COMPARISON OF CO IN THE GALAXY AND THE MAGELLANIC CLOUDS

F.P. Israel, Th. de Graauw
Astronomy Division, ESA Space Science Department, Estec

H. van de Stadt, C.P. de Vries
Sterrewacht Sonnenborgh, Utrecht

We have used the Estec/Utrecht heterodyne submillimetre receiver and the ESO 3.6-m telescope at La Silla (Chile) to observe the CO(2-1) transition at 230 GHz (1.3 mm) in the Magellanic Clouds. We used a beam of 2 arcmin HPBW (corresponding to linear resolutions of 32 and 46 pc for LMC and SMC respectively), the system temperature was 2200 K (DSB) and the overall system efficiency was 0.55. In this paper we summarize the results, which are published in more detail elsewhere (cf. Israel et al., 1982, 1983; Israel, 1984).

In the LMC we sampled 22 positions, in the SMC 16 positions. The majority was near or coincident with bright HII regions and dark clouds. Four positions coincided with the known LMC OH masers and SMC H_2O masers. Five positions were taken as representative for the LMC Bar and three for the SMC Bar, i.e. they were not selected on the presence of HII regions, dark clouds etc. Detection statistics are overall 50 per cent for the LMC and 35 per cent for the SMC. All four maser positions were detected in CO. In the LMC, the region containing 30 Doradus and the bright HII regions and dark clouds to the south represents the greatest single concentration of molecular clouds. A strong CO signal of 2.6 K was detected in the direction of N159 which shows all the characteristics of a giant molecular cloud associated with a site of active star formation (Israel et al., 1982). The 30 Doradus complex itself is relatively poor in CO which may be due to the violent interaction of the HII region with its surroundings. In the SMC, molecular clouds are concentrated in the SW end of the Bar. The rest of the Bar, with the giant HII regions N66 and N76 in the NE, has a low detection rate (about 15 per cent) as has the LMC Bar. No CO was detected in the three Wing positions.

Thus, both LMC and SMC seem on the whole to have a lower CO cloud content than the Galaxy, especially when one allows for the fact that most observed positions were selected on the presence of objects that in the Galaxy usually are associated with giant molecular clouds. In addition, the CO content of the clouds detected is rather low. The strongest signals measured are of order 2.5 K, whereas a Galactic giant molecular cloud at Magellanic distances would be about two times stronger.

H. van Woerden et al. (eds.), The Milky Way Galaxy, 333–334.

The mean detected signal in the Clouds is only 1.5 K; all detections in the LMC and SMC added together show an area-integrated signal about as strong as expected from two to three Galactic GMC's, which is four to five times less than expected from an extrapolation of Galactic results. In view of the number of detections, this difference is statistically significant. Nevertheless, the detection pattern is similar to that seen in the Galaxy; CO is found near bright HII regions, dark clouds and molecular masers. In particular the concentrations of CO clouds south of 30 Doradus and in the SMC SW Bar correlate well with concentrations of dark clouds, neutral hydrogen, and young stars.

Elmegreen et al. (1980) have attempted to explain nondetection of CO in several Magellanic-type galaxies (but not including the LMC and SMC) by invoking the following explanations. 1. An underabundance of CO with respect to H_2. 2. A low level of cosmic-ray heating, resulting in low excitation temperatures of CO. 3. A relatively high rate of luminous-star formation, resulting in decreased molecular-cloud lifetimes. Local high star-formation rates may explain the difference at some positions (e.g. 30 Doradus), but most likely do not influence the majority of the observed positions. A low level of cosmic rays is also not a likely explanation (Israel et al., 1983), and an underabundance of CO with respect to H_2 would only show up at extremely high levels of depletion, when the CO line would become optically thin.

We suggest that the key to the difference is provided by the low dust-to-gas ratio in the Clouds; different dust properties are also suggested by low metal abundances and discrepant UV extinction laws. A lower dust content will cause a gas concentration in the Clouds to be more transparant to destructive UV radiation, leading to stronger CO dissociation. Because of its self-shielding properties, molecular hydrogen is not subject to dissociation. However, its formation is thought to take place primarily on dust-grain surfaces; it will thus be impaired. Compared to the Galaxy, a smaller fraction of the LMC and SMC total gas mass will therefore be in molecular form and a larger fraction in atomic form. Since the processes that lead to depletion of CO and H_2 are not the same, one would also expect the Galactic conversion factor of CO to H_2 not to apply to the Magellanic Clouds. Finally, the same reasoning suggests that the above also applies to different localities in galaxies with abundance gradients, such as the Galaxy.

REFERENCES

Elmegreen, B.G., Elmegreen, D.M., Morris, M.: 1980, Astrophys. J. 240, 455.

Israel, F.P., de Graauw, Th., van de Stadt, H., de Vries, C.P.: 1982, Astrophys. J. 262, 100

Israel, F.P., de Graauw, Th., van de Stadt, H., de Vries, C.P.: 1983, Astrophys. J., submitted

Israel, F.P.: 1984, in Proc. IAU Symposium No. 108, S. van den Bergh, and K.S. de Boer (eds.), 319

https://doi.org/10.1017/S0074180900242733 Published online by Cambridge University Press