VLBI OBSERVATIONS OF THE NUCLEUS OF CENTAURUS A

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VLBI observations of the nucleus of Centaurus A have been made at three southern hemisphere observatories. Since Centaurus A is the nearest active galaxy, VLBI investigations are important because the physical processes in the nucleus can be studied in greater linear detail than in other similar galaxies. Previous VLBI observations of Centaurus A have been hampered by its southerly declination (-43°) and the sparsity of VLBI capability in the southern hemisphere, leading to only scattered single point u,v coverage. This paper presents results from the early stages of development of a southern hemisphere VLBI network.

The known radio structure of Centaurus A has three prominent features: i) a large double structure centered on the optical galaxy with a position angle of $\sim 0^{\circ}$. These components extend over $\sim 10^{\circ}$, or equivalently $\sim$900 kpc; ii) A smaller double structure also centered on the optical galaxy with a position angle of $\sim 50^{\circ}$, which is nearly perpendicular to the optical dust lane. The component separation is $\sim 7'$ ($\sim$10 kpc), which is comparable in size to the optical galaxy; iii) An extremely small nucleus positioned in the center of the optical galaxy. Wade et al. (1971) determined the size of the radio nucleus to be $\lesssim 0\farcs5$ ($\sim$10 pc), and VLBI nuclear structure has been detected at the $5 \times 10^{-4}{}''$ ($\sim 10^{-2}$pc) level (Jauncey et al. 1981). Optical and x-ray jets have been detected within a few arcminutes of the nucleus, and are aligned with the nucleus with a principal axis that roughly matches (PA $\sim 60^{\circ}$) the inner double radio structure (Dufour and Van den Bergh 1978, Schreier et al. 1979). A recent VLA map (Feigelson, this volume) also shows an inner radio jet extending inward to within a few arcseconds of the nucleus, with a strong correlation between radio and x-ray hotspots.

The Mark II VLBI observations were performed at 2.3 GHz on 1980 April 22-27 with right circular polarization. Participating observatories were located at Tidbinbilla and Parkes in Australia and Hartebeesthoek in South Africa, providing baselines with maximum resolutions of $\sim 0\farcs10$ and $\sim 0\farcs0027$. Complete u,v tracks were obtained.

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FIGURE 1

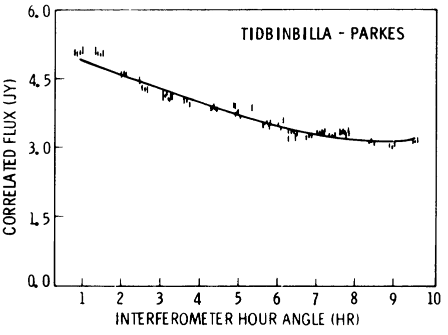

Figure 1 shows the history of measured correlated flux densities as a function of interferometer hour angle on the Tidbinbilla-Parkes baseline. An elliptical Gaussian model of the nucleus was fitted to these results (see solid line in Fig. 1). The total flux density of the nucleus at 2.3 GHz was constrained to be 6.8 Jy by a separate VLBI measurement in April 1981 on a 25 km baseline at Goldstone, California. We note that the 2.3 GHz nuclear flux density is about double the 2.7 GHz value measured a decade earlier by Wade et al. (1971). The best fit elliptical Gaussian model had a major axis of $\sim 0\farcs05$ ($\sim$1 pc). The minor axis has a maximum value of $\sim 0\farcs03$ ($\sim$0.6 pc), but could be much smaller. The position angle along which the nucleus is elongated is $30^\circ \pm 20^\circ$, indicating a possible jet which is roughly aligned with the larger radio, optical, and x-ray jets and the inner double radio lobes, with the aligned structure extending over a dynamic range in size of $\sim 10^4$. The linear size of the elongated nucleus is typical of the sizes of nuclear jets found in other active galaxies by VLBI (Linfield 1981).

On the Australian-South African baseline, the nucleus was completely resolved, indicating there is no 2.3 GHz nuclear source $\lesssim 0\farcs001$ ($\lesssim$0.02 pc) with a flux density $\gtrsim$20 mJy. However, a previous VLBI measurement at 8.4 GHz by Jauncey et al. (1981) found a nuclear source of strength $\sim$0.5 Jy with a size of $\sim 0\farcs0005$ ($\sim$0.01 pc). This 8.4 GHz component must be highly self-absorbed at 2.3 GHz to account for our nondetection. It is interesting to note that the detected radio structure in Centaurus A extends over a dynamic range in size of $\sim 10^8$.

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