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ORIGINAL ARTICLE

Study of interacting CMEs and DH type II radio bursts

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Abstract The subject of interaction between the Corona Mass Ejections (CMEs) is important in the concept of space-weather studies. In this paper, we analyzed a set of 15 interacting events taken from the list compiled by Manoharan et al. (in J. Geophys. Res. 109:A06109, 2004) and their associated DH type II radio bursts. The pre and primary CMEs, and their associated DH type II bursts are identified using the SOHO/LASCO catalog and Wind/WAVES catalog, respectively. All the primary CMEs are associated with shocks and interplanetary CMEs. These CMEs are found to be preceded by secondary slow CMEs. Most of primary CMEs are halo type CME and much faster (Mean speed $= 1205\ \mathrm{km\,s^{-1}}$) than the pre CME (Mean speed $= 450\ \mathrm{km\,s^{-1}}$). The average delay between the pre and primary CMEs, drift rate of DH type IIs and interaction height are found to be 211 min, 0.878 kHz/s and 17.87 Ro, respectively. The final observed distance (FOD) of all pre CMEs are found to be less than 15 Ro and it is seen that many of the pre CMEs got merged with the primary CMEs, and, they were not traced as separate CMEs in the LASCO field of view. Some radio signatures are identified for these events in the DH spectrum around the time of interaction. The interaction height obtained from the height-time plots of pre and primary CMEs is found to have correlations with (i) the time delay between the two CMEs and (ii) the central frequency of emission in the radio signatures in the DH spectrum around the time of interaction. The centre frequency of emission in the DH spectrum around the time of interaction seems to decrease when the interaction height increases. This result is compared with an interplanetary density model of Saito et al. (in Solar Phys. 55:121, 1977).

Keywords Coronal Mass Ejections (CME) · Type II Bursts · Interacting CMEs

1 Introduction

Coronal Mass Ejections (CMEs) are the magnetized plasma ejected from the Sun into the interplanetary medium. In the interplanetary medium these are called as ICMEs. When they reach the Earth, they cause severe effects such as, geomagnetic storms (Zhang et al. 2004). Radio bursts produced by the CMEs in the deca-hectometric range are called as DH type IIs. Gopalswamy et al. (2001a) studied the characteristics of CMEs associated with DH type IIs and reported that CMEs that produce decameter-hectometric (DH) type II radio bursts are faster and wider than the general CMEs.

When CMEs interact with the previously ejected CMEs, various phenomena occur in the interplanetary medium. For example, radio signature in the deca-hectometric (DH) range due to CME interaction (CME cannibalism) was first studied by Gopalswamy et al. (2001b). They interpreted the observation of radio enhancement on 2000 June 10 as a consequence of shock strengthening when the shock ahead of the fast CME plows through the core of the preceding slow CME. Also, interaction between ICMEs have been discussed by Burlaga et al. (2002) and Wang et al. (2002).

Gopalswamy et al. (2002) studied the interaction of CMEs associated with large Solar Energetic Particle (SEP) events. They found that the interaction between CMEs can

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