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Observation of two coronal mass ejections on April 7, 2011 by radio telescope URAN-2

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Abstract

Two CME's (coronal mass ejection) were registered by SOHO and STEREO on April 7, 2011. The results of observations obtained by radio telescope URAN-2 of different CME manifestations in radio emission at decameter wavelengths are discussed in this paper. Particularly we report about registration of new type of fine structure of type II bursts.

1. Introduction

CME is manifested themselves in radio emission as a consequence of type III bursts group, type II burst and type IV burst [1]. Type II burst at decameter wavelengths can be usual type II bursts and type II bursts with herring born structure [2]. The first one consists of sub-bursts with positive frequency drift rates mainly. Type II bursts with herring born structure have two groups of sub-bursts, one group with positive and other one with negative drift rates. These groups separated by back born radio emission. In this paper we report about results of solar observations carried out on April, 7, 2011. In this day two CME's were ejected during the time of URAN-2 observations. One of these CME accompanied by type II burst with fine structure in the form of "tadpoles". We discuss the properties of type II bursts and "tadpole" bursts. Also we attract attention to the unusual type III bursts preceding this type II burst.

2. Observations and results

Radio telescope URAN-2 (Poltava, Ukraine) [3] works at the frequencies 8-32 MHz. The spectrometer DSPZ allows to register the radio emission at the whole the frequency band (8-32 MHz) with high frequency (4kHz) and time (10ms) resolutions.

During observations by radio telescope URAN-2 from 6:15 till 13:50 on April, 7th 2011 there were two CME's, the first one began at 7:09, and the second one began at 11:16. The first CME was initiated by active area NOAA1183 which was situated at 60° to the West from the central meridian. The average velocity of this was about 500 km/s on distances 3-5 R_S. The active area NOAA1178, which was the cause of faster CME, was situated behind a limb, approximately at 45° from its edge. This is agreed with the presence of radio emission registered by STEREO A and the absence of it on STEREO B. The average velocity of this CME is equaled to 1000 km/s. We remark that both CME's were accelerated with time.

There were a group of type III bursts, which began at 10:51 and preceded the following type II burst which, we believe, was initiated by CME. These type III bursts were differed from usual type III bursts on their drift rate dependence on frequency. At high frequencies their drift rates were about 3.2 MHz/s, the usual value for type III bursts. But the drift rates at low frequencies were unusually small, only about 0.4 MHz/s. We conclude that these type III bursts are result of radio emission of electron beam propagating in magnetic arches and were initiated by the passage of CME through/near these aches.

Radio emission connected with this CME is also type IV burst and type II bursts observed after 11:16. The maximum radio flux of type IV burst was 10^2 s.f.u. and its polarization was 20-40 % . This type IV burst as others type IV bursts observed at decameter wavelengths [4] show oscillations. Properties of these oscillations will be considered somewhere else. In this paper we discuss the properties of type II burst. This type II burst consists of three different parts of type II burst. The first one began at 11:22 and ended at 11:42. Its frequency drift rate was not large, only about 10 kHz/s. It corresponds to linear velocity about of 300 km/s. The following type II burst started

at 11:43 (Fig.1) and continued about 6 minutes. Its drift rate was larger, 25 kHz/s (the shock velocity is about 800km/s). The third part of type II burst had 8 minute duration, from 11:52 to 11:59 (Fig.1). This part of type II burst had practically zero drift rate.

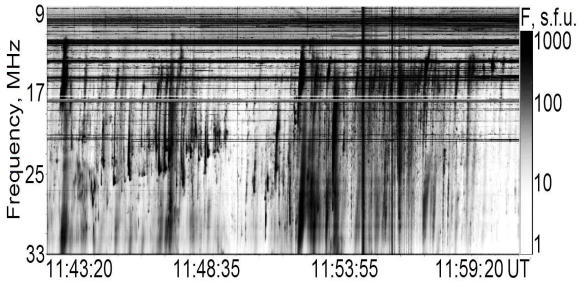

Figure 1: Two parts of type II bursts following one after other.

The main feature of all three parts of type II burst is their fine structure. This fine structure presents a consequence of “”tadpoles” (Fig.2). The frequency band of "tadpoles" changed from 2 MHz to 10 MHz. Their frequency drift was both positive, and negative. The maximum value of “tadpoles” drift rates of frequency drift was 4 MHz/s and was observed in the first part of type II burst. The drift rates of "tadpoles" belonged to the third part of the type II burst had the lowest values up to 0.4 MHz/s.

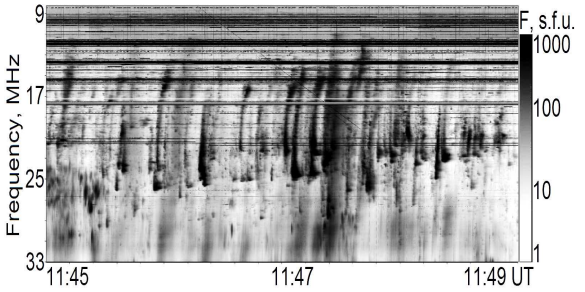

Figure 2: Fragment of type II burst, consisting of “tadpoles”.

A “tadpole” burst consists from two parts, a “head” and a “tail”. Duration of a "head" is about 4 s, and "tail" duration equaled to 2 s. The polarization of "tail" is higher, up to 20 % and only 10% and even lower for “tail”. Appearance of such unusual bursts as “tadpoles” can be understood in the frame of type II shock models, in which electron acceleration happens in some separate regions, for example so called SLAMs [5]. From such regions radio emission as a “head” is generated. At the same time radio emission in the form of “tail” is radio emission of electron beams which leave the acceleration regions. On our point of view the existence of different parts of type II burst show that we observed different spatial parts of shock initiated by the same CME.

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