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COHERENCE ANALYSIS OF PHOTOSPHERIC LINE PARAMETERS IN ACTIVE AND NON-ACTIVE SOLAR REGIONS

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ABSTRACT Examples of coherence functions between continuum intensity and line center velocity fluctuations are discussed for non active and active regions. It seems that the magnetic field leads to a different phase shift between intensity and velocity fluctuations than for non active regions.

Keywords: Convection; solar granulation; active and non active regions

INTRODUCTION

The dynamics of the overshoot region in the solar photosphere can be studied using spectrograms of high spatial resolution and high dispersion. By selecting a spectral range that contains lines of different strengths, the variation of parameters such as intensity and velocity fluctuations can be followed throughout the whole photosphere. In this way coherence analyses of line parameters derived from spectral lines that are formed at different heights have been performed by several authors. In this paper we compare coherence analyses between temperature (intensity) fields and velocity fields from active (AR) and non active regions (NAR).

OBSERVATIONS AND DATA

The spectrograms were taken photographically using the 70cm VTT and the 45cm GCT telescopes at the solar observatory in Izaña, Tenerife. The exposure times were about 3s. The spectrograms were digitized with a microdensitometer and the relative intensity was computed from standard calibration curves. Finally, the line profiles with the corresponding line parameters were calculated. Further details about the observational aspects can be found in Hanslmeier et al. (1990,1991). The GCT data are from ARs and NARs where activity was defined by means of simultaneously taken CaII slit jaw images. In Table 1 the observed lines and their line core formation heights are given. The line core formation heights for lines I-IV have been estimated using a relation between equivalent width and line core formation height for neutral atoms that has been given by Mattig (1981).

TABLE 1: Observed lines and parameters

Line	Instrument	Element	λ	W_λ[mÅ]	Height [km]
I	VTT	FeI	4911.536	24	70
II	VTT	FeI	4911.782	44	150
III	VTT	NiI	4912.025	47	150
IV	VTT	TiII	4911.199	50	150
V	GCT	FeI	6495.740	42	135
VI	GCT	FeI	6494.994	165	500
VII	GCT	FeI	6494.499	34	105

RESULTS AND DISCUSSION

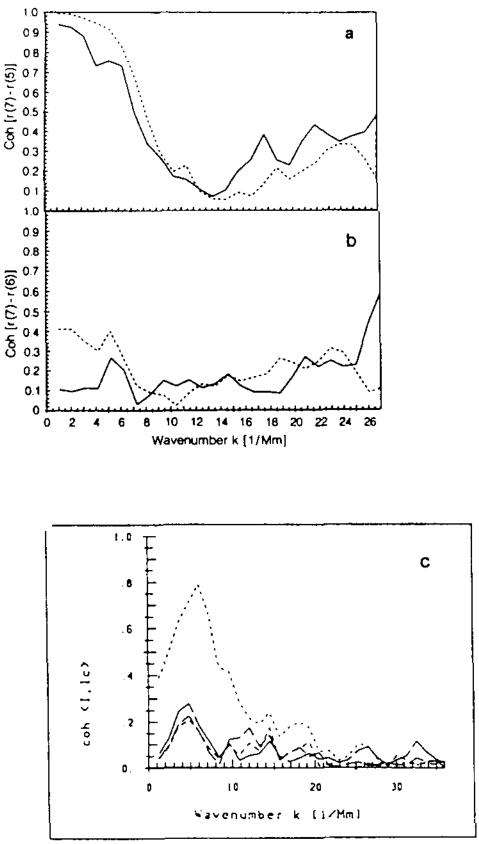
The coherences between intensity fluctuations are shown in Fig. 1a–c. In Figs. 1a,1b the coherences between the intensity fluctuations at the line core of line VII (h=105) and a) at the line cores of line V (h=135km) and b) line VI (h=500km) are shown for NAR (solid line) and AR (dashed line). As it is seen the coherence breaks down rapidly with increasing difference of line core formation height and seems to be slightly enhanced in AR. In Fig. 1c we give the coherence between the continuum intensity and line core intensity fluctuations of lines I–IV from the VTT spectrogram that contained a NAR.Again it is seen that the coherence breaks down for greater height differences. The maximum is about wavenumber k=6Mm^{-1}. The corresponding phase curves, which are not given here, were stable up to k=10Mm^{-1}.

The coherence between intensity and velocity fluctuations is shown by Figs. 2. In Figs. 2a,b,c we give both NAR (solid line) and AR data (dashed line) from the GCT spectrum and we see the decline of the coherence with line core formation height. As is seen in Fig. 2b, the coherence between continuum intensity fluctuations and line center velocity fluctuations is lower in AR than in NAR. The data from the VTT spectrogram shown by Fig. 2d show a higher coherence between δI and δv with a sharp maximum about k=6Mm^{-1}.

The power spectra of continuum intensity and line center velocity fluctuations showed higher values at greater wavenumbers in AR than for NAR. This power enhancement in AR can be explained by larger temperature and velocity fluctuations at smaller spatial scales (higher wavenumbers) and was shown in Hanslmeier et al. (1991).

In no case is a coherence near 1 observed at granular scales. The sharply defined maximum of the coherence for the VTT data may be explained by better observational conditions. A measure for the stability of a coherence function is the corresponding phase curve. Strongly oscillating phases always indicate a breakdown of the coherences. The phase curves between the coherences $\delta I, \delta v$, which are not given here, are shifted from $155^0 \pm 5^0$ for NAR data toward $170^0 \pm 5^0$ for AR data. That means that the magnetic fields contribute toward a phase shift of 180^0 which means that exactly the brightest elements are moving upward (since we defined a negative sign of the velocity fluctuations as a blueshift) and the cooler elements downward.

On the one hand, the magnetic field seems to contribute to a breakdown of intensity–velocity correlations at deeper levels (cf. Fig. 2b) on the other hand however, the magnetic field strengthens the phase shift between intensity velocity fluctuations.



Coherence function between continuum intensity and intensity fluctuations at the line cores of lines I (. . .),II (_ _ _),III (_ _ _) and IV (__ __ __) from a spatial sample of 84arcsec.

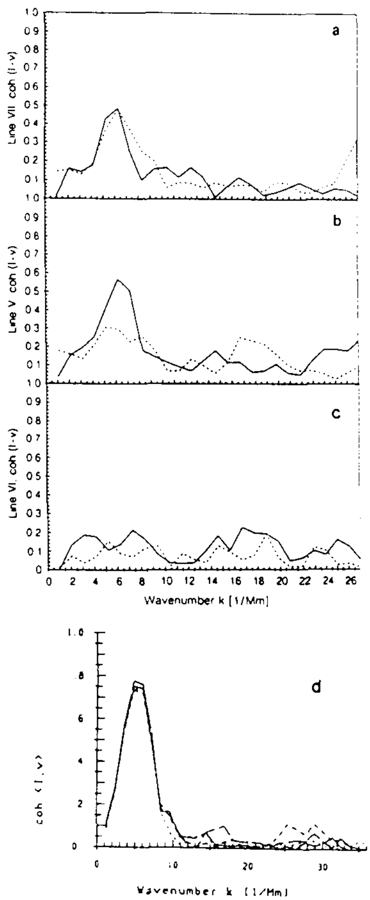


Fig. 1:Coherence between δI

Fig. 2:Coherence between δI and δv

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