FIRST AUSTRALIA TELESCOPE OBSERVATIONS OF SNR 0540-693

M.J. KESTEVEN, R.N. MANCHESTER, L. STAVELEY-SMITH
Australia Telescope National Facility[*], *CSIRO*
P.O. Box 76, Epping, NSW 2121
Australia

ABSTRACT. **Observations of the LMC SNR 0540-693 using the Australia Telescope Compact Array at a wavelength of 6cm show that the remnant consists of a central core coincident with the associated pulsar and a partial ring of about 65 arcsec diameter.**

1. Introduction

The radio source 0540-693 was first identified by Le Marne (1968) from the Molonglo 408MHz survey and its non-thermal nature was first suggested by McGee and Newton (1972). Prior to the present observations, the best radio image was from the Molonglo Observatory Synthesis Telescope at 843MHz with 44 arcsec resolution (Mills *et al.* 1984, Turtle and Mills, private communication). This image shows a slightly resolved source of total flux density 1100 mJy[†]. From these radio observations the mean spectral index of the source is -0.45.

[OIII] optical emission lines have been detected from an annular region of diameter 8 arcsec centred on the pulsar and from a region approximately 30 arcsec west (Mathewson *et al.* 1980). Chanan *et al.* (1984) discovered non-thermal optical continuum emission from a region of diameter 4 arcsec within the [OIII] ring. An unresolved non-thermal X-ray source was detected in data from the Einstein satellite by Clark *et al.* (1982), and a young pulsar of period 50ms was discovered by Seward *et al.* (1984), also from X-ray data. Within the position uncertainties, the X-ray source and the pulsar are also centred on the [OIII] ring.

2. Observations and Results

In 1990, May and June, three 12-hour observations of SNR 0540-693 were obtained using the Compact Array of the Australia Telescope. The observations were made at two frequencies, 4790 and 5814MHz, using five antennas with a 3km maximum baseline. The resulting CLEANed image (Fig. 1) shows that SNR 0540-693 consists of a strong central source surrounded by a partial ring of diameter approximately 65 arcsec. The peak of the central source is within 2 arcsec of the pulsar, and so there is no doubt that it is a pulsar-driven source similar to the Crab Nebula

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[†] The extended halo in the image of Mills et al. (1984) is spurious (Turtle and Mills, private communication).

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and the radio analogue of the optical and X-ray non-thermal sources. It is resolved and has a deconvolved diameter of 5.5 arcsec, corresponding to a linear diameter of 1.5 parsec, similar to that of the Crab Nebula. Its integrated flux density is 65 mJy, very close to that predicted from the optical and X-ray spectra assuming a spectral break at 10^{14} Hz (Chanan *et al.* 1984). However comparison of images made separately at the two frequencies suggests that the spectral index of the core component is about -1.3, much steeper that the expected value of -0.3. This result needs to be confirmed with observations which have a wider frequency separation.

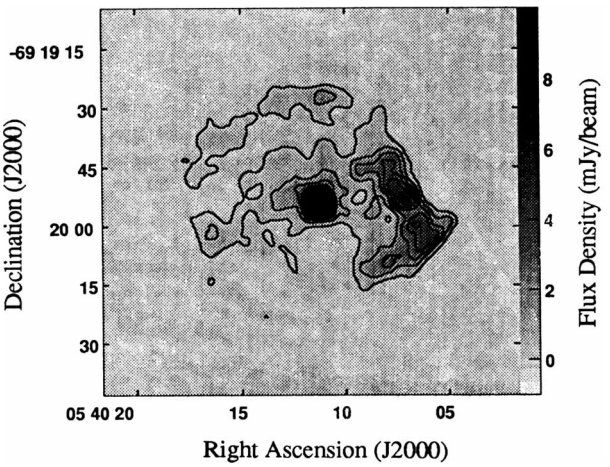

Figure 1. 6cm radio image of the supernova remnant 0540-693 in the LMC. The synthesised beamwidth is 2.7 arcsec in diameter. Contour levels are at 1 mJy/beam intervals up to 5 mJy/beam.

The integrated flux density of the annular emission is approximately 400 mJy, consistent with an overall spectral index of -0.45, and its linear diameter is about 18 pc. Given an age of the remnant of 760 years (Kirshner *et al.* 1989), the mean expansion velocity of the shell is relatively high (about 11,000 km s^{-1}). The interstellar environment of SN1987A is likely to be similar to that of SNR 0540-693. This apparent rapid expansion suggests that the remnant of SN1987A may soon be detectable as a radio source.

3. References

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