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CO Emission toward HI Absorption Sources in the Large Magellanic Cloud

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1. Introduction

In the Large Magellanic Cloud (LMC) a large number of cool HI clouds have been detected with temperatures much lower than those found for atomic clouds in the Milky Way (Dickey et al. 1994; Mebold et al. 1997; Marx-Zimmer et al. 1998). Apparently, the population of cool HI clouds reaches kinetic gas temperatures down to as low as 10 or 20 K. These clouds may play an important role in the formation of stars in the LMC. We studied the association between the cool atomic gas and molecular gas in the LMC by ^{12}CO(1-0) line observations in directions of cool HI clouds using the 15-m Swedish-ESO Submillimetre Telescope (SEST[1]).

2. Observations

We used the SEST to survey ^{12}CO(1-0) line emission toward 25 lines of sight showing cool HI (57 HI absorption features) with spin temperatures down to 4 K. The sources have been selected from the HI absorption line surveys of Dickey et al. (1994) and Marx-Zimmer et al. (1998). We also studied the surroundings of 13 of these lines of sight by a four-point map around the central position with $40''$ spacing. The ^{12}CO(1-0) observations were carried out in a dual beam-switching mode (switching frequency 6 Hz) with a beam throw of $11'37''$ in azimuth and in a frequency-switching mode with a frequency offset of 15 MHz (40 km s^{-1}). At the frequency of 115 GHz of the J=1-0 transition of ^{12}CO the SEST beamwidth is $45''$, corresponding to a linear resolution of about 10 pc in the LMC. The velocity resolution is 0.11 km s^{-1}. Typical integration times were 20 min on the source, which provides an rms of about 0.06 K.

[1]Based on observations with the Swedish-ESO Submillimetre Telescope (SEST) at the European Southern Observatory (ESO), La Silla, Chile.

3. Results

Out of a total sample of 25 lines of sight showing cool atomic hydrogen CO emission has been detected toward 8 lines of sight with T_{MB} between 0.3 K and 8 K. Five of these lines of sight showing CO emission are in direction of the 30 Doradus complex. The other clouds have been detected toward the bar of the LMC, toward the far southwest, and in direction of LMC4. Four of these clouds have not been detected in the CO survey of Cohen et al. (1988) due to a smaller beam filling factor (8$'$.8 resolution). We mapped five of the detected CO clouds and found cloud sizes between about $110'' \times 80''$ (26 pc $\times$ 19 pc) and $600'' \times 180''$ (144 pc $\times$ 43 pc). The cool HI gas is mostly located toward the rim of the molecular clouds.

There is no clear correlation of CO emission with the HI spin temperature or the optical depth, τ_{HI}, although the probability of finding a CO-HI association increases with τ_{HI} and with the absorption integral. CO emission always occurs near but does not necessarily coincide with an HI absorption feature. The velocity differences $Dv = v_{HI} - v_{CO}$, where v_{HI} is the HI feature closest in velocity to the CO feature, are between 1 and 6 km s^{-1}. In general the value is smaller than the FWHM of the HI feature detected. Turbulent gas motion near 30 Doradus and LMC4 can cause this velocity shift of the CO gas with respect to the HI gas.

Although LMC clouds seem to have lower temperatures than atomic clouds in the Milky Way, the fraction of cool HI clouds showing CO emission is the same as in the Milky Way, where about 19% of the HI absorption components show CO emission (Despois & Baudry 1985). Whereas in the Milky Way the transition from atomic to molecular gas (H_2, CO), leaving little HI, seems to take place at temperatures below about 30 to 40 K, the non-detection of CO towards unusually cool HI clouds in the LMC might indicate that here the gas phase transition is determined by a different temperature-density combination. Another explanation of our result is that the conversion factor from CO emission to H_2 column density is lower in the LMC than in the Milky Way. The unusually cool HI clouds may be the key in understanding the high star formation activity in the LMC.

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References

Cohen, R.S., Dame, M.T., Garay, G., et al. 1988, ApJ, 331, L95

Despois D., & Baudry, A. 1985, A&A, 148, 83

Dickey, J.M., Mebold, U., Marx, M., Amy, S., Haynes, R.F., & Wilson, W. 1994, A&A, 289, 357

Marx-Zimmer, M., Herbstmeier, U., Zimmer, F., Dickey, J.M., Staveley-Smith, L., & Mebold, U. 1998, Proceedings of the Workshop *The Magellanic Clouds and other Dwarf Galaxies*, p. 275

Mebold, U., Düsterberg, C., Dickey, J.M., Staveley-Smith, L., & Kalberla, P. 1997, A&A, 490, 65L

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