FIRST DETECTION OF CORRELATED ELECTRON BEAMS AND PLASMA JETS IN RADIO AND SOFT X-RAY DATA

H. AURASS
Astrophysikalisches Institut Potsdam, Observatorium für solare Radioastronomie, D-14482 Tremsdorf, Germany

K.-L. KLEIN
DASOP, CNRS-URA 1756, Observatoire de Paris, Section d'Astrophysique de Meudon, F-92195 Meudon, France

and

P.C.H. MARTENS
Space Science Department of ESA, ESTEC, P.O. Box 299, NL - 2200 AG Noordwijk, The Netherlands

Abstract. From a common analysis of solar radio spectral and imaging data of a fast drift burst of type U(N) together with Yohkoh soft X-ray images it is shown that the radio emission is compatible with electron beams injected and reflected in extended loops. The electron beam production coincides with the injection of hot matter, visible as a jetlike soft X-ray feature in the underlying loop system.

1. Introduction

Rapidly drifting bursts at radio wavelengths are so far the most direct diagnostic of particle beam propagation in the solar corona. In the present letter we use spectrographic (radio) and imaging (soft X-ray, radio) observations to investigate the site where the beams are produced, the structures which guide them through the corona, and the relationship of the beam acceleration with dynamic phenomena in the active region plasma.

2. Observations

Figure 1a shows the dynamic radio spectrogram of fast-drift bursts recorded with the sweep-frequency part of the OSRA Tremsdorf 40-800 MHz spectrometer (Mann et al., 1992). Within a group of type III bursts a type U burst is observed between 200 MHz (the frequency of the turning point in the spectrum) and 300 MHz. It is followed by a further negatively drifting burst thus forming together a type N burst (Caroubalos et al., 1987) attributed to electron beams bouncing in an extended loop. The spatial distribution of radio sources observed with the Nançay Radioheliograph (NRIH, Radioheliograph Group, 1993) is illustrated by a contour plot of equal brightness projected onto the terrestrial east-west direction (236 MHz, Figure 1b) and

Fig. 1. Radio observations of type III and U(N) emission on 13 Nov 1992: (a) dynamic spectrum; frequency from 200 to 300 MHz on the abscissa, the arrow points at the frequency 236 MHz; (b) contour map of 1-D (east-west) brightness distribution at 236 MHz, abscissa graded in units of 0.6', contour levels from 0.5 to 99% of maximum brightness; (c) heliographic positions of centroids and source dimensions at 164 and 230 MHz overlaid on the Yohkoh soft X-ray image at 12:13:12 UT, see also Figure 2.

by the heliographic positions of burst sources (c). The centroids and sizes of burst sources are determined by Gaussian fits to the 1-D scans with the east-west and the north-south branch of the NRH. Refraction in the terrestrial ionosphere is corrected both for time-dependent variations (by comparison with a noise storm) and for the quiet ionosphere. The following sources are distinguished:

1. A type III burst (also visible below 200 MHz) is detected at 236 MHz until 12:12:41 UT. Its centroid positions are plotted in Figure 1(c) as open (164 MHz) and filled (236 MHz) triangles.

2. The onset of the rising branch of the U(N) burst (12:12:43 UT) at 236 MHz is confused with the preceding type III emission, but the U(N) burst appears as a bright feature at a distinct location. Its centroid position and half widths are plotted by the solid cross in Figure 1(c).

3. The descending (positively drifting) branch of the U(N) burst has its 236 MHz source west of the ascending branch (12:12:46 UT, dashed cross in Figure 1(c)).

4. The second ascending branch of the U(N) burst occurs close to the descending branch (12:12:50 UT, filled pentagon in Figure 1(c)). A new type III burst is nearly simultaneously observed at 164 MHz at a site closer to the initial type III burst (open pentagon).

Figure 1(c) illustrates that the radio sources lie on either side of the main line of field inversion in AR 7335, in the high regions of a fan of soft X-ray loops. The ascending branch of the U(N) burst is situated above