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Dynamics of photosphere in presence of magnetic field

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Abstract.
In this paper we report the results of the preliminary analysis of observations carried out with the panoramic monochromator IBIS, installed at the Dunn Solar Telescope, Sacramento Peak (NM), in the spectral lines Ca II 854.2 nm, Fe I 709.0 nm and Fe II 722.4 nm. We analyzed the dynamical properties of a quiet region centered on a large scale (~ 30 Mm) structure of magnetic network.

1. Introduction

Solar surface shows a wide variety of magnetic structures, ranging from the largest sunspots (tens of Mm across) down to the 100 km scale magnetic elements, the smallest observable forms of magnetic flux in the photosphere. The distribution of magnetic structures on the solar surface and their dynamical evolution are influenced by the solar plasma which, under the control of convective motions, concentrates or diffuses the magnetic field emerging on the solar surface. In quiet areas magnetic field concentrations appear as single bright points, whose dynamics is determined by granular flows. These bright points are passively advected towards the borders of supergranular cells, where they gather and produce the magnetic network, a useful proxy for supergranules. In this paper we present preliminary results about the interaction between photospheric velocity fields and magnetic elements obtained from high spatial, temporal and spectral resolution observations, which allowed a 3-D reconstruction of the photospheric velocity field.

2. Observations and data analysis

The data set contains observations of a roundish network cell collected by the IBIS 2-D spectrometer on October, 16 2003 (from 14:24 UT to 17:32 UT) in the spectral lines Ca II 854.2 nm, Fe I 709.0 nm and Fe II 722.4 nm. The temporal interval between successive images was ~ 300 ms. Each monochromatic image was acquired with 25 ms exposure time by a CCD detector, whose pixel scale was 0.17"pixel^{-1}. Each image was corrected for CCD non linearity effects, dark current, gain table and blue shift (Reardon et al. 2003). The vertical velocity fields were computed for the Fe I and Fe II lines by means of a Doppler shift evaluated, pixel by pixel, using a Gaussian fit of the line profile. The line core and width fields were obtained by the amplitude and width, respectively, of the same Gaussian function. In order to identify the small magnetic fields we use the strong correlation between

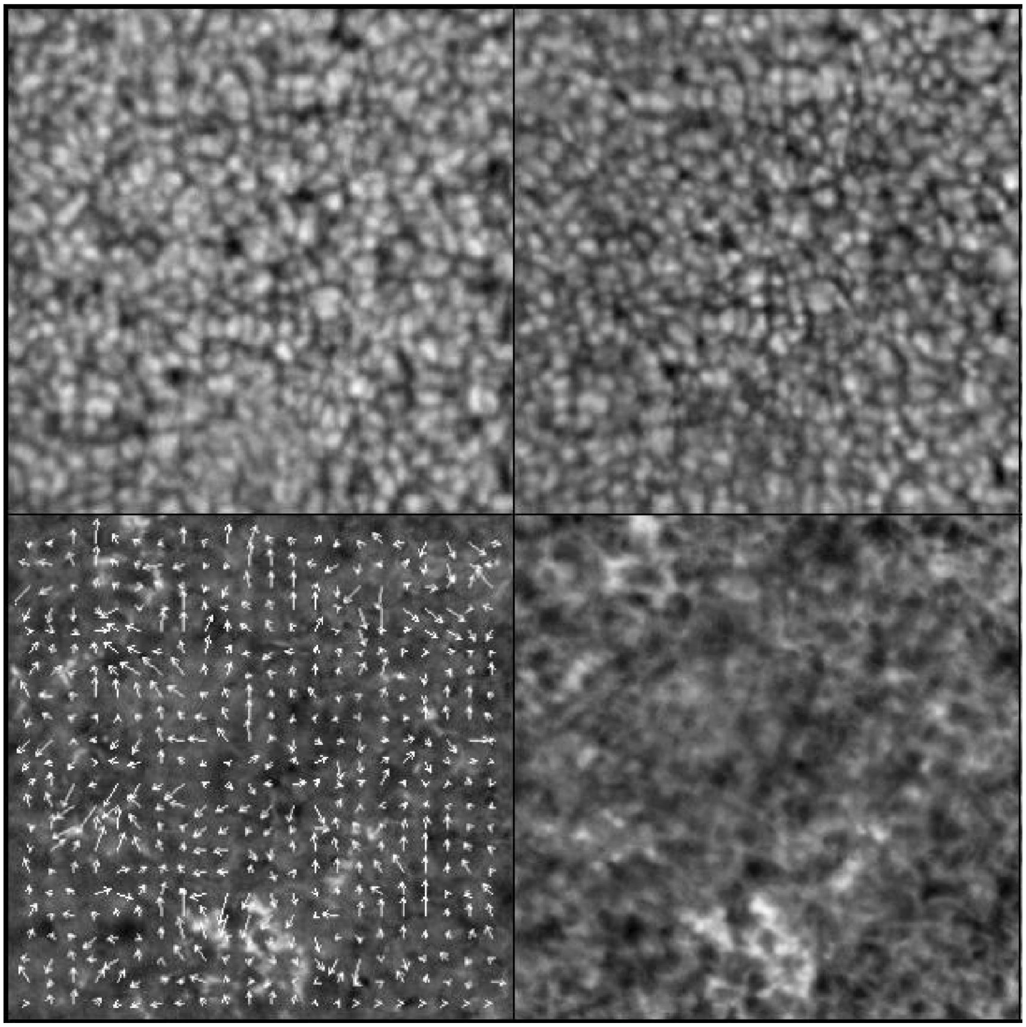

Fig. 1. Upper left panel: continuum image; upper central panel: Fe I 709.0 nm Doppler velocity field; upper right panel: Fe II 722.4 nm Doppler velocity field; lower left panel: Ca II wing intensity image with superimposed the tracked granule displacements relative to $< h >= 0\ km$; lower central panel: Fe I 709.0 nm line core intensity; lower right panel: Fe II 722.4 nm line core intensity.

magnetic field signal and brightness in the Ca II 854.2 nm line wing. These "chromospheric magnetograms" are used to derive a mask to apply on Fe I 709.0 nm velocity (Doppler) and line core intensity fields.

An analysis of the histograms of Fe I 709.0 plasma line-of-sight velocity (Fig. 2) and line core intensity (Fig. 3) associated with magnetic features outlines that magnetic regions correspond to downflows and to region of reduced contrast in the line core. We apply the TST procedure (Del Moro 2004) on the continuum image series and on both the Fe II 722.4 nm and Fe I 709.0 nm velocity field series in order to retrieve the horizontal velocity field at different depths of the solar atmosphere. In fact,

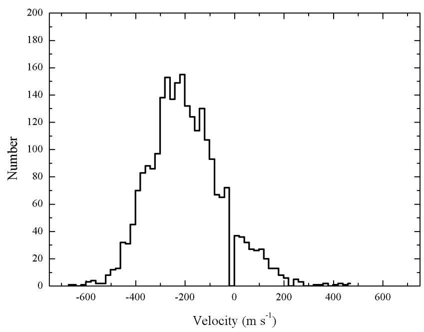

Fig. 2. Histogram of the 709.0 nm Doppler velocity values associated to magnetic regions.

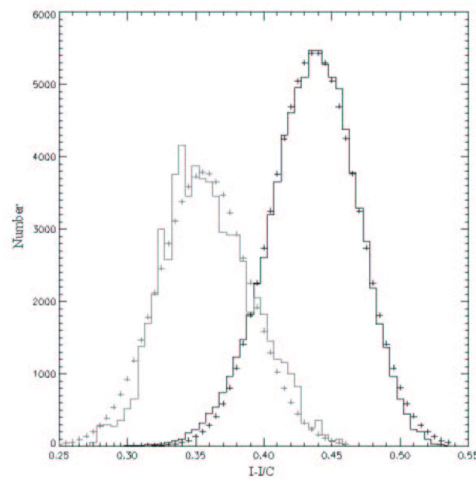

Fig. 3. Histogram of the contrast value for the quiet sun (*black continuous*) and the magnetic region (*grey continuous*). The crosses represent the Gaussian fit to the distributions

the major contribution to these Doppler fields comes from the two layers at about 140 km and 70 km above the photospheric surface, for the 722.4 nm and 709.0 nm lines respectively. For each time series the TST produced two horizontal velocity fields, associated with the first and second 30 minutes of the series (see Fig. 1). The tracked granules seem to gather on the borders of the supergranule, with the exception of an extended cluster of bright structures.

This behaviour is also confirmed by the mean divergence image, extracted from the horizontal velocity field, which shows that the bright magnetic area is not a region of convergence. This seems to suggest that granules on the edge of the supergranule are in some way different from the granules in the centre.

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