ESTIMATION OF SHOCK THICKNESS FROM DYNAMIC SPECTRA OF TYPE II BURSTS

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ABSTRACT

Twenty type II solar radio bursts were observed during the period 1968 to 1972 by a solar radio spectroscope (240-40 MHz) at Ahmedebad. Intensity variations in type II bursts as a function of frequency and time are sometimes observed in their dynamic spectra. This fine structure enables determination of the shock thickness of the order of a few hundred to a few thousand kilometers. In a few cases, an interaction between streams of fast electrons and propagating shocks is clearly evidenced by simultaneous observations of short duration narrow band structures in type III bursts and type II bursts.

INTRODUCTION

Type II bursts are characterized by slow frequency drift with time as compared to fast frequency drifts observed in type III. They occur less frequently than type III bursts and are generally associated with large solar flares. The velocity of a type II disturbance as estimated from the frequency drift with time is of the order of 10^3 Km/sec. The drifting feature of type II is identified with a collisionless shock wave set up as a result of an explosion at the time of a flash phase in a solar flare (Kundu, 1965; Wild and Smerd, 1972).

With the help of a solar radio spectroscope (frequency range 240-40 MHz; bandwidth ∿300 KHz; time resolution ∿0.5s) at Ahmedabad, twenty type II events were recorded between 1968 and 1972. A typical example showing interaction between type II and III is shown in Figure 1.

RESULTS

Besides the usual macroscopic features some microscopic features in type II bursts are observed. These are: (i) short duration narrow band patchy structures, and (ii) simultaneous appearance of short

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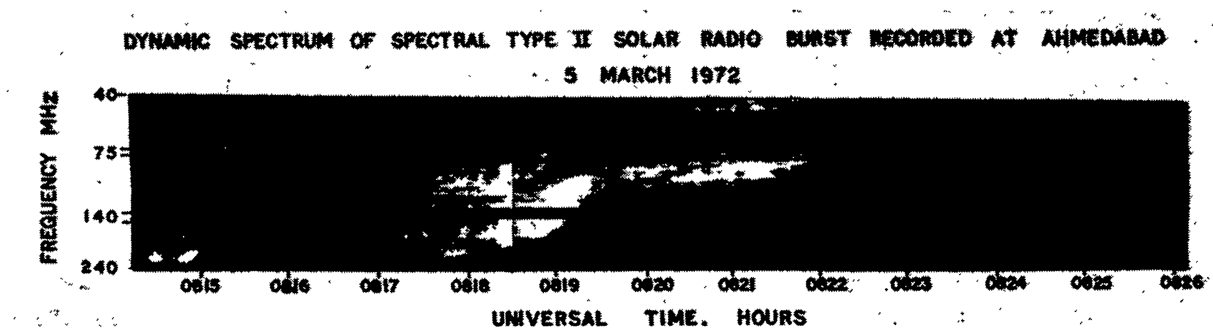

Figure 1. Dynamic spectrum of type II burst showing fine structure and interaction with type III burst.

duration narrow band patches in type III and type II bursts. The patchy structures have the following characteristics: (a) they occur predominantly below 100 MHz; (b) their bandwidth was as low as 500 kHz, to tens of megahertz; and (c) their duration varied from 1 to 5 seconds.

INTERPRETATION

The short-lived patchy structures within type II bursts can be understood from the following mechanism. As the shock front encounters electron density irregularities, the enhancement in the emission takes place as a result of the interaction between the shock and the irregularity. It is possible to estimate the scale size of the density irregularities and obtain a lower limit to the shock thickness. Radiation can be generated ahead of the shock front by the escaping electrons from the shock (McLean, 1974). Knowing the velocity of the shock from the frequency drift and the electron density model, and from the time duration of the patches seen in type II, we have obtained the linear dimensions of 10^2 - 10^3 km of the irregularity. This puts an upper limit to the shock thickness since the shock has to interact with the density irregularity to produce enhanced intensity. Observation of shock thicknesses by satellites have shown that the shock thickness varies from 600 to 1600 km (Dryer, 1975).

CONCLUSION

From the intensity variations of narrow band short duration patches, sometimes observed in type II bursts, the thickness of the shock front from a hundred to a few thousand kilometers has been derived. These values are a lower limit to the shock thickness and are consistent with *in situ* satellite measurements.

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DISCUSSION

Gergely: Do you have any positional measurements of the type II and type III's? If not, one may not know for certain if the shock and the electron beams interact, since they may be in entirely different parts of the corona.

Sawant: True, we didn't have positional information of type II and associated type III bursts. But considering the fact that the type II shock fronts generally have large heliolongitudinal extent, we have assumed that the electrons causing type III bursts might have interacted with the type II shock front. Further, the narrow frequency range over which type III's have been observed just prior to the type II burst may justify our above assumption.

Petelski: Is there any direct evidence for the shocks?

Sawant: Yes, the occurrence of type II burst is a sufficient evidence for the shock.

Newkirk: Since one does not know the scale of the inhomogeneities, your derivation of the thickness of the shock must be regarded as upper limit.

Sawant: Yes, I agree.

Dryer: What shock velocities did you observe?

Sawant: Usually type II bursts imply shock velocities of 1000 to 2000 km/s but at the time of August 1972 events, shock velocities of about 4000 km/s were inferred.