APERTURE SYNTHESIS OBSERVATIONS OF CYGNUS A AT 86.2 GHz

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ABSTRACT

Recent observations of Cygnus A with the Hat Creek interferometer at 86.2 GHz limit the spectral curvature of the hotspots and show that the diffuse lobe emission has a spectral index of about 1.5. The central component is, at most, weakly variable and its spectrum shows a distinct break to a spectral index near 0.65 at about 20 GHz.

OBSERVATIONS

The improved 2-element Hat Creek interferometer was used over the period 1981 June - July at four EW antenna spacings from 30 - 120 m to map Cygnus A in order to establish the high-frequency spectral properties of the central component, the diffuse lobe emission and hotspots A and D (using the nomenclature of Hargrave & Ryle 1974). Two observations were made at each of the four antenna spacings, and almost complete 12-hr tracks of Cygnus A were obtained. The baselines were calculated from observations of a number of quasars with well-determined positions, and phase drifts were removed using frequent observations of the nearby point source V2005+403. The synthesized beam had half-power widths 4 x 6 arcsec, and the CLEANed map of Cygnus A had a noise level of about 70 mJy at its centre.

Two earlier syntheses of Cygnus A, using antenna spacings from 13 - 55 m have also been made, and have been used to measure the flux density of the central component on several dates. The 13-m data also provide good measurements of the integrated flux densities of the Np and Sf lobes of the source.

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RESULTS

In the Sf component, only the hotspot D is seen clearly on the full-resolution map. D is unresolved (angular size < 2 arcsec) and has a spectral index (defined in the sense $S_\nu \propto \nu^{-\alpha}$) of 0.94 ± 0.10 from 15 to 86 GHz. The diffuse emission in the Sf lobe has a spectral index α_5^{86} = 1.4 ± 0.1 (the 5 and 15 GHz flux densities are taken from Hargrave & Ryle 1974 and 1976 respectively). In the Np lobe, component A is seen to be resolved with an angular size ~ 4 arcsec and a spectral index α_5^{86} = 0.82 ± 0.08. In this lobe, the diffuse emission has α_5^{86} = 1.7 ± 0.2. These hotspot and diffuse emission spectral indices agree with previous determinations at lower frequencies (Hargrave & Ryle 1976), indicating little spectral curvature over the range 5 to 86 GHz.

The central component, however, has a flux density of only 0.39 ± 0.05 Jy at 86.2 GHz (averaged over three epochs of observation), significantly below the result of about 1 Jy found at most other frequencies, and, in particular, significantly below the single-dish measurements at 35, 99 and 150 GHz (Hachenberg *et al.* 1976; Hobbs *et al.* 1978; Kafatos *et al.* 1980). This discrepancy is not produced by variability (on the evidence of our three independent observations of the flux density of the central component over an interval of 20 months) and is probably a result of the severe problems of measuring the flux density of the central component in the presence of the bright lobes of Cygnus A. Discarding the single dish results, the spectrum of the central component appears almost flat from 1.7 to 15 GHz, then breaks to a spectral index of 0.65 ± 0.16 from 23 to 86 GHz. This spectral shape resembles that produced by a single-component, isotropic source with a magnetic field ~ 2×10^{-7} T, a size ~ 0.001 arcsec (as found by VLBI; Kellermann *et al.* 1981) and an electron energy spectrum cut off below about 0.5 GeV.

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