts of O V spectral line in internetwork and in network as the function of the Doppler shifts errors.

3. Conclusions

Very short exposure times (less than 10 s) are not suitable for detection of dynamics of internetwork dynamical events in the quiet Sun by CDS instrument because of low S/N ratio even in the most prominent spectral lines. Nevertheless the Doppler shifts of spectral lines obtained from supergranular network are proper for identification of small-scale eruptive events (Gömöry *et al.*, 2003).

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