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CO IN THE MAGELLANIC CLOUDS

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RESUMEN. Presentamos algunos resultados preliminares de las observaciones de las nubes moleculares en las Nubes de Magallanes realizadas con el telescopio SEST. Estas observaciones son parte del programa "Estudios de CO en las Nubes de Magallanes", del cual damos a conocer sus objetivos científicos.

ABSTRACT. We present the scientifics goals of the ESO-SWEDISH SEST KEY PROGRAMME: "CO studies in the Magellanic Clouds". We give a description of the observational strategy, and we present some preliminary results of the ^{12}CO(J=1-0) mapping of selected regions in the LMC and SMC.

Key words: GALAXIES-MAGELLANIC CLOUDS — INTERSTELLAR-CLOUDS

The Magellanic Clouds are the most suitable extragalactic systems where we can study the molecular gas in detail. Because they are so close and have different metallicities and gas to dust radio than our Galaxy, they are the ideal systems to study the properties of molecular clouds in an environment different than our own.

The results of the Columbia low resolution survey of the LMC (Cohen et al. 1988) and SMC (Rubio et al. 1990) showed the distribution of the molecular gas in both Clouds. These maps revealed the presence of molecular cloud complexes whose characteristics were different from those of Galactic molecular clouds. A very important result of this study was the observational evidence that the factor to convert the velocity integrated CO emission, WCO, into molecular hydrogen column density, N(H2), was different in the Magellanic Clouds, than the factor derived in our Galaxy. In the LMC, Cohen et al. 1988, proposed a conversion factor six times larger than the Galactic factor. In the SMC, Rubio et al. 1990 have suggested that this factor is twenty times the Galactic value. Thus, the conversion factor derived from Galactic molecular clouds most possibly depends on the ambient physical conditions where the molecular clouds are formed, and is not a universal value.

With the commissioning of the 15m SEST telescope (Swedish-ESO Submillimeter Telescope) at La Silla at the end of 1987, several groups sent proposals to observe the molecular clouds in the Magellanic Clouds and determine their properties. In view of the scientific importance and the large angular extent of the Magellanic Clouds, ESO and Sweden decided to designate the study of the molecular clouds in the Magellanic CLouds a KEY PROGRAMME of the 15m SEST telescope and created an international Consortium of astronomers to undertake a major long term study of the molecular content in the LMC and SMC (Israel and Johansson 1989). Both, ESO and Sweden allocate at least seven half days per semester of SEST telescope time to this project.

The main goals of this study are:

- Mapping of LMC and SMC molecular clouds in ^{12}CO (J=1->0), J=2->1, J=3->2) and ist isotopes ^{13}CO and ^{18}CO.
- The determination of the relation between CO luminosity and molecular hydrogen column density, N(H2), in the LMC and SMC.
  The observations with SEST will enable us to resolve the individual clouds and determine their virial masses.

- Study the physical properties of molecular clouds in ambient conditions significantly different to the ones in our Galaxy.

- Investigate the relation between molecular clouds and regions of star formation.

- The results obtained in this study are essential to the interpretation of extragalactic CO observations.

In view of the great angular extension of the Magellanic Clouds we have followed an observational strategy that will allows us to cover the most representative regions in the LMC and SMC in a reasonable amount of observing time. At present, there have been three observing periods, plus the Swedish observations done during the testing time of the telescope. A preliminary survey of selected sources in the LMC and SMC was done. CO emission was detected from 19 of 21 sources surveyed in the LMC, and from 20 of 38 sources observed in the SMC. Mapping around the strongest detections was then began.

In the LMC, we have mapped the N11 (Henize 1956) region and a 2° strip of constant R.A. in the molecular cloud complex south of 30Dor. The maps were made with 20" spacing, and every position was observed for 4 min. Maps around N159, N160 and 30 Dor, with 1' spacing were obtained by Johansson et al (1989) during the testing time of SEST.

In the SMC the CO emission is very weak and we have to integrate for 20 to 30 minutes in each position. We have mapped a few clouds, i.e. N12, N27, N88, with full resolution and at present we are observing the southwest region of the SMC-BAR where Rubio et al. 1990 found the maximum of CO emission.

The preliminary results obtained from these observations show a clumpy nature of the CO molecular complexes. In the LMC we have found about 10 CO clouds in the N11 region and about a dozen in the strip south of 30 Doradus. These clouds have typical sizes of ~20 pc in diameter. The CO lines show antenna temperature of about ~2K and linewidths of 4-8 km/s. The strongest CO line with TA ~4K has been observed toward N159. In the SMC, the cloud sizes are about 15 pc and in some cases we do not resolve the clouds at the CO(J=1->0) line. Preliminar results of ^{13}CO observations indicate that the ^{12}CO to ^{13}CO ratio ranges between 7-10 in both LMC and 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 of about ~ <1, suggesting that the CO clouds in the Magellanic Cloud have excitation temperatures similar to Galactic CO clouds.

It is interesting to mention that these data have confirmed the previous estimates that the factor to convert CO luminosities to molecular hydrogen column density is about 5 times t is about 5 times the Galactic factor in the LMC, and ~20 times in the SMC (Cohen et al. 1988 Rubio and Garay 1989; Rubio et al. 1990). However, Johansson and Booth 1989 has found in the region south of 30 Doradus that for the most luminous CO clouds the ratio between the virial masses and the CO mass tends to approach unity. Thus, careful further investigation and more observations are required to confirm this observed trend.

The observations will continue during the next semesters and we expect to map several molecular clouds covering a wide range of ambient physical conditions in the LMC and SMC. The SEST consortium has produced guidelines which consider the membership of the astronomers to this programme, their participation in the data adquisition, reduction, analysis and collaboration with other astronomers. Publication of the CO observations will be done at regular intervals in Astronomy and Astrophysics.

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REFERENCES

Cohen, R.S., Dame, T.M., Garay, G., Montani, J., Rubio, M., and Thaddeus, P., 1988, Ap. J. Lett., 331, L95.

Israel, F.P., and Johansson, L.E.B., 1989,Proc. IAU Colloquia The Magellanic Clouds, Paris, 10-11 May, 1989.
Johansson, L.E.B., Booth, R., 1989,Proc. IAU Colloquia The Magellanic Clouds, Paris, 10-11 May, 1989.
Rubio, M. and Garay, G., 1989, in "The Physics and Chemistry of Interstellar Molecular Clouds", eds. G. Winnewisser and J.T. Armstrong, (Springer-Verlag), p. 270.
Rubio, M., Garay, G., Montani, J., and Thaddeus, P., 1990, Ap. J. Submitted (Dec. 1989).

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