WAVE PROPERTIES IN THE UPPER CHROMOSPHERE AND AT THE BASE OF THE CORONA

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Abstract. From a 83 min long sequence of observations of Ca II K and He I (1083 nm) line profiles, some dynamical properties of the main components of the quiet upper chromosphere are derived: for both the magnetic network and the internetwork, amplitude and phase spectra of the Doppler velocities are presented.

Key words: Sun – Chromosphere – Corona – Oscillations

1. Introduction

Wave heating of the chromosphere and the corona is a viable mechanism which needs detailed observations for confirmation (Zirker, 1993). In this respect, it is especially important to measure the velocity fields (Mein and Mein, 1976) at two well-separated heights in the atmosphere.

The observations we consider here were simultaneously performed near Ca II K₃ and 1083 nm He I lines, formed respectively from 900 to 1,700 km and from 1,600 to 1,900 km (Avrett and Loeser, 1992), in an average quiet Sun atmosphere.

Two typical regions of the chromosphere were studied: an Active Network (AN) region and a Quiet Region (QR) free of prominent and/or vertical magnetic field.

2. Observations and Data Reduction

The observations were performed on March 22, 1993 at the National Solar Observatory (NSO) /Sacramento Peak Vacuum Tower Telescope with the new Horizontal Spectrograph and CCD’s. The final resolutions of the spectra are 1.2 arcsec/px and 5.8 pm/px for Ca II K and 16.2 pm/px for He I. The sequence is 5,000 s long and the sampling interval is 5 s. More details about the observed region and the data processing are given in Bocchialini et al. (1993a,b).

IAU Colloq. 144 “Solar Coronal Structures”, V. Rušin, P. Heinzel, & J.-C. Vial (eds.), 123–125

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3. Results of the Fourier Spectra Analysis and Discussion

To compute Doppler velocity, we used the fast method based on the subtraction of line wing intensity modulations (Bocchialini et al., 1993c). The amplitude Fourier spectra of the computed Doppler velocities are presented for both regions. We found (Fig. 1a) that more power is present at low frequency (LF) at 3 min for QR; at 5 min, the amplitudes are similar for AN and QR. At high frequency (HF), the amplitude in QR is higher than in AN (Fig. 1b).

![Amplitude spectra of K3 velocity LF](image)

![Amplitude spectra of K3 velocity LF and HF](image)

![Amplitude spectra of He I velocity LF](image)

![Amplitude spectra of He I velocity LF and HF](image)

**Figure 1.** Amplitude spectra of K3 velocity (a) at LF, (b) at LF and HF; Amplitude spectra of the He I velocity (c) at LF, (d) at LF and HF; full line: AN, dotted line: QR

In He I, we observe the same properties as in Ca II K3 in the magnetic (AN) and the non-magnetic (QR) regions: a large amount of power is again present near 3-min in QR, and near 5-min in AN; whatever the frequency, more power is present in QR than in AN (Fig. 1c). At HF, the power measured in velocity is once again higher in QR, (Fig. 1d). The power recorded in the magnetic network (AN) is significantly above the noise level (lower than the signal by a factor of 10 to 2 from 10 to 100 mHz).

We conclude that 3 and 5 min oscillations are present in both AN and QR: 3 min oscillations are prominent in QR (and 5 min in AN). However, the power diminishes in the He I, especially in AN: perhaps, the AN “resonator” has a shorter extension towards the transition region; consequently, the line may be formed above the upper boundary of the cavity and is no longer sensitive to the trapped waves.

The variation of the Doppler velocity (V-V) phase difference (He I - Ca II K) for AN is shown for the first time in Figs. 2a,b for LF and HF. Around 3.3 mHz (Fig.
2a), the (V-V) phase difference reaches an average value of 20 degrees (±20 degrees), indicating that the He I velocity is ahead of the K₃ velocity. Around 5 mHz (Fig. 2a), we found a phase difference close to 0. At HF (Fig. 2b), the phase difference exhibits rather stochastic variations. The variation of the (V-V) phase difference for QR is shown at LF in Fig. 2c. At HF (Fig. 2d), nothing significant appears above 20 mHz.

As a preliminary conclusion, we can say that in AN the 5-min wave in He I is about 16 s in advance of K₃. However, these results are being analysed with a more advanced method (wavelet analysis), to be presented in a forthcoming paper.

Acknowledgements. We thank the staff of the VTT at NSO/SP for supporting these observations; financial support was received from the “Action Spécifique Grands Télescopes” of INSU-CNRS and the GdR “Magnetisme dans les Etoiles” of CNRS.

References