SOME PROPERTIES OF ACTIVE REGIONS ON 9 AND 21 CM

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Abstract: The contribution of active regions to the total radio flux of the Sun on λ 9 cm is deduced from radioheliograms. The relative increase of the 9 cm flux with the size of the region is larger than for the 21 cm flux which may explain the spectral peak of the slowly varying component in the maximum of solar activity.

Introduction and the Material

The slowly varying component is emitted from active regions. It is, therefore, useful to look for the contribution of different active regions to the total solar radio flux, recorded by many radiometers all over the world.

For this purpose we have used the radioheliograms (radio maps), published in Solar-Geophysical Data, from 1967 to 1972. Only well defined radioplages, located not far from the central meridian, have been treated, a total of 392 regions for the mentioned period. The radioheliograms for 9.1 cm from Stanford and those for 21 cm from Fleurs have been used. The isophotes of 10 brightness units and of 50 brightness units have been chosen for the boundary of radioplages of 9.1 cm and 21 cm, respectively. This means that the areas with a brightness temperature $T_b \geqslant 50\,000$°K for the 9.1 cm and $T_b \geqslant 85\,000$°K for the 21 cm radiation have been considered.

Treatment and Results

To convert the brightness temperature readings in the radio maps into flux densities, the following approximation of the Rayleigh — Jeans law is used:

$$S = \frac{2\,k}{\lambda^2}\, C \Sigma Y_{jk}\, \Delta\Omega\,. \quad [\text{watt m}^{-2}\text{Hz}^{-1}] \quad (1)$$

The symbols in the formula have the following meaning:

S — flux density (watt m^{-2}Hz^{-1}) k — Boltzmann constant, λ — wavelength (0.09 m or 0.21 m), C — unit of brightness temperature (5000°K for 9.1 cm and 1700°K for 21 cm), Y_{jk} — reading in the radio map (for 9.1 cm Y_{jk}10; for 21 cm Y_{jk}50), $\Delta\Omega$ — element of solid angle corresponding to one reading (2.5×10^{-7} steradian for 9.1 cm and 5.8×10^{-7} steradian for 21 cm), Σ — summation over the whole radioplage.

On introducing numerical constants Eq. (1) may be altered to read

$$S_9 = 4.3 \times 10^{-24}\, \Sigma\, Y_{jk} \quad (\text{watt m}^{-2}\,\text{Hz}^{-1}) \quad (2a)$$

or

$$S_9 = 4.3 \times 10^{-2}\, \Sigma\, Y_{jk} \quad (\text{flux units}) \quad (2b)$$

and

$$S_{21} = 6.8 \times 10^{-25}\, \Sigma\, Y_{jk} \quad (\text{watt m}^{-2}\,\text{Hz}^{-1}) \quad (3a)$$

or

$$S_{21} = 6.8 \times 10^{-3}\, \Sigma\, Y_{jk} \quad (\text{flux units}) \quad (3b)$$

In our computations Eqs (2a, 2b) and (3a, 3b) have been used.

The Results are represented (in preliminary form) in figures 1—3.

Discussion

The mean of the radioplages on 9.1 cm and 21 cm are comparable (see Fig. 1). The radioplages over the *F* spotgroups are slightly larger on 21 cm than on 9.1 cm. (The value for *G* is only deduced from 8 active regions and is of small significance.)

The maximum brightness temperature in the active regions is considerably higher for the E and, especially, the *F* spotgroups on 9.1 cm than on 21

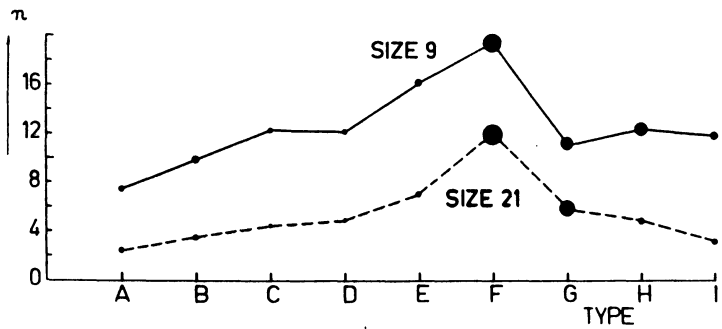

Fig. 1. Size of radioplages over different types of spotgroups. Unit of coordinates represents the area of the solar surface corresponding to one brightness temperature reading in the radioheliograms, i. e. 1.6 × 1.8 square minutes for 9.1 cm and 2.6 × 2.6 square minutes for 21 cm. The area unit for 21 cm is, therefore, 2.3 times larger than the 9.1 cm unit.

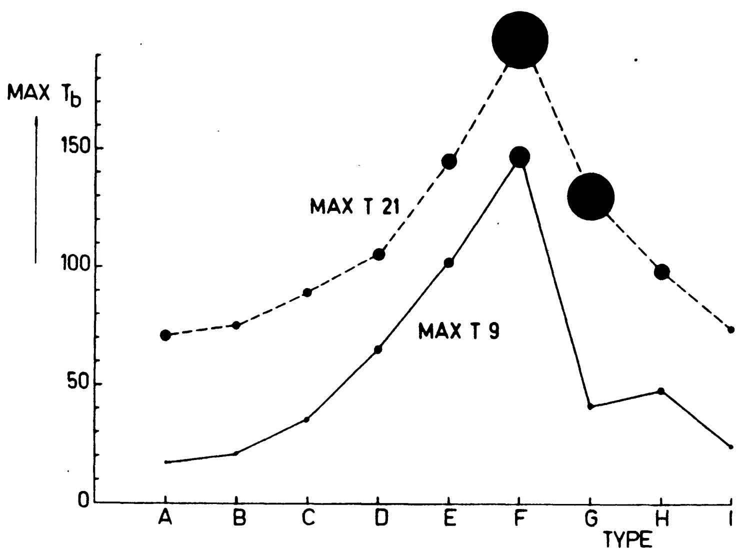

Fig. 2. Maximum brightness temperature for different types of active regions. Mean values are represented by the centre of the circle and the standard deviation by its diameter. The coordinates are given in brightness units, i. e. 5000° K for 9.1 cm and 1700° K for 21 cm. If the maximum temperature is expressed in ° K, the coordinates of max T9 are to be increased three times.

cm (see Fig. 2). This is apparently due to the high plasma content of the coronal condensations overlying the regions and the resulting high optical depth for the 9.1 cm radiations.

The fluxes on 9.1 cm are larger then those on 21 cm as follows from Figure 3, with a predominance in the *D, E* and *F* radioplages. These large active regions are rare in the minimum of solar activity and frequent during its maximum (Kleczek 1952). We may, therefore, expect a larger ratio $\frac{\text{total flux 9.1 cm}}{\text{total flux 21 cm}}$ during maximum activity than during its minimum, when small active regions are abundant and represent the only contributors to the slowly varying component.

The spectra of the slowly varying component measured during the maximum do have a pronounced peak at 9 cm, while they are much flatter in the minimum years (Nesmyanovich et al., 1969).

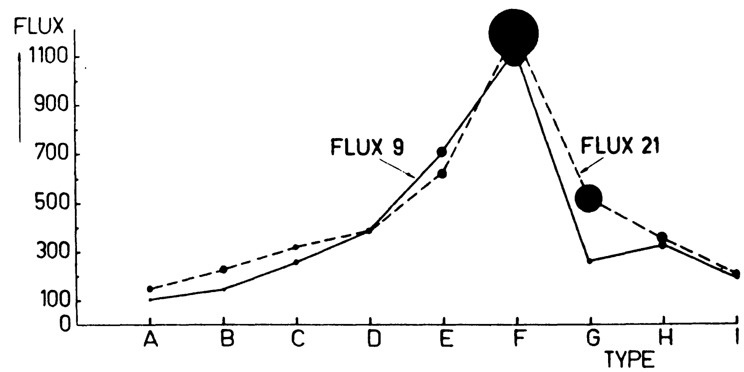

Fig. 3. Radio fluxes for 9.1 and 21 cm of different active regions. The coordinates represent the mean values of $\Sigma\ Y_{jk}$. The coordinate unit for 9.1 cm is 4.3×10^{-24} watt m^{-2} Hz^{-1} (or 4.3×10^{-2} flux unit); for 21 cm the coordinate unit is 6.8×10^{-25} watt m^{-2} Hz^{-1} (or 6.8×10^{-3} flux unit). To get the proper relation (in flux units) the coordinates for flux 9 are, therefore, to be increased by a factor of 6.3.

References

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