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INTERACTION OF SUNSPOTS WITH THE SURROUNDING PLASMA - A PROGRESS REPORT

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Abstract. The historic development of the search for interactions of sunspots and solar plasma around them was given in a contribution at the IVth Hvar Astrophysical Colloquium (Wöhl, 1997). It was concentrated on the results of measurements and their reductions perfomed by Lustig and Wöhl (1993), showing a dependence of plasma velocity difference in front and behind stable sunspots depending on their relative speed within the plasma. Since the result obtained was not significant, new attempts were started to use MDI/SoHO data and mainly to collect data ourselves at telescopes and the horizontal spectrometer of the Astronomical Institute of the Slovak Academy of Sciences in Tatranská Lomnica, Slovakia. The main difference is that now the plasma velocity data are gained by a matrix of fiber optics collecting light at several positions around the sunspot. In addition the sunspot positions are collected by a different telescope. The reductions of the sunspot positions give very reliable rotation data and - as expected - very small meridonal motions, while the plasma velocity data are not yet reliable. Attempts to improve this situation are described.

Key words: sunspots - solar plasma - solar rotation

1. Introduction

As described within the proceedings of the IVth Hvar Astrophysical Colloquium by Wöhl (1997), there was a first attempt to determine interactions of sunspot rotation and plasma rotation using modern detectors by Lustig and Wöhl (1993) at the Vacuum Tower Telescope (VTT) on Tenerife. The result of their measurements and data reduction showed a dependence of plasma velocity difference in front and behind stable sunspots depending on the relative speed of the sunspot within the plasma. Since the result obtained was not significant, new attempts were started: First to use data from the Michelson Doppler Imager (MDI) on board of the Solar Heliospheric Observatory (SoHO) and in addition to observe sunspot positions and plasma motions at the solar telescopes and spectrometer of the Astronomical Institute fo the Slovak Academy of Sciences in Tatranská Lomnica, Slovakia.

2. MDI/SoHO data

Data of the MDI on board of SoHo have been used by Schmidt et al. (1999) to determine the center-to-limb variation of the solar 5-min. oscillations. Within that investigation they found a discrepancy of the plasma rotation of the Sun determined from the MDI data by about - 10 % as compared to the classical value of the solar rotation. This was investigated in more detail by Wöhl and Schmidt (2000) by comparison of solar plasma rotation measurements of MDI as compared with measurements using two different spectrometers at the VTT. These investigations and several unpublished tests of MDI data by our group did not encourage us to use MDI data for another attempt to investigate the interaction of sunspots and the solar plasma.

3. The new setup in Slovakia

Instead we started a joint effort to gain data ourselves. There are two main differences as compared to the measurements at the VTT: (1) This time we do not scan with the entrance slit of the spectrometer over the image of the sunspot and the plasma around it. Instead optical fibers within a fixed matrix are placed at several points around the sunspot image, which is formed by the horizontal telescope at Tatranská Lomnica. The light from these positions is fed into the spectrometer's entrance slit and the spectra are taken with a CCD camera. The averaging of the local velocities of granulation and oscillation are now performed more by averages in time - many spectra are collected within one hour - than in space. Nevertheless some averaging in space is caused by local seeing effects. Again iodine lines serve as wavelength references. (2) Precise positions of sunspots are collected as often as possible by drawing the sunspot images projected on sheets of paper. This is done at a refractor nearby the horizontal telescope. Some more details of the project and especially about the fiber optics matrix used are given by Kučera et al. (1997, 1999).

4. Results and Improvements

We have collected from 4 sunspots 152 position observations in 1997, from 23 spots 602 position observations in 1998, and from 11 spots 209 position observations in 1999. All these samples show a differential rotation comparable with other sunspot rotation results. They show a mean of only a few meters per second in meridional motion. For many sunspot positions in 1998 our data were compared with similar data obtained at the Kanzelhöhe solar observatory. For the sunspot group NOAA 8742 in November 1999 the positions, rotations and meridional motions derived were compared with data from several public observatories in Slovakia. The agreement was always very good. We rely much on the quality of the sunspot position and rotation determination performed.

Unfortunately the spectral data exhibit less quality: Due to varying transmission of the fibers and a readout noise of the CCD camera used the quality of the spectra obtained was not good. The fiber optics matrix and the CCD camera were exchanged begin of 2000. In addition we have to improve the quality of the iodine spectra obtained: They show a varying of the iodine line depths due to different temperatures within the iodine vessel. After these improvements we expect to gain plasma rotation data with a reliable precision of better than $\pm$ 50 m/s rms within about an hour of observing time.

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SoHO, the Solar Heliospheric Observatory, is a joint project of ESA and NASA. MDI, the Michelson Doppler Imager, is an experiment on SoHO. We thank the MDI/SoHO team for the possibility to use the data of MDI.

References

Kučera, A., Rybák, J., Wöhl, H.: 1997, in Saniga, M. (ed.): *JOSO Annual Report 1996*, 68.

Kučera, A., Rybák, J., Wöhl, H., Hanslmeier, A.: 1999, in Schmieder, B., Hofmann, A., Staude, J. (eds.): *Proceedings of the 'Third advances in solar physics euroconference: Magnetic fields and oscillations', Astronomical Society of the Pacific Conference Series* **184**, 319.

Lustig, G., Wöhl, H.: 1993, *Astron.Astrophys.* **278**, 637.

Schmidt, W., Stix, M., Wöhl, H.: 1999, *Astron.Astrophys.* **346**, 633.

Wöhl, H.: 1997, *Hvar Obs. Bull.* **21**, 1.

Wöhl, H., Schmidt, W.: 2000, *Astron.Astrophys.* **357**, 763.