

## RADIO EMISSION FROM SPIRAL GALAXIES

## I. Detection of spiral galaxies

A. Rare (< 1% of sources) in general surveys, except at very low flux densities

1. Low "visibility function"  $L^{5/2}\rho$
2.  $L \lesssim 10^{22} \text{ W Hz}^{-1}$  at 1400 MHz
3. Significant for  $S \lesssim 0.5 \text{ mJy}$  at 1400 MHz

B. Radio surveys of optically selected spirals

1. Intrinsic dispersion greater than measurement errors
2. Catalogs of bright "normal" galaxies and "active" galaxies
3. Low- and medium-resolution surveys

## II. Results from detection surveys

A. Most spirals are weak but detectable sources

B.  $L_r \propto L_o$ ,  $\log R \equiv \left( \frac{B-12.5}{2.5} \right) S_{\text{mJy}} \approx 1 \pm 1$

C. Dependence on Hubble stage, color

D. Radio spectra

1.  $\langle \alpha \rangle \equiv -d(\ln S)/d(\ln \nu) = +0.7$  normal
2. Exceptions

E. Radio morphologies

1. Central core

2. Disk  $\langle T_d \rangle \equiv \frac{2c^2}{\pi k \nu^2} \left( \frac{S_d}{D_o^2} \right) \approx 0.3 \text{ K}$  at  $\nu = 1400 \text{ MHz}$

3. Halo, protrusions

### III. Emission mechanisms

A. Thermal bremsstrahlung

B. Synchrotron radiation

1. Transparent

2. Opaque

C. Other

### IV. Energy sources

A. Ordinary sources

1. HII regions

2. Supernova remnants

a. energy problems with galactic SNR's

b. ages

3. Other stellar objects

4. Compression and diffusion

B. Monster in nucleus

### V. Results from high resolution observations of strong sources in spiral galaxies

A. Strong cores ( $\log R > 2$ )

1. Extent and morphology

2. Associated emission

3. Galaxy-galaxy collisions

B. Bright disks ( $T_d > 2.5$  K)

1. Brightness distributions

2. Parker stability

3. Galaxy-gas cloud collisions

4. Nonthermal HII regions

## References:

- Biermann, P. 1976, Astr. Ap., 53, 295. (models of radio emission from SNR's)
- Cameron, M. J. 1971, M.N.R.A.S., 152, 403. (408 MHz low-resolution survey)
- Condon, J. J. 1983, Ap. J. Suppl., 53, 459. (VLA maps of bright disks)
- Condon, J. J., Condon, M. A., Gisler, G., and Puschell, J. J. 1982, Ap. J., 252, 102. (VLA maps of strong cores in normal spirals, galaxy collisions trigger starbursts)
- de Vaucouleurs, G., de Vaucouleurs, A., and Corwin, H. G. 1976, Second Reference Catalogue of Bright Galaxies (Austin: University of Texas Press).
- Dressel, L. L., and Condon, J. J. 1978, Ap. J. Suppl., 36, 53. (2380 MHz low-resolution survey)
- Ekers, R. D., and Sancisi, R. 1977, Astr. Ap., 54, 973. (Radio halo)
- Gioia, I. M., Gregorini, L., and Klein, U. 1982, Astr. Ap., 116, 164. (radio spectra)
- Heckman, T. M., van Breugel, W., Miley, G. K., and Butcher, H. R. 1983, A. J., 88, 1077. (Starburst-versus-monster debate)
- Heeschen, D. S., and Wade, C. M. 1964, Astron. J., 69, 277. (early low-resolution survey)
- Hummel, E. 1980, Astr. Ap. Suppl., 41, 151. (1400 MHz medium-resolution survey)
- Hummel, E. 1981, Astr. Ap. 93, 93. (statistical study of radio emission from optically bright spirals)
- Nilson, P. 1973, Uppsala General Catalogue of Galaxies (Uppsala: Uppsala Astronomical Observatory)

Rieke, G. H., Lebofsky, M. J., Thompson, R. I., Low, F. J., and

Tokunaga, A. T. 1980, Ap. J., 238, 24. (starburst models for M82 and NGC 253)

Shostak, G. S., Hummel, E., Shaver, P. A., van der Hulst, J. M., and

van der Kruit, P. C. 1982, Astr. Ap., 115, 293. (collision of NGC 1961 with gas cloud)

Wilson, A. S., and Meurs, E.J.A. 1982, Astr. Ap. Suppl., 50, 217. (1415 MHz survey of Seyfert galaxies)

Wilson, A. S., and Ulvestad, J. S. 1982, Ap. J., 263, 576. (jet models for NGC 1068 and NGC 4151)

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7/9/84