ECLIPSE OBSERVATIONS OF MICROWAVE RADIO SOURCES ON THE SOLAR DISK ON 19 APRIL 1958

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The partial and annular eclipse on 19 April 1958 was observed at Toyokawa and Hachijo Island (situated in an annular eclipse zone about 300 km south of Tokyo) at four frequencies, *i.e.* 9400, 3750, 2000 and 1000 Mc/s. The eclipse observations of polarization at four frequencies were substantially new trials and some interesting results were obtained. The results of observations and details of the reductions are reported in "Report of Ionosphere Research in Japan, Vol. XII, No. 3, 1958". In the present paper we will extract the results obtained.

Brightness distribution over the solar disk at these frequencies was derived with the aid of interferometric observations at 4000 Mc/s in full course of the eclipse. Total flux density (units are 10^{-22}W.m.$^{-2}$(c/s)$^{-1}$) of the sun at the beginning of the eclipse (0200 U.T.) and the estimated values of Base (quiet sun) and Slowly Varying Components are shown in Table 1. We assumed that B component comprised U (uniform disk) component and E (ear) component of additional brightness near the east and west limbs. The distributions of sources of S component on the solar disk at four frequencies are shown in Fig. 1. Numerals are flux density in % of total flux at 0200 U.T. R and L denote the excess of right- and left-handed circularly polarized components respectively.

TABLE 1. Estimation of B and S Components in % of the Total Flux Density at 0200 U.T.

Frequency in Mc/s	Size of uniform disk in R_0	U comp.	E comp.	(U+E) B comp.	S comp.	Total
9400	1.1	74.1 (235)	6.0 (19)	80.1 (254)	19.9 (63)	100 (317)
3750	1.15	50.7 (105)	8.2 (17)	58.9 (122)	41.1 (85)	100 (207)
2000	1.15	50.6 (80)	17.0 (26.8)	67.6 (106.8)	32.4 (51.2)	100 (158)
1000	1.2	58.3 (70)	22.0 (26.4)	80.3 (96.4)	19.7 (23.6)	100 (120)

( ) are the value of flux density in standard unit.

From these results it is concluded that:

(1) The size of the sources of S component is very likely to be of the same order in a frequency range between 9400 and 2000 Mc/s. At 1000 Mc/s, however, the source seems to be spread over a wide area and the outline is more indeterminate.

(2) The brightness temperature of the strongest S region in the southern hemisphere is estimated at the values as shown in Table 2, assuming that the source is uniformly distributed over the area surrounded by the outline of calcium plage, about 1/86 of the optical disk area. However, as the size of the source 1000

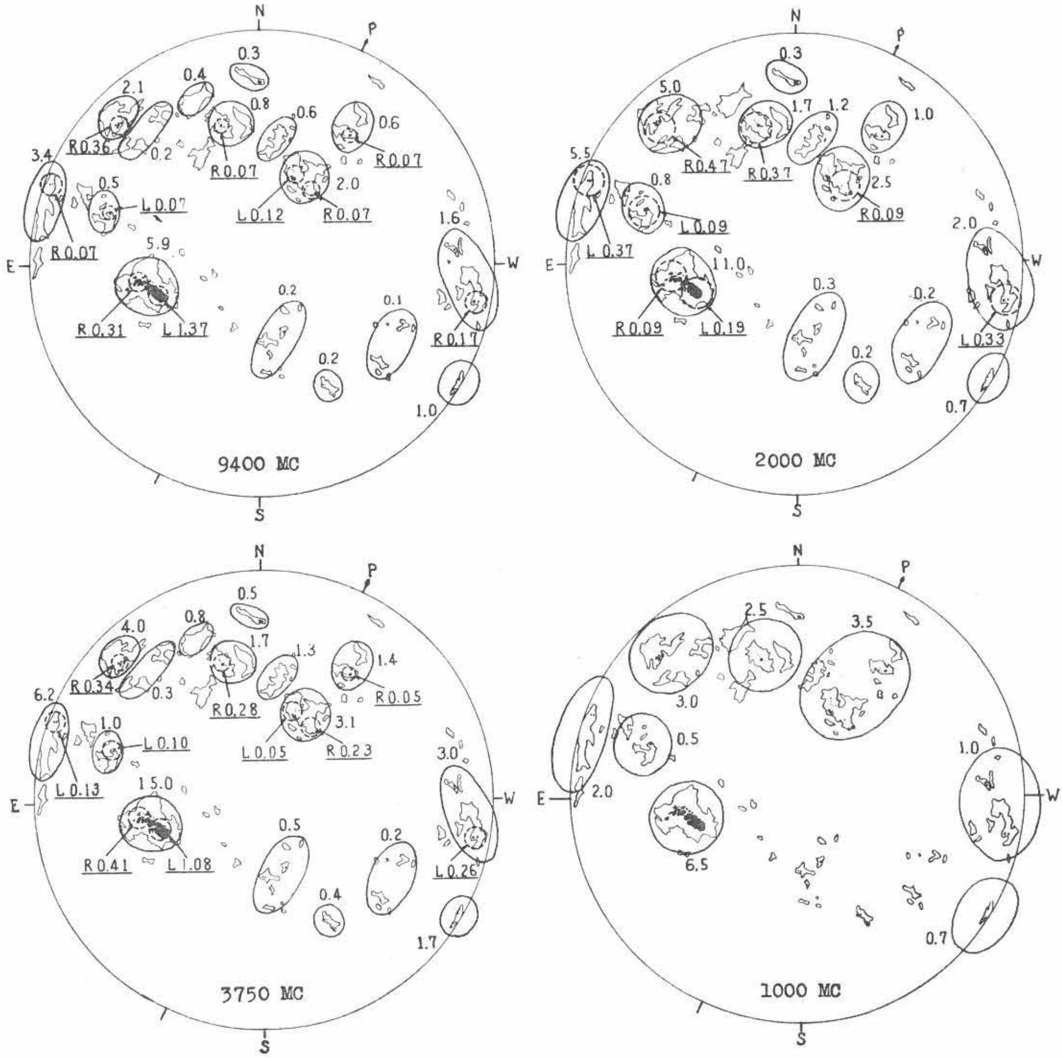

FIG. 1. Brightness distributions of S component. Numerals are flux density in % of total flux at 0200 U.T. R and L denote the excess of right- and left-handed circularly polarized components respectively.

TABLE 2. Flux Density and the estimated Brightness Temperature of the strongest S Region

Frequency in M c/s	9400	3750	2000	1000
Flux density (S+U)*	21	32	18	8
Brightness in °K	0.98×10^5	0.94×10^6	1.9×10^6	3.3×10^6

* The background U component lying on the assumed area of S region are added.

Mc/s appears to be larger than that at higher frequencies (conclusion (1)), the brightness temperature will be lower than the value shown in Table 2. Then the frequency variation of the brightness temperature is roughly explained by the thermal radiation from the dense region which has the electron temperature of about $2\sim3\times10^{6}$°K. If we assume that the emitting region extends from the chromosphere up to 70,000 km above the photosphere (conclusion (3)), the average electron density is estimated at about 5×10^{9} cm^{-3}. This value of electron density is much greater than that of the undisturbed corona.

(3) The source of S component at the east limb seems to extend over the photosphere up to the height of about 0.1 R_0 at 3750 Mc/s.

(4) The values of B component derived from daily observations are consistent with the eclipse observations.

(5) The source of polarized component is confined in a very small area over the sunspot, about 1′ in diameter.

(6) Two sources of polarization of different sense exist over each pole of a bipolar sunspot. The sense of polarization corresponds to that of the extraordinary wave. The limiting polarization seems to be determined at a lower altitude than what has been considered. It must be emphasized that the polarization of the strongest S region followed the ordinary rule as a whole and reversed its sense near the central meridian passage, which is presumable from daily interferometric observations.

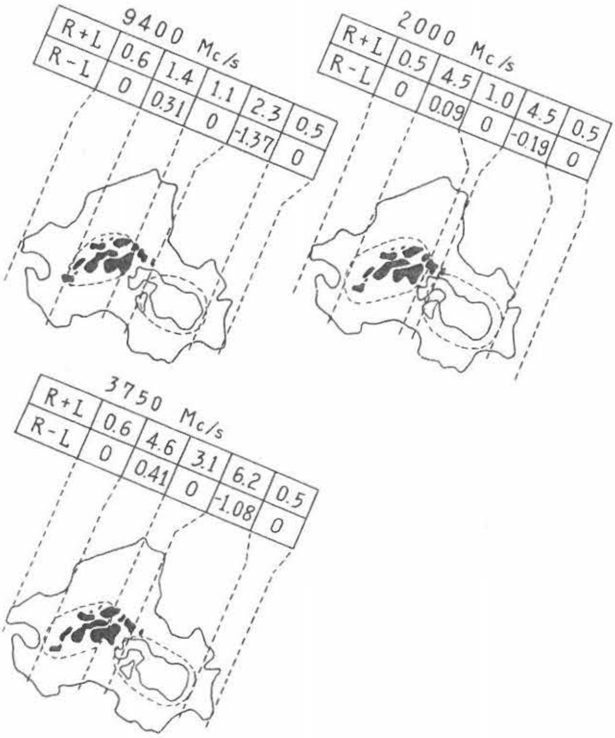

FIG. 2. Enlarged pictures of the strongest S region. Outline of calcium faculae (by courtesy of the Tokyo Astr. Obs.) and sunspot* are described. ● N pole, ○ S pole.

* From a copy of observation reports at Mt. Wilson kindly sent to Dr. Hatanaka. The authors are grateful.

(7) Some sources of polarization have an opposite sense between 9400 and 3750 Mc/s, which was suggested by the authors from their daily observations reported in Proc. Res. Inst. Atmospherics, Vol. 5. In Fig. 1, the sources at the east and west limbs correspond to this case and the smaller bipolar spot near the central meridian also has an opposite sense, on the whole, between these frequencies.

(8) The degree of polarization increases with frequency, and the polarization at 1000 Mc/s is very small. Enlarged pictures of the strongest S region are shown in Fig. 2. At the west side of the region (S pole) the degree of polarization at 9400 Mc/s is very large, and amounts to 60%, even if it is assumed that the size of S component agrees with that of the source of polarization.

To explain this large value of the degree of polarization, the mean magnetic field strength over the sunspot must be more than 1,000 gauss. And it is considered that the high brightness temperature and the small degree of polarization at lower frequencies are due to the large optical depth, *i.e.* high electron density over the sunspot.