ATCA RADIO POLARIZATION OBSERVATIONS OF NGC 1566 AND NGC 1672

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Abstract. NGC 1566 and NGC 1672 have successfully been observed in radio continuum at 6 cm (26" HPBW) with the Australia Telescope Compact Array (ATCA) using a 375-m array. We have detected for the first time with this telescope linearly polarized radio emission from two southern hemisphere spiral galaxies, NGC 1566 and NGC 1672.

NGC 1566:

This galaxy is the brightest member of the Doradus group. It consists of the nucleus, which is an active and compact energy source, a very small bar, and a double two-armed spiral pattern, the inner one of which originates at the ends of the bar. It is the faintest known Seyfert galaxy. The radio continuum map at 843 MHz (Harnett 1984) resolved the nucleus, bar and inner spiral arms.

The total radio continuum emission at 4.80 GHz (Fig. 1, left) is distributed smoothly across the galaxy with only weak enhancement at the positions of the two main spiral arms. In a density-wave model the enhancement of the field strength and cosmic ray intensity will therefore only be small. At our observing resolution magnetic fields and cosmic rays appear to fill the whole of the interarm space which would imply a high cosmic-ray propagation velocity, or the presence of sources forming cosmic rays not directly being associated with the Population I distribution of young stars.

Linearly polarized emission (Fig. 1, right) is detected in interarm regions where the degree of polarization reaches 40% in the SE quadrant. This would imply that the magnetic field is almost completely uniform in the interarm regions, but is tangled or turbulent in the spiral arms themselves. At 6 cm wavelength internal Faraday rotation is expected to be small in this galaxy so that the magnetic field orientations (as shown in Fig. 1) are perpendicular to the E-vectors, i.e. parallel to the optical spiral structure. Similar results have been obtained for a number of northern hemisphere spiral galaxies (Beck 1993).

NGC 1566, in contrast to all other spiral galaxies already studied in radio polarization, reveals an exceptionally uniform two-armed structure undisturbed by gravitational interaction as is the case for M51. Hence NGC 1566 offers the chance to study the action of a galactic dynamo under the influence of density waves.

NGC 1672:

This Sb galaxy, also a member of the Doradus Group, has a low-excitation nucleus

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with a transitory burst of star formation, weak Seyfert characteristics and radio continuum morphology comprising an intense nuclear source and extended low-level disc emission pattern (Harnett 1987). Two well-defined dust lanes extend out from the nucleus, follow the leading edges of the bar and then track the inner sides of the arms which start at the bar's ends. However, the galaxy is quite asymmetric, as the eastern arm with its bright regions is easily discernible, but only a faint extension of the western arm away from the bar is observed. CO observations of NGC 1672 (Bajaja et al. 1993) in the ^{12}CO(1–0) transition with the SEST revealed a circum-nuclear molecular ring, an active nucleus and disturbed motions along the bar and inner spiral arms.

The distribution of total emission at 4.80 GHz (Fig. 2, left) is again smooth so that the same arguments as for NGC 1566 also apply here.

The map of polarized emission (Fig. 2, right) again shows emission from the interarm regions and a lack of emission from the main spiral arms. The degree of polarization reaches 20%, indicating highly uniform fields, with an orientation parallel to the optical spiral arms. In contrast to NGC 1566 and *all* northern hemisphere spiral galaxies, the highest polarized intensity is found in the *central* region of the galaxy, 10" north of the nucleus.

The most striking feature in the new maps is a spur of radiation emerging to the south side of the core region. The degree of polarization along the spur is at least 20% so that the spur is clearly nonthermal. The orientation of the B-vectors change dramatically along the spur. This anomalous feature possibly does not belong to the disk at all, and the polarization vectors could be turned by Faraday rotation in the foreground plasma of the disk. NGC 1672 may in fact be another case of a radio spur emerging from the nuclear region of a galaxy as seen in, for example, NGC 3079 (Duric et al. 1983), NGC 4945 (Harnett at al. 1989) or the Circinus galaxy (Harnett et al. 1990).

Work on both galaxies is continuing with the Australia Telescope Compact Array at Narrabri.

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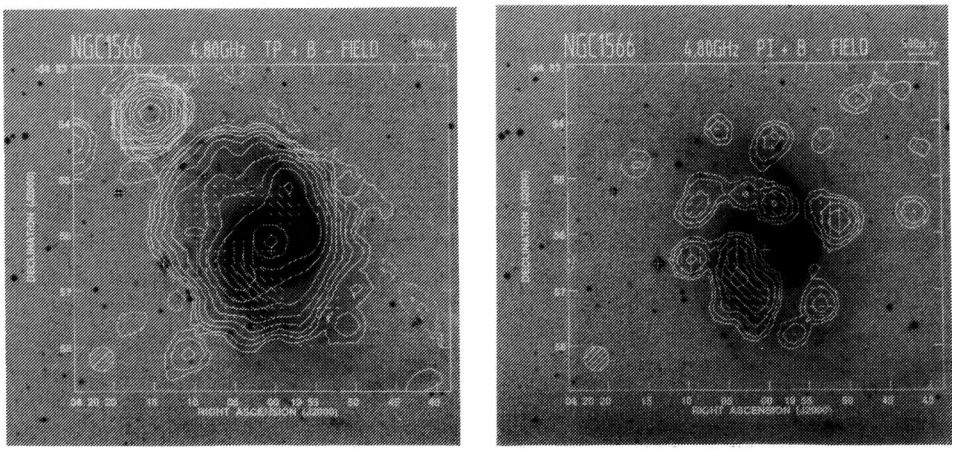

Fig. 1. Total emission (left) and polarized emission (right) from NGC 1566 at 4.80 GHz, observed with the ATCA (26" synthesized beam). Contour levels are: (1,2,4,8,...)×20μJy. The vectors show the magnetic field orientations.

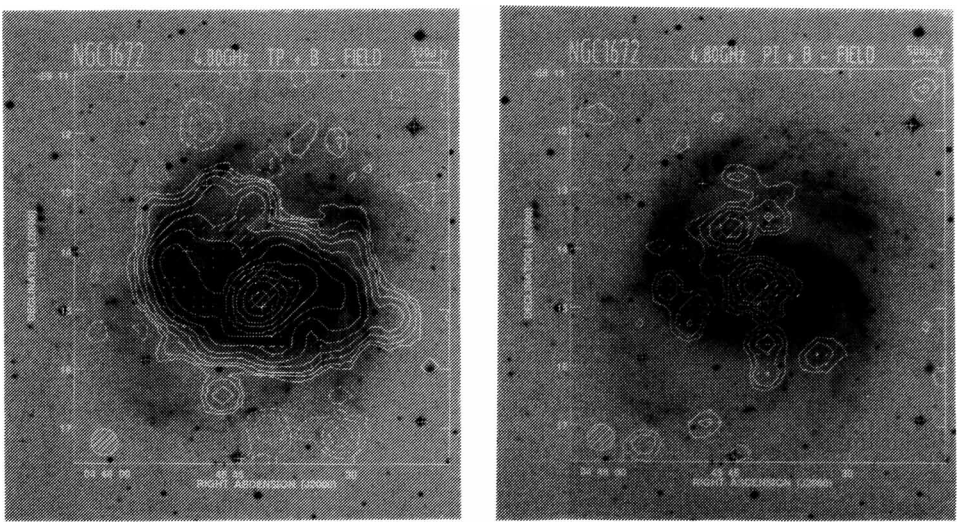

Fig. 2. Total emission (left) and polarized emission (right) from NGC 1672 at 4.80 GHz, observed with the ATCA (26" synthesized beam). Contour levels are: (1,2,4,8,...)×20μJy. The vectors show the magnetic field orientations.

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