DISTRIBUTION OF CIRCULARLY POLARIZED EMISSION ACROSS THE SOLAR DISK AT $\lambda = 4.3$ cm*

PIERRE KAUFMANN and E. SCALISE, JR.

Centro de Rádio-Astronomia e Astrofísica, Universidade Mackenzie, São Paulo, Brazil

Abstract (*Solar Phys.*). The emission of circularly polarized radiation of reversed senses from the respective solar hemispheres at $\lambda = 4.3$ cm is discussed, referring to consistent eclipse results obtained in November 1966 (Figure 1), March 1970, and January 1973 (Figure 2). Further qualitative information were obtained by performing a series of 18 daily solar maps (Figure 3) at the same wavelength, with moderate angular resolution (i.e., 12′). We were not able to resolve individual centers' polarities, but have confirmed that reversed senses of circular polarization occur, tending to be right-handed at southern areas of the solar disk, and left-handed at northern areas. These senses correspond to preceding polarities at the hemispheres for the 20th solar cycle, and a 'neutral line' divide the two polarized hemispheres, showing a contour that depends strongly on the presence of active centres and on their displacement with solar rotation. This suggest that the polarized features are strongly controlled, if not completely, by the presence of photospheric underlying magnetic areas.
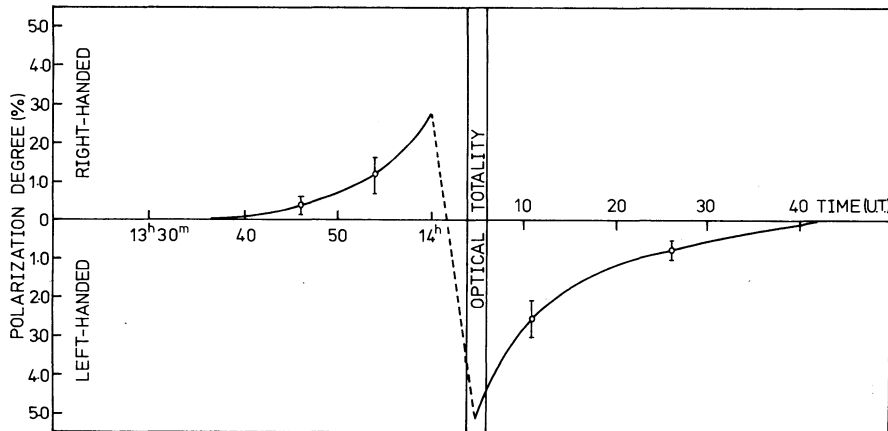
Fig. 1. The variation of the polarization degree (in percent) at $\lambda = 4.3$ cm with time, during 12 November 1966 total solar eclipse. Areas seen in excess from the southern hemisphere before totality, and from the northern hemisphere after totality, had provided right-handed and left-handed senses of circular polarization, respectively.

Polarized radiation was attributed to net magnetic fluxes existent on the areas observed in the case of eclipses, or on the areas subtended by the antenna beam in the case of the maps. Gross structures of coronal magnetic fields, as proposed by Altschuler and Newkirk (*Solar Phys.* **9**, 131, 1969), can well account for the existence of the microwave polarized radiation. Over active centres, the so-called 'missing'
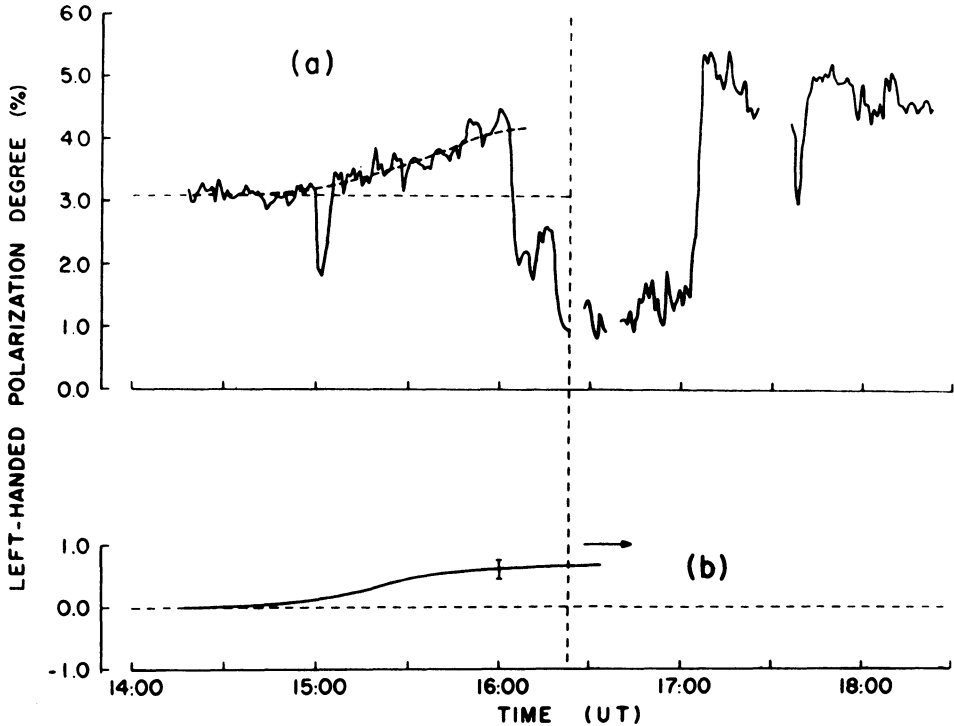

Fig. 2. Result obtained during the 4 January 1973 partial solar eclipse at $\lambda = 4.3$ cm. The polarization degree (in percent) has shown a gradual left-handed increase as the northern hemisphere was observed in excess (or as the southern hemisphere has been progressively eclipsed). Curve (a) shows the original result, with the presence of a small flare, and the eclipsing of two active centers. Curve (b) is the same data reduced for the presence of the sources. The data for the second half of the eclipse was spoiled due to thunderstorm and power failures at the observing site (Itapetinga Radio Observatory, Atibaia, SP, Brazil). At the elipse's maximum no active radio source was present in the uncovered area of the solar disk.

magnetic fluxes could be invoked to explain the effect. Solar polarization maps of moderate resolution could then provide useful information on morphology and temporal variations of large scale magnetic fields on the solar corona.
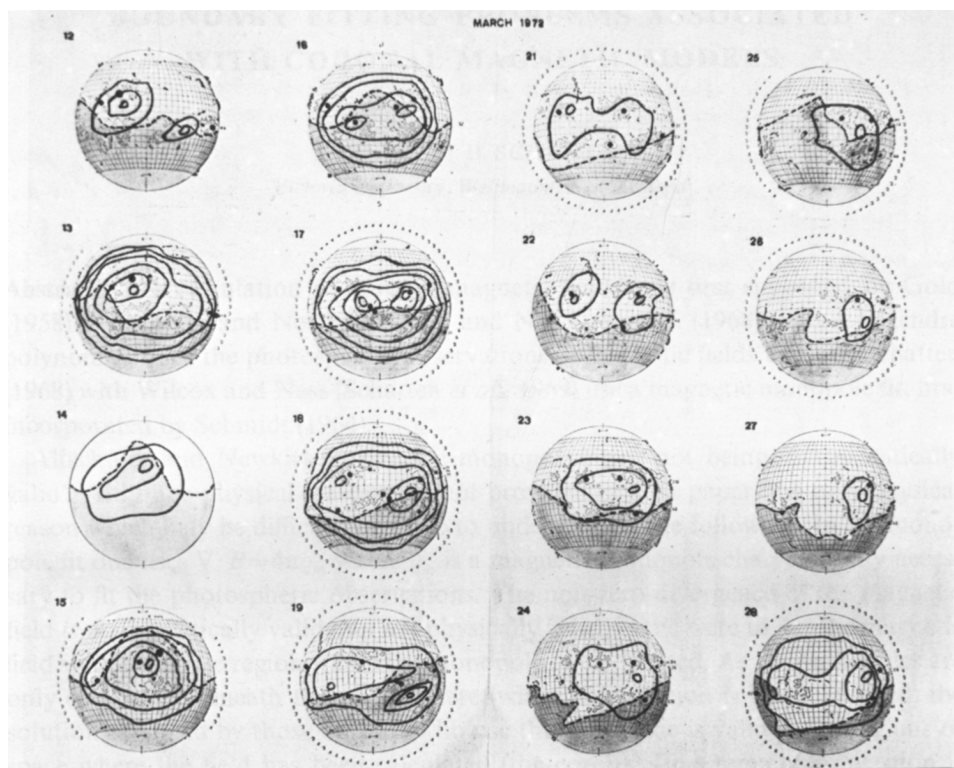
Fig. 3. Polarization maps from the Sun taken in 12–29 March 1972 at Itapetinga Radio Observatory with a 45 ft radio telescope, providing 12′ resolution at $\lambda = 4.3$ cm. The data was plotted over Fraunhofer Institut maps and North is at the top. Days 20 and 29 were omitted due to incomplete data. Dark areas are for right-handed polarization senses and clear areas are for left-handed polarization. Unrestored intensity contour lines obtained at the same wavelength are also shown, in relative but uncalibrated antenna temperatures, being the outer contour for 6000 K, and the inner contours increasing by steps of 500 K. It is clearly shown the strong dependence of the 'neutral line' on the presence of net magnetic fluxes from active centres, and on their displacement with solar rotation.

DISCUSSION

Kundu: Are you measuring quiet Sun polarization or active region polarization. If it is active region polarization, your discussion in terms of one sense of polarization for the northern hemisphere and the opposite sense for the southern hemisphere is misleading. If it is the quiet Sun polarization, how do you calibrate your instrument for zero circular polarization?

Kaufmann: Several of the large-scale magnetic structures due to active centers may well spread into uneclipsed areas even if no apparent spot or radio active center was present. The eclipse data are then not representative of quiet sun conditions. The polarization maps, the strong dependence of polarized areas on the active centers, and their evolution with solar rotation, suggests that nearly all net magnetic fluxes necessary to explain the polarization are due to the centers.