Microwave observations of sub-second pulses with spatial resolution

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Since 1992, interferometric observations with millisecond resolution during the whole daytime became available at 5.7 and 17 GHz. A few tens of sub-second pulses (SSP) with amplitudes well above noise level were recorded at each frequency. The study of these events has a great importance for the problems of fragmented energy release and electron acceleration in solar flares.

At both frequencies, the SSP can occur at any phase of background flare burst and occur more frequently in the same active regions. The polarisation degree of SSP was small.

Observations at the SSRT show that the SSP appear at 5.7 GHz in ~ 15 % of flares. The duration of the most of them was in the range of 20–200 ms. The minimal recorded duration of 20 ms is certainly a lower limit due to the comparable time constant of the receiver. Appropriate simulations showed that the minimal observed pulse duration corresponded to the real one of ≤ 5 ms. The flux pulses were distributed after their duration into two clusters with a mean duration of 50 ms and 150 ms, respectively.

It was found that the apparent sizes of the SSP sources reach unexpectedly high values of several tens of arc seconds which increase toward the solar limb. The center-to-limb variation of the source size is explained by scattering on plasma turbulence along the ray path in the solar corona. For the limb event of November 2, 1992, the emission source was found to be located at a height of 35×10^3 km, well above the SXR-emitting loop with high density and temperature and relatively low magnetic field.

Powerful pulses of sub-second duration were recorded starting from the beginning of the NRH observations. The sizes of the SSP sources at 17 GHz are close to the NRH beam size (about $10''$) in all cases. For some events, soft X-ray images are also available. For disk events, positions of the SSP sources were close to the footpoints of the SXR-loops. For the limb flare of November 2, 1992, it was possible to find the height of the source above the photosphere (15×10^3 km).

For three 17 GHz events, the BATSE/CGRO data of 64 ms resolution are available. There are several sub-second structures in the HXR data which are highly correlated with microwave pulses, regarding the relative timing as well as the pulse duration.

The most remarkable is September 7, 1992 (05:09 UT) event, when the source was located on the solar limb, and the corresponding SSP at 5.7 GHz were also recorded. There is high one-to-one correlation between the HXR and microwave spike emission at the both frequencies with small relative delays. The delay between the 17 GHz and 25–50 keV HXR emission is considerably less than delays of about 0.3 s which were reported for radio emission at 1.3 GHz. It is remarkable that with the same duration of < 250 ms, the size of the SSP source at 5.7 GHz considerably exceeded that one of 17 GHz which confirms the substantial influence of the scattering on the observations of microwave burst at longer wavelength.

The emission mechanisms of SSP are discussed and the plasma parameters in the sources are estimated.

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