VLA OBSERVATIONS OF A RADIO PLAGE AT CENTIMETER WAVELENGTHS

R. K. SHEVGAONKAR and M. R. KUNDU
Astronomy Program, University of Maryland, College Park, MD 20742, U.S.A.

(Received 11 January; in revised form 19 April, 1985)

Abstract. VLA observations of a solar plage region at 6 and 20 cm wavelengths are presented. The high frequency 6 cm emission correlates well with the associated sunspots, whereas 20 cm emission shows good correlation with the Hα plage. Large temperature variations over a period of one day are observed in the plage associated component without any significant changes in the sunspots. The dominant emission mechanisms at 6 and 20 cm are found to be gyroresonance radiation and bremsstrahlung respectively. It is concluded that the coronal condensation above the chromospheric Hα plage has an electron density of \( \sim 5 \times 10^9 \text{ cm}^{-3} \) and it extends to a height of \( \sim 5 \times 10^4 \text{ km} \).

1. Introduction

The slowly varying component (SVC) of the Sun's radio emission, which has its spectral maximum at centimeter wavelengths, originates from above active regions in the Sun's atmosphere. Observations of the centimetric emission of active regions made with high spatial resolution can provide information on the structure of the chromosphere and low corona. Observations with aperture synthesis instruments at a wavelength of 6 cm (e.g., Kundu et al., 1977; Lang and Willson, 1979; Felli et al., 1981; Lang et al., 1983; Lang and Willson, 1982; Alissandrakis and Kundu, 1982; Kundu and Velusamy, 1980; Pallavicini, 1979) have shown the existence of (a) bright sources \((T_b \sim 0.5-2.5 \times 10^6 \text{ K})\) associated with sunspots, occasionally with a depression in the radio contours directly over the umbrae; (b) weaker sources \((T_b \sim 10^5 \text{ K})\) associated with strong magnetic fields in plage areas; and (c) sources, sometimes bright \((T_b \sim 5 \times 10^6 \text{ K})\), associated with the magnetic neutral line on the underlying photosphere.

The centimetric emission of active regions is believed to be thermal, with the opacity being due to either bremsstrahlung or gyroresonance absorption. Alissandrakis et al. (1980) found that bremsstrahlung opacity was insufficient to explain the observed brightness temperature of sunspot-associated emission at 6 cm. These authors successfully modeled the emission by making use of resonance at the second and third harmonics of the gyrofrequency to provide a major part of the opacity. On the other hand, the plage-associated emission at 6 cm wavelength can be due to bremsstrahlung (Kundu et al., 1977), unless the plage magnetic field is very strong. Plage-associated emission at 20 cm has also been attributed to thermal bremsstrahlung by Chiuderi-Drago et al. (1977) and by Lang and Willson (1980).

In this paper, we present further observations of plage associated emission at microwave frequencies. Our observations are characterized by the fact that we carried out observations simultaneously at 6 and 20 cm wavelengths, and on days when there were...
no flaring activities on the Sun. The dual wavelength observations permit us to constrain the generating mechanism of this emission, and to make good estimates of the physical parameters of the plage associated region.

2. Observations and Results

The observations presented here were carried out with the Very Large Array (VLA) on March 6 and 7, 1983. During the observations, the VLA was in the C-configuration. The VLA antennas were divided into two subarrays in such a way that similar uv coverage could be obtained at both wavelengths for a full day synthesis. At the two observing wavelengths of 6 and 20 cm the full day synthesis provided a uv coverage of 500 wavelengths ($\lambda$) to 50 kilowavelengths ($k\lambda$) and 170$\lambda$ to 15 $k\lambda$, respectively. The synthesized maps were CLEANed by the standard algorithm developed by NRAO, and the CLEANed maps were convolved with a gaussian beam of 9" $\times$ 7" at 6 cm and 15" $\times$ 15" at 20 cm.

The region under observation was located in the south–west quadrant of the solar disk and consisted of five isolated sunspots along with an H$\alpha$ plage. On the first day of observation (March 6), the phase center of the VLA antennas was at S 16 W 13 and on the second day (March 7), it was located at S 14 W 21 heliographic coordinates. Two dimensional total intensity ($I$) and circular polarization ($V$) maps were produced. At 20 cm only total intensity maps are presented since the degree of polarization was less

![Figure 1](image_url)