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A Radio Continuum Survey of Edge-On Spiral Galaxies at 90 cm

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Abstract

Accurate spectral indices of the radio emission from both the thin disk and thick disk or halo components are critical to understand the propagation mechanisms of electrons within spiral galaxies. These spectral indices give information on the relative importance of diffusion and synchrotron energy loss in the propagation of electrons in the disk. Our goal of this survey is to locate a larger sample of spiral galaxies that exhibit halo phenomena so that a statistical analysis will be possible.

Introduction

Recent observations of the late type spiral galaxies NGC4631 (Hummel and Dettmar 1990; and references therein) and NGC 891 (Hummel et al. 1991; and references therein) have indicated that these two galaxies have extended radio halos. The spectral index of the radio emission from these galaxies also appears to increase with distance perpendicular to the disk. Do only late type spirals have radio halos or do all types exhibit this phenomena? Are the electrons responsible for the radio emission propagated primarily by diffusion related transport or does convection due to galactic winds play a role? In order to answer these questions in a statistical sense we have initiated a multi-frequency radio continuum study of a sample of twenty-seven edge-on ($i > 75°$) spiral galaxies that cover a wide range in morphological type (Sa - Sdm). The first phase of the observations at 90 cm has been completed, and analysis of the data is now in progress. The following two sections outline the selection criteria we used in chosing our sample of galaxies and our results at this stage in the analysis.

Selection Criteria

We selected a sample of galaxies from Tully's "Nearby Galaxies Catalog", which contains 2367 galaxies with systemic velocities less than 3000 km/s, using the following criteria:

- Inclination: Only those galaxies with inclinations greater than 75 degrees were selected. These inclinations facilitate the study of the spatial distribution of the radio halos perpendicular to the galactic plane.
- D25: The observed 25 mag/arcsecond^2 isophotal diameter range was limited to $3' \leq D25 \leq 15'$. Observationally, galaxies within this isophotal diameter range offer the best chance of showing resolved halos at the observing frequency of 90 cm.
- Morphology: All galaxies in the sample were required to be spirals (Revised Hubble Type: Sa - Sdm).
- Declination: To provide good *uv* coverage using the VLA "snapshot" mode, a lower limit of $18°$ was placed on the declinations of the sources.

The net result was a list of 47 galaxies. Due to limited telescope time, and the need to maximize our integration time on each source, only 27 of these galaxies were observed.

Observations and Data Analysis

The initial "snapshot" observations at 90 cm were completed on May 24/25, 1992 using the C-Configuration of the Very Large Array telescope (VLA) at Socorro, New Mexico. The approximate synthesized half-power beamwidth for this configuration at 90 cm is 56 arcseconds. In order to reach a theoretical sensitivity of 1 mJy/Beam using a bandwidth of 3.125 MHz we observed each of the twenty-seven galaxies for approximately twenty minutes split between two different hour angles. The 90 cm observations were calibrated and reduced with the AIPS processing software. Of the twenty-seven galaxies observed we have detected fifteen at the 4σ level and another five galaxies at the 2σ level. There appears to be no detections above the noise level in seven of the fields. Table I shows these results along with individual galaxy data tabulated from Tully's "Nearby Galaxy Catalog". Additional observations at 20 cm using the D-Configuration of the VLA are currently scheduled for each galaxy in our sample.

Table I: Results

GALAXY	RA	DEC	D25	INC	MORPH	BMAG	DIST	VEL(H)	PA
$\geq 4\ \sigma$ Detections									
NGC 2683	8 49 35.6	+33 36 32	9.1	79.	3A	9.82	5.7	415.	44
NGC 2820	9 17 43.7	+64 28 16	4.1	90.	5BP	12.46	26.0	1576.	59
NGC 3003	9 45 38.5	+33 39 19	6.0	90.	4B	11.48	24.4	1480.	79
NGC 3556	11 08 36.8	+55 56 33	7.8	81.	6B	9.97	14.1	697.	80
NGC 3735	11 33 04.8	+70 48 42	4.0	85.	5A	11.60	41.0	2696.	131
NGC 4013	11 55 56.6	+44 13 32	4.7	84.	4	11.60	17.0	835.	66
NGC 4096	12 03 28.4	+47 45 20	6.4	82.	5X	10.33	8.8	577.	20
NGC 4144	12 07 30.0	+46 44 00	6.3	81.	6X	11.20	4.1	267.	104
NGC 4157	12 08 34.6	+50 45 51	7.0	90.	3X	11.00	17.0	771.	66
NGC 4217	12 13 21.5	+47 22 17	5.1	78.	3	11.30	17.0	1028.	50
UGC 8246	13 07 44.3	+34 26 47	3.2	81.	6B	13.50	17.3	813.	83
NGC 5290	13 43 11.4	+41 57 46	3.4	81.	4BP	11.90	37.8	2579.	95
NGC 5529	14 13 27.7	+36 27 26	5.7	90.	5	11.90	43.9	2878.	115
NGC 5907	15 14 34.8	+56 30 33	11.2	90.	5A	10.31	14.9	666.	155
UGC 9858	15 24 52.4	+40 44 14	4.2	89.	4X	12.50	40.6	2619.	83
$2\ \sigma$ Detections									
NGC 3877	11 43 28.9	+47 46 21	5.1	85.	5A	10.90	17.0	894.	35
NGC 3972	11 53 10.0	+55 35 48	3.9	81.	4A	11.90	17.0	848.	120
NGC 4256	12 16 21.9	+66 10 37	4.2	89.	3A	11.70	39.1	2531.	42
UGC 7699	12 30 21.3	+37 53 49	3.7	79.	5B	12.20	6.2	503.	32
NGC 5297	13 44 18.4	+44 07 18	5.3	89.	3X	11.50	37.8	2404.	148
Null Detections									
NGC 2654	8 45 11.4	+60 24 21	3.9	90.	1	11.94	23.3	1382.	63
UGC 5459	10 04 54.0	+53 19 36	4.0	90.	5	12.80	20.3	1121.	132
NGC 3769	11 35 03.0	+48 10 05	3.2	76.	3B	11.20	17.0	714.	152
NGC 3917	11 48 07.7	+52 06 14	4.7	84.	6A	11.60	17.0	975.	77
NGC 4183	12 10 46.5	+43 58 33	5.1	90.	6A	12.30	17.0	934.	166
NGC 4359	12 21 41.8	+31 47 56	3.4	79.	5B	12.50	9.7	1253.	108
UGC 7941	12 44 00.0	+64 50 00	4.4	90.	7	13.20	36.2	2294.	8

References

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