Correlation of Impulsive Microwave Bursts with Type III Bursts and Solar Flares

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Correlation between impulsive microwave bursts, H$\alpha$ flares and type III bursts was frequently investigated (see Krüger, 1979 and references therein). This study is based on the sample of 194 impulsive microwave bursts which have been registered at 37 GHz in the period April 1989 - October 1991 with the 13.5 m radiotelescope at the Metsähovi Radio Research Station. The telescope beam size at 37 GHz is 2.4 arc min, so the locations of the microwave bursts were accurate enough to enable also the study of the correlation with H$\alpha$ flares. A microwave burst has been considered to be correlated to a flare if it fell into the interval between the start and maximum of the flare, i.e. during the impulsive phase. The correlation with type III bursts was based on the time coincidence only. Solar Geophysical Data reports and when available original Weissenau station recordings have been used, allowing for a time window of one minute between the maximum of a microwave burst and the type III event as the correlation criterium.

In Figure 1 the distribution the impulsive microwave bursts is presented according to the classification used at Metsähovi:

\begin{align*}
S &= \text{spike or simple burst; duration < 1 min} \\
S_1 &= \text{minor simple burst; duration > 1 min; intensity < 1 sfu} \\
S_2 &= \text{simple burst; 1 min < duration < 10 min; 1 sfu < intensity < 50 sfu} \\
C &= \text{complex, combination of simple bursts; intensity < 50 sfu} \\
GB &= \text{great burst, major C; intensity > 50 sfu}
\end{align*}

In the histograms presenting the distribution of microwave bursts the number of correlated type III bursts (Fig. 1a) and the number of correlated H$\alpha$ flares (Fig. 1b) is superposed. In total 33 (17%) of microwave bursts were correlated with type III bursts and the correlation rate increases from 5% for S type to 55% for GB type (Fig. 1a). We would like to stress that the correlated S type bursts occurred in the frame of two complex microwave events containing various types
Figure 1. Correlation rate of impulsive microwave bursts with type III bursts (a) and with Hα flares (b) depending on the type of the microwave burst.

Figure 2. Time profile of the impulsive microwave burst observed on March 29, 1991 at 37 GHz (time elapsed at 13:57 UT). Vertical lines denote the starting times of type III bursts.
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Figure 3. Histogram of the time differences between the start of a correlated type III burst and the maximum of an individual microwave peak.

of bursts. The impulsive microwave bursts from our sample showed a higher correlation rate with flares (Fig. 1b) than with type III bursts by a factor of two to four, depending on the type of the microwave burst (Fig. 1a,b). This can be explained by the fact that the occurrence of type III bursts associated with flares is highly depressed if the energy release site of the flare is located inside the general bipolar configuration of the active region, i.e. there is no access to open magnetic field lines (Zlobec et al., 1990).

A detailed inspection of the microwave time plots and starting times of individual type III bursts within a group (Fig. 2) for 11 events covered by Weissenau spectrographic records revealed that the starting times of the type III bursts preceded the peak emission in microwaves typically by 1 to 5 seconds (Fig. 3).

References


Part VIII
The Quiet Sun