MOLECULAR CLOUDS IN THE SMALL MAGELLANIC CLOUD

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ABSTRACT. Molecular clouds in the Small Magellanic Cloud (SMC) show characteristics different to those of Galactic molecular clouds. They have weak CO emission and low CO luminosities. Preliminary results of high resolution observations of SMC molecular clouds with the SEST telescope are presented.

In the SMC, the factor to convert the velocity integrated CO emission into molecular hydrogen column density appears to be different than the factor derived in our Galaxy, and in the Large Magellanic Cloud.

The Small Magellanic Clouds (SMC) is an irregular galaxy in which 40% of the total mass is in the form of neutral hydrogen gas. As most irregulars, it exhibits abundant evidence for present day star forming activity, although these galaxies show strong defficiency in CO emission when compared to spirals of similar star forming activity. Because it is so close and have different metallicities and gas to dust ratio than our Galaxy, the SMC is the ideal extragalactic system to study the properties of molecular clouds in an environment different than our own. It can also help us understand if the CO line emission is a fair tracer of the mass of molecular gas.

The SMC was fully surveyed at an angular resolution of 8.8 arcmin in the ^{12}CO emission line (Rubio et al. 1990).The CO emission arises from two complexes located in the northeast and southwest region of the SMC Bar. These complexes lie proyected towards regions of atomic gas having the largest HI column densities, N(HI) ~ 10^{22} cm^{-2}. Five molecular clouds were identified with characteristics different than those of Galactic CO clouds. The CO emission was extremely weak with typical T_A^* ~0.04K, about 50 times lower than a typical Galactic GMC would produce at the distance of the SMC, and CO luminosities of about 20 times smaller than Galactic GMC's. Assuming optically thick CO clouds and excitation temperature of T~10K as in Galactic molecular clouds, the weakness of the CO emission could be explained mainly due to beam dilution and/or small filling factors of the emission. Hence, the CO emission should arise from emitting regions with effective sizes smaller than the CO regions in Galactic molecular clouds.

The SMC CO clouds followed a similar mass-linewidth relation as Galactic molecular clouds except that the Galactic clouds appeared a

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factor of twenty times stronger in CO than SMC clouds. This result suggested that using the Galactic conversion factor to derive masses from CO luminosities might underestimate the amount of H2. Further support to this fact was found in the comparison between the virial masses and the CO masses, as the former were a factor of 30 than the later ones. Thus, Rubio et al. 1990, suggested that in the SMC the factor to convert the velocity integrated CO emission, W_{CO} into molecular hydrogen column density, N(H2), was different in the SMC than the factor derived in our Galaxy (Bloemen et al. 1986), and in the LMC (Cohen et al. 1988). They proposed that in the SMC this factor is about twenty times the Galactic value.

High angular resolution observations of the molecular clouds in the SMC are being been done with the SEST telescope as part of the ESO-SWEDISH KEY PROGRAMME: CO STUDIES OF THE MAGELLANIC CLOUDS (Israel and Johansson 1989). The beam of the SEST telescope is 40" at the ^{12}CO (J=1->0) transition, increasing the angular resolution by more than a factor of 100 compared to the low resolution survey. At a distance of 63 Kpc for the SMC the linear resolution is 15 pc, adecuate for resolving GMC's and study the physical properties of CO clouds.

We have been observing in the CO(J=1->0) line and we have mapped a few clouds with full resolution, LIRS36 and LIRS49 (Schwering 1989) and N88 (Henize 1956). The observations are made in frequency switching mode and the integration time is 10 min per position. At present we are mapping the southwest region of the SMC-BAR (SW-1), where Rubio et al. 1990 found the maximum of CO emission. Several clouds have been identified in this are.

The preliminary results obtained from these observations show a clumpy nature of the CO molecular complexes, with CO clouds having about 20pc in size. These clouds show peak T_A^* 1K, CO luminosities of 10^3 K kms^{-1}, and the linewidths range between 3 to 7 km/s. The CO luminosities of these SMC clouds are about 10 times smaller than those of Galactic molecular clouds. A comparison between the antenna temperatures measured with the Columbia Telescope and SEST shows that the latter ones have raised only 50% of what was expected due to the difference in beam sizes of the two telescopes. A possible explanation is that SMC molecular clouds could be fragmented into smaller structures. We have added up all the CO luminosity measured with SEST within one Columbia beam and we find that they are similar, suggesting that there is a negligeable contribution from diffuse clouds.

Preliminary results of ^{13}CO observations indicate that the ^{12}CO to ^{13}CO ratio ranges between 7-10 in SMC molecular clouds. Observations done in the CO (J=2->1) line of some CO peaks give a CO(1->0)/CO(2->1) ratio close to unity, consistent with optically thick, thermalized emission (Castets et al. 1990). The strongest TA(2->1) measured is only ~1K and this low value can be due to a combination of two effects: lower excitation temperatures and/or small beam filling factors of the CO emission. Two clouds have been mapped in the CO(2->1) line and they show several peaks where only one was seen in the CO(1->0) map. Thus, the CO clouds are showing more structure as the resolution is increased.

SEST observations also suggest that the factor to convert CO luminosities to molecular hydrogen column density in the SMC is probably

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different to the Galactic conversion factor. The parameters of the CO clouds observed with SEST fit the same mass-linewidth relation as that found for the SMC CO clouds observed at lower resolution and therefore confirms that the SMC CO clouds are less luminous when compared to Galactic molecular clouds of the same velocity linewidth. In addition, the virial masses are about 10 times larger than the CO masses derived using the Galactic conversion factor.

SEST results are still very preliminary. Only with more observations, careful further investigation, and adecuate modelling, we will be able to determine the physical properties of SMC molecular clouds and calibrate adequately the conversion factor in the SMC.

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