CENTAURUS A: THE ^{13}CO MAP AND MOLECULAR LINE RATIOS

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1. Introduction

Centaurus A (NGC 5128) is the closest radio galaxy (distance about 3 Mpc) and belongs to the class of elliptical galaxies with dust lanes. It is a strong radio source with a milliarsecond nuclear continuum source and two giant radio lobes. Absorption against the nuclear source has been found in HI and several molecular species and transitions. Due to its proximity, it offers the possibility of studying in detail the interstellar medium in an elliptical galaxy.

Here we present the first fully sampled map of ^{13}CO J=1–0 along the dust lane of Centaurus A. The data, obtained with the 15m Swedish-ESO Submillimetre Telescope (SEST) in La Silla, Chile, have a resolution of 44$''$ (FWHM). In combination with the ^{12}CO J=1–0 and J=2–1 maps that we presented earlier (Eckart *et al.* 1990; Rydbeck *et al.* 1993) and newly obtained spectra of ^{13}CO J=2–1 and C^{18}O J=1–0 at selected positions, study of the excitation conditions of the molecular gas along the dust lane and its variation in the disk is possible. A detailed report of this work will be published elsewhere (Wild *et al.*, in preparation).

2. The ^{13}CO J=1–0 map

Fig. 1 (top panel) shows the velocity integrated ^{13}CO J=1–0 emission along the dust lane. The emission is well concentrated along the dust lane and the map shows two peaks of emission symmetrically displaced from the central position. The morphology is quite similar to the ^{12}CO J=1–0 and J=2–1 maps.

3. Molecular line ratios

Fig. 1 (middle panel) shows the ^{12}CO/^{13}CO J=1–0 ratio along the disk of Centaurus A. The ^{12}CO/^{13}CO ratio throughout the disk ranges from 10 to 16, a value found for a large sample of galaxies.

Before calculating the ^{12}CO J=2–1/1–0 ratio, the J=2–1 map was smoothed to the resolution of the J=1–0 data (44″). The ^{12}CO J=2–1/1–0 ratio (Fig. 1, lower panel) has a value of 0.8–0.9 for the major part of the disk and shows no large variation along the major axis. In the SE the ratio rises to 1.1 .

TABLE 1. CO emission line ratios

line ratio	center	disk
^{12}CO J=2–1/1–0	0.8–0.9	0.8–0.9 (1.1)
^{12}CO/^{13}CO J=1–0	14	11–14
^{13}CO J=2–1/1–0	1.0±0.4	0.85±0.3
^{12}CO/C^{18}O J=1–0	∼75	

Table 1 summarizes the molecular line ratios in the center and disk of Centaurus A. There is no significant variation between the central position and the disk, indicating that the excitation of the molecular gas is not very different between the center and the disk in this galaxy.

Radiative transfer calculations for various CO column densities in the framework of a one component model (taking into account non-LTE effects, clumping, and optical depth dependent filling factors) show that these line ratios are characteristic for gas with a kinetic temperature of 10–15 K and hydrogen densities $n(H_2)$ of 10^4 cm^{-3} to 3×10^4 cm^{-3}. The inferred CO column density is $\sim 3 \times 10^{17}$ cm^{-2}.

References

Eckart A., *et al.*, 1990, *Ap.J.* **363**, 451.
Rydbeck G., *et al.*, 1993, *Astron. Astrophys. (Letters)* **270**, L13.

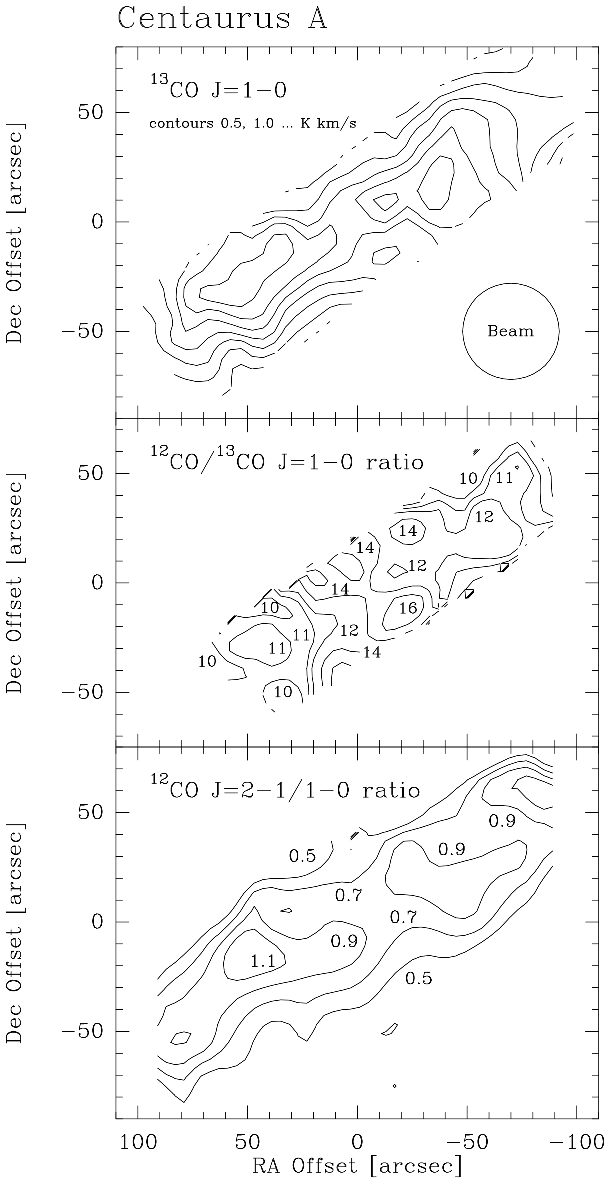

Figure 1. Maps of the ^{13}CO integrated intensity, the ^{12}CO/^{13}CO J=1–0 and ^{12}CO J=2–1/1–0 ratios along the dust lane of Centaurus A. The molecular line ratios do not vary significantly across the disk.