FIRST DETECTION OF ^{13}CO J = 3 → 2 IN NGC 253

W. F. Wall, D. T. Jaffe
University of Texas, Astronomy Dept.
Austin, Texas, USA 78712

ABSTRACT. The detected ^{13}CO J = 3 → 2 line in the center of the Sc galaxy NGC 253, along with lower frequency line data, provide further evidence that the starburst nucleus contains warm ($T_K \sim 100$ K), dense ($n(H_2) \sim 10^4$-10^5 cm^{-3}) molecular gas.

1. Introduction:

NGC 253 is a nearby (D = 2.5 Mpc, de Vaucouleurs 1978) highly inclined ($i = 78°.5$, Pence 1981) Sc galaxy undergoing a starburst. To explore the density and temperature structure in NGC 253's molecular gas, we have made observations of the J = 3 → 2 (at the CSO), J = 2 → 1 (at the JCMT and the SEST) lines of ^{13}CO and ^{12}CO – all with 20-24″ resolution.

2. Results:

The results are as follows:

(1) The ^{13}CO J = 3 → 2 line originates in a $\lesssim 15''$ source while emission from the other lines is consistent with the 39″ × 12″ bar observed by Canzian *et al.* (1988).

(2) The ^{13}CO J = 3 → 2/^{13}CO J = 2 → 1 ratio (= 2) implies warm ($T_K \sim$ 100K), dense ($n(H_2) \approx 10^4$ - 10^5 cm^{-3}) molecular gas at (0,0).

(3) Spatial variation of the ^{13}CO J = 3 → 2/^{13}CO J = 2 → 1 ratio is likely due to density, as well as temperature, variations. HCO$^+$ and HCN observations (Rieu *et al.* 1989) support this conclusion. Density variations can also explain the low ^{12}CO J = 3 → 2 to ^{12}CO J = 2 → 1 ratio observed $\gtrsim 30''$ to the northeast ($n(H_2) \lesssim 10^4$ cm^{-3}).

(4) The ^{13}CO J = 2 → 1/^{12}CO J = 2 → 1 ratio suggests a high ^{13}CO/^{12}CO abundance ratio (i.e. ∼ 1/10), but opacity inhomogeneities along the line of sight through NGC 253 could yield high *apparent* ^{13}CO/^{12}CO abundances despite lower *actual* abundance.

(5) $M(H_2) \approx 10^7\ M_\odot$ for the central 40-50″ diameter, when scaled for distance disagreements, is about 5 times smaller than the mass estimate of Scoville *et al.* (1985).

References:

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