OBSERVATIONS OF SOLAR TYPE III RADIO BURSTS WITH THE NANCAY RADIOHELIOGRAPH

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Results on the space-time evolution of type III burst sources are summarized (Raoult and Pick, 1979) and observations on the temporal characteristics of the circular polarization are presented. It is shown that type III burst sources can be resolved into narrow components. Complex or very large sources may be explained by the occurrence of electron beams which propagate along different diverging paths. Propagating effects in a scattering corona are not required to explain the observations. The origin of the fundamental-harmonic pairs is briefly discussed.

The Nançay Radioheliograph provides observations with both high space and time resolutions : these are respectively 1.15 arc minute at 169 MHz and at best 50 images per second including the circular polarization measurement.

Firstly, we shall summarize the results of a study which has been published in another paper (Raoult and Pick, 1979) ; it concerns the space-time evolution of type III burst sources and the interpretation of these observations. Secondly, we shall present preliminary results on the temporal characteristics of the circular polarization of type III bursts.

SPACE-TIME EVOLUTION OF TYPE III BURST SOURCES

An analysis has been made of the size, shape and temporal behaviour of type III burst sources. Two sets of observations have been reduced with a time resolution of 0.02 sec and 0.04 sec. This analysis has revealed that :

- Most of the sources are complex in space and time. Significant modification of the shape can be observed within a few hundredths of a second.
- When the source is unstructured in space and/or time, the diameter remains constant until the moment of maximum intensity and then in-

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creases with a rate of about 1 arc minute per second.
When the source is structured in space and/or time, the diameter has a tendency to increase from the beginning of the burst.

From these observations, it is shown that the type III burst sources can be resolved into narrow components of typical sizes about 2 arc minutes at 169 MHz (mean altitude ≃ 0.34 R.S.). This elementary size may correspond, either to the transverse dimension of the electron beam which generates type III burst emission or the emitting cone. Complex or very large sources may be explained by the almost simultaneous occurrence of two or more electron beams which propagate along different diverging paths. This is in agreement with earlier results which revealed the existence of strongly diverging fields from active regions spreading on a range of longitude as large as 100° (Mercier, 1975).

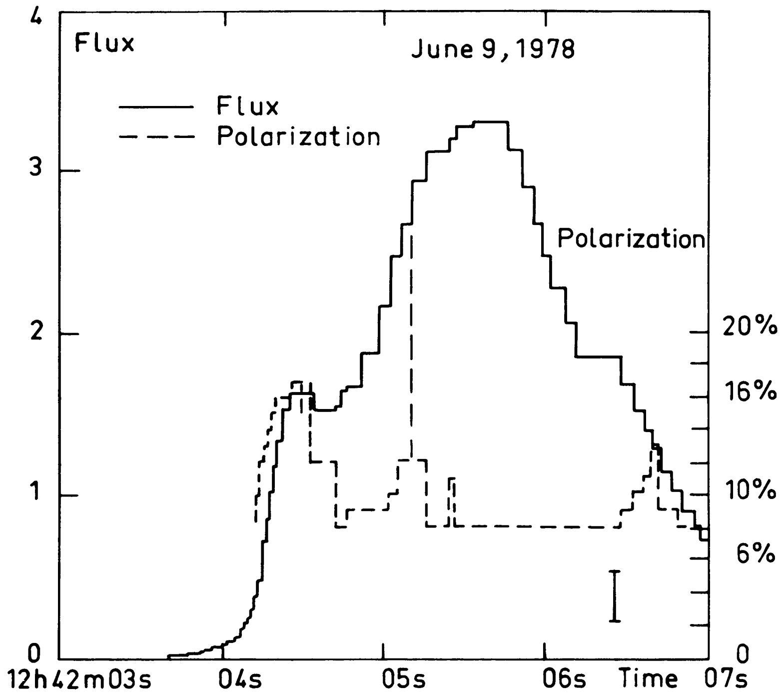
The broadening of the burst size within its life-time cannot be explained by coronal scattering and may be an effect of the primary source itself (G. de Genouillac, private communication). Indeed a broadening resulting from a scattering corona should correspond to an appatent speed of about 3c (Steinberg and al., 1971) which is not observed.

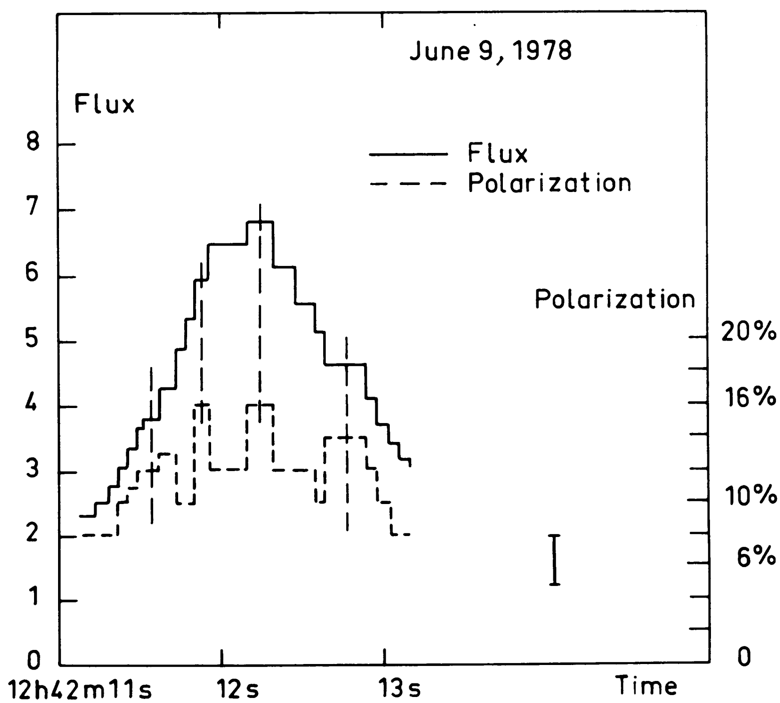
In conclusion, the present observations of type III burst sources are best interpreted in terms of a "multi-component model". Propagating effects in a scattering corona are not required to explain the observations. The influence of the mean corona is weaker than that usually accepted and this is in agreement with earlier results (Mercier and Rosenberg, 1974 ; Kerdraon, 1973 ; Trottet and Lantos, 1978).

TEMPORAL CHARACTERISTICS OF THE CIRCULAR POLARIZATION OF TYPE III BURSTS : PRELIMINARY RESULTS.

The circular polarization of 10 groups corresponding to 64 type III bursts has been measured. A degree of polarization greater than 10% was found in about 50% of the cases. Figures 1 and 2 which correspond to bursts belonging to the same group, show typical examples of the temporal evolution of the polarization of a burst. The sources have no spatial structure and a diameter of about 2.5 arc minutes. It is seen that the polarized emission has an impulsive character : it corresponds to a succession of spikes, hardly or not at all visible on the total flux curve, as already noted in previous studies (Slottje, 1974).

Figure 3 shows a burst pair : the first one is short (< 1 sec), polarized and corresponds to an unstructured source with a narrow diameter, less than 2 arc minutes. The second one is long (> 1 sec), unpolarized and corresponds to a complex source which has at least 3 components in space and time. The position of the two members of the pairs are also distinct. The separation between the first short source and the main component of the second one is about 2 arc minutes. A few pairs have been now observed with the Radioheliograph. It seems that most of them present similar characteristics : the first, short and polarized burst source is systematically to be found narrower and at the same position or at a higher one than the second source (it is the total





Figures 1 and 2. Time evolution of a burst

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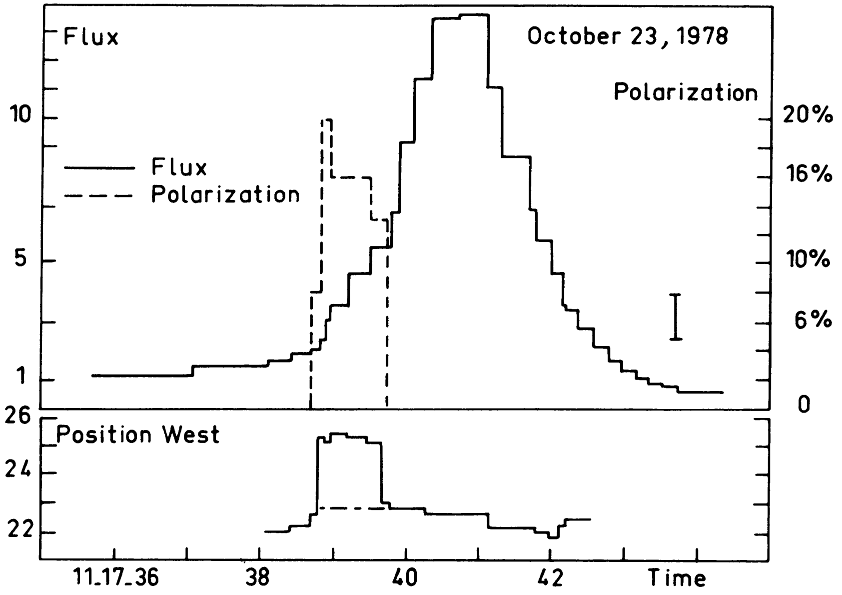

Figure 3. Upper part : time evolution of a burst pair.
Lower part : full line : East-West position of the maximum intensity,
broken line : other visible position.
Only the position of the main component of the second pair member has been reported. The positions of the 2 pair members are distinct.

diameter of the second source which is taken into account when the latter is complex).

It must be noted that in the present study, the observed evolution of the polarization may be significantly affected by the real time data compression which is only based on the evolution of the flux (Radioheliograph Group, 1977).

Figure 4 shows the duration distribution for respectively the polarized and unpolarized bursts. The polarized emission corresponds either to bursts with a life-time typically shorter than 0.8 second (often < 0.4 second), or to a succession of spikes detected in bursts of longer duration

In conclusion, these results based on the measurement of the polarized emission, also confirm the existence of multiple components during the occurrence of a type III burst. It seems that the polarized emission is confined into components or bursts of short duration. Finally, it is emphasized that both high space and time resolution are essential in the investigation of the circular polarization characteristics, particularly as far as the fundamental-harmonic (F - H) pair problem is concerned.

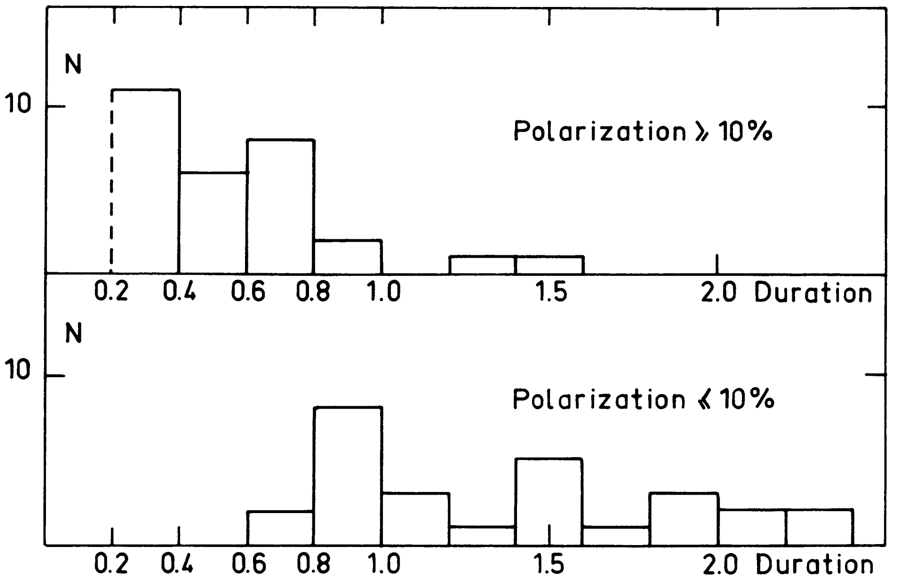

Figure 4. Duration distribution.

Indeed, though in the present study no detailed spectral data were available, it seems plausible that pairs such as that shown in Figure 3 are F - H pairs : their temporal characteristics and polarization are similar to what has been reported for the F - H pairs in the litterature (Suzuki and Sheridan, 1978 ; Caroubalos and al., 1974). The puzzling question thus arises : must all such pairs interpreted, as is classically done, as the fundamental and second harmonics of the local plasma frequency ? In that case, we must explain how the F component is sometimes confined into a narrow source at the same position or at a higher one than the H component. Or, can these pairs be interpreted in terms of a multiple component model ? In that case, we suggest that the properties of the first member of the pair might be related to the electron beam itself and/or the coronal structure.

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DISCUSSION

Gergely: I would like to know if the type III bursts you talked about occur in storms or are isolated.

Pick: This study concerns isolated groups of type III bursts.

Dulk: I want to comment that fundamental components of type III bursts are very rare at high frequencies. Suzuki and I found that only four of nearly 1000 type III bursts were visible at frequencies greater than 160 MHz. Also, a large fraction of type III's are multiple.

Pick: Yes, the fundamentals are probably rare at 169 MHz. Nevertheless, the "F component" has been observed by different groups and when observed presents similar properties to those at lower frequencies: short duration, prolonged emission. These properties characterize more easily the "F component" than a frequency ratio of 2 between the "H" and "F" component. Rosenberg pointed out this difficulty in 1973 (Chiuderi, C., Giachetti, R., Mercier, H., Rosenberg, H. and Slottje, C. in G. Newkirk (ed.) 'Coronal Disturbances', I.A.U. Symp. 57, 225). I don't see any reason why the problem would be quite different at higher frequencies from that at lower frequencies.

Concerning your second remark, indeed a large fraction of type III bursts are multiple. Our results show that whenever a type III burst seen on the disk has a large diameter or a long duration, the source is systematically resolved into multiple narrow components.

Kundu: Do you have any interpretation for the diameter that continues to increase all through the duration of type III. It is important, because it certainly says something about the nature of the electron stream. Intuitively, I'd think that the stream is compact or condensed, until the maximum emission, and then the stream spreads out.

Pick: This property is indeed perhaps related to the stream itself or maybe an effect of the primary source.