OBSERVATIONS OF MAGNETIC FEATURES WITH THE GERMAN SOLAR TELESCOPES AT THE OBSERVATORIO DEL TEIDE/TENERIFE

F. KNEER[1], D. SOLTAU[2], E. WIEHR[1]

[1] Universitäts-Sternwarte
Geismarlandstr. 11, D-3400 Göttingen, Fed. Rep. of Germany

[2] Kiepenheuer-Institut für Sonnenphysik
Schöneckstr. 6, D-7800 Freiburg, Fed. Rep. of Germany

ABSTRACT. The German solar facilities at the Obsrvatorio del Teide are described first. Then, a few examples of recent results from magnetic features are given: spatial variation and velocity fluctuation of small-scale magnetic fluxtubes in the quiet Sun, Evershed flow and magnetic field in connection with penumbral fine structure, and magnetic field variation in sunspot umbrae.

1. OBSERVING FACILITIES

The telescopes and their postfocus equipment are described extensively elsewhere (Wiehr, 1987, Kneer et al., 1987, Schmidt and Soltau, 1987, Kneer and Wiehr, 1989, Soltau 1989). Here, only a short summary is given.

1.1. GREGORY COUDÉ TELESCOPE (GCT)

At an altitude of 2400m, the evacuated GCT is housed in a dome on top of a 20m high tower. The 45cm parabolic primary mirror has a focal length of 2.40m which is enlarged to f_{eff} = 25.0m by the Gregorian. Instrumental polarisation is low and constant for a period of 2-3 days (Wiehr, 1971). The telescope feeds a) a slit-jaw camera for simultaneous observations in white light, Ca K, and Hα and b) a horizontal Czerny-Turner spectrograph (focal length 10m, grating: 316 grooves/mm, ruled area 180mmx360mm, blaze at 63.5 deg.). Computers perform positioning, scanning, data acquisition, and dome control. Exposure times in the spectrum (quiet sun centre) are 1/2-1s on film and few 10ms on CCDs. Operation of the GCT started 1986.

1.2. VACUUM TOWER TELESCOPE (VTT)

The VTT is located at the same site. The main mirror (diameter 70cm, focal length 46m) is fed by a coelostat. The VTT is equipped with a slit-jaw camera for simultaneous observation (photographically and on TV recording) in white light, Ca K, and Hα. The spectrograph consists of a low dispersion predisperser and the main vertical spectrograph (focal length 15m, echelle grating: 79 grooves/mm, ruled area 220mmx440mm, blaze at 63.5 deg.). Exposure times are similar as in the GCT. The spectrograph can also run in a multi-channel subtractive double pass mode (MSDP) supplied by colleagues from Meudon/France (Mein and Blondel, 1972). In addition, the telescope can feed optical laboratories for small-band imaging. Computer control exists as well. The VTT has operated since 1989.

E. R. Priest and V. Krishan (eds.), Basic Plasma Processes on the Sun, 113–117.

1.3. NEWTON TELESCOPE

This evacuated telescope with a 40cm parabolic main mirror on an equatorial mounting has an effective focal length of 37.5m. Filters, film cassettes, and photometers can be fixed to it. It has operated since 1972.

1.4. POLARIMETRY

Information about magnetic fields is obtained from the Zeeman splitting of spectral lines and from their polarisation properties. Several analysers for left and right circular polarized light, i.e. for the Stokes I and V intensities can presently be mounted at the entrances or exits of the spectrographs. An analyser for the complete Stokes vector $\underline{S}$ = (I, Q, U, V) is under construction.

2. MAGNETIC FEATURE OBSERVATIONS

From the many investigations concerning the observation of magnetic features only a few examples can be touched upon here. More detailed analyses are or will be published elsewhere.

2.1. SMALL FLUXTUBES

The motion of a small magnetic element beneath a Ca + flocculum was investigated by Wiehr (1988). The zero-crossing of the Stokes V profile of the Fe I 6302 Å line shows wavelength shifts corresponding to peak-to-peak velocities of 750 m s^{-1} on timescales of 5min. Recent observations of magnetic elements in the quiet sun Ca network show rapid changes (within few arcsec) of the magnetic polarity.

2.2. SUNSPOT FINE STRUCTURE

2.2.1. *Penumbra*. Continuum intensity pattern, Evershed-flow, and magnetic field fluctuations are uncorrelated among each other (Wiehr and Stellmacher, 1989).

2.2.2. *Umbra*. Figure 1 shows a white light slit-jaw picture of umbral fine structures and the spectrogram containing the spectrum of the umbral dot to the left of the light bridge. Some densitometer recordings are collected in Figure 2. The Zeeman splitting of spectral lines yields magnetic field strengths given in Table 1. In the umbral dot, the field is weaker than in the surrounding penumbra, but not as much as suggested earlier (Kneer, 1973). Similar data are presently under analysis and the implications for atmospheric and magnetic field structure have yet to be investigated.

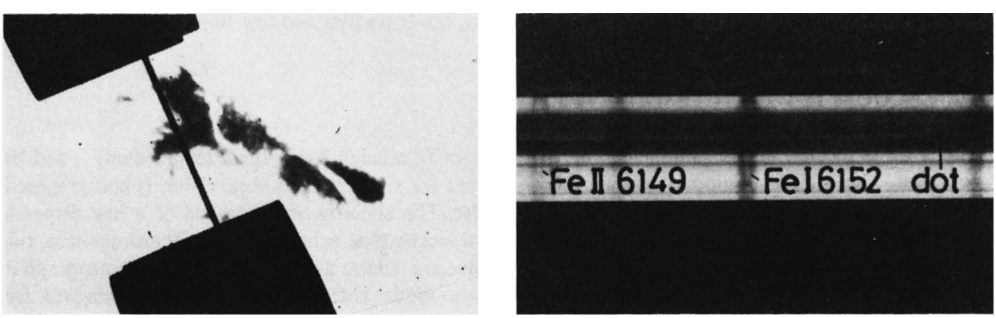

Fig. 1. White light picture and spectrogram of umbral fine structure.

TABLE 1. Magnetic field strengths (in gauss) in sunspot features.

	FeII 6149.2	FeI 6151.6	CaI 6156.0
inner penumbra	1900	1700	1900
umbra	-	2750	3050
umbral dot	2460	2330	2750

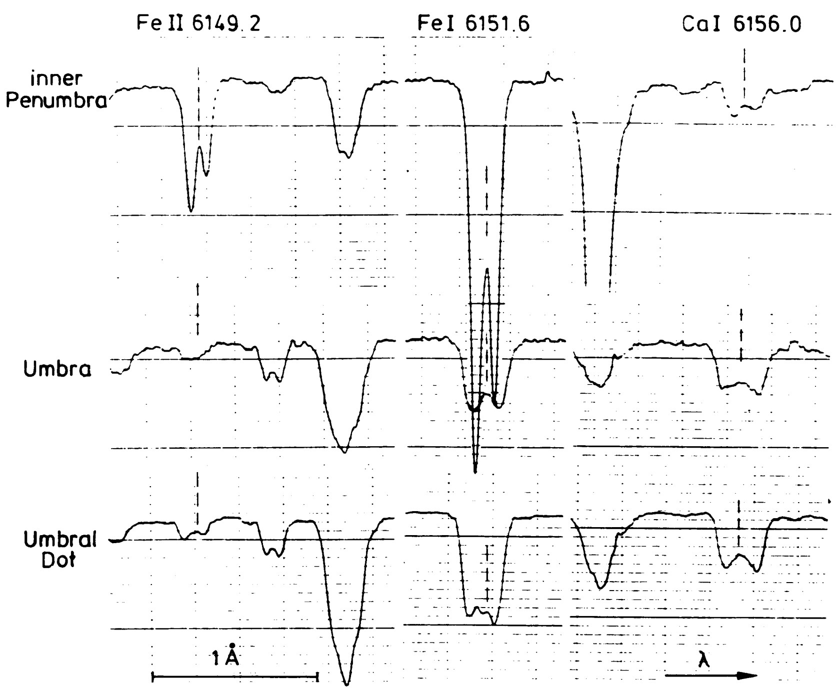

Fig. 2. Densitometer recordings of spectral lines from sunspot features

https://doi.org/10.1017/S0074180900087830 Published online by Cambridge University Press

ACKNOWLEDGEMENTS. The "Hilfseinrichtung Sonnenphysik" is financed by the Deutsche Forschungsgemeinschaft.

REFERENCES

Kneer, F.: 1973, Solar Phys. **28**, 361

Kneer, F., Schmidt, W., Wiehr, E., Wittmann, A.D.: 1987, Mitt. Astron. Ges. **68**, 181

Kneer, F., Wiehr, E.: 1989, Proc. Workshop on Solar and Stellar Granulation, R.J. Rutten and G. Severino (eds.), Kluwer/Dordrecht, p. 13

Mein, P., Blondel, M.: 1972, Solar Phys. **27**, 489

Schmidt, W., Soltau, D.: 1987, Mitt. Astron. Ges. **68**, 184

Soltau, D.: 1989, Proc. Workshop on Solar and Stellar Granulation, R.J. Rutten and G. Severino (eds.), Kluwer/Dordrecht, p. 17

Wiehr, E.: 1971, Solar Phys. **18**, 226

Wiehr, E.: 1987, Proc. Workshop on the Role of Fine-Scale Magnetic Fields on the Structure of the Solar Atmosphere, E.-H. Schröter, M. Vázquez, A.A. Wyller (eds.), Cambridge Univ. Press, p. 354

Wiehr, E.: 1988, Proc. Symp. Seismology of the Sun and Sun-like Stars, Tenerife, Spain, ESA SP-286, p. 269

Wiehr, E., Stellmacher, G.: 1989, Astron. Astrophys., in press

DISCUSSION

VENKATAKRISHNAN (i) How do you measure instrumental polarisation? (ii) Can the weak line correlation with the continuum be due to scattered light in the spectrograph?

KNEER: (i) Linear polarisers, ($\lambda/4$) and $\lambda/2$ sheets are mounted to the entrance window and the Stokes vector is measured for several rotational positions of the linear polariser.
(ii) We do see strong horizontal fluctuations in intensity, velocity, and magnetic field, much beyond observational noise. I do not think that they arise from scattered light for which I would expect a broad distribution.

WEISS: In order to describe the structure of a sunspot it is important to know the inclination of the magnetic field and its variation with radius in the outer penumbra. Do You have any new measurements of the field direction in the penumbra?

KNEER: We are constantly trying to obtain better and better data on the variation of field strength and direction. They have yet to be analysed.

CHOUDHURI: In the past some observers claimed that umbral dots are merely granules which have been somewhat modified by the presence of a strong magnetic field, whereas other observers felt that umbral dots are totally different from granules. Would you like to comment on this controversy?

KNEER: The spectroscopic characteristics of umbral dots are very different from those in the dark umbra. FeII is certainly present in dots and the magnetic splitting of lines measured in dots is different from both umbra and penumbra. Thus temperature fluctuations are much higher than in ordinary quiet-Sun "granulation". I think dots need a different name!

SIVARAM: What is the range of magnetic fields you can measure?

KNEER: The magnetic flux densities given here are measured from the Zeeman splitting. The lower limit for such measurements is about 1200-1500 Gauss, due to thermal broadening of the spectral lines. The upper limit we see in sunspot umbrae is about 3500 Gauss.

VAN BALLEGOOIJEN: Could the lack of correlation between intensity and velocity fluctuations in sunspots be explained in terms of an upward motion followed by a downward motion for each bright point?

KNEER: It is a possibility. To my knowledge, such an analysis of time sequences has not yet been performed. Certainly it should be done.