The solar coronal origin of a slowly drifting decimetric pulsation burst structure
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Abstract

We present an analysis of radio and soft X-ray imaging observations associated with a slowly drifting decimetric pulsation structure seen by the Phoenix-2 spectrometer at about 14:29 UT on 2000 August 25. It has been suggested that such radio features (which occur roughly during the hard X-ray emission interval) may be associated with either chromospheric evaporation or plasmoid ejection during flares. Since the range of frequencies over which this drifting radio feature occurred included several frequencies observed by the Nançay Radiotelescope, we can determine the spatial location and development of both the radio and soft X-ray features from the first time we can compare the digitized soft X-ray images with the Nançay soft X-ray images. Our results indicate that the drifting pulsation structure for this event is associated with soft X-ray plasmoid ejection, not chromospheric evaporation.

Introduction

Drifting pulsation structures are narrow-band, short duration, slowly drifting features consisting of many quasi-periodic pulsations. It has been suggested that they may be the radio signature of a chromospheric evaporation process in solar flares (Karlsson & Östlund 1994, Aschwanden & Benz 1995).

An alternative suggestion is that these radio features are associated with a magnetic reconnection process accompanying the ejection of a plasmoid in the early stages of some flares (Hori 1998; Kliem et al. 2000, Karlsson et al. 2001).

Observations

- Fig. 1 is part of a dynamic radio spectogram from the Phoenix-2 Radio Spectrometer (Mesorren et al. 1999) showing the slowly drifting decimetric feature (consisting of several tens of pulsations).
- The drifting pulsation structure was associated with an M1.0-1.3 flare which began at about 14:23 UT on 2000 August 25 at roughly S0.0E00 in NOAA area 9143.
- Fig. 2 shows the Nançay soft X-ray flux and the Yohkoh HXT L channel flux for the flare. The drifting pulsation structure occurred during the second hard X-ray burst.
- Figs. 3a-b show the whole-sun fluxes measured at each of the relevant Nançay Radiotelescopes (NH1, NH2, and CH1) as well as the Nançay soft X-ray fluxes over the entire solar rotation (Mesorren et al. 1999). The Nançay soft X-ray fluxes were obtained by averaging the entire solar rotation (Mesorren et al. 1999). The Nançay soft X-ray fluxes were obtained by averaging the entire solar rotation (Mesorren et al. 1999).
- The Nançay and NRL 32.0 MHz data in Fig. 5 indicate that the drifting pulsation structure emission occurs near a soft X-ray plasmoid. The source of the drifting pulsation structure emission moves with the soft X-ray plasmoid outflow away from the flaring region.
- We fitted a 2-D elliptical Gaussian function to each of the NH sources. From the centroid locations of the fitted features we can determine the motion of the NH sources. The x- and y-coordinates in NH pixel units of the fitted sources are shown in Figs. 3e & f. The linear fits to the x- and y-coordinates of the 32.0 and 6.3 MHz sources can be used to determine the speeds of the radio sources. Above each of the linear fits in Figs. 3e & f we give the speeds (in km s\(^{-1}\)) determined by the linear fit of the radio sources. The speeds of the radio sources were determined by fitting a straight line to the data points in Figs. 3e & f. The linear fits in Figs. 3e & f are of the same level as the data points in Figs. 3e & f.
- We have presented the first analysis of radio imaging observations of a drifting pulsation structure seen at decimetric wavelengths. We have also examined the soft X-ray images associated with the drifting pulsation structure. We find that the site of the radio emission was not near the flaring region and that the X-rays would be expected for an association with chromospheric evaporation. Rather we find that the drifting pulsation structure was strongly associated with a soft X-ray plasmoid ejection occurring during the impulse phase of a solar flare.
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Conclusions

We have presented the first analysis of radio imaging observations of a drifting pulsation structure seen at decimetric wavelengths. We have also examined the soft X-ray images associated with the drifting pulsation structure. We find that the site of the radio emission was not near the flaring region and that the X-rays would be expected for an association with chromospheric evaporation. Rather we find that the drifting pulsation structure was strongly associated with a soft X-ray plasmoid ejection occurring during the impulse phase of a solar flare. It has been suggested (e.g., Kliem et al. 2000, Karlsson et al. 2001), that the drifting pulsation structure emission might originate from (i) a reconnection region between an ejected plasmoid and underlying loops, (ii) outflow jet plasma, (iii) jet plasma below an overlying ejected plasmoid, or (iv) from inside a plasmoid (i.e., from particles threading through or trapped within the magnetic structure containing the plasmoid).

The observed locations and development of the 32.0 and 23.6 MHz sources appear to exclude proposals (i) and (ii). Proposal (iii) appears to be most consistent with present observations. We conclude that the drifting source in the radio emission is due to the expansion of the plasmoid as it propagates outward away from the flaring region.

References