A STATISTICAL RESEARCH ON SOLAR MICROWAVE BURSTS

(Research Note)

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The spectrum of solar burst emission shows a broad continuum in the frequency range between 1 GHz and 50 GHz and sometimes beyond it, as has been known since 1958 (Hachenberg).

Normally this continuum has a broad maximum the frequency of which has a certain importance for the interpretation of the processes in the radiation source. Sometimes one observes two or more maxima, but it may be that in these cases several active regions contribute to the radiation.

Near the frequency of the spectral maximum the source becomes optically thin and from this fact we can determine certain parameters, e.g. the magnetic field strength. Therefore a statistical research on this frequency and its dependence on the intensity of bursts seems to be important.

While measurements in the range from 1 GHz till 10 GHz had been made already for a certain period, in the range above 10 GHz measurements have been continuously made only within the last three years. In the first line, it is the Sagamore Hill Observatory that observes at the frequencies 1.495 GHz, 2.695 GHz, 4.995 GHz, 8.8 GHz, 15.4 GHz, and 35 GHz. The data have been published in *Solar-Geophysical Data* (1967–1970). We ourselves use the frequencies 17.6 GHz and 34 GHz at the Stockert Radio Observatory near Bonn.

From Jan. 1967 until Dec. 1969 more than 1000 bursts were recorded. This number is sufficiently high to justify a statistical research on these events. For this purpose, we specify two parameters for each burst.

(i) The maximum S_{max} of the radiation flux during the whole lifetime of the burst and in the entire microwave spectrum.

(ii) The frequency ν_{max} at which S_{max} was reached; ν_{max} is approximated by the nearest measuring frequency of the observatory Sagamore Hill, because this station has made most of the observations. For instance, if the burst has its maximum at a frequency between 6.9 GHz and 12.1 GHz, ν_{max} is fixed by 8.8 GHz.

The radiation flux is divided into 7 steps ($S_j, j=1, 2, \ldots, 7$). These steps are 5 FU (1 FU$=10^{-22}$ W m^{-2} (c/s)$^{-1}$), 25 FU, 50 FU, 100 FU, 200 FU, 500 FU and 1000 FU. The intensity resolution at 15.4 GHz has a lower limit near 4 FU, so that up to this frequency no selection effects occur.

The average frequency of those bursts which have a radiation flux S_{max} above S_j is plotted against S_j in Figure 1. Accordingly, intensive bursts reach their maximum

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S_{max} at frequencies about 10 GHz. Figure 2 shows the average maximums S_{max} of bursts which have the same frequency ν_{max}. It is remarkable that S_{max} is proportional to ν_{max}^2 in a wide frequency range. The deviation of the curve above 15.4 GHz is of no great importance because only 6 bursts were found which had a spectral maximum

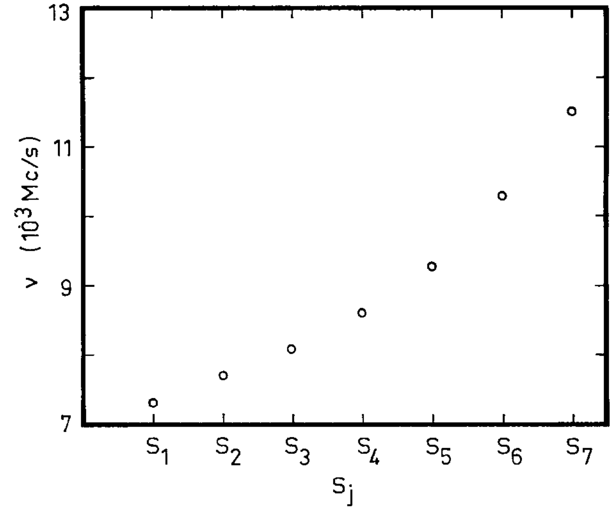

Fig. 1. The average frequency ν_{max} of bursts which have a radiation flux above S_j.

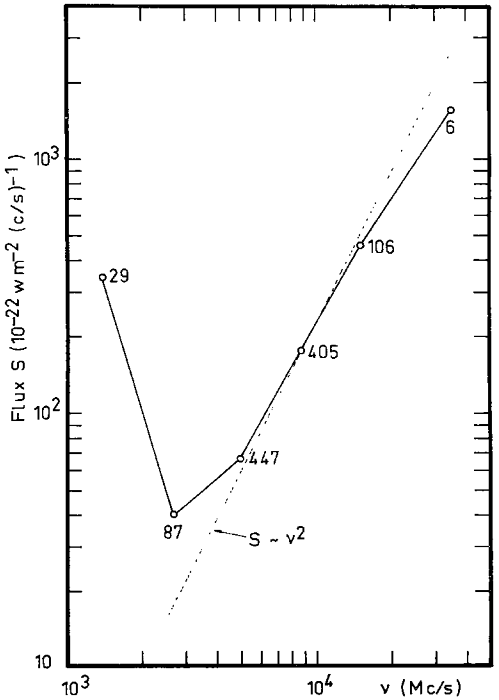

Fig. 2. The average radiation flux of bursts which have the same frequency ν_{max}. The numbers on the curve give the quantity of the averaged bursts.

at 35 GHz or higher. Additional selection effects are of a certain importance since the intensity resolution near 35 GHz is much higher than 5 F.U.

We conclude from this simple relation between S_{max} and ν_{max} that the parameters of the radiation function should be determined by the frequency ν_{max} if we refer to the temporal and spectral maximum of the intensity of bursts. If we assume that microwave bursts are generated by synchrotron radiation of mildly relativistic electrons as proposed by Takakura (1960), ν_{max} if of the order of 3–4 ν_H where ν_H is the gyro-frequency of non-relativistic electrons in a magnetic field H. If one assumes that, on an average, in the frequency range between 5 GHz and 15 GHz ν_{max} is 4 ν_H, then, because of the proportionality of ν_H and H, the radiation flux during the maximum is a function of the magnetic field alone.

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