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# Correlation of the Observational Characteristics of Microwave Type III Bursts with CMEs

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**Abstract.** A total of 266 type III bursts observed with the 2.6 - 3.8 GHz high temporal resolution dynamic spectrometer of NAOC during the 23rd solar cycle (from April in 1998 to January in 2003) are statistically analyzed in this present paper. The frequency drift rates (normal and reverse slop), durations, polarizations, bandwidth, starting and ending frequencies are analyzed in detail. From the statistical results of starting and ending frequencies we show that the regions of starting frequencies are very large, which are from less than 2.6 GHz to greater than 3.8 GHz; but the ending frequencies regions are relative concentration, which are from 2.82 GHz to 3.76 GHz. These phenomena mean that the sites of electrons acceleration are quite scatter, while the cutoff regions of the radio type III bursts are in the limiting domain. The bursts number with positive and negative drift rates are nearly equal. This correlation may interpret the suggest that a proportional number of electron beams in the directions of upward and downward are accelerated in the range of 2.6 - 3.8 GHz. The other statistical results are similar to those of decimetric type III bursts as statistics in previous literature. The emission mechanisms of microwave type III bursts are mainly caused by the plasma radiation and electron gyro-maser radiation.

From the statistics of microwave type III bursts and associated coronal mass ejections (CMEs), it is found that the 36% of type III bursts (97) are corresponding to the CMEs for occurring time and site. The correlation between the type III bursts and CMEs is not close, and most type III bursts are occurred in the time regions of 26 – 30 minutes before CMEs. This means that the partial microwave type III bursts may be a precursor of the CMEs.

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

## 1. Introduction

Since type III bursts play a very important role for electron acceleration in solar flares, it is of great importance to observe and research type III bursts at different frequencies. The researches on type III bursts are mostly those on metric and decimetric type III bursts and only no more authors have reported on the statistical studies of microwave type III bursts (e.g., Aschwanden *et al.*, 1995; Benz *et al.*, 1983). A coronal mass ejection (CME) is one of the highest energy activities on the solar surface, and the connection between the CMEs on the solar disk and other active phenomena is one of the open question. Previous studies show that CMEs have close relation to H$\alpha$ flares, X-ray, type

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II and type IV bursts, there would be about 60% or 80% of the events accompanied by CMEs (Chertok, 1997; Chernov, 1998 Xiaoma, *et al.*, 2003; Kejun, *et al.*). However, up to now it has not been clear whether CMEs are related to type III bursts in radio bursts or not.

## 2. Results

(1). We have found 189 type III bursts appeared in the range of 2.6 - 3.8 GHz, in which 86 are negative drift rates, 103 are positive drift rates. In addition, 77 bursts are starting beyond the frequency band of instrument, but ending in this region of 2.80 - 3.76 GHz. (2). The most (185) of type III bursts are occurred in the impulsive phase of the flares. Only 53 bursts are in the decade phases. In 266 bursts contain 9 narrow-band ($\Delta f \leqslant$ 100 MHz) and 114 broad-band ($\Delta f \geqslant 500$ MHz) bursts. (3). The half-power duration lies between 100 ms and 1620 ms, with the average of 613 ms. The type III bursts with long durations are much less than those with short durations. (4). 61% of bursts have polarization degree of 6% – 90% with the average of 35%. (5). The correlation between the type III bursts and the CMEs is 36%. Most type III bursts occurred 26 – 30 minutes before the CMEs.

## 3. Discussions

(1). 189 type III bursts are started in the region of 2.62 - 3.76 GHz, and 41 in the regions less than 2.6 GHz and 36 in the regions greater than 3.8 GHz. It has known that the starting frequencies of type III bursts are co-spatial with the acceleration regions (Aschwanden, 2002), so the electrons acceleration sites are very scatter. The acceleration regions are up to the centimeter wavelength, which is greatly beyond the region of 400 - 1000 MHz (Bastian, Benz and Gary, 1998). (2). From the statistics of type III bursts and CMEs, we may known that some acceleration electrons have escaped before the CMEs. This suggests that some type III bursts may be the precursor of the CMEs.

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