A FLARE-ASSOCIATED THERMAL BURST IN
THE mm-WAVE REGION

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(Received 28 May, in revised form 20 August, 1973)

Abstract. A ram-wave thermal burst has been observed at 73 GHz. The simultaneous observation at
17 GHz revealed that this mm-wave burst was quite a different component from the non-thermal
burst co-existing at a cm-wavelength range. Since the source of this burst seemed to be opaque or
nearly opaque, the temperature became several tens of thousands degrees. Considering also the
similarity between time profiles of the 73 GHz intensity and the Hα light curve, it is concluded that
this mm-wave burst is situated very close to the Hα flare region.

Shimabukuro (1972) examined a number of solar radio bursts at the shortest wave-
length, and summarized the characteristics of burst spectra up to 90 GHz, but a differ-
ent type of burst spectra in the mm-wave region was observed on 31 October, 1972,
at the Tokyo Astronomical Observatory (TAO). The burst shows a spectrum suggest-
ing a thermal origin with a rather low electron temperature of $1 \times 10^4$ K to $1 \times 10^5$ K
for an assumed opaque structure of the source. This possibility was also suggested by
Shimabukuro (1970) with a 3.3 mm solar burst.

An almost complete sequence of Hα patrol pictures during the radio burst was
obtained at the TAO, and a flare of importance 1b was detected on the same location
(17°W, 14°S) as the radio burst source. Figure 1 shows the filtergram taken at the
maximum phase of the flare.

73 GHz observation was made with the new 6 meter dish of the TAO. The beam-
width between half power points was 2.4 min of arc (approximately circular), and a
beam switching system, a splitted reference beam being located at both sides of the
center of the main beam, was used during the observation.* An active region was
scanned through the solar disk, according to the Earth's rotation, every three minutes
of time, and the intensity of the burst was estimated referring to the magnitude of the
preceding quasi-quiet S component. Total (integrated) but merely excess flux density
of the S component was obtained as about 7 sfu (1 sfu = $10^{-22}$ W m$^{-2}$ Hz$^{-1}$) with an
assumed transparent source on the $7 \times 10^3$ K uniform solar disk.

The upper curve in Figure 2 is a typical record of the 17 GHz grating interferometer
having a fan beam as a. in the figure. The area P excluding that of S, the excess com-
ponent on a smoothed background just before the start of burst, corresponds to the
burst intensity, under the assumption that the source of area S was quite transparent
and was not affected by any activities throughout the burst occurrence. We used here
600 sfu of the 17 GHz integrated flux density for the quiet solar disk.

* The reference beam, which is shown as b in Figure 2 with marks R, has been made by a rotating
(46 Hz) half-wave dielectric sector plate covering the half area of the main beam between the Cassegrain
mirror and its focus.

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The lower curve in Figure 2 is an example of the 73 GHz record which shows a drift scan response of the beam switching system. The height of $P$ above the background in the figure was compared with that of $S$ (dotted curve in the figure), which was the response due to the undisturbed $S$ component, and then the flux density of the burst was roughly evaluated with an error of about $\pm 30\%$.

A probable size of the source of mm-wave burst was estimated here as about $2' \times 2'$ taking both the width of drift scans on the burst source (17 GHz and 73 GHz) and the area bounded by the Hz flare ropes (not the total area of the flaring region itself), into consideration. When the source has a large optical thickness, the intensity of the burst must be corrected with respect to the contribution from the quiet solar disk compo-