DIRECTIVITY OF SOLAR MICROWAVE BRIGHT REGIONS

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The slowly varying component of solar radio emission associated with sunspots and plage regions were studied at various frequencies, particularly in the microwave region (Christensen *et al.*, 1957; Christensen *et al.*, 1960; Swarup, 1961; Kundu, 1965). These studies indicated the main features of the solar active regions. Inferences were drawn regarding the size and shape of the active regions. The directivity of the regions was determined by measuring the flux received from a source during its change in position from limb to limb of the solar disk. Most of these measurements, at or near 10 cm λ, were made during high sunspot-activity period and the results indicated that the source behaves as though it were a disk of small but finite thickness lying parallel to the photosphere.

In the present analysis Stanford microwave spectroheliograms (9.1 cm λ) (CRPL solar geophysical data, Part B) were used to investigate the directivity of bright regions of relatively weak intensity observed during 1963–65. The maximum brightness temperature of a source as its position on the solar disk changes from limb to limb was noted for each day and the values were normalized taking the brightness temperature at CMP as unity. The regions were divided into four categories depending on their brightness temperatures. They are:

(I) regions with $T_B < 75 \times 10^3$ K
(II) regions with $T_B > 75 \times 10^3$ K but $< 100 \times 10^3$ K
(III) regions with $T_B > 100 \times 10^3$ K but $< 250 \times 10^3$ K
(IV) regions with $T_B > 250 \times 10^3$ K

The variation of the brightness temperature for the four groups of regions is shown in Figure 1. Each curve represents an average of about 15–20 bright regions. We see that maximum emission occurs about 5 days before CMP for weak regions, and that this peak shifts gradually towards the central meridian with increase in the intensity of the source. For regions whose brightness temperature is $> 250 \times 10^3$ K the maximum emission occurs near CMP and the centre-to-limb variation approximates to the cosine law reported by previous workers.

The asymmetry observed for relatively weak sources is significant and conspicuous. It will be interesting to see if this behaviour is clearly seen for individual regions. Figure 2 shows some typical examples of radio emission associated with recurrent active regions. We find that in general the individual regions show the same asymmetrical tendency demonstrated by the average curve of 15–20 regions. We also note

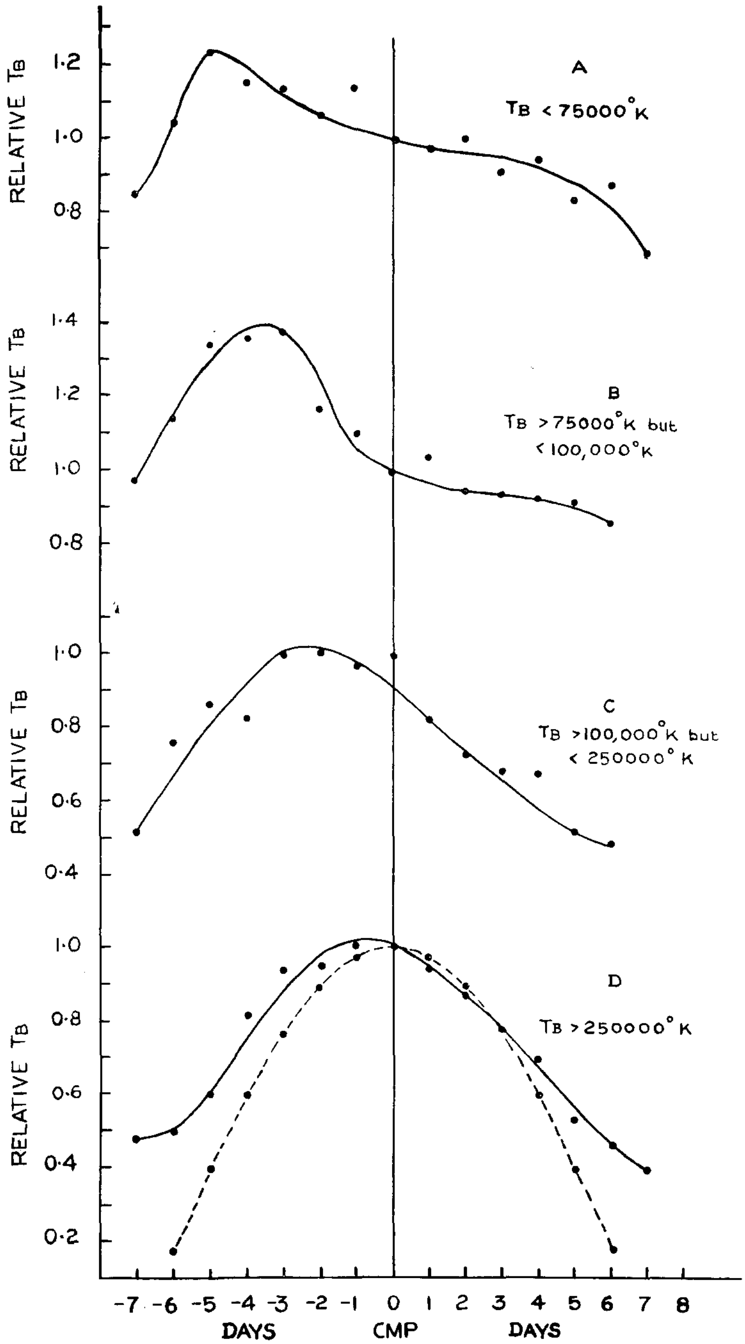

Fig. 1. Limb-to-limb variation of maximum brightness temperature of bright regions at 9.1 cm. Broken curve in *D* shows the variation due to a thin circular emitting region.

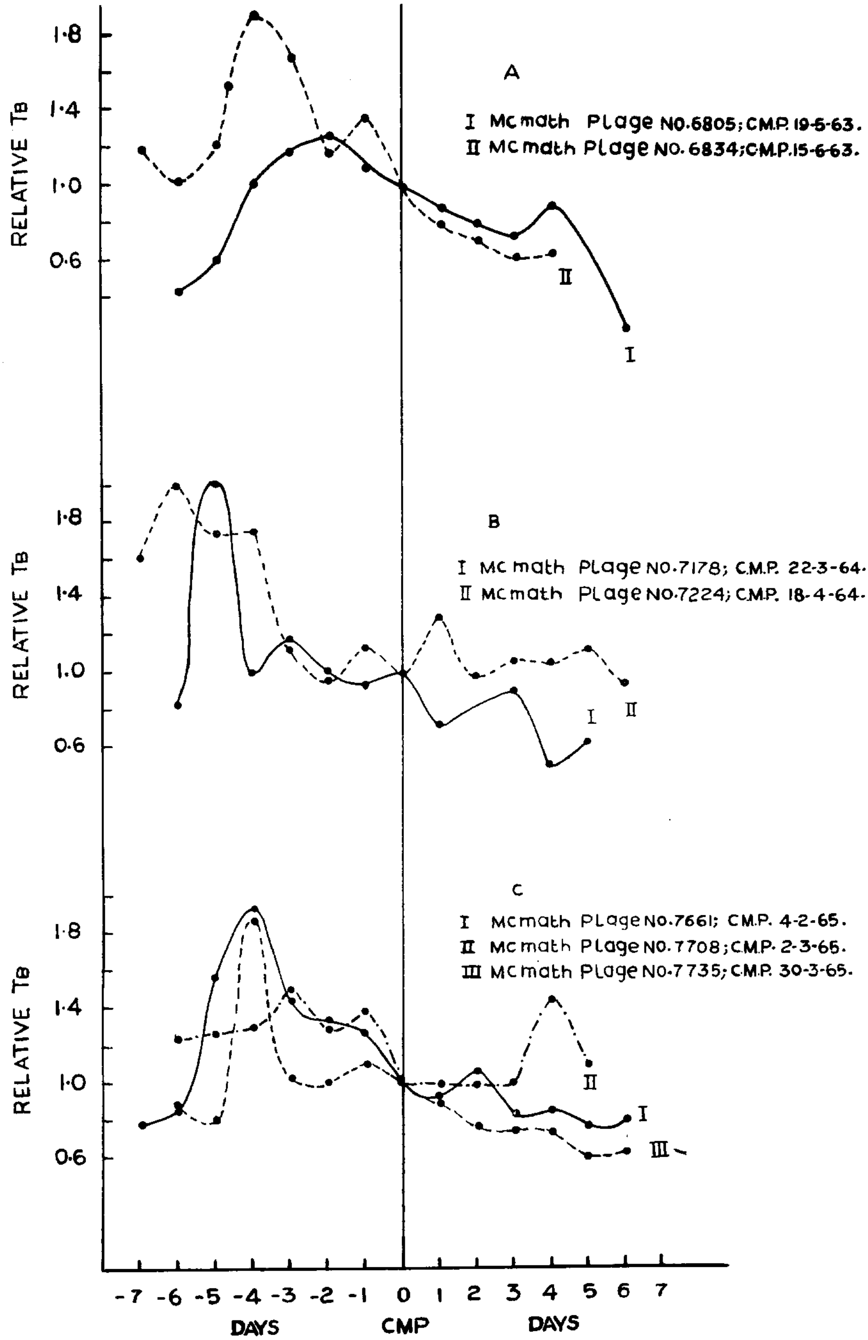

Fig. 2. Limb-to-limb variations of typical recurrent bright regions.

that in the case of many of these regions, as seen in Figure 2, the asymmetry discussed above is retained in successive rotations. We may consider instrumental causes for such an asymmetry to be non-existent following ROOSEN and GOH (1967).

It is difficult at this stage to give a satisfactory model for the source of the bright region to account for the observed behaviour. One possibility is that the radio emission from the active regions on the sun may have two components: one with symmetrical directivity, whose intensity varies during the sunspot cycle, and the other, a weak emission with an asymmetrical directivity. This model can explain qualitatively the shifting of the maximum reported here. The asymmetrical emission may be due to weak coronal streamers which will be tilted due to the solar rotation. A model on these lines was suggested by ROOSEN and GOH (1967) while explaining the asymmetrical distribution of radio emission on the solar disk.

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