PECULARITIES OF THE DYNAMIC SPECTRA OF TYPE V SOLAR RADIO BURSTS

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The data on type V solar radio bursts obtained at IZMIRAN with the 45-90 MHz radiospectrograph are analyzed. A great variety and complexity in the dynamic spectra of these events is found. A number of categories of bursts with different emission characteristics of the leading and following edges are distinguished. A number of types of fine structure were found in the dynamic spectra of many bursts. Type V bursts, for which the radio emission at the fundamental and the second harmonic is clearly observed are analyzed.

1. INTRODUCTION

It is now generally accepted that type V bursts are smooth, weakly polarized intense continuum bursts, which occur at frequencies below 150 MHz and which immediately follow type III bursts (Wild et al., 1959; Thompson and Maxwell, 1962; Weiss and Stewart, 1965; Kundu et al., 1970; Labrum and Duncan, 1973; Robinson, 1977). This report is devoted to the detailed analysis of the pecularities of dynamic spectra of type V bursts, in particular the general shape of spectrum, fine structure and harmonic structure of these events. In this study we analyze approximately 120 type V bursts, observed with IZMIRAN's radiospectrograph, in the frequency range 45-90 MHz, during 1967-1976 (Markeev, 1961). Some events were also observed with the 93-186 MHz radiospectrograph (Korolev, 1975) and with a number of fixed-frequency radiometers at Tremsdorf Observatory. All selected continuum events have a duration of more than 30 seconds.

2. SHAPE OF THE DYNAMIC SPECTRA

In classical type V burst the leading and following edges drift towards low frequencies. Analysis of the dynamic spectra shows that events are often observed in which the features of radioemission on the leading and the following edges differ significantly from that of classical events. Beginning with the emission pecularities in the appearance of the leading edge one can pick out the following groups of events: a) bursts with a sharp, fast-drifting leading edge, b) bursts with a diffuse edge, and c) bursts with a reverse drift of the leading edge.

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The departures from the classical appearance of the following edge, as seen on the dynamic spectra may be classified as: a) Bursts with reverse drift of the following edge, the frequency drift ranging from 2 MHz s^{-7} to 10 MHz s^{-7}, b) Bursts with fast drifting following edge. The duration of these events is nearly constant at different frequencies, c) Burst with arch-like following edge. The duration is minimum at intermediate frequencies $\sim$ 70 MHz, and d) Bursts with the anomalous slow frequency drift ($\sim$ 0.1 MHz s^{-1}) of the following edge.

3. FINE STRUCTURE

The presence of different details contrasting with the continuum forming the fine structure is characteristic of most of the type V bursts. Typical varieties of the fine structure include the following: a) Superposition of continua with different intensity, b) Wideband pulsations, quasi-regular consistency of the continuum intensification and reduction with time scale of a few seconds, c) Irregular structure of spectra. It arises due to the large scale, bright elements arranged more or less chaotically in the dynamic spectra, d) Small scale bright elements with duration of 2-5 seconds and bandwidth of 2-4 MHz. e) Zebra pattern-a system of narrow band, slow drifting strips which are usually characteristic of type IV bursts. In type V bursts zebra-pattern can be observed at frequencies below 100 MHz.

4. HARMONIC STRUCTURE

Observation of harmonic structure is very important to determine the generation mechanism of the bursts. Harmonics in type V bursts were only recently reported (Benz, 1973; Robinson, 1977). Several events with well developed radioemission of the fundamental frequency and the second harmonic were observed on July 4 and 8, 1974 with IZMIRAN's radiospectrograph. According to the measurements at Tremsdorf Observatory in both cases the intensity of the fundamental band exceeded significantly (approximately 100 and 20 times) the intensity of the second harmonic, and was equal to 2×10^{-17} Wm^{-2} Hz for the event of July 4 (at 40 MHz). Within the framework of plasma generation mechanism, such large intensity of the fundamental band can be explained by induced scattering of plasma waves by the thermal ions of the corona and an energy density of plasma waves of 2×10^{-7} erg cm^{-3}.

If the recovery of the beam-plasma instability in the source of type V bursts is due to collisions between the fast electrons and coronal particles (Zheleznyakov and Zaitsev, 1968), we need a fast electron density $N_S \gtrsim 10^4$ cm^{-3} for the necessary plasma wave energy level to be set up. This value exceeds the concentration of the streams resulting in type III bursts, by two or three orders of magnitude.

5. CONCLUSION

The experimental data on the dynamic spectra of type V bursts, given above shows that these bursts present more complex events than it was thought before. The great variety in the appearance of the dynamic spectra and of fine structure are characteristics of these bursts.

At present it is difficult to explain such variety of the dynamic spectra. One can suppose only that the peculiarities of the spectra are due to different injection conditions and dynamics of movement of fast electrons in magnetic traps. The origin of the fine structure can be conditioned by both the features of generation mechanism (different regimes of plasma instabilities) and the specific physical conditions in the source.

The rare occurrence of harmonic structure in type V bursts can be conditioned by high electron stream density required for the radioemission of the fundamental band to be intense.

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DISCUSSION

McLean: I had the impression that for the example of a reverse-drift start of a type V burst the record was saturated. Perhaps a record with lower sensitivity would have given a quite different impression. Do you have an example of reverse-drift starts of type V bursts which are not saturated?

Fomichev: We kept in mind these points. We believe the peculiarities of the dynamic spectra of type V bursts analyzed are real.

Slottje: How many times did you observe Zebra patterns in type V bursts and was their ridge separation always about 2 Mhz with ridge widths of similar values?

Fomichev: Out of approximately 120 type V bursts we observed zebra-pattern in three events. In all these events the ridge separation and the ridge width were about 2-3 MHz.