Abstract. We present 4.9 GHz observations of an impulsive radio burst observed at the Very Large Array on 1981 May 16. The flare occurred in a complex active region containing several spots. The radio burst lay at the edge of an active-region microwave source, close to a neutral line. The compact burst showed morphological evidence for the presence of two loops in the rise phase, with the subsequent burst peak lying between these loops. This suggests that interaction between the loops played some role in the initiation of the flare. The flare spectrum is consistent with thermal gyrosynchrotron emission. The main microwave peak was displaced from the nearest Hz kernels by about 10", but there is strong evidence for post-flare loops coincident with the Hz kernels during the later stages of the event.

1. Introduction

It is generally agreed that solar flares involve the transformation of stored magnetic free energy into plasma energy. One of the aims of imaging studies of solar flares is to identify the magnetic topology of the region in which energy release occurs. This identification can be used to test various flare models, which have different signatures: thus, release of magnetic torsion in a twisted magnetic loop requires only one loop to be present in the flare site, whereas driven reconnection of two adjacent loops or of emerging and pre-existing flux requires two loops.

However, existing images of flares in hard X-rays and microwaves (presently the two diagnostics best suited for observing high-temperature coronal material) are often ambiguous or confusing on this issue. Both suffer from a restriction common to all types of observation: limited dynamic range. Since the relevant emission mechanisms are not uniform throughout the burst source, this has the result that spatial studies tend to be dominated by the brightest part of a flare, rather than showing the whole structure in which a flare takes place. In the case of hard X-ray images, emission is by bremsstrahlung which favors high densities and hence thick-target emission at the feet of flux tubes: thus they usually provide only a cross-section of coronal morphology. In addition, most hard-X-ray imaging studies refer to low-energy X-rays (< 20 keV), rather than the higher energy range thought to be more closely associated with the primary energy release in flares (20 to 200 keV). Dennis (1988) reviews the X-ray observations, but no clear impression of the magnetic topology in the flaring region has yet been gleaned from the hard X-ray data. Further complication arises from the probable existence of a number of different types of flares (Tanaka, 1983, 1987; Tsuneta, 1983).

The gyrosynchrotron process responsible for most flash-phase flare radio emission depends strongly on the strength of the magnetic field and its orientation to the line of

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sight, which also produces a highly localized peak rather than uniform brightness in the source. Dynamic range in imaging observations with a synthesis radio interferometer is restricted by the need to deconvolve a 'dirty' image in order to remove the complex response of the telescope to a point source. For the snapshot images necessary to study solar flares, the point response function is complex and this deconvolution process is only reliable for very simple source structures; for more complex structures dynamic ranges of less than 10 often result. Despite these problems, observations with the Westerbork Synthesis Radio Telescope and with the Very Large Array (VLA)* have proven to be the most useful technique for determining the magnetic topology in solar flares, because they allow high spatial resolution, are generally not dominated by footpoint emission, and by the magnetic nature of the emission process they refer directly to the magnetic fields.

These radio studies have revealed a number of different scenarios for the magnetic topology. The most common seems to be the detection of a compact source over a magnetic neutral line, suggesting a single flaring loop (Alissandrakis and Kundu, 1978; Marsh and Hurford, 1980; Hoyng et al., 1983; Willson, 1983; Kundu, Velusamy, and White, 1987). Single loops are also suggested by those observations in which two footpoints are apparently observed, or where multifrequency observations suggest high-frequency emission from low in a loop and low-frequency emission from higher in the same loop (Shevgaonkar and Kundu, 1985; Dulk, Bastian, and Kane, 1986; Alissandrakis, Schadee, and Kundu, 1988). Observations interpreted as arcades of loops straddling a neutral line suggest a related picture (Kundu, Schmahl, and Velusamy, 1982). On the other hand, Kundu et al. (1982) found evidence for a quadrupole structure, and interpreted their observation as the result of a newly-emerged loop interacting with a pre-existing loop to produce a current sheet and eventually a flare. Kundu et al. (1984) also reported the presence of interactions between multiple structures in a series of flares, while Velusamy et al. (1987) observed complex structure with no obvious interpretation.

The apparent dominance of single-loop structures in flare observations may seem to favor single-loop models for energy release (e.g., Alfvén and Carlqvist, 1967; Block, 1972; Spicer, 1977, 1981). However, the limited dynamic range of the observations allows the interpretation that in some cases the observed compact sources may simply be the brightest parts of more complicated interacting structures. Here we present high-spatial-resolution observations of a small radio burst at 4.9 GHz which appears to show two clear loop structures in the rise phase. This observation favors models in which interaction between structures is involved in the energy release. The brightest location at the peak of the flare lies exactly midway between the two loops. The peak lies away from the Hz flare kernels, which however are coincident with probable post-flare loops seen in the radio images. We first briefly present the active region maps, and then proceed to discuss the observations of the flare.

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