Radio continuum emission from the barred spiral galaxy NGC 5383

Sancisi, R; Ekers, RD

Published in:
Astronomy & astrophysics

Publication date:
1978

Astron. Astrophys. 67, L21—L22 (1978)

ASTRONOMY AND ASTROPHYSICS

Letter to the Editor

Radio Continuum Emission from the Barred Spiral Galaxy NGC 5383

R. Sancisi and R. D. Ekers

Kapteyn Astronomical Institute, Postbus 800, 9700 AV Groningen, The Netherlands

Received April 21, 1978

Summary. Aperture synthesis observations of the radio continuum at 1415 MHz from the barred spiral NGC 5383 (Mark 281) show a bright, slightly extended central source and weaker emission from the region of the bar.

Key words: Barred spiral, Radio radiation.

In recent years the distribution of radio continuum emission has been determined for a number of nearby normal spiral galaxies (cf. Van der Kruit, 1978). In some cases, e.g. M51, the observations clearly show that the disk radio emission is concentrated in the dust lanes along the arms. Dust lanes are also common in the bars of barred spiral galaxies and, as for the normal spiral galaxies, these dust lanes have been attributed to shocks. In the barred spirals the shocks are caused by the highly supersonic gas motions in a bar potential (e.g. Prendergast, 1975). Observations of the continuum emission may eventually contribute to our understanding of the conditions in barred systems. So far the information available on the continuum radio emission from barred is very meagre. Four barred spirals were included in Van der Kruit's (1973) survey of bright spiral galaxies at 1415 MHz. No emission was found in either the bars or the disks of these systems, but in NGC 5383 and possibly in NGC 1300 some emission from the central region was detected.

A 21-cm hydrogen study of NGC 5383 at Westerbork by Sancisi, Allen and Sullivan (in preparation) indicated that in addition to the bright central source there might be weak radio continuum from its bar. This stimulated further higher sensitivity radio continuum observations of this galaxy using the Westerbork array with the more sensitive receivers now available at 1415 MHz. The present note reports the results of these new observations.

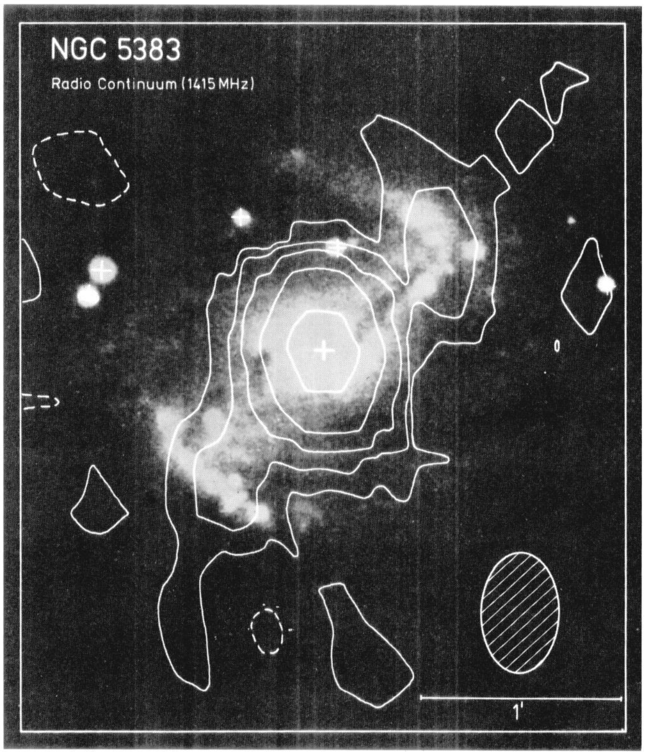
The 21-cm receiver system is described by Casse and Muller (1974). Two 12-hour observations were obtained, giving a synthesized beam (FHPW) of 24$''$.8 in right ascension and 37$''$.0 in declination, and an rms noise of 0.5 mJy*/beam area (0.45 K). The observing bandwidth of 4 MHz was centred at 1415 MHz. The HI line emission falls outside this range. The data were reduced following the standard reduction described by Högbom and Brouw (1974) and Van Someren Greve (1974).

The resulting map of the continuum radio brightness at 1415 MHz is shown in the Figure superimposed on a photograph of NGC 5383. In addition to the relatively strong and slightly extended source in the central region, this map shows weak emission at a 4 x rms noise level extended in the direction along the bar. The flux density integrated over an area of 1$'$.5 x 2$'$.5 is 34.0 ± 1.5 mJy.

An observation was also made at 610 MHz at Westerbork with a resolution of 58$''$ x 86$''$ and an rms noise of 2.5 mJy/beam area. From this we obtained a total flux density of 67.5 ± 6.0 mJy and a spectral index of -0.81 but the resolution was insufficient to see any structure. These results are summarized in the Table.

The Central Source.

This source was first detected by Van der Kruit (1973). The present observations show that the central source is extended by about 13$''$ arc roughly in the E-W direction and has a flux density between 20 and



Map of the radio continuum emission at 1415 MHz superposed on a photograph of NGC 5383. The contour values are -0.75 (dashed), 0.75 (1.5 x rms noise), 1.5, 3, 6, 12 mJy/beam area. (1 mJy/beam area = 0.9 K). The beam width at half power, 24$''$.8 x 37$''$.0, is shown by the hatched ellipse. The crosses mark the positions of some stars in the field. The cross at the centre marks the position

R.A. (1950) = $13^h 55^m 0^s.2$

Dec. (1950) = $42° 05' 21''$.

North is at the top, east on the left.

Send offprint requests to: R. Sancisi

* 1 mJy = 10^{-29} Wm^{-2} Hz^{-1}

30 mJy depending on the contribution made by the emission from the bar. The corresponding intrinsic parameters are given in the Table. Continuum radio emission with this linear extent and spectral index in the central regions of galaxies is not unusual, but the power of this source is in the upper range of that seen from disk galaxies (cf. Ekers, 1977) and is comparable to that seen in the galaxies NGC 253 and M 82. NGC 5383 is also classified as a Markarian galaxy (Mark 281). Surveys of Markarian galaxies have shown some excess radio emission radio emission (e.g. De Bruyn and Wilson 1976), however, this excess seems to be confined to those which also have the Seyfert characteristics and NGC 5383 does not have the spectral characteristics of a Seyfert galaxy. It might be noted, however, that most of the existing Markarian galaxy surveys (Sramek and Tovmassian, 1975; Sulentic, 1976; Beiging et al., 1977) have insufficient sensitivity to detect galaxies unless they are more powerful than NGC 5383.

Radio Continuum Data for NGC 5383

	Total	*Central Region*
Flux Density		
1.4 GHz	34 ± 1.5 mJy	25 ± 5 mJy
0.6 GHz	67.5 ± 6 mJy	-
Spectral index	-0.81 ± .15	-
Angular size	~ 120″	13″
Linear size*	14 kpc	1.5 kpc
Power (W Hz^{-1} ster^{-1})	1.7 x 10^{20}	1.3 x 10^{20}

* Assuming D = 23.5 Mpc which is based on a Hubble constant of 100 km sec^{-1} Mpc^{-1} and a velocity of 2350 km sec^{-1} (Sancisi et al., in preparation).

Emission along the Bar.

The observed radio emission is clearly extended in the direction along the bar, as shown in the Figure. This extended emission is affected by the instrumental side lobes from the relatively strong central source which are a few percent of the peak and may explain the slight depression on both sides of the central source. The peak intensity (beam averaged) of the emission along the bar is about 2.2 mJy/beam area (~ 4.5 x rms), which corresponds to about 2 K. If this emission is uniformly distributed along the bar and is resolved in only one direction the brightness must be comparable to that seen in the arms of M 51. A simple comparison can be made by scaling the 8 K found by Mathewson et al. (1972) in M 51 (4 Mpc) to the distance of NGC 5383 (23.5 Mpc for H = 100 km sec^{-1} Mpc^{-1}). At this distance the brightness of M 51 would be reduced to 1.6 K compared with the 2 K observed in NGC 5383. However, because of the confusion with the central source, the limited angular resolution, and the poor signal-to-noise ratio of our data, it is not possible to tell whether this emission comes from the dust lanes, the bar in general or the HII regions along and at the end of the bar.

It is also possible (although rather unlikely) that a significant amount of this emission is thermal emission from the giant HII complexes. But at least 10-20 HII regions as bright as the giant HII region complexes seen in M 101 (Israël et al., 1975) would be needed to give the continuum flux density observed in the region of the bar. From the present data it is not possible to separate the central source from the bar with sufficient accuracy to obtain useful information on the spectral index in the bar. The possibility that it is thermal can be tested either by obtaining intensities of the Hα emission or by mapping the continuum radio emission at a higher frequency.

Conclusions.

The data show that in addition to the relatively powerful central source there is continuum radio emission from the region of the bar with brightness temperature comparable to that seen in M 51. In order to obtain more detailed information on the distribution of this emission along the bar, observations with both higher angular resolution and better sensitivity are required.

Acknowledgement.

We wish to thank Mr. W. Haaima for the preparation of the figure. The Westerbork Observatory is operated by the Netherlands Foundation for Radio Astronomy with the financial support of the Netherlands Organization for the Advancement of Pure Research (Z.W.O.).

References

Bieging, J.H., Bierman, P., Fricke, K., Pauliny-Toth, I.I.K., Witzel, A. 1977, *Astron. Astrophys.* **60**, 353.
de Bruyn, A.G. and Wilson, A.S. 1976, *Astron. Astrophys.* **53**, 92.
Casse, J.L., Muller, C.A. 1974, *Astron. Astrophys.* **31**, 333.
Ekers, R.D. 1977, *Physica Scripta* **17**, 188.
Högbom, J.A., Brouw, W.N. 1974, *Astron. Astrophys.* **33**, 289.
Israël, F.P., Goss, W.M. and Allen, R.J. 1975, *Astron. Astrophys.* **40**, 421.
Van der Kruit, P.C. 1973, *Astron. Astrophys.* **29**, 249.
Van der Kruit, P.C. 1978, I.A.U. Symp. **77** on "Structure and Properties of Nearby Galaxies", Ed. E.M. Berkhuijsen and R. Wielebinski, Reidel Publ. (Dordrecht-Holland).
Mathewson, D.S., Van der Kruit, P.C., Brouw, W.N. 1972, *Astron. Astrophys.* **17**, 468.
Prendergast, K.H. 1975, "Structure and Evolution of Galaxies", p. 59, Ed. G. Setti, Reidel Publ. Company (Dordrecht-Holland).
Van Someren Greve, H.W. 1974, *Astron. Astrophys. Suppl.* **15**, 343.
Sramek, R.A., Tovmassian, H.M. 1975, *Astrophys. J.* **196**, 339.
Sulentic, J.W. 1976, *Astrophys. J. Suppl. Ser.* **32**, No. 2.