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Studies on Some Aspects of Enhanced Solar Microwave Radiation

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Data on disturbed sun emission at different microwave frequencies observed at Sagamore Hill Solar Radio Observatory for a period of about 4 years have been examined in relation to their occurrences, peak flux values, energy excesses and spectral distributions. Important results obtained from the statistical analyses are: (i) spectrum of the average S-component shows a maximum at 4995 MHz and is independent of the phase of the 27-day cycle, (ii) occurrences of both the 'simple' bursts ('simple impulsive' and 'gradual rise and fall') are maximum at 4995 MHz, and (iii) spectra of majority of the 'inverted U' type of microwave bursts have the peak at 4995 MHz. The analysis suggests that for the study of solar terrestrial phenomena the solar flux observation at 4995 MHz would serve as a better index instead of at 2800 MHz assumed till now to be a reliable index.

1. Introduction

It is well established\(^1\)\(^2\) that the disturbed sun emission includes radiations in the wavelength range covering lower dm, cm and mm (collectively referred to as 'microwaves'). This radiation from the sun can be classified into two variable components: (a) the slowly varying component, abbreviated as the S-component, showing roughly a 27-day periodicity, and (b) the burst component having different time profiles and durations. It is believed that the S-component and the bursts are generated, in general, from the same active region in the solar atmosphere and most probably by the same mechanism of generation such as the synchrotron or magneto-bremssstrahlung. Similarities between the two types of radiation, particularly in regard to their frequency dependence, are normally to be expected. The authors were thus prompted to examine some of these aspects, viz. (a) average spectrum of the S-component, (b) occurrences of common types of microwave bursts at different frequencies, and (c) peak flux and energy excess spectra of simultaneous microwave bursts. Results obtained from the different statistical investigations are reported in this paper.

2. Analysis and Results

(a) Average spectrum of the S-component — In order to find the average spectrum of the S-component the daily adjusted mean solar fluxes at 606, 1415, 2695, 4995, 8800 MHz recorded by the Solar Radio Observatory at Sagamore Hill over the period July 1967-March 1970 were first plotted, and the por-

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(c) Peak flux and energy excess spectra of microwave bursts — Peak flux and energy excess spectra of solar microwave bursts occurring simultaneously at 1415, 2695, 4995, 8800 and 15400 MHz over the period December 1967-March 1970 were examined. The spectra obtained can be classified under four different types, viz. (i) increasing, (ii) decreasing, (iii) inverted U, and (iv) complex or zigzag. Typical plots of the spectra are shown in Fig. 3. The relative percentage values of these spectral types are shown individually in Fig. 3. The inverted U spectra are found to be predominant over all other spectral types. Moreover, these spectra show the peak at different frequencies. The relative percentage occurrences of peaks at 2695, 4995, 8800 and 15400 MHz are found to be about 10%, 55%, 33% and 2% respectively, thus showing a maximum value at 4995 MHz. Altogether 83 such spectra have been analyzed by the 'superposed epoch method' and the overall normalized spectrum is shown in Fig. 4. The normalized average spectrum of the S-component is also shown on the above curve in order to see closely the relative variation of the different components with frequency. Except the lower decimetre (dm) wavelength range the two spectra are identical in nature.

3. Summary of the Results

Results obtained from the present analysis can be summarized as follows:

(i) The S-component spectra show a maximum at a frequency around 4995 MHz. This is true for any position of the source on the solar disc.

(ii) The occurrences of microwave simple bursts are also seen to be maximum around 4995 MHz.

(iii) Of the four spectral types of the microwave bursts, the major group is formed by the 'inverted U type' having its peak around 4995 MHz.

4. Discussion

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The results obtained from the present analysis clearly show that the S-component as also the burst
component, particularly in the frequency band considered, are highly correlated with each other. It can thus be concluded that both these components are generated in the same active region and are probably generated by the same mechanism. However, with the limited data available the exact frequency at which the different maxima occur cannot be precisely determined. More observations at different other frequencies centred around 5000 MHz may be useful in this respect.

For a long time solar flux measured at 2800 MHz has been taken to be one of the reliable indices for the study of different solar terrestrial phenomena. Results obtained in this analysis lead us to suggest that solar flux data at 4995 MHz would perhaps serve as a better index.

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