3. SUNSPOT MAGNETIC FIELDS AND LOOP PROMINENCES

V. Bumba and *J. Kleczek*

A large active sunspot group was on the Sun during the summer of 1957. It lasted for five rotations and about 146 flares were observed in it. During its limb passages it was accompanied by a conspicuous loop activity.

One of the authors obtained magnetic maps of the group with the Crimean magnetograph. The loop activity is demonstrated by many photographs from different observatories.

We compared the loop configuration with the magnetic maps and with Hα filtergrams. Using daily photographs of the group, we could find any large changes in the group. One of several pictures we used for comparison is reproduced in Figure 1. It represents: *right part*—the loops and corona of 1957 June 28 (the ordinates of the green curve, dashed, are to be multiplied by two relatively to those of the red curve, dotted); *middle right*—plage area and spot group on June 29, that is one day later, since the active region was not well visible on June 28; *left part*—chromosphere (upper), magnetic map (middle) and spot group (bottom). A good agreement of a quiescent filament stretching across the spot group (upper left) with the line dividing both polarities (dashed in middle left) is obvious. Drifts of individual spots in the group are marked by dashed lines with arrows (bottom left).

It is evident from Figure 1, that the loops are anchored in the peaks of the photospheric magnetic field. The evidence is further stressed by the Hα filtergrams, in which the loops continue against the chromosphere like hazy streamers directly into the umbrae. The peaks for both main loop systems coincide with umbrae of the group. The loops studied by us should therefore represent magnetic tubes of force. It is worth noticing the twisting in the northern arm (denoted by C in Figure 1). It is in agreement with the model of the configuration of a spot magnetic field, proposed by one of the authors (V. Bumba, in the following paper).

A detailed discussion of the association of loops with the underlying photospheric field will be published in the *Bulletin of the Astronomical Institutes of Czechoslovakia*. See also *Observatory* **81**, 141, 1961.

4. CONFIGURATION OF MAGNETIC FIELDS IN SUNSPOT UMBRAE

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We have studied the behaviour of some Fraunhofer lines in umbra spectra, obtained at the Crimean Astrophysical Observatory. By measurement of the intensities of the individual components of the split line Fe I (6302·508 Å) we came to the following conclusion: The enhancement of the π component in the Zeeman pattern could be simply explained by the configuration of the magnetic field in the umbra. We came to this idea after elaboration of a few tens of spectra for 19 umbrae in 31 different heliographic positions. We used the measured intensities of σ components for evaluation of γ, which is the angle between the line of sight and the magnetic field direction (Sears, 1913). The angle depends on the distance α of the spot from the centre of the solar disk (see Figure 1), according to the following empirical formula:

$$\gamma_s = \frac{90^\circ + \alpha \sin \alpha}{1 + \sin \alpha} \qquad (\alpha \text{ in degrees}) \qquad \text{(a)}$$

This is in good agreement with the following simple model: The lines of force are arranged in the tubes of force, coming from the umbra in form of spirals, the pitch of which rapidly increases with height. This means, that in the lower layers the lines of force form practically

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a horizontal ring, while in the higher levels their arms are nearly perpendicular to the solar surface.

This model also explains some other effects observed in the spectra of sunspot umbrae, for example the 'disappearence of the characteristic serpent-like fringes' (obtained with the aid of polaroid strips and a quarter-wave plate, see Figure 2) in some lines (D_1, D_2, Na I, Ni I 5892·885 Å, etc.). This effect occurs in those regions of the umbra where the faint lines of Ti I and V I (with the large factor $(mg - m'g')$ split in a Zeeman triplet, have a strong π component. This effect is generally observed in large and dark P-spots ($H > 2500$ gauss) of those spot groups where the F-spot is replaced by a few small spots. The effect shows dependence on the orientation of the slit. At the same time the lines $H\alpha$ of H I, H_2 and K_2 of Ca II show a distinct splitting into the 'characteristic serpent-like fringes'.

After a detailed discussion of about 50 spectral lines in three spectral regions (D_1, D_2; 6302 Å; Hα) for a few spots we came to the following conclusion: The effect is dependent upon the configuration of the splitting pattern and the equivalent width of the spectral line, the components σ and π of which can blend with each other. All the lines therefore show that, in the given region of the spot, the field is nearly transverse with the angle determined by the formula (a) and that the proposed model of the field can therefore explain the 'disappearance of characteristic serpent-like fringes'. Also the distinct splitting of the Hα and emission lines H_2, K_2 over the umbrae of the studied spots corroborates our model. These lines are formed only in the longitudinal field, that is in the region where the arms of spiral force lines are nearly perpendicular to the solar surface. Upon the umbral system, in which the lines of force in a tube of force are twisted in spirals with a pitch increasing with height, the penumbral lines of force are wound up. They stretch partially in the surrounding photosphere. The lines of force of this penumbral system have practically the form of a fan. The projected lines of force of the penumbral system are practically radial in relation to the centre of the spot. Their curvature however strongly increases at the boundary between umbra and penumbra (as proposed by Severny, 1959) and the lines wind up on the horizontal ring of the umbral system. It may be shown that the proposed model is in agreement with the classical results of the Mount Wilson observers.

A detailed discussion will be published in the *Bulletin of the Astronomical Institutes of Czechoslovakia.*

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5. THE SUN'S MAGNETIC FIELD FROM RADIO OBSERVATIONS

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Introduction. Magnetograph observations give a detailed picture of magnetic fields in the vicinity of the solar surface, but little is known about magnetic conditions at higher levels in the chromosphere and the corona. Some evidence about these regions may be obtained from radio measurements.

Local Fields. Two methods, based on observations of radio emission, have been used to estimate the field strength in the vicinity of active regions from measurements of the gyro-frequency. Eclipse data were used by observers at Pulkovo to isolate the radiation from a coronal condensation at wave-lengths ranging from 2 cm to 5 cm. The radio spectrum, combined with observations of the degree of circular polarization, gave a gyro-frequency consistent with a field strength of 360 gauss at a height of 50 000 km. A somewhat different