

HIGH-RESOLUTION RADIO OBSERVATIONS OF FIVE PLANETARY NEBULAE

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ABSTRACT

Observations have been made of 5 planetary nebulae at 1407 and 408 MHz with beam widths of $23''$ of arc and $80''$ of arc respectively. Measurements of positions, fluxes and angular structure have been obtained; some results are presented in the form of contour maps.

The Cambridge 1-mile radio telescope has been used to map the structure of 5 planetary nebulae. The radio telescope and its mode of operation have been described elsewhere (Ryle, 1962; Elsmore *et al.*, 1966), and only a brief account is given here.

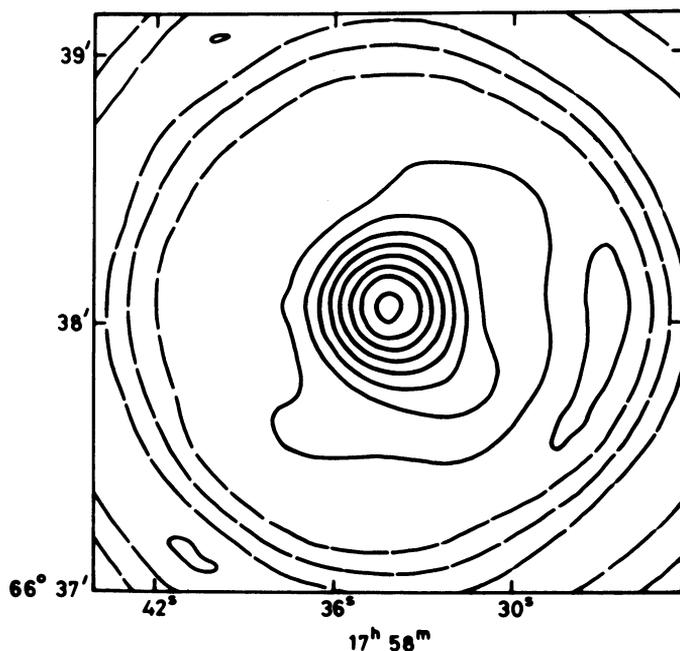


FIG. 1. 1407 MHz map of NGC 6543. (The broken contours are due to the grating side-lobe response of the instrument.)

Osterbrock and O'Dell (eds.), *Planetary Nebulae*, 108–111. © I.A.U.

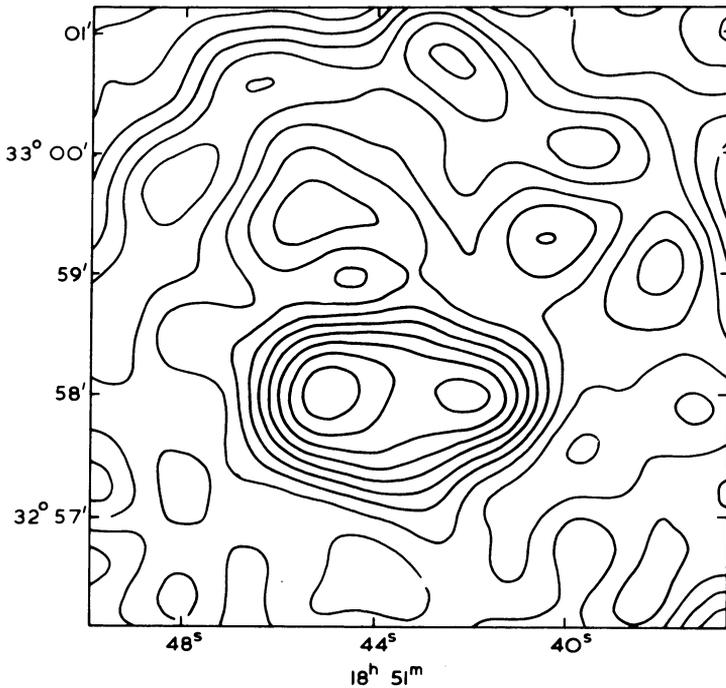


FIG. 2. 1407 MHz map of NGC 6720. The distance between the two peaks of radio emission is 36" of arc.

Each nebula was observed continuously for at least one 12-hour period using aerials mounted on an East-West base line. The rotation of the Earth carries one aerial around the other, enabling the amplitude and phase of the radiation from the nebula to be sampled along a circular strip. The radius of this strip is equal to the distance between the aerials.

If observations of the nebula are combined with those made at different spacings, a pencil-beam response is obtained in the vicinity of the nebula, together with a circular-grating response, the angular separation of which depends upon the number of different spacings used. Observations were made at two frequencies simultaneously, 1407 MHz and 408 MHz, giving pencil-beam widths of 23" of arc and 80" of arc in right ascension; the beam widths being greater in declination by a factor $\text{cosec } \delta$.

The results appear in the form of contour maps of radio intensity of which four are shown in Figures 1-4. The declination scale of the maps has been compressed by a factor $\text{sine } \delta$ so that the beam appears circular. A summary of the observations is given in Table 1.

Generally, the radio emission originates in a region slightly smaller than that of the optical nebula except in the case of NGC 7662, where the size of the nebula at 1407

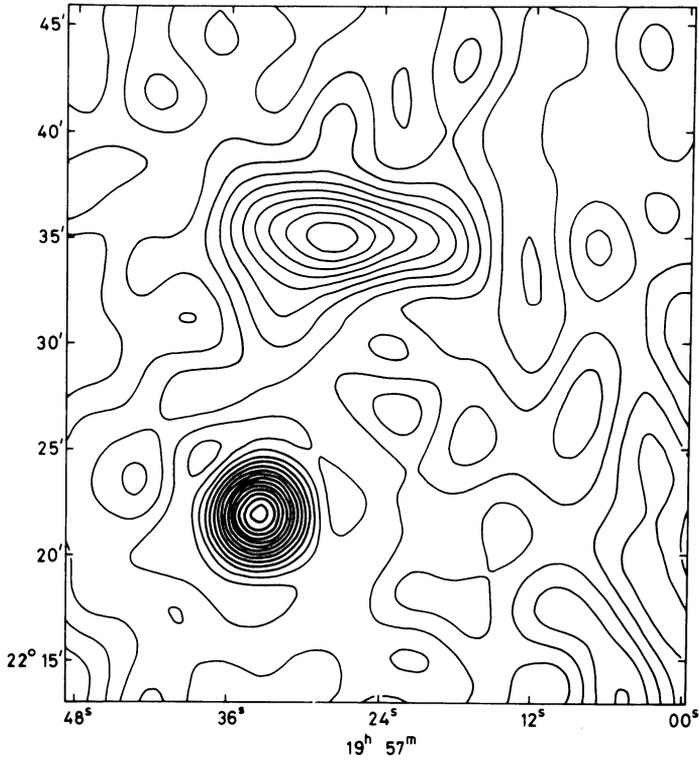


FIG. 3. 408 MHz map of NGC 6853. The object shown at declination $22^{\circ}22'$ is a small diameter source of 0.5 flux units, which is not related to the nebula.

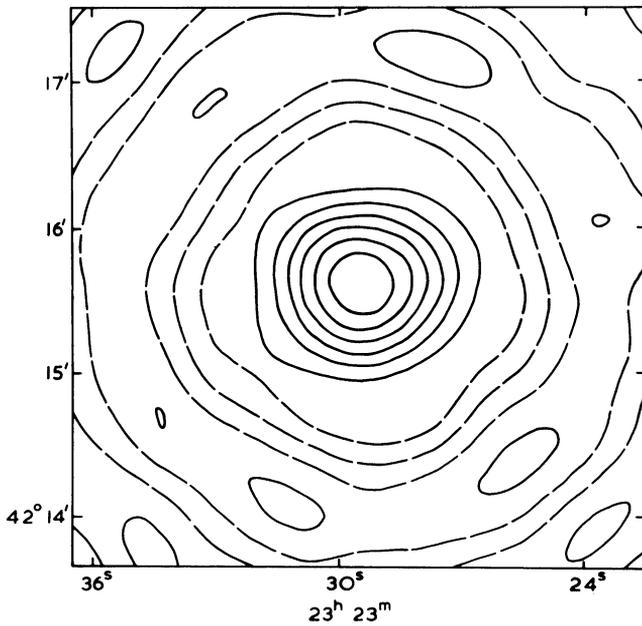


FIG. 4. 1407 MHz map of NGC 7662. (The broken contours are due to the grating side-lobe response of the instrument.)

Table 1

NGC	Integrated Flux $\times 10^{-26} \text{ Wm}^{-2} \text{ Hz}^{-1}$		Width to Half Power at 1407MHz
	1407 MHz	408 MHz	
6543	0.7	≤ 0.2	$< 10''$
6720	0.45	0.15	EW = 62" NS = 47"
6853	0.9 (± 0.3)	1.2	— (At 408 MHz: EW = 190", NS = 140")
7027	1.3	≤ 0.2	$< 5''$
7662	0.51	0.25	EW = 28" NS = 36"

MHz is slightly larger than the optical size. In all cases the centre of the radio emission coincides closely with the centre of the visible nebula.

The fluxes given in Table 1 are believed to be accurate to $\pm 10\%$ and are in general agreement with previous observations, with the exception of the measurement of NGC 6720 at 408 MHz, which disagrees with the value 0.5 ± 0.12 f.u. measured at 430 MHz by Terzian (1966). There is no evidence for non-thermal emission.

References

- Elsmore, B., Kenderdine, S., Ryle, M. (1966) *Mon. Not. R. astr. Soc.*, **134**, 87.
 Ryle, M. (1962) *Nature*, **194**, 517.
 Terzian, Y. (1966) *Astrophys. J.*, **144**, 657.

DISCUSSION

Kaftan-Kassim: I would like to ask why NGC 7293, the largest planetary nebula, was not observed. I have attempted to map it at 2 cm using the 140-ft dish at Green Bank with a 2' beam. A double structure similar to that shown for NGC 6720 was observed.

Elsmore: NGC 7293 is too far South to be observed by the Cambridge 1-mile telescope.

Sheglov: Does the radio centre of NGC 6853 coincide with the central star of this nebula or with the brightest part of the planetary?

Elsmore: The peak of the radio emission coincides closely with the centre of the nebula rather than with the optically brightest region.