On the correlation of Metsähovi solar mm-wave bursts and Type III metric wave observations

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Introduction

This report contains preliminary results of the comparison study of possible correlation between mm-wave and m-wave solar radio events. High frequency mm-wave observations were done at Metsähovi Radio Observatory, Finland, at 22, 37 or 87 GHz. Low frequency measurements were mainly done at Basovizza Observing Station of the Trieste Astronomical Observatory, Italy, at 237 MHz. The original list of events which was studied contained more than 200 events. A critical selection process reduced the number of events to 44. The main rejection criteria were the uncertainty of pointing to the same active region and lack of original data from Metsähovi (Metsähovi computer system has changed two times and old magnetic tapes are not any more readable.)

Correlation criteria and results

First it should be noted that there are two different types of mm-wave radio burst: impulsive bursts and GRFs (Gradual Rise Fall events). Typically the duration of an impulsive energy release event is less than 60 seconds. Time series of an impulsive event can be very simple (one fast onset followed by exponential decay) or extremely complex (several energy releases followed by each others and intensity oscillations during both onset and decay phases). The duration of a GRF at mm-waves is typically about 30 minutes and no special features can be seen in the time series. Actually there exists third type of events which can be characterized by a short impulsive event in the beginning followed by a GRF.

We have considered the following possibilities for the correlation of mm-wave and Type III events:

1. simultaneous or almost simultaneous starting time of the events
2. simultaneous time of maximums
3. simultaneous time of the end of the events
4. same length of the events
5. similar time profiles
6. similar relative intensities of the events.

The analysis of our data base revealed that the most important feature in possible correlation of events is the starting time. This is valid for the impulsive events and for GRFs. From our previous experience we have established a criteria that if the starting times are more than 10 seconds delayed they are not correlated or correlation is questionable. In principle this is valid for both the impulsive events and for the GRFs, but often the accurate starting time of a GRF is difficult to determine. In some cases also the times of maximums are clearly correlated.

The results of our correlation study of 44 events can be summarized as follows:

- in 21 cases events clearly correlated
- in 12 cases events perhaps correlated, a study of spectrum needed
- in 6 cases events perhaps not correlated, a study of spectrum needed
- in 5 cases events clearly not correlated.

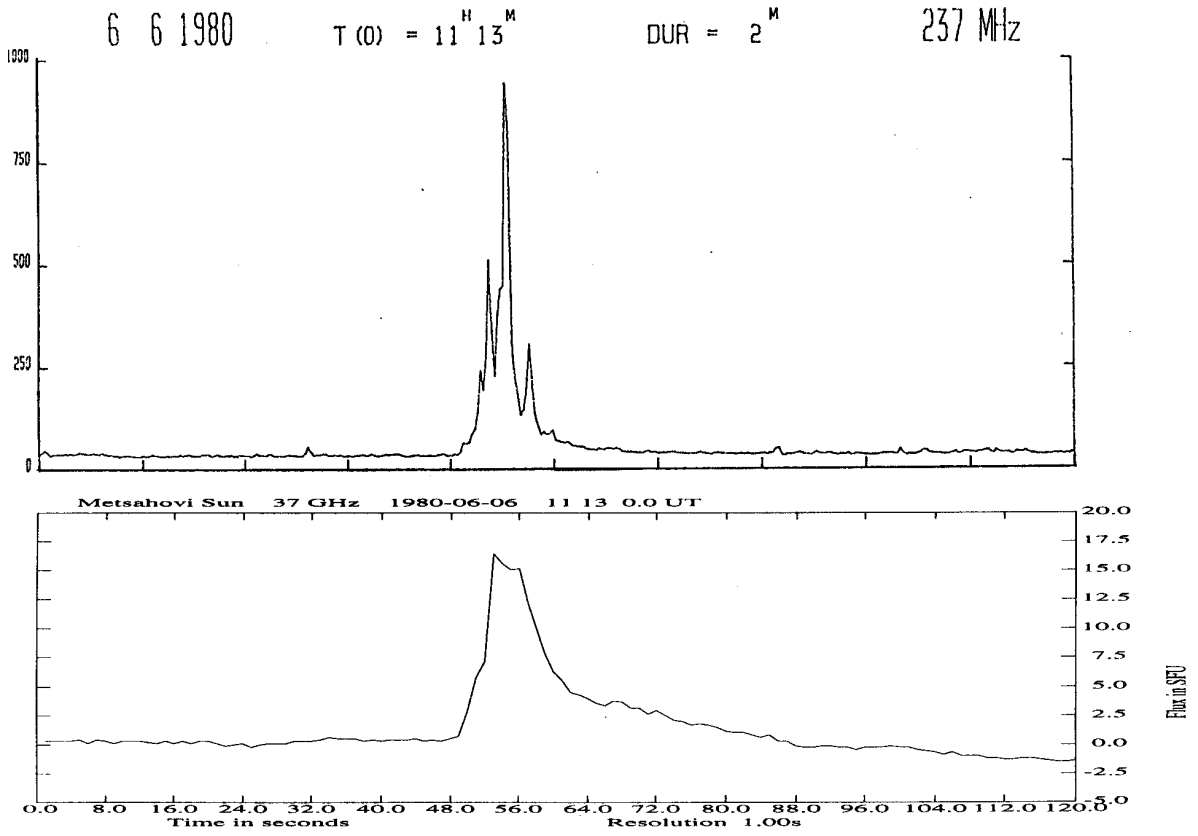

Figure 1: Event on June 6, 1980. Upper part measured at Basovizza Observing Station, Trieste, Italy, frequency 237 MHz. The lower part measured at Metsähovi Radio Observatory, Finland, frequency 37 GHz. The intensity of the event was 1000 sfu at 237 MHz and 17 sfu at 37 GHz

An excellent correlation event is shown in Figure 1 from June 6, 1980. The source position was S15 E40. At 37 GHz a short impulsive burst started at 11h13m48s. Duration was about half a minute and peak intensity 17 sfu. In Tremsdorf high frequency data it was seen as a weak event only at 9500 MHz.

At 237 MHz Trieste observed a group of large-bandwidth Type III bursts with maximum intensity of 1000 sfu. The starting time 11h13m48s was simultaneous with Metsähovi. Also the duration was similar to the one at 37 GHz. The event was also observed in low frequency records of Tremsdorf up to 23 MHz.

Conclusion (Discussion)

A clear correlation has been established between Metsähovi 37 GHz measurements and Trieste 237 MHz Type III observations. It is proposed that the physical explanation for the correlation is a common triggering point of the flare at a foot-point of a magnetic loop or at the top of that loop. In addition a topology of open magnetic field lines is needed. This scenario can explain all the events were the delay from mm-wave to Type III is 0 - 3 seconds. Longer delays and negative delays can be due to complexity of the event with several energy releases where only some of the individual energy releases are visible both at mm-waves and at metric waves.