MOLECULAR CLOUDS IN THE LARGE AND SMALL MAGELLANIC CLOUDS

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To determine the distribution of molecular gas in the Large and Small Magellanic Clouds (LMC and SMC), we made complete surveys in the J=1-0 transition of CO, of the central 6°x6° and 3°x2° areas of the LMC and SMC, respectively. The observations were made with the 1.2m Columbia Telescope at Cerro Tololo, which provides and angular resolution of 8.8 arcmin at 115 GHz. The spectral resolution of the surveys was 1.3 km s^{-1} and the sensitivity in antenna temperature was 0.05 K for the LMC and 0.02 K for the SMC.

In the LMC we detected 40 CO complexes. Positions, masses and other physical characteristics of the identified molecular clouds are given in Cohen et al. (1988). In the SMC we detected CO emission from two large complexes located in the southwest, near N19, and northeast, near N78, regions of the SMC bar (Rubio et al. 1989).

The general correspondence of molecular complexes in the Magellanic Clouds to other Pop I objects is close. In the LMC, nearly all the CO sources appear projected toward peaks in the HI emission having HI column densities $>2x10^{21}$ cm^{-2}. In the SMC, both complexes are projected toward regions of atomic gas having the largest HI column densities ($N(HI) \sim 10^{22} cm^{-2}$). The CO sources in the Magellanic Clouds are found projected near either optical HII regions, radio continuum sources, and peaks in the IRAS 100μ emission, suggesting that in these galaxies the presence of molecular clouds is a prerequisite for star formation.

The intensity of the CO emission from molecular clouds in the LMC and SMC is weak compared with that from Galactic giant molecular clouds (see Table 1). Molecular clouds in the LMC and SMC have antenna temperatures, T_a, 10 and 50 times smaller, respectively, than those of Galactic clouds. The average CO luminosity, L_{CO}, of the complexes in the LMC and SMC is 4 and 6 times smaller than in the Galaxy. The observed size of molecular clouds are 3 to 4 times greater in the Magellanic Clouds than in the Galaxy, but we note that they do not correspond to the cloud physical dimensions but to correlated sizes of CO emission.

The most likely explanation for the striking low antenna temperature of the ^{12}CO emission from molecular complexes in the Magellanic Clouds is beam dilution already suggested by Rubio and Garay (1988). They conclude that the characteristic physical length of individual CO clumps, making

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Table 1. Observed parameters of the ^{12}CO emission

Object	T_A K	DV km s^{-1}	R pc	L_{CO} K km s^{-1} pc^2
SMC	0.04+0.01	15+5	220+50	0.6 10^5
LMC	0.2+0.1	11+4	180+65	1.0 10^5
Galaxy	(2-3)	9+4	63+35	3.6 10^5

up a molecular complex, in the LMC and SMC is 3 and 10 times smaller than that in the Galaxy, respectively. In addition, they propose that molecular clouds in the LMC and SMC are the UV shielded cores of large diffuse HI clouds. The small dimensions of the CO clouds are probably a consequence of the low dust content and the low metallicity of the interstellar gas of the Magellanic Clouds. Further support to this suggestion are given by the good agreement between the theoretical critical HI column density required to shield the cloud interior from the external UV radiation field (Franco and Cox 1986) and the observed column densities of HI toward the CO sources, and by the similar radial velocities between the HI and CO gas.

To determine the molecular mass of the Magellanic Clouds we assume that the velocity integrated CO emission (W_{CO}) is a tracer of the molecular hydrogen column density $N(H_2)$. However, due to differences in the physical conditions in the LMC and SMC and the Galaxy it is not wise to adopt the Galactic value for the ratio $N(H_2)/W_{CO}$. From a comparison of the empirical CO luminosity versus linewidth relationship of molecular clouds in the Magellanic Clouds and our Galaxy we propose a conversion factor, to derive molecular masses from the CO luminosities, that is six and twenty five times larger than the Galactic value for the LMC and SMC, respectively. The total mass of molecular hydrogen is 1.5×10^8 $M_\odot$ in the LMC and 3.5×10^7 $M_\odot$ in the SMC. The ratio of molecular to atomic mass is $\sim$0.3 and $\sim$0.09 for the LMC and SMC, respectively, about three and ten times smaller than the ratio derived in our Galaxy.

Preliminary results of observations of the molecular clouds in the Magellanic Clouds with the 15m SEST telescope at La Silla (Booth 1988) have confirmed the suggestion that the size of the CO clumps making up a molecular complex in the LMC and SMC is smaller than the typical size of Galactic giant molecular clouds.

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