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Some THEMIS tip-tilt images

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Abstract. In the MTR ('MulTiRaies', i.e. multiline spectropolarimetry) mode of THEMIS, a map is the result of a reconstruction from a scan of the solar image on the spectrograph entrance slit. The result of image motion appears as zigzags along non-vertical lines or structures in the map. As an image stabilization system, the new tip-tilt acts in reducing such zigzags. A map is presented obtained with the tip-tilt ON where nearly no zigzag is visible.

Key words. Instrumentation: miscellaneous

1. Introduction

In his pioneering work, Stenflo (1973) retrieved information about the unresolved magnetic field of the solar photosphere from a line ratio analysis of multiline observations taken with the Kitt Peak multichannel magnetograph. He draws conclusions about an inhomogeneous structure of the photospheric magnetic field: strong fields, on the order of 2 kGauss, would be concentrated in unresolved structures of about 100-300 km size, the so-called 'flux tubes'. Since that time, the resolution of these flux tubes has become an objective for the next instrumental progress, and in particular for building new instruments such as the THEMIS telescope. Such an objective requires simultaneous spatial, spectral and polarimetric adequate resolution. In the case of the THEMIS telescope, the adequate polarimetric resolution of 1.5×10^{-3} is currently reached in one record on one pixel whose size is set at 0.45 arcsec, the spectral resolution being on the order of 22 mÅ. This telescope has the original feature of being 'polarization free'; i.e. the polarization analysis is performed on axis, before any oblique reflection. The second original feature of THEMIS is being able to simultaneously record several spectral windows, in order to probe the solar atmosphere along its depth, because the different lines simultaneously observed are formed at different altitudes. A more detailed description of the THEMIS instrument can be found in Arnaud et al. (1998), although it has to be updated with the tip-tilt correction, which has been modified and is now operational, and the polarization analyzer quarter-wave plate positions that are now free to take any position needed.

In the MTR ('MulTiRaies', i.e. multiline spectropolarimetry) mode of THEMIS, a map is the result of a reconstruction from a scan of the solar image on the spectrograph entrance slit. The result of image motion appears as zigzags along non-vertical lines or structures in the map. As an image stabilization system, the new tip-tilt acts in reducing such zigzags.

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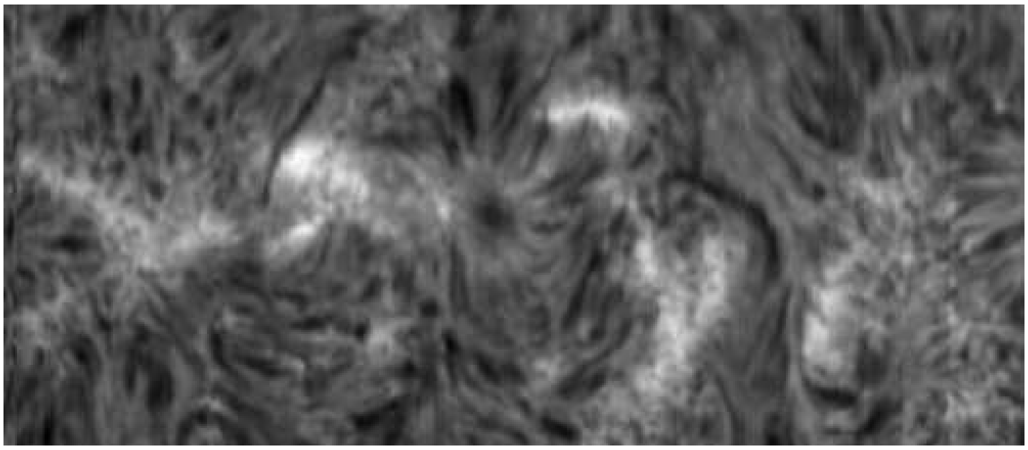

Fig. 1. Hα reconstructed map of a sunspot (NOAA 10886) observed on 28 May 2006, 7:30-8:16 am UT. The image size is 240x120 arcsec and the pixel size is 0.45 arcsec.

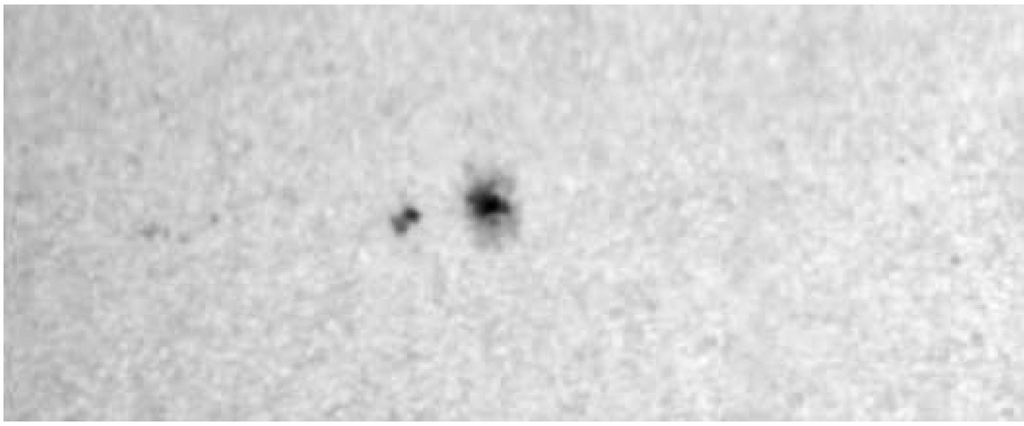

Fig. 2. Same map, but in the Fe I 6302.5 continuum.

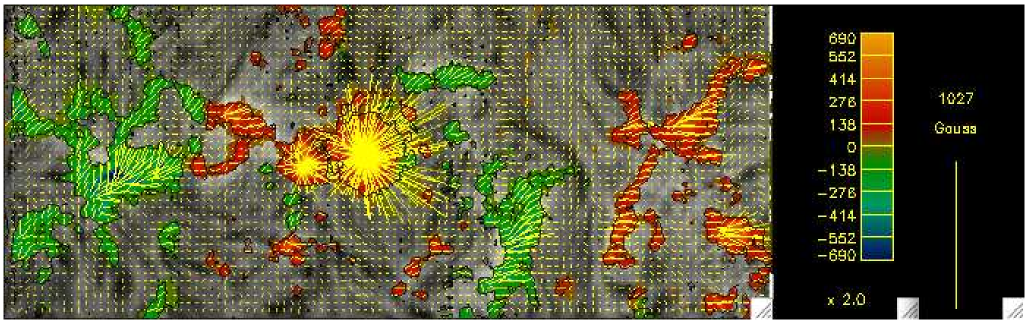

Fig. 3. Vector magnetic field map. The longitudinal field is in color: warm colors (yellow, red) for field going out of the Sun, cold colors (blue, green) for field entering the Sun. The transverse field is drawn with dashes without arrow, because the 180° ambiguity is not solved. The line draws the contour of 100 Gauss local average magnetic field strength, which draws also the limit of the network (see Fig. 4).

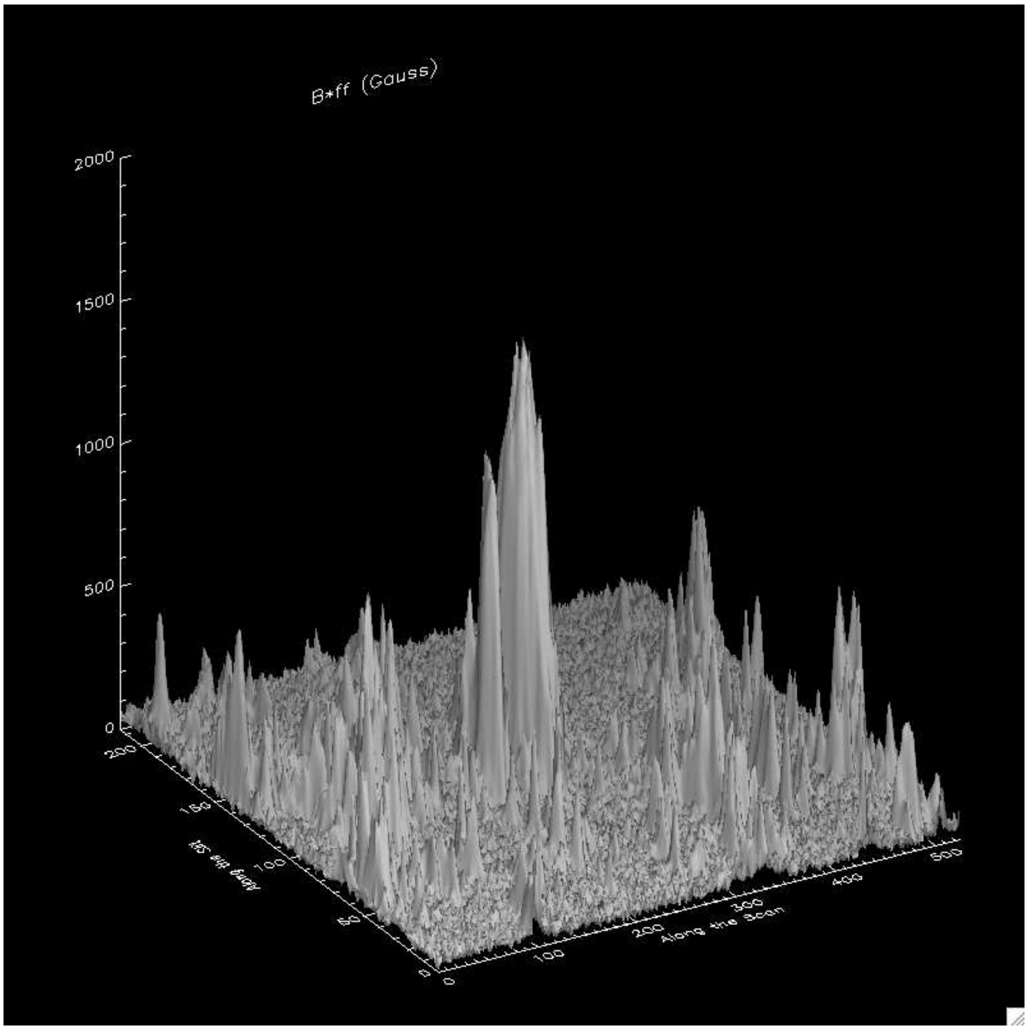

Fig. 4. Variation of the local average magnetic field strength along the scan and along the slit. This figure makes appear the 100 Gauss level as able to draw the limit between the network that emerges from the turbulent internetwork.

A map is presented in the following, obtained with the tip-tilt ON where nearly no zigzag is visible.

2. The reconstructed map

The map presented in Figs. 1-3 is the result of a scan of the active region NOAA 10886, performed on 28 May 2006 between 7:30 and 8:16 am UT. In Fig. 1, the wavelength is the one of the Hα line center. Three other spectral windows were simultaneously recorded: Fe I 6301/6302, Na I D_1 and Cr I 5782. The wavelength in Fig. 2 is located in the continuum near Fe I 6302.5. The slit length was 2 arcmin, and the scan consisted in 299 steps of 0.8 arcsec done perpendicularly to the slit. The pixel size was 0.45 arcsec and the map was corrected from anamorphosis by linear interpolation in the scan direction.

The methods applied for line straightening and flat field correction are the ones described in Bommier & Rayrole (2002). In particular, the method of line position measurement, which is at the basis of this treatment, is described in this reference.

The polarimetric analysis was done as described in Bommier & Molodij (2002), except for the 'generalized beam exchange', which had become unnecessary with the new polarization analyzer now free to take any position needed. The usual beam exchange was then done sequentially in each Stokes parameter, Q, U, and V.

The vector magnetic field map presented in Fig. 3 was obtained by UNNOFIT inversion of the Fe I 6302.5 spectropolarimetric data. The UNNOFIT inversion code (Landolfi et al. 1984) is based on the Marquardt algorithm to reach the minimum theory/observation discrepancy with the theoretical profiles given by the Unno-Rachkowsky solution, which provides the Stokes profiles emerging from a Milne-Eddington atmosphere embedded in a homogeneous magnetic field. It has been complemented by Bommier et al. (2007) to add the magnetic filling factor α determination, but finally the local average magnetic field αB can only be determined with one line, and is the one that is drawn in Fig. 3.

3. Conclusion

Nearly no zigzag due to image motion is visible in the reconstructed map presented in Fig. 1 obtained in the Hα line center. Accordingly, the granulation is well visible in Fig. 2 obtained in the Fe I 6302.5 continuum.

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