WIDE-BAND AVERAGE SPECTRA OF SOLAR RADIO BURSTS

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Abstract: Peak flux spectra of solar radio bursts in a wide frequency band have been statistically determined for different morphological types of bursts, for various ranges of magnetic field of the burst-associated sunspots and also for the bursts occurring in the central and limb region of the solar disk. Important results obtained are: (i) The generalised spectra have two peaks, one near to meter-wave and the other in the centimeter-wave region, the former peak being more pronounced than the latter; (ii) identical spectral shape is observed for the great and impulsive types and also for GRF and PBI types of bursts; (iii) the radio emission intensity is relatively higher in the central part than that in the limb part of the solar disk for frequencies 1-10 GHz, while the reverse is true for frequencies 0.245-1 GHz and 10-35 GHz; (iv) the optical depth of the absorbing layer above the source of a burst is found to be the same for meter to centimeter-wavelength bursts, implying that the radio sources in this wide band have uniform characteristics with respect to optical thickness; (v) in case of simultaneous emission in the dekameter to X-ray band, most of the decimetric bursts are seen to be very prompt and coincident with the associated flare's starting time. The interpretations of the obtained spectra give an insight into the possible generation mechanisms, pointing to the location of the source region in the solar atmosphere.

1. Introduction

The study of energy or peak flux spectra of solar bursts in a wide radio band owes its importance to gaining an insight into the generation mechanism of radio emission at different wavelengths, making it depend on the actual conditions at the centre of activity. Spectra of continuum type sporadic radio emission in different ranges of wavelength were evaluated from time to time by various authors (Smerd, 1964; Hachenberg and Wallis, 1961; Castelli et al., 1969; Fokker, 1969; Dasgupta and Sarkar, 1971; Croom, 1971). But hardly any attempt has been made for ascertaining the spectral shape in a continuous manner from meter-to-millimeter-wave region on consideration of burst-events having the characteristics of simultaneous multi-frequency emission, being reported by the same station in order to avoid the error in the given flux densities due to the use of different time constants of receivers, to the differences or deficiencies of the calibration systems. The aim of this present paper is to determine statistically the nature of spectra in the aforesaid wave region under different considerations by taking the data of the same observatory. The data of 106 multi-frequency burst-events along with the relevant phenomena which occurred during the period of about nine years since July, 1969 were collected from the monthly Solar Geophysical Data bulletins issued by NOAA, U.S.A. These bursts were observed at least at eight of the nine observing frequencies 0.245, 0.41, 0.606, 1.415, 2.695, 8.8, 15.4, and 35 GHz by Sagamore Hill Radio Observatory, Mass.

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The times of start of a burst event at different frequencies occur within ±5 min from each other.

2. Average Peak Flux Spectra

In order to evaluate the average peak flux spectra, each of the spectra has been first normalised individually with respect to its maximum value of peak intensity observed for that burst-event, and the averaging has been effected only for those spectra in which the normalised values at a particular frequency do not deviate much from each other. The bursts which have been considered for drawing the average spectra have their peak intensity $I > 100$ f.u. ($1 \text{ f.u.} = 10^{-22} \text{ W m}^{-2} \text{ Hz}^{-1}$) near meter-wave (0.245 and 0.41 GHz) region and have $I > 5$ f.u. in the lower wavelength region. The generalised spectra thus obtained as shown in Figure 1 reveal that the flux density attains its maximum (hereafter called primary maximum) value near to meter wave region (at or below 0.245 GHz in curve I, at 0.41 and 0.606 GHz respectively in curves II and III) in case of 79 burst-events and in the microwave region for the rest 27 events. The secondary maxima of the spectra occur in the centimeter-wave region.

Fig. 1. Wide band spectra of radio bursts, the ordinate shows the normalised values of peak flux density and the abscissa the frequency of bursts.