SHORT COMMUNICATIONS

SOME OBSERVATIONS AT 6 CM WAVELENGTH WITH THE AUSTRALIAN 210–FT RADIO TELESCOPE*

By N. W. Broten,†‡ B. F. C. Cooper,† F. F. Gardner,† H. C. Minnett,† R. M. Price,† F. G. Tonking,† and D. E. Yabsley†

Recent research in radio astronomy has shown the desirability of making observations at shorter and shorter wavelengths. Although designed originally for operation at a wavelength of 21 cm, the Australian 210-ft telescope has given satisfactory performances at 11 cm, and operation at still shorter wavelengths appeared possible (Bowen and Minnett 1963).

A wavelength of 6 cm was therefore chosen for test and measurements were made with a crystal mixer receiver having an intermediate frequency bandwidth of 10 Mc/s. With a 1 s time-constant the r.m.s. noise fluctuation was then equivalent to about $0\cdot3^{\circ}$ antenna temperature.

Using this receiver, the overall telescope performance may be summarized as follows. After correcting for the sizes and shapes of the sources used, the mean observed beamwidth is $4\cdot1'$ of arc, in close agreement with the theoretical value. The shape of the beam below the half-power level is slightly asymmetrical in the vertical plane. This asymmetry is probably due to distortion of the reflector when tilted, but it is not yet known precisely how the effect varies with zenith angle. Scans through the strongest sources show no evidence of side lobes above the 13 dB level.

At long wavelengths the aperture efficiency, calculated from the angular characteristics of the feed, mesh leakage, and aperture blocking, is 62%. At 6 cm and at zero zenith angle, the measured aperture efficiency is $34\cdot5$%, corresponding to a gain of $65\cdot9$ dB relative to an isotropic antenna. If the reduced efficiency at 6 cm is attributed entirely to random errors in the reflector shape, the root-mean-square value of these errors at zero zenith angle must be about $3\cdot7$ mm.

The optimum axial position of the feed horn varies slightly with zenith angle, the total range being about 1 in. or $0\cdot1$% of the focal length. In addition, the optimum gain thus found decreases 10 or 12% when the telescope is tilted from the zenith to an angle of 60°.

Source Intensities and Spectra

Approximate values of the flux obtained from a selection of radio sources are given in Table 1. A probable error of 30% is assigned to the flux values, except for sources CTA 102, 3C 433, and 2356–61 where it is somewhat higher. Flux values in

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† Division of Radiophysics, CSIRO, University Grounds, Chippendale, N.S.W.

‡ On leave from the National Research Council, Ottawa, Canada.

parentheses are the 6-cm values, derived from spectral curves, used in determining the aperture efficiency of the telescope.

Except for two or three sources, the values are consistent with a simple power-law reduction of flux density with increasing frequency, with a tendency for the spectrum to steepen at high frequencies. This relationship is shown in Figure 1 by the spectra of 0438–43 and 3C 161. The 6-cm value for 3C 279 maintains the upward trend in flux which is already evident at a wavelength of 11 cm. The source 1934–63, whose spectrum has been reported previously as unusual (Bolton, Gardner, and Mackey 1963), shows a decrease in flux at 6 cm.

TABLE 1

SOURCE INTENSITIES AT A WAVELENGTH OF 6 CM

Source	Antenna Temperature T_A (°K)	Flux (10^{-26} Wm^{-2}(c/s)$^{-1}$)
0409–75	1·3	5·0
0438–43	1·8	5·5
0521–36	3·2	10·5
3C 161	2·5	6·5
3C 279	5·5	16·0
3C 353	4·7	17·0
1932–46	1·1	3·0
1934–63	1·9	5·0
3C 433	1·1	3·5
2152–69	3·4	14·5
CTA 102	1·1	3·5
2356–61	1·4	5·0
Sources used in determining telescopic parameters		
Orion	79	(400)
Hydra A	4·6	(12·4)
3C 273	12·4	(29·5)
Virgo A	20·4	(76)
Hercules A	4·15	(11·8)
Taurus A	140	(610)

Centaurus A

The central double source of Centaurus A, whose components are separated by 7′ in a NE.–SW. direction, is well resolved with the 4·1′ beam. Figure 2 shows the effect of scanning the source with different position angles of the feed horn. Polarization of the north-east source is plainly evident.

Observations made by rotating the feed horn while tracking the source components in turn showed that the north-east source has a degree of polarization of 18%±2% with a position angle of the electric vector (measured eastward from the north celestial pole) of 132°±5°, while the other source is 3%±1·5% polarized in position angle 103°±10°. These percentages are uncorrected for resolution effects in the sources.

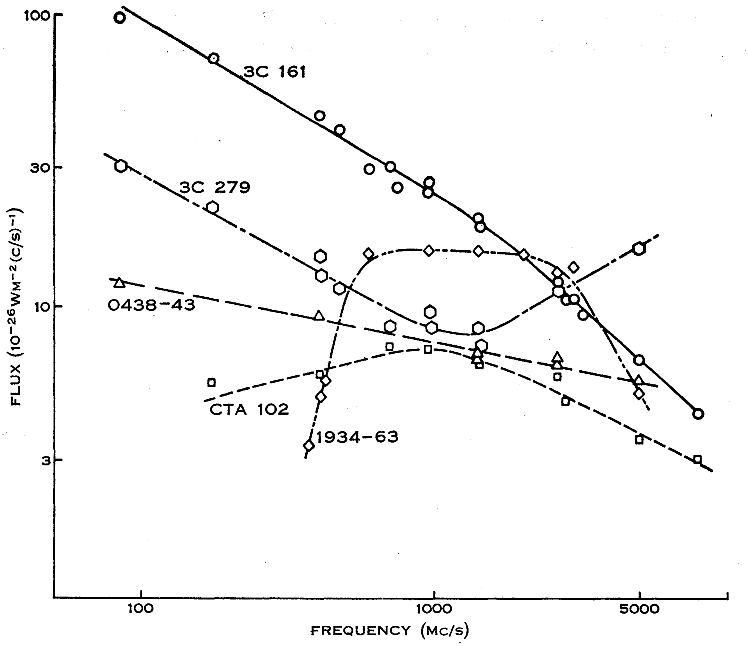

Fig. 1.—Spectra of five radio sources derived from the work of various authors, together with the new 5000-Mc/s observations at Parkes.

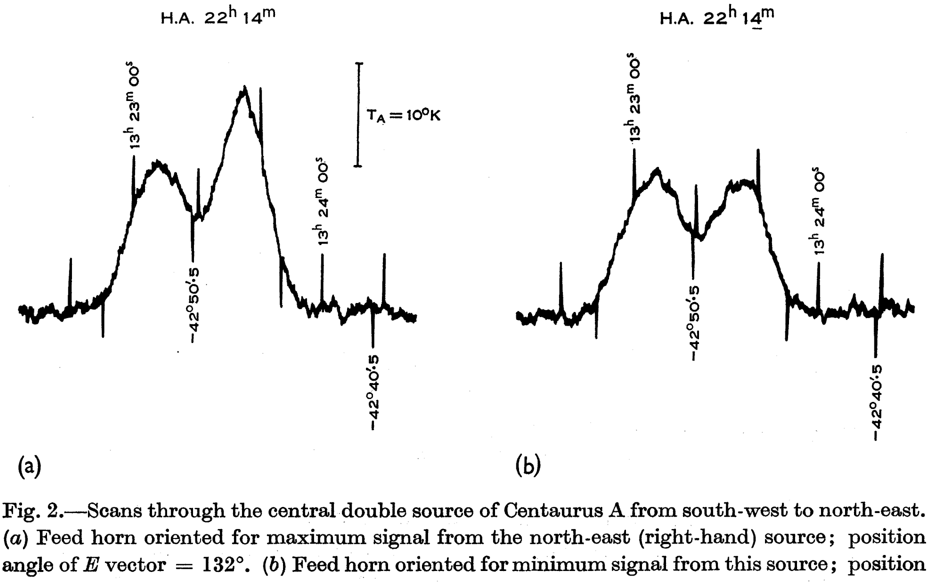

Fig. 2.—Scans through the central double source of Centaurus A from south-west to north-east. (*a*) Feed horn oriented for maximum signal from the north-east (right-hand) source; position angle of E vector $= 132°$. (*b*) Feed horn oriented for minimum signal from this source; position angle of E vector $= 42°$.

Scans made through the north-east source in various directions and with various feed angles show that the polarized region of the north-east source is smaller than the unpolarized region, confirming a conclusion recently reached at the California

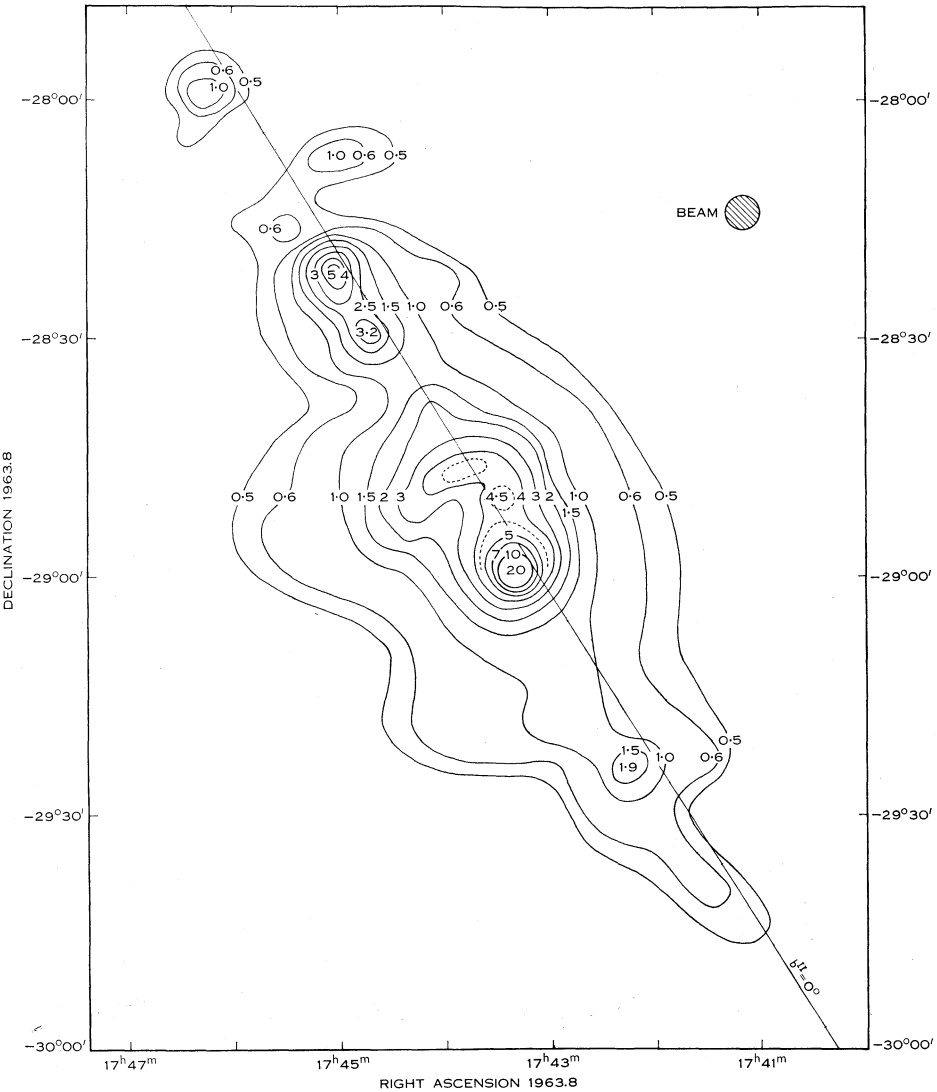

Fig. 3.—Isophotes of relative brightness of a region about the galactic centre (contour level 1·0 equals about 2·3°K antenna temperature).

Institute of Technology (Morris, Radhakrishman, and Seilstad 1963) using an interferometer at 10·7 cm wavelength. The equivalent Gaussian diameter of the polarized region is not more than 2′ at half intensity while the unpolarized regions of both sources are approximately $3\cdot5\times2'$ in angular extent. The sources are elongated in the general direction of the line joining their centres as shown by Maltby (1961).

The flux density at 6 cm wavelength of the north-east source is estimated to be $71 \pm 20 \times 10^{-26}$ $\mathrm{W m^{-2} (c/s)^{-1}}$ and that of the south-west source $55 \pm 13 \times 10^{-26}$ $\mathrm{W m^{-2} (c/s)^{-1}}$.

The Galactic Centre

The region in the direction of the galactic centre is made up of a group of sources, the brightest of which, Sagittarius A, is generally considered to be associated with the nucleus of our Galaxy. Previous high resolution pencil-beam surveys of this region by Drake (1959), by Biraud, Lequeux, and Le Roux (1960), and by Cooper and Price (1964) have shown much of the structure. Contours of constant antenna temperature at 6 cm wavelength are shown in Figure 3.

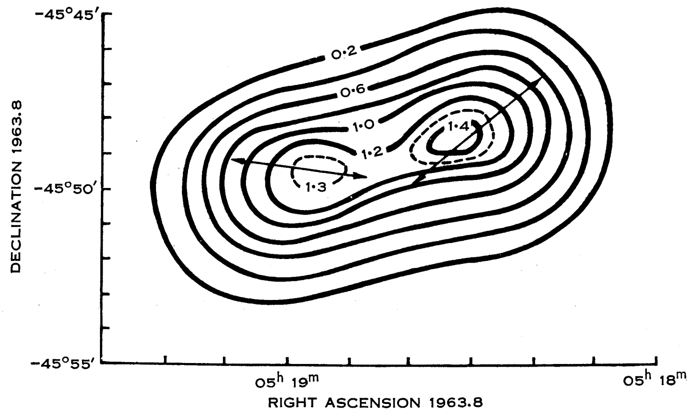

Fig. 4.—Isophotes of relative brightness of the extragalactic source Pictor A showing the direction of maximum polarization in the two components (contour level 1·0 equals 2·6°K antenna temperature). Mean position angle of E vector of feed = 98°.

To the north-east of the central peak there is a source showing marked elongation in galactic latitude and a "hook" appearance. This structure appears in lesser details in Drake's isophotes at 3·74 cm, but there is only slight evidence of it in the 10-cm observations of Cooper and Price. The emission at $17^{h}\,45^{m}$ and $-28°\,22'$, previously shown as an extended region, is well resolved into a double source lying nearly along the galactic equator.

The position of the bright central component, in 1950 coordinates is: right ascension $17^{h}\,42^{m}\,27^{s}{\cdot}7 \pm 4^{s}$, declination $-28°\;59'{\cdot}0 \pm 1'{\cdot}0$. This is about 1^{s} east and 4′ south of the new IAU coordinates of the galactic centre.

Pictor A

A 6-cm map of the extragalactic source Pictor A (Fig. 4) shows that the source is extended in position angle $104° \pm 2°$, and is resolved into two components, each of which is also elongated along this direction. The transverse widths of the two components are about 2′, but vary with feed position angle. The component at $05^h\,18^m\,30^s$ is $11\% \pm 2\%$ polarized and the component at $05^h\,18^m\,55^s$ is $9\% \pm 2\%$ polarized. The mean intrinsic polarization angle, with 9° of Faraday rotation from Gardner and Whiteoak's (1963) measurements, is $101° \pm 15°$. This alignment between the mean polarization direction and the elongation of the source has been found in other sources of low surface brightness.

Conclusion

The measurements described above demonstrate that the 210-ft reflector has a useful performance at a wavelength of 6 cm and justify extending the scope of the Parkes observations in this region. A more sensitive receiver now under construction will be used for this purpose and for a fuller investigation of the high frequency performance of the reflector itself.

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