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

A. Hewish

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 method, in which a particular emission spectrum was explained in terms of enhanced radiation at harmonics of the gyro-frequency, led Kakinuma to a value of 600 gauss at 20 000 – 30 000 km.

It has been suggested by Denisse and others that certain features of the spectrum of enhanced radio emission from active regions are most readily accounted for as synchrotron radiation from relativistic electrons spiralling in a magnetic field. The spectrum of this radiation has a broad maximum at a frequency proportional to HE^2 where E is the electron energy. Takakura has recently accounted for the radio spectrum in this way and with an assumed electron energy of the order of 0·1 MeV he obtains field strengths of 1000–2000 gauss in the chromosphere and 20-40 gauss in the corona.

It should be emphasized that the above estimates are tentative, since the spectrum of the radio emission cannot yet be understood with certainty.

The Polar Field. In the presence of a general bipolar magnetic field, thermal radio emission from the undisturbed solar corona will contain circularly polarized components whose sense is different in the northern and southern hemisphere. Smerd utilized a partial eclipse to isolate the component from one hemisphere and hence showed that the general field in the vicinity of the pole was less than 8 gauss.

More recently the method was refined by Conway who used an interferometer to separate components from the two hemispheres and showed that the field was smaller than 2·5 gauss — a value consistent with Babcock's measurements.

The Far-Out Field. The scattering of radio waves from the Crab nebula during their passage through the outer portion of the corona can now be detected to distances of the order of 100 solar radii. Measurements by Högbom and by Gorgolewski and Hewish have indicated that the ray scattering which occurs is due to a filamentary structure in which the filaments are aligned approximately radially. This result strongly suggests that the general magnetic field is radial to very great distances.

No evidence has been detected for the presence of looped lines of force, as in the common dipole field, but the radial alignment appears to be more disordered towards sunspot minimum. Such a magnetic field might be maintained by a general outflow of material from the corona, the outflow becoming less pronounced and hence more easily disorganized at sunspot minimum.

DISCUSSION

P. A. Sturroch. One may also infer the strength of the magnetic field in the corona from observations of Type II bursts. Each of the spectral lines of these bursts is often split into two, the splitting amounting to a few per cent. This may be ascribed to the excitation of the two resonance frequencies w_p and $(w_p^2 + w_g^2)^{1/2}$, where w_p and w_g are the plasma and gyro-frequencies, respectively. For a given model of density variation with height, one may infer the variation of the magnetic field strength with height. Field strengths of up to 30 gauss are indicated for the heights at which Type II bursts are first observed.

6. VARIATIONS OF THE SUN'S POLOIDAL MAGNETIC FIELD

M. Waldmeier

The polar streamers of the corona have generally been interpreted as magnetic field lines. These streamers are inclined to the radial direction at an angle β. The inclination β is proportional to the angular distance α from the Sun's axis: $\beta = c \times \alpha$. This law holds up to $\alpha = 25°$ or even up to $\alpha = 30°$. The constant c depends on the distance from the Sun's limb at which the inclination is measured. In addition, c may be different for the northern and the southern