SEST CO STUDIES OF NGC 4945

J.B. WHITEOAK[1], M. DAHLEM[2], R. WIELEBINSKI[2],
S. HÜTTEMEISTER[2], C. HENKEL[2], G. GOLLA[2], J.I. HARNETT[3]
[1] *Australia Telescope National Facility, P.O. Box 76, Epping, NSW 2121, Australia*
[2] *Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-5300 Bonn 1, Federal Republic of Germany*
[3] *School of Physics, University of Sydney, Sydney NSW 2006, Australia*

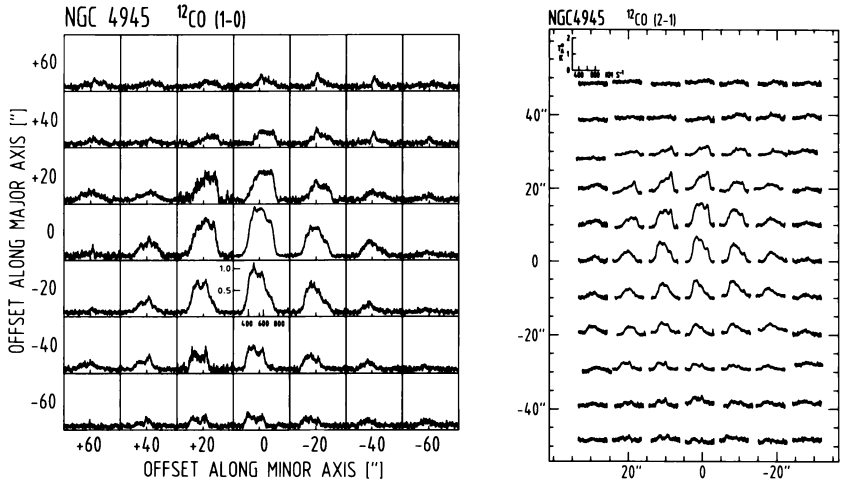
We have mapped the southern edge-on spiral galaxy NGC 4945 in ^{12}CO(1-0) and ^{12}CO(2-1) with the SEST telescope. Additional ^{13}CO spectra were also obtained. The intense nuclear CO emission is in agreement with the revised classification of this galaxy as an Sc object. NGC 4945 was for many years known to be a prototype of nuclear activity with detections of various molecular lines at cm-wavelengths, an OH kilomaser, a superluminous H_2O maser, etc. (Whiteoak, 1986). A host of molecules (CN, CS, C_2H, HCN, CH_3OH, etc.) has recently been detected at mm-wavelengths in the nucleus of NGC 4945 (Henkel et al., 1990).

In the nuclear area broad emission spectra are seen both in the CO(1-0) and CO(2-1) transitions. This is in contrast to HI and OH observations which show the nucleus in absorption. Also the HI and OH spectra, which were obtained with high angular resolution, show absorption but in the central velocities only. This suggests the superposition of a rotating ring in the nucleus (Whiteoak et al., 1990). There is an indication that the ring rotates at an inclination to the major axis. This was already suggested in the HI observations (Ables et al., 1987) and seen best in the HI channel maps.

The CO(2-1)/(1-0) ratios can be used to study the optical depth. The peak temperature of the (2-1) spectrum in the nucleus is 2.0 times higher than the (1-0) one in the T_{MB} scale. However, after convolution to the same beam, the ratio drops to 1.1±0.2 for the central 43". There is some indication that the ratio drops further to 0.9±0.2 in the positions adjacent to the nucleus. This can be interpreted to be due to either density variations in the molecular clouds or to temperature gradients at cloud edges, or both. The galaxy NGC 4945 shows after M82 and NGC 1808 the highest (2-1)/(1-0) ratios as yet measured.

The 225 CO(1-0) spectra show the global morphology of NGC 4945. Many spectra have multiple components. Some "hot spots" are particularly prominent in the disk where narrow intense spectra are seen. These areas

F. Combes and F. Casoli (eds.), Dynamics of Galaxies and Their Molecular Cloud Distributions, 164–165.



The spectra in the nuclear area in the CO(1–0) and CO(2–1) transitions

coincide with dust concentrations as seen in the optical image. The (2–1)/(1–0) ratio in these hot spots is 0.6±0.2, a value typical for disks of galaxies. The rotation curve derived from the CO(1–0) data along the major axis suggests rigid rotation in the central 100". Rotation "peaks" are seen at −60" and +40". Differential rotation sets in further out in the rotation curve. However, a separation of the individual components gives another picture: some components are seen at a constant velocity (at 410 and 720 km s^{-1}) from the edge of the galaxy to the minor axis.

The $^{12}CO(1-0)/^{13}CO(1-0)$ ratio in the nucleus is 16. This suggests a ^{12}CO optical depth of 1–2. The molecular column density which follows from these data is 7.10^{22} cm^{-2} when the temperature is 20 K. The total mass of the nuclear complex is $1.3.10^{8}$ $M_{\odot}$. Both values are typical for other nearby spiral galaxies.

The most recent observation of radio continuum with the Parkes telescope showed two polarization maxima on opposite sides of the nucleus (Harnett et al., 1989). The mirror symmetry of the CO velocity components is in the same sense as this magnetic field symmetry.

References

Ables, J.G. et al.: 1987, *Monthly Notices Roy. Astron. Soc.* **226**, 157

Harnett, J.I., Haynes, R.F., Klein, U., Wielebinski, R.: 1989, *Astron. Astrophys.* **216**, 39

Henkel, C., Whiteoak, J.B., Nyman, L.-Å., Harju, J.: 1990, *Astron. Astrophys.* **230**, L5

Whiteoak, J.B.: 1986, *Proc. Astron. Soc. Australia* **6**, 467

Whiteoak, J.B., M. Dahlem, R. Wielebinski, J.I. Harnett: 1990, *Astron. Astrophys.* **231**, 25