The study of solar flares with the microwave sub-second pulses at 5.7 and 17 GHz

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Flares with fine-structured features in their time profiles are of a special interest as sub-second time structures are attributed to processes of primary energy release. Keeping two-frequency microwave data recorded by the SSRT (5.7 GHz) and the Nobeyama Radioheliograph (17 GHz) together with X-ray data, we have a chance to study emission mechanisms and physical conditions favorable to generation of sub-second pulses and, probably, to find out what does proceed in sites of energy release.

Since 1992, more than thirty fine-structured bursts were recorded by the SSRT. At the Nobeyama Radioheliograph at least 25 events with sub-second pulses also were detected. However, we have found only four of them, in which fine time structures were recorded by both radio telescopes.

We have comprehensively studied two flares and started with the two more. In all the four flares, the impulsive sources coincided with the main sources of the burst continuum observed at the corresponding frequency.

The event of September 6, 1992 (NOAA 7270) was an ordinary slender impulsive flare observed on the solar disk. The microwave source was projected onto a dense loop emitting soft X-rays.

The limb flare of November 2, 1992 (NOAA 7321) was a prominent powerful LDE with a complicated changeable structure of emitting sources. The sub-second features were recorded at different frequencies in various time intervals: pulses of the emission at 17 GHz during the growth, a series of sub-second pulses at 5.7 GHz near the peak of the burst. The sources were located up to 35×10^3 km at 5.7 GHz and up to 15×10^3 km at 17 GHz. Gyrosynchrotron mechanism was responsible for the sub-second emission at 17 GHz, while the 5.7 GHz pulses near the peak were generated by plasma emission.

It has appeared to be possible, to explain the main qualities of the flare within the framework of a closed configuration, by a sequence of reconnection acts in the multi-loop system. In the impulsive phase, the dense SXR loop top was located inside the extended optically thick source, and the optically thin source emitting the sub-second pulses at 5.7 GHz was much higher.

The event of March 3, 1994 (NOAA 7682) was an ordinary slender flare on the disk. The spatial structure did not pass through appreciable changes. The source of the sub-second pulses coincided with the main source of the burst continuum and seems to be located in a loop footpoint. Remarkable is the correspondence of the details of the time profiles at the both frequencies.

The event of September 7, 1992 (NOAA 7276) was a slender limb flare. Outstanding is the correspondence of the total flux time profiles at the both frequencies and with hard X-rays.

In the investigated cases, the sub-second pulses were emitted from loop-top sources with a moderate magnetic field ($\sim 100 - 300$ G). The sources were found to be compact ($\leq 3 \times 10^3$ km). The basic way of appearance of sub-second pulses at 5.7 GHz is plasma emission. The emission mechanism responsible for the fine time structure observed in the flare of March 3, 1994 has not yet been definitely qualified. Possibly, it may be a high-frequency analog of the type III bursts which was generated in this case in a rather compact region.

Although the statistics is not representative, the considered events suggest that sub-second structures can be recorded at the both frequencies if they are generated in footpoints (type III bursts) rather than in loop-top sources.

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