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ISO-[CII]-Investigation of Cool HI Clouds in the Large Magellanic Cloud

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1. Introduction

Despite a strong UV radiation field, the Large Magellanic Cloud (LMC) shows a relatively large abundance of cool HI gas. Neither CO- nor [CII]-lines have been detected in most of these regions in previous surveys. The energy balance of these cool clouds, of which some are located in warm surroundings, is still an open question. The improved resolution and sensitivity of the ISO telescope compared to previous measurements offers a unique opportunity to study the heating and cooling of these clouds in the LMC. Here we present first results of an investigation of the dominant cooling line, [CII] (158 μm), toward cool HI clouds.

2. Observations

We searched for [CII] line emission at 158 μm toward 13 lines of sight showing cool HI gas using the Long-Wavelength Spectrometer (LWS, Clegg et al. 1996) on board the Infrared Space Observatory[1] (ISO, Kessler et al. 1996) with an angular resolution of 1.'65. The sources have been selected from the HI absorption line surveys of Dickey et al. (1994) and Marx-Zimmer et al. (1998a). The typical integration time was 9 minutes on each source, which provides an rms of 0.8 Jy. The velocity resolution is 260 km s^{-1}.

[1]Based on observations with ISO, an ESA project with instruments funded by ESA Member States (especially the PI countries: France, Germany, the Netherlands and the United Kingdom) with the participation of ISAS and NASA.

3. Results

Our ISO-[CII]-observations toward cool atomic clouds reveal emission of ionized carbon toward 6 out of the 13 lines of sight. [CII] emission has been detected in the surroundings of 30 Doradus, in direction of the giant molecular cloud south of 30 Doradus, near LMC4 and toward the eastern steep HI boundary. Three of these lines of sight do not show [CII] emission in the previous survey of Mochizuki et al. (1994) due to a smaller beam filling factor (12′ resolution).

There is no clear correlation of [CII] emission with the spin temperature or the optical depth, τ_{HI}, of the cool HI, although the probability of finding [CII] emission in direction of cool HI gas increases with τ_{HI}.

We have compared the ISO-[CII]-data with our SEST-CO-survey of cool HI clouds in the LMC (Marx-Zimmer et al. 1998b). No CO emission has been detected in direction of the [CII] emitting gas. CO seems to be completely dissociated in these regions. In contrast, one HI cloud in the outer region of the LMC shows CO but no [CII] emission, indicating a low strength of the UV radiation field in the far south-west of the LMC.

The large amount of cool HI gas in the LMC and the non-detection of the dominant cooling lines CO and [CII] in most directions of the cool HI suggest that the low temperature of the atomic phase is not the result of a high cooling rate. This indicates a low heating rate of gas in many directions of the LMC despite a high UV radiation field. One possibility for a lower heating rate of gas in the LMC compared to the Milky Way might be a reduced number of small dust grains, since photoelectric heating from small grains is expected to dominate the heating of the cool neutral phase (Wolfire et al. 1995).

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