Coronal and Stellar Mass Ejections
Proceedings IAU Symposium No. 226, 2005
K. P. Dere, J. Wang & Y. Yan, eds.

doi:10.1017/S1743921305000621

Spectral Features in Solar Microwave Emission Preceeding CME Onset

Olga A. Sheiner[1] and Vladimir M. Fridman[2]

[1,2]Radiophysical Research Institute (NIRFI),
25 Bol'shaya Pecherskaya Street, Nizhny Novgorod, 603950 Russia,
[1]email: rfj@nirfi.sci-nnov.ru
[2]email: fridman@nirfi.sci-nnov.ru

Abstract. The sporadic solar radio emission of patrol solar radio observations within the periods 1980, 1984–1989 and of observations with high temporal and spectral resolution in 1989 are used to find the manifestation of pre CMEs activity.

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

1. Introduction

Studies of the phenomena in the microwave radio emission, which precede CMEs registration, are based on the concept of their formation and initial propagation in the lower layers of solar atmosphere, inaccessible to observations on coronagraphs. Such phenomena cover the significant high-altitude three-dimensional scales of solar atmosphere. In this case for determining the mechanisms of emission in the radio-frequency band it is important the spectral approach to a study of CMEs phenomena.

2. Observational Data

For this purpose we used as the observational data of sporadic radio emission obtained using regular observations as special observations with high spatial resolution. The first one was carried out over a wide range of wavelengths (3cm–3m) at the Radio Astronomical Observatory NIRFI "Zimenki" within the periods 1980, 1984, and 1989.

Special observations of microwave emission were made by RT–22 array of the Crimea Astrophysical Observatory (angular resolution about 3–4′) in August 1989. Sweeping spectrograph in 14–17 GHz was used to obtain the spectrum each second with 100 MHz spectral resolution and the average one during 1 min. The results of high spatial resolution presented are concerned to observations of solar radio emission from Active Region (AR) NOAA/USAF 5638 (S18W90) on the 12th of August. The observational time (5:00–14:00 UT) is coincide with the time of CMEs formation and propagation (SMM gives 12:59–14:32 UT as the time of CMEs observations).

3. Results

Spectra of radio emission have stable smooth behavior with flux increasing in frequency range. Approximately 5 hours before CMEs detection one can see very small spectral feature on the right side of spectra in 14–17 GHz range, which is less than 10% of AR flux and about 100–150 MHz in frequency range. The closer the time of CMEs detection

the larger amplitude of feature is. The value of its flux is about 1 sfu and spectral interval varies in 200–400 MHz frequency interval just 1.5 hours before CMEs registration.

Spectra become flatter in the average: mean spectral indexes over the frequency range observed are 0.65–0.7 for a long time increasing to 0.75–0.8 in 2–3 h before CMEs registration.

Flattening spectrum can be connected with several reasons, one of which is the shift of the maximum of emission to short waves. The fact of the retention of emission value in the long-wave part of the range during the observations testifies in favor of this assumption. The latter can be caused by both the warming up of low layers of chromosphere and corona and by increase in the magnetic field because of the floating up new magnetic fluxes.

One more special feature of the dynamics of radiation spectrum into this period, is observed: the presence of the narrow-band component of emission with the frequency width 1–1.5 GHz. It appears in the band of the analysis of spectrograph for 1.5–3 seconds and moves from the low frequencies to the high, which composes the speed of the motion of about 1–2 GHz/s. The presence of such narrow-band component have been discovered by us with the earlier observations in the range 8–12 GHz and found satisfactory explanation within the framework of the transformation of plasma emission into the electromagnetic during the motion of thermal fronts in the flare loops.

Analyzing monitoring solar radio emission coincided CMEs onset we looked at so called isolated CMEs events. It is the situation when during the 8-hour time interval before and 6-hour time interval after these CMEs there were no other recorded CMEs events. It corresponds to well-known fact that it takes many hours for the atmosphere of active region to recover after the CMEs pass.

We find the presence of definite class of non stationary radio events before CMEs appearance during 2-hour intervals. During this interval there are observed sharp decay or variations of noise storm in meter emission, simultaneous appearance of microwave bursts of C- or S-types in cm–dm region. In most cases CMEs formation is accompanied by non stationary events in radio emission (about 80% of all events registered on SMM coronagraph). Non stationary radioemission corresponding to CME formation is observed in a greater frequency range than the radioemission without CME. 50% of nonstationary events preceding the CMEs onset are broad-band, they are observed at least in 3 parts of cm–dm frequency region.

CMEs that are not accompanied by non stationary events in solar radio emission mostly have high speed (mean value is about 700 km/s) and narrow width (mean width is less than 40 ang.deg). There are no CMEs Loop type among them.

4. Conclusions

The studies performed allow us to obtain results on the spectral-time dynamics of the preflare development of high-power solar events and demonstrate the promising nature of the spectral studies of microwave emission before CMEs onset. The high sensitivity and stability of the data on the fluxes of radio emission of the Sun at “Zimenki” facility show their effectiveness for statistical studies of weak events of solar activity.

Acknowledgements

The work is carried out with the support of Russian Fund for Basic Research (grant 03-02-16691), Ministry of Education (grant E02-11.0- 27) and FPSTP (Astronomy).

O. A. Sheiner would like to thank IAU for the supporting participation in IAU Symposium 226.