FAST DRIFT BURST OBSERVATIONS WITH THE NEW ONDŘEJOV RADIOSPECTROGRAPH

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(received: May 30, 1993)

Abstract. The new 100-4200 MHz Ondřejov radiospectrograph and the high-time resolution 3 GHz radiometer are described and the observations of fast drift bursts during the increased solar activity of September 5-7, 1992 are presented and analyzed.

Introduction

At the Ondřejov Observatory, located 40 km south–east off Prague, a new 100–4200 MHz radiospectrograph and a new high–time resolution 3 GHz radiometer started regular daily observations of the solar radio emission. Presently, the main goal is to elucidate the role of fast drift bursts in the solar flare process; in general we want by new and more sophisticated observations to obtain additional radio information e.g. to the excellent results of the Yohkoh mission (Initial results from Yohkoh, 1992) and thus to contribute to better understanding of solar flare processes.

Instrumentation

The 100–4200 MHz radiospectograph consists of three single swept radiospectrographs, mounted in separate dishes:
(a) — The 100–1000 MHz radiospectrograph uses a 7.5 m dish and a wide-band log-per antenna as primary feed. The time resolution is 0.1 s (10 sweeps per second) and the frequency resolution is of about 1 MHz. The spectrograph has the analog output to a film band.
(b) — The 1000–2000 MHz radiospectrograph uses a 10 m dish and a flat wide-band helical antenna as primary feed. The time resolution is 0.1 s (10 sweeps per second) and the frequency band is divided into 256 channels (which means the frequency resolution is of about 4 MHz). The spectrograph is fully automated using a digital control and data acquisition system based on a PC AT computer.
(c) — The 2000–4200 MHz radiospectrograph uses a 3 m dish and a wide-band horn antenna as primary feed. The time resolution is 0.1 s (10 sweeps per second) and the frequency band is divided into 256 channels (which means the frequency resolution is of about 10 MHz). The spectrograph is fully automated using a digital control and data acquisition system based on a PC AT computer.

The data files are about 62 kB long, which represents 24 seconds of observation. Because the amount of the recorded data is immense (about 9 MB of data per hour for one spectrograph), only the interesting intervals with solar radio bursts are chosen and archived

Solar Physics **147**: 203–206, 1993.

on floppy disks. Special software was developed for quick data files evaluation and processing. It enables displaying data files in form of spectrograms, time or frequency profiles, processing of data (calibrating, smoothing, filtering, integrating, etc.), and printing of the displayed pictures on matrix or laser printers. As an example of a computer print-out see the radio spectrum in Figure 1.

The single frequency 3000 MHz radiometer uses a 3 m dish and a thick wide-band dipole as primary feed. The time resolution is 0.01 s (100 samples per second), the frequency bandwidth is of about 4 MHz. This receiver is fully automated using a digital control and data acquisition system based on a PC AT computer. To save the disk space, the system is equipped with an automatic sofware burst detection and so only the detected bursts are stored on the disk. The data files are 360 kB long and represent 30 minutes of observation. For quick data files evaluation and processing special software was developed. It supports a number of operations with data files, including displaying of data, reading of coordinates, changing both vertical and horizontal scales, choice and zooming of details, smoothing, spectral analysis, statistics (max, min, mean value), and printing of displayed pictures on matrix or laser printers (see example Figure 2). For detailed description of the radiometer see Jiřička (1992).

Observations

The period from Sept. 5 to Sept. 7 of 1992 was characterized by an exceptional increase in solar activity. The total number of flares observed at Sept. 5, 6, and 7 was 19, 21, and 11, respectively (Solar Geophysical Data 578/I, 579/I).

From the radioastronomical point of view type III and type III-like fast drift bursts were predominant in this period. We observed altogether 26 groups of these bursts. While most of them had negative frequency drifts, which corresponds to the standard description of type III radio bursts (Krüger, 1979), some of them, mostly the high-frequency ones, showed positive frequency drifts. It was found that for negatively drifting bursts the frequency drifts were from -70 to -500 MHz/s in the 100-500 MHz frequency range and from -1000 to -4000 MHz/s in the 1000-4200 MHz frequency range, respectively. On the other hand, for positively drifting bursts in the frequency range 1000-4200 MHz the frequency drifts were from 1000 to 4000 MHz/s. Further we determined the starting frequencies of these bursts, which were in the interval of 400-3000 MHz for positively drifting bursts and 400-4000 MHz for negatively drifting bursts, respectively. In some cases it was found that the bursts started on frequencies higher than the highest observing frequency of our radiospectrograph, i.e. above 4200 MHz, or they continued from lower to higher frequencies beyond the observing frequency range. This is in agreement with the type III-like observations in the 6.2-8.4 MHz range made by Benz et al. (1992).

One example of the recorded bursts is shown in Figures 1 and 2, where the 200-4200 MHz radio spectrum and the corresponding high-time resolution 3 GHz record are depicted. In this case type III bursts with both negative and positive frequency drifts were observed; on higher frequencies, these bursts were superimposed on slowly varying continuum. While the "normal", i.e. the type III bursts with negative frequency drifts (-150 MHz/s) were observed on lower frequencies (100-500 MHz), positively drifting type III bursts with frequency drifts 1300-4000 MHz/s were observed in the frequency range 600-4000 MHz.

Accepting the standard plasma emission model for all the fast drift bursts observed during the above mentioned period, i.e. the radio emissions of these bursts is assumed to be caused by electron beams, which propagate upwards or downwards in the low corona and generate Langmuir waves, which after transformation into electromagnetic waves are observed as fast drift bursts, we estimated from starting frequencies of these bursts the electron density in the beam acceleration space as $n_e = 2 \times 10^9 - 2 \times 10^{11}$ cm^{-3}.