ARE SPIRAL NUCLEI "ACTIVE" IN THE RADIO CONTINUUM?

Paul T. P. Ho
Harvard University

Jean L. Turner
University of California, Berkeley

ABSTRACT

Using the VLA, we obtained matched-array continuum observations at 6 and 2 cm. An angular resolution of ∿1" and an rms sensitivity of ∿0.05 mJy were achieved for a sample of 17 nearby spiral galaxies. Spectral-index maps derived for the nuclear regions reveal a mixture of thermal and nonthermal activity. The use of high angular resolution and high frequencies was the key to the success in detecting thermal activity. Conversion from thermal fluxes to total number of ionizing photons suggests that star formation is very active in some of these cores (inner 500 pc), with a rate typically 10 times greater than in our own nuclear region. A number of the nuclear regions appear to be dominated by extended nonthermal emission with a steep spectrum. Among these, some are closely associated with thermal emission and hence are consistent with supernova activity. However there are sources exhibiting aligned structures, suggesting possible connections with a central active nucleus. In any case, at our achieved sensitivity level 16 out of 17 galaxies were detected in the radio continuum.

DISCUSSIONS

A number of sensitive surveys have been made recently to study the radio continuum emission from nearby spiral galaxies, e.g. single-dish work of Klein and Emerson (1981), Gioia, Gregorini and Klein (1982), Berkhuijsen, Wielebinski and Beck (1983); interferometric studies of Israel (1980), Hummel (1981), vander Hulst, Crane and Keel (1981), and Condon et al. (1982). The current experiment which we report here concentrates on the inner nuclear region. The objectives are to (a) achieve high sensitivity (∿0.05 mJy), (b) match angular resolution (1") to the expected sizescale of giant HII regions (∿10 pc), (c) use the shortest wavelengths (6 and 2 cm) to enhance the thermal contribution. We used the B array at 6 cm and the C array at 2 cm in order to be sensitive to the same spatial structures at both wavelengths. Reliable spectral-index maps were thereby derived.

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Our sample consists of 17 spirals, at distances of 1-7 Mpc: NGC253, Maffei 2, IC342, NGC2403, NGC2903, NGC3031, NGC4236, NGC4258, NGC4736, NGC4826, NGC5194, NGC5236, NGC5457, NGC5474, NGC6946, M31 and M33. We detected emission in 16 cases; NGC5474 being the exception. The sources are predominantly weak, with 14 regions having peak fluxes per 1" beam of 0.2-7 mJy, while 2 regions (NGC253 and NGC3031) have peak fluxes $\geq$100 mJy.

The morphology of the continuum emission can be roughly classified into 3 distinct groups: (a) point-like compact source (e.g. NGC3031, NGC4736), (b) extended clumpy complex (e.g. IC342, NGC5236), (c) disk-like complex with aligned compact structures (e.g. NGC253, Maffei 2). From spectral-index maps, the smooth disk-like sources appear predominantly non-thermal while the clumpier complexes appear thermal. The point-like sources, which are unresolved with our angular resolution, tend to have rather flat spectra. These sources are most likely also non-thermal. For the brighter sources such as NGC3031 (M81), we can in fact conclude that they are non-thermal from brightness arguments and also from existing VLBI measurements (Bartel et al. 1982).

Preliminary results based on this technique of attempting to separate thermal and non-thermal emission from high-angular-resolution spectral-index maps have been reported for 3 galaxies (Turner and Ho, 1983). With the larger sample, we find that, as before, whenever thermal activity can be detected, the total number of ionizing photons correspond to vigorous star formation with $\sim 10^3$ OB stars. This is probably due to selection effects, in that weaker thermal activity cannot be detected at present sensitivity. Nevertheless, it appears that most of the nearby spirals are in fact active at the 1 mJy level in the inner 500-pc region, although the nature of the radio emission is not always clear-cut.

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REFERENCES

Bartel, N. et al.: 1982, Astrophys. J. 262, 556.
Berkhuijsen, E.M., Wielebinski, R., Beck, R.: 1983, Astron. Astrophys. 117, 141
Condon, J.J., Condon, M.A., Gisler, G., Puschell, J.J.: 1982, Astrophys. J. 252, 102.
Gioia, I.M., Gregorini, L., Klein, U.: 1982, Astron. Astrophys. 116, 164.
Hummel, E.: 1981, Astron. Astrophys. 93, 93.
Israel, F.P.: 1980, Astron. Astrophys. 90, 246.
Klein, U., Emerson, D.T.: 1981, Astron. Astrophys. 94, 29.
Turner, J.L., Ho, P.T.P.: 1983, Astrophys. J. 268, L79.
van der Hulst, J.M., Crane, P.C., Keel, W.C.: 1981, Astron. J. 86, 1175.