ON MODULATIONS OF RADIO TYPE IV BURSTS

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It is well known that pulsations with quasi periodicities of the order of 1 s occur during type IV emissions. Recent observations of the Nançay Radioheliograph operating at 169 MHz have revealed the existence of modulations on a longer time scale and brought new information on the faster one.

One minute oscillations have been observed in three successive moving type IV bursts occurring on April 12, 1977 (Trottet et al., 1979). This modulation took place into two well localized sources (diameter of about 2') located at each border of a diffuse (diameter of about 6') weak and non modulated continuum. The structure rising as a whole in the corona this suggests that the emission was due to electrons trapped in expanding magnetic arches the modulated sources being located at the magnetic mirrors. Spectral information revealed that the modulated as well as the non modulated emissions were broad band (high frequency cut-off between 800 and 500 MHz and low frequency cut off below 40 MHz) and that there was no measurable frequency drift. Thus the emission can be attributed to gyrosynchrotron radiation.

Possible causes of intensity modulations can be envisaged from two rather different points of view.

- A mere MHD oscillation of the arch is involved. Its effect is to modulate both the magnetic field strength and the spatial and energetic distributions of the trapped electrons in an adiabatic manner. In this picture the efficiency of synchrotron variation is increased during compression times at the mirror points where both the magnetic field strength and the particle velocities are enhanced.
- The second sort of explanations would involve a more or less periodic precipitation of particles towards lower regions of the trapping arch. One such a mechanism could be the loss cone-Whistler instability.

Shorter time scale (~ 1 s) pulsations superimposed on type IV continuums have been often observed with instruments without resolving power (spectrograph or single frequency records). Nevertheless few radioheliographic observations are available. Observations of the Nançay Radioheliograph reveal that the sources of the pulsations are moving.

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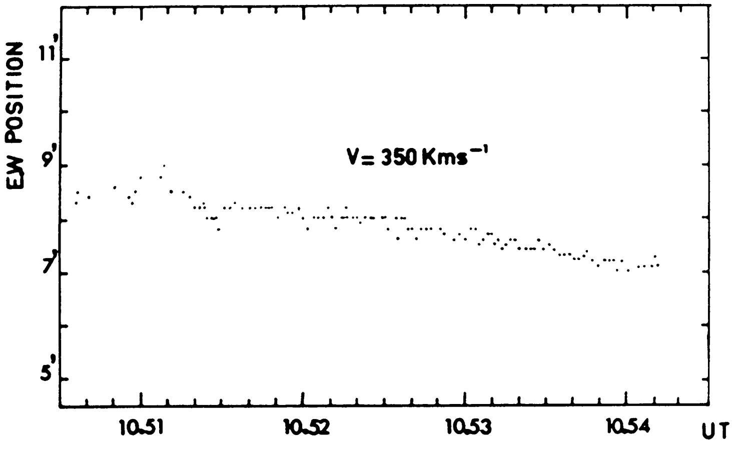

Figure 1. Positions of the pulses maxima versus time.

Actually, two cases of such pulsating sources have been observed by the Nançay Radioheliograph (Pick and Trottet, 1978 ; Trottet et al., 1979). In both cases the sources are found to move and in one of them they constitute the early beginning of the type IV continuum. We report here the principal properties of the latter. The emissions starts with about one hundred pulses followed by a continuous emission moving with the same apparent speed of 350 Km s^{-1} (Figure 1). The total duration of the event is 10 mn. Some of the pulses are plotted on Figure 2 and their main characteristics are :

- periodicity	: (1.7 ± 0.5)s
- diameter	: 2×10^5 km
- modulation	: > 90 %
- brightness temperature	: $\geq 10^9$ K
- frequency bandwidth	: 140 - 250 MHz
- frequency drift	: $\sim$ 300 MHz/s

In order to understand such pulsed emissions two problems have to be solved : (i) what is the emission mechanism, (ii) how is it modulated ?

Moving type IV emission is often attributed to gyro-synchrotron radiation. In the present case the limited observed bandwidth and mainly the frequency drift are hardly compatible with such a mechanism. Other emission mechanisms have been proposed. They involve interactions between trapped particles and Langmuir or Whistler waves. In that case the expected frequency bandwidth is compatible with the observed one.

In both cases the emission may be modulated by a global resonance of a magnetic arch (Rosenberg, 1970 ; Meerson et al., 1978). In fact these modulation mechanisms can hardly explain the lack of a strict periodicity, the large dimensions of the sources and the frequency drift. Another modulation process may act for the second type of emission mechanisms. If a new acceleration occurs, it will change the fast particle distribution and the emission will stop. Such a process has been proposed to explain type IV dm sudden reductions (Benz and Kuijpers, 1976). In this frame the acceleration has to be quasi periodic and more work has to be done to understand the implication of the observed source size for this mechanism

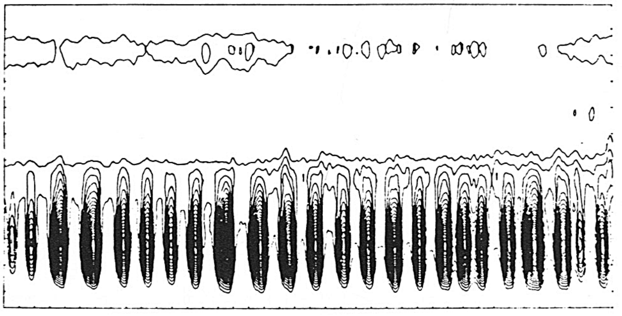

Figure 2. Iso intensity contours during the pulsations.
Vertical axis : E-W position (one graduation every 2').
Horizontal axis : Universal time (one graduation every second)

In summary, the present observations are hardly explainable in the frame of the existing theories. More observational as well as theoretical work has to be done before reaching definite conclusions. We intend to make a research of such fluctuations in type IV bursts to obtain more systematic properties.

References

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DISCUSSION

Kai: It seems to me that the pulsation shown on the figure occurs exactly simultaneously over the whole source. Are there time differences depending on position within the source?

Trottet: The pulsating source presents brightness variations occurring at the same time over its entire diameter.

Wild: What is the smallest angular size you have measured (a) on any kind of burst, (b) on moving type IV bursts?

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Trottet and Pick: The smallest source sizes observed are of the order of 1'. The usual observed size of type IV continua is of the order of 6'. That was the case for the one minute oscillating events but the sources of modulation have diameters of 2' and are located at each border of the 6' continua.

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