SOME CHARACTERISTICS OF ULTRA-FAST TIME STRUCTURES SUPERIMPOSED ON IMPULSIVE mm-WAVE BURSTS

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Summary. The use of increased sensitivity and temporal resolution at mm-wavelengths has revealed a number of novel features associated with solar activity (Kaufmann *et al.*, 1979a). Of particular interest are the ultra-fast time structures superimposed on impulsive bursts. They are distinguished by time scales and repetition rates much shorter than the impulsive times scales. For weak bursts at λ = 13mm (i.e., few s.f.u.) the superimposed spikes are separated in time by several seconds. For moderate fluxes (i.e., 100 s.f.u.) the repetition rate of superimposed spikes is $\sim$ 10-15 per second (i.e., time interval between two repeated spikes $\sim$ 80 msec). For bursts larger than 500 s.f.u. the predicted times between repeated ultra-fast structures are shorter than 10 msec. Various examples have been studied with a time resolution better than 10 msec. (Kaufmann *et al.*, 1979b). The impulsive flux level increases with the repetition rate of the ultra-fast component, following a nearly linear relationship. The simplest interpretation suggests that the injected spikes are associated with the bursting source function and are quasi-quantized in energy (Kaufmann *et al.*, 1979b).

The ultra-fast component should not be confused with long-lasting steady quasi-periodic oscillations (period $\sim$ few seconds) which were observed to set in during certain large bursts in microwaves (Kaufmann *et al.*, 1977), and soft X-rays (Thomas and Neupert, 1978) and appears to be a different phenomenon.

Flux levels of the superimposed spikes are nearly 10 times larger at λ = 13mm than at λ = 7mm, and their spectral indices are different from the impulsive component (Kaufmann *et al.*, 1979a, 1979b).

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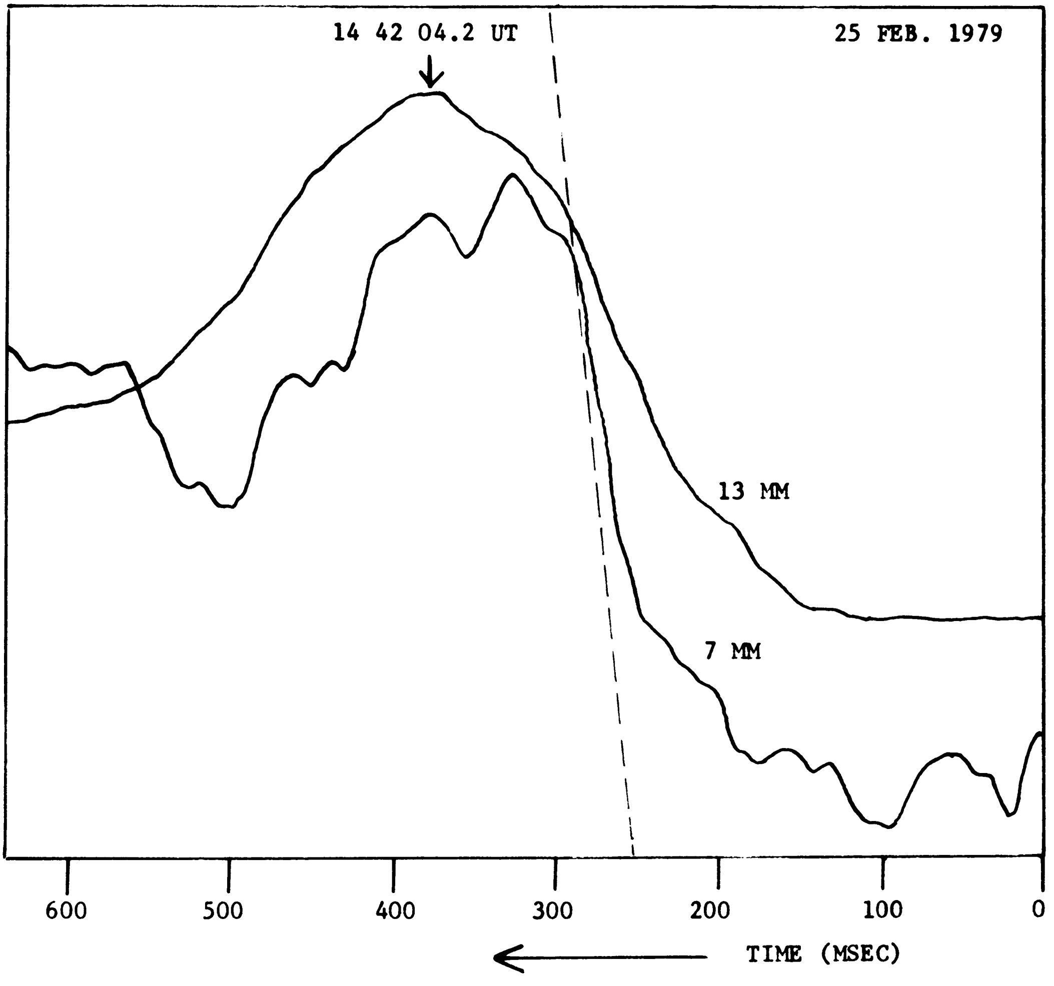

Fig. 1. Ultra-fast time structure observed at mm-waves. The dashed line indicate the response of the recorder to a step function.

A spike observed simultaneously at 13mm and 7mm which was analysed in considerable detail is shown in an expanded time scale in figure 1. (This spike also appears in a compressed time scale as feature 2 of figure 1 in Kaufmann *et al.*, 1979b). The maximum flux was about 14 s.f.u. at 13mm and 1.7 s.f.u. at 7mm. The noise level at 13mm is about the thickness of the trace, and at 7mm is approximately the amplitude of the smaller fluctuations.

In figure 1 the 7mm rise phase is observed to be considerably faster than the rise phase at 13mm. The rise phase at 7mm is undoubtedly faster than shown. It was limited by the recorder time constant. The event also shows the following additional features: 1) the maximum of the spike at 7mm leads by about 40 msec the maximum at 13mm; 2) the pulse half-power width is narrower at 7mm (200 msec) than at 13mm (280 msec); 3) the maximum slopes of the rise phases at both wavelengths are nearly coincident within a time difference appreciably shorter than the delay between the maxima.

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DISCUSSION

Benz: I wonder whether the observed time delay is due to the effect of different group delays of the radio emission. What is the observed time delay between the 7 and 13 mm spikes?

Kaufmann: The time difference between pulse maxima is about 40 milli second for 7 mm and 13 mm, in this particular example. Differences in group velocity require dense plasma in progagation lengths comparable to the entire size of an active center, which might not be realistic.

Kundu: Am I correct in assuming that in no case the burst starts at the same time at 7 and 13 mm wavelengths.

Kaufmann: The start time is usually not so well defined as the pulses' maxima, which are not at the same time in the example shown here. For higher mean flux levels, the repetition rates rise, and the relative amplitude of the U.F. structures reduces. Timing measurements become more difficult within our current instrumental possibilities. Although your assumption seems to be qualitatively correct for our data, I would like to analyse in detail a larger number of well resolved fast time structures at the two wavelengths, in order to make a more general and definitive statement.

Degaonkar: What is the physical significance of the millisecond spikes in mm bursts?

Kaufmann: The ultra-fast structures are possibly a direct response to the energetic injections which originate in the flare. Since mean fluxes are proportional to the repetition rate of injections, these behave as quasi-quantized in energy. The bursts' source function would then be made up by discrete discontinuous injections, with characteristic energy content, at various repetition rates.