SMALL SCALE MAGNETIC STRUCTURES IN ACTIVE CENTERS

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ABSTRACT. Active sunspot group n° 4567 was observed with high angular magnification on Sept. 2, 1984, using the instrument FPSS at Meudon Observatory. Within the sunspots umbrae, the longitudinal magnetic field shows a collection of small elements down to the limit of resolution of around 600 km. Between the trailing and leading spots, there were very sharp gradients, both in magnetization (450 gauss over 1000 km) and in Doppler velocity (350 m s^{-1} over 1 000 km). The line defined by these gradients was the location of a flare. Evershed driving forces may be responsible for building up these gradients and flare.

1. INSTRUMENT

The monochromatic solar telescope of Meudon Observatory, using the birefringent filter FPSS (Filtre Polarisant Solaire Sélectif) produces images of the solar surface with a spectral resolution of 2×10^{-5} (Dollfus et al. 1985). An optical design shifts the transmitted band from bottom to wings of a spectral line and to adjacent continuum, and selects the different states of polarization of the incident light. The images recorded in the different configurations are combined to produce new images of the Doppler motion, the magnetization, the line depth and the line width (Dollfus et al. 1986).

The images are obtained through a 27cm reflector directly pointed at the sun, in order to preserve a maximum telescopic image resolution. Our best magnetic images disclose an angular resolution on magnetic features of around 0,8 arc sec. (600 km at the solar surface).

2. MAGNETIC STRUCTURES IN SPOT UMBRAE

On September 2, 1984, the two small trailing spots of bipolar group n° 4567 (fig. 1), displayed the magnetic configuration enlarged in the figure 2. Into the umbrae, the magnetic field appears to be structured like a cluster of small elements, typically 600 km in diameter and smaller.

J. O. Stenflo (ed.), Solar Photosphere: Structure, Convection, and Magnetic Fields, 157–160.

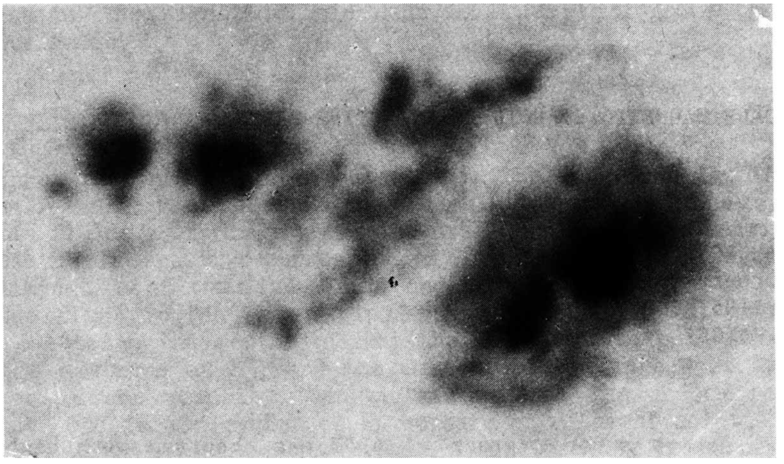

Figure 1 : Sunspot group n° 4567 on September 2, 1984 at 08:28 UT. Field 110x70(arcsec)² centered at Long:140°, lat.=-10°. Meudon solar telescope with FPSS. A. Dollfus.

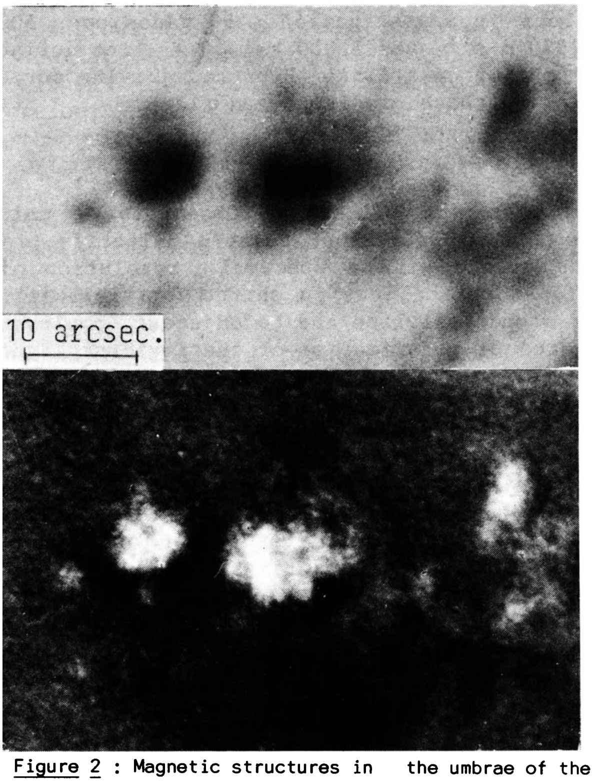

Figure 2 : Magnetic structures in the umbrae of the two trailing spots of fig. 1. Positive polarity is white. Line Fe I 6173.

A processing which avoids sharpness degradation due to pixelization and intensity discretization can enhance this structuration : the best negative photographic image taken in a wing of the line with a given circular polarization is copied by contact on another film which gives a positive image with a contrast of exactly 1.0. This image is then superimposed upon the best sharpest negative image taken with the other circular polarization component. The result is an image of the magnetization, with a minimum processing degradation. Now when the image centered upon the other is slightly shifted with excursions alternatively each side of the optimum position, the grey background, where there is no field, keeps

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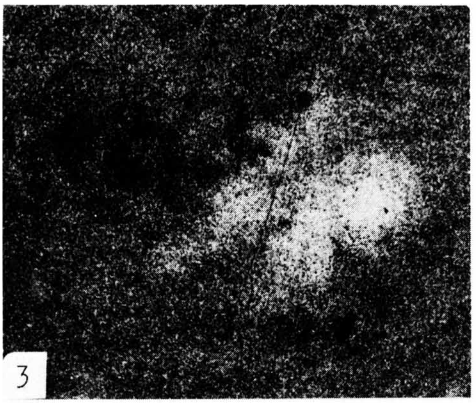
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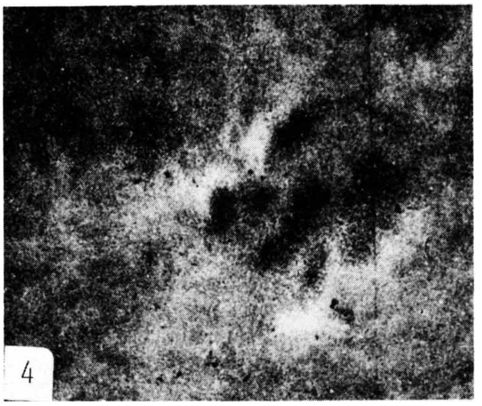
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Figure 3 : Longitudinal magnetic field configuration around the spot group n°4567 of fig.1. Line FeI 6173.

Figure 4 : Longitudinal velocity field configuration around the spot group n°4567 of fig.1. Line FeI 6173.

a clotted aspect which fluctuates randomly due to the graininess of the emulsion. But on the spot umbrae, these fluctuations are drastically enhanced, because of a real magnetic field structuration down to the limit of the angular resolution.

3. SHARP GRADIENTS

Between the two spots and the larger leading spot of opposite polarity (fig.1), there was a magnetic neutral line. And across this line, there were steep gradients (fig.3). The longitudinal field gradient reaches at least 450 gauss over 1000 km. At the same place, the longitudinal Doppler velocity image (fig.4) exhibits at least 350 m s^{-1} over 1000km.

Evershed photospheric radial motions are observed around each of the spot umbrae, particularly around the larger spot. We speculate that it is the forces driving the Evershed motion which displace the photospheric

Figure 5 : Flare evolution of sunspot group n°4567 on Sept.1,1984. Observed in Hα at Osservatorio Astrofisico di Catania by C.Bianco et al. From top to bottom:10:50-10:15-10:36-10:40-10:45TU

material toward a same area between the two spots, antagonistically from both sides, and produce a concentration of material which have to escape laterally or vertically. This border appears as a dark cold lane in the white light image of fig. 1. Simultaneously some magnetization is moved accordingly and produces the magnetic concentration and gradient.

Around this area and one half hour later a two-ribbon flare occurred, at 10:15 UT. Recorded namely at Osservatorio Astronomico di Catania (fig. 5), this event imprinted on each side of the neutral magnetic and velocity line, as shown in fig. 6.

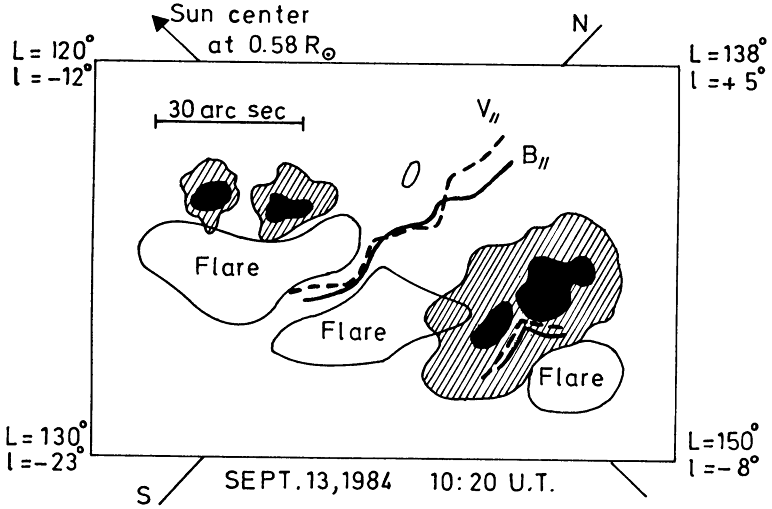

Figure 6 : Neutral magnetic line, neutral velocity line and flare configuration around sunspot group n°4567 on Sept.2, 1984.

Configurations with sharp gradients in motion and in magnetization are able to produce electric currents, responsible for flare occurrence. It is suggested that the flare eventually resulted at the expense of the Evershed driving forces.

Such a mechanism for flare occurrence may not be rare. The configuration required is seldom suitably position ed to be observable. Our bipolar group was observed at near 60° from disk center with the direction joi ning the spots of opposite polarities pointing precisely toward the disk center.

REFERENCES

Dollfus A., Colson F., Crussaire D. and Launay F. (1985). Ann. Astrophys. 151, 235-253.

Dollfus A., Crussaire D., Pernot E. and Lioure A. (1986). Compte-Rendus Acad. Sci. Paris 303, Série II, 153-158.