MOLECULAR GAS IN THE SMALL MAGELLANIC CLOUD

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ABSTRACT. We summarize the results of observations of molecular gas from the Small Magellanic Cloud (SMC) made with low angular resolution (8'.8). These observations show that the CO emission is weak ($T_A \sim 0.04K$) and that the CO luminosities of the Clouds are low compared to those of Galactic molecular clouds. The factor to convert the CO luminosity to molecular hydrogen column density for the SMC is ~20 and three times larger than those derived for clouds in our Galaxy and in the Large Magellanic Cloud (LMC) respectively. In addition, we present preliminary results of high resolution (40") observations of SMC molecular clouds made with the SEST telescope.

1. Low angular resolution observations.

Because it is so close and has lower metallicity and a higher gas-to-dust ratio than our Galaxy, the SMC is an ideal extragalactic system to study the properties of molecular clouds in an environment different from our own. Recently, Rubio *et al.* (1990) fully surveyed the SMC in the $^{12}CO(J=1\rightarrow0)$ line, using the Columbia Southern Telescope (angular resolution of 8'.8). They found two large CO complexes, identifying five separate molecular clouds. The complexes lie projected towards regions of atomic gas with the largest HI column densities($\sim10^{22}$ cm^{-2}) towards the SMC, and are associated with other Population I tracers such as dark clouds, HII regions, etc.

The peak antenna temperatures are ~0.04K, 50 times lower than the antenna temperature for a typical Galactic GMC if it were located at the distance of the SMC. Assuming that the CO clouds are optically thick and their excitation temperatures are similar to those of Galactic molecular clouds, the weakness of the CO emission could be explained by beam dilution effects. Rubio *et al.* (1990) suggested that the effective size of the CO-emitting regions is ~8 times smaller in the SMC than in our Galaxy.

The CO luminosities of the SMC clouds are ~20 times smaller than those of the Galactic GMCs with the same velocity line width. This result suggests that using the Galactic conversion factor to derive the masses of the clouds in the SMC from their CO luminosities might underestimate the amount of H_2. Further support for this suggestion is given by comparing the virial masses with the CO masses derived using the Galactic conversion factor, the former being a factor of 30 larger than the latter. Rubio *et al.* (1990) suggested that in the SMC, the factor to convert the velocity-integrated CO emission into molecular hydrogen column density, $N(H_2)$, is ~20 times the Galactic value.

R. Haynes and D. Milne (eds.), The Magellanic Clouds, 429–430.

2. High resolution observations

High angular resolution (40") observations of the molecular clouds in the SMC are being currently undertaken with the SEST telescope as part of an ESO-SWEDISH Key Programme (Israel & Johansson 1989). The linear resolution of the SEST telescope at the frequency of the ^{12}CO(J=1→0) transition, of 15 pc at a distance of the SMC of 63 kpc, is probably adequate to resolve most of the clouds in the SMC. The observations are being made in frequency switching mode with an integration time of 10 min per position.

We have mapped, in the ^{12}CO line and with full angular resolution, the IR sources LIRS36 and LIRS49 (Schwering 1988; N88, Henize 1956), and at present we are mapping the region of the SMC-BAR where Rubio *et al.* (1990) found the maximum CO emission (their source SW-1).

The Columbia CO complexes are resolved into different components. Several clouds were identified in the SW-1 area, with sizes of ~20pc. The CO clouds show peak antenna temperatures of ~1K, CO luminosities of 10^3K km s^{-1} pc^2, and line widths of between 3 to 8 km s^{-1}. Observations of the CO(J=2→1) line at the positions of the peak emission in the CO(J=1→0) maps show that the antenna temperature ratio T_A(J=1→0)/T_A(J=2→1) $\simeq$ 1; the strongest value of T_A(2→1) measured so far is ~1K. In addition, observations of the ^{13}CO(J=1→0) line show that the ^{12}CO to ^{13}CO antenna temperature ratio ranges between 7-10. If LTE is assumed, implying that the ^{12}CO is optically thick, then the low values of the observed antenna temperatures could be explained as due to a combination of two effects: excitation temperatures lower than those of Galactic molecular clouds and small beam filling factors of the CO emission. Johansson (1990) and Castets *et al.* (1990) suggest, however, that large velocity gradient (LVG) models may be more appropriate in explaining the observed line ratios and low antenna temperatures.

The luminosity and line width of the CO clouds observed with SEST follow the same luminosity versus line-width relation found for the CO clouds observed with lower resolution (Rubio *et al.* 1990). However, from SEST observations we compute virial masses that are ~ 10 times larger than the CO masses derived using the Galactic conversion factor. Thus, these results also suggest that the factor to convert CO luminosities to molecular hydrogen density in the SMC is different from the Galactic factor, but the value of the conversion factor could be somewhat smaller than that derived from the low resolution data.

SEST observations will continue, and during the next few years we expect to calibrate, more precisely, the conversion factor and determine the physical properties of SMC molecular clouds.

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3. References

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