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Microwave Fine Structures in the Initial Phase of Solar Flares and CMEs

C.M Tan, Y.H. Yan, Q.J. Fu, Y.Y. Liu, H.R. Ji and Z.J. Chen

National Astronomical Observatories Chinese Academy of Sciences, Beijing 100012, China
email: Email: Tanchm@bao.ac.cn

Abstract. Solar radio fine structures (FSs) may be as an important diagnostics stool to draw the evolution map of the flare loop in the initial phase of solar flares. Also, it may be an important signature of the initial phase of CMEs. Here we analyzed a series of solar radio bursts with drift pulsation structures (DPS) and FSs during the former part of the 23rd solar activity cycle. Found they were associated with CMEs, and got some important statistic conclusions.

Keywords. Sun: coronal mass ejections (CMEs), flares, radio radiation

1. Introduction

Radio emission from solar flares offers a number of unique diagnostic tools to address a long-standing questions about energy release, plasma heating, particle acceleration, and particle transport in magnetized plasmas (Bastian *et al.* 1998). For example, drift pulsation structures (DPS) may be a signature of dynamic magnetic reconnection, the harmonic structure of zebra pattern structures (ZPS) indicate the localized region with the anisotropic distribution function of accelerated electrons, and the narrow-band dm-spikes with the MHD turbulence in the reconnection plasma out flows (Karlicky *et al.* 2000). Solar radio FSs was described in many papers (Benz 1986, 1992; Isliker *et al.* 1994; Karlicky 2000; Jiricka *et al.* 2001). DPS is a new phenomenon. It was firstly described in these papers (Karlicky 2000; Kliem *et al.* 2000; Jiricka *et al.* 2001).

2. observations and results

During the former part of 23rd solar activity cycle (1996-2003), 885 solar radio bursts were observed with Solar Radio Spectrometers of China in 1.0-2.0GHz waveband. 154 bursts have FSs. More than 40 events have DPSs. Here we select the 1.0-2.0GHz waveband to analyzed because the FSs and DPSs arose at low waveband more frequently than high waveband. Most of the DPSs are associated with CMEs, including the four significant LDEs (07/12/2000, 07/14/2000, 04/10/2001, 10/26/2003). The Oct.26, 2003 event was showed as Fig. 1

3. conclusion and discussion

Generally, DPS is a phenomenon that a groups of pulsations drifting negatively (from high frequency to low frequency) and slowly as a whole. They usually happened after or between the initial phase of flare, with a duration of ∼1min to ∼10min. The DPS might be consists of fast drifting burst (FDB), slowly drifting burst (SDB), type III burst, zebra pattern structures (ZPS), spikes or other types of FSs. The duration of

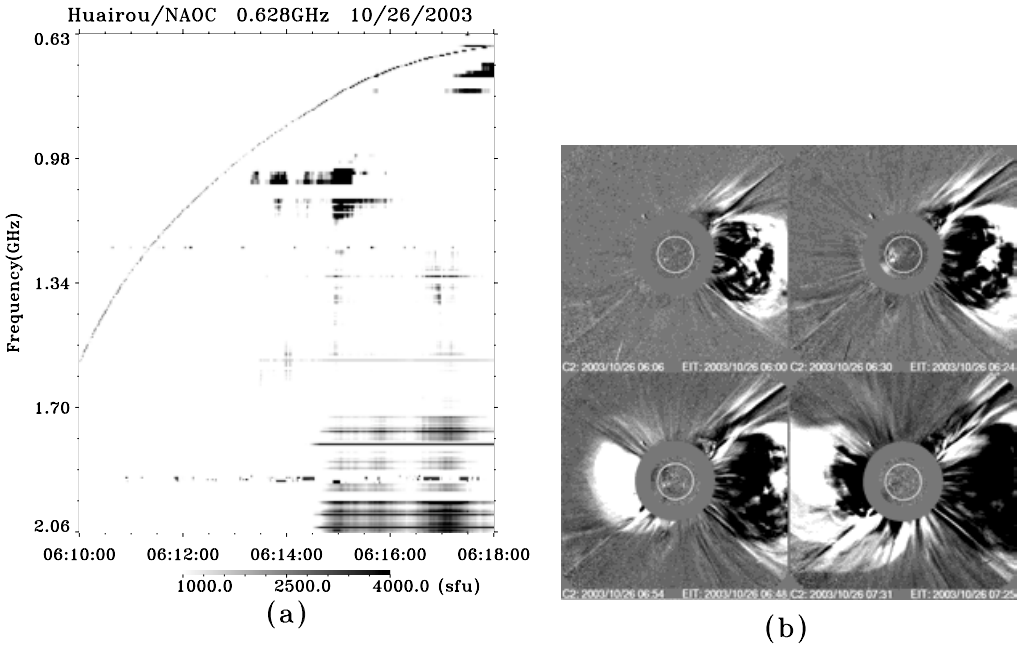

Figure 1. a is the DPS on Oct.26, 2003, the drift rate is -3∼-7MHz/s, the black curve line describe the drift trend. b is the CME on the same day.

the individual pulsation is ∼1sec to <1min. The global drift rate of the DPS is -2.0∼-20.0MHz/s (corresponding velocity is ∼100 to ∼1000Km/s). In addition, the DPS might has harmonic structures (The Apr.10, 2001 event).

The four significant LDEs that have been mentioned above were associated with CME. Moreover, the corresponding four CMEs are fast and large angle width. In a same active region, the time sequence of the DPS, FSs, flare and CME might be as follows: Usually, DPS emerged after or between the pulse phase of flare, several minutes later was ZPS, spikes or other types of FSs, and 10∼30 minutes later CME expanded. The time difference between DPS and the initial enhance of EIT is several minutes. The global drifting DPS, which happened during the initial phase of flare, is consistent with CME well.

Anyway, FSs and DPS are a series of important microwave spectrum burst phenomena. While DPS is a new phenomenon. It maybe caused by quasi-periodic particle acceleration episode that result from a dynamic phase of magnetic reconnection on a large-scale current sheet. And it plays a certain role in explaining the spatial structure and evolvement of flare loop, particle acceleration and shock wave acceleration.

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