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Detection of H_2 in UV Absorption in the LMC

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Abstract. Based on measurements with the ORFEUS far UV echelle spectrograph, we present the first detection of H_2 in absorption in the Large Magellanic Cloud (LMC) in the spectrum of the star LH 10:3120.

1. Introduction

Molecular hydrogen (H_2) is the most abundant molecule in the interstellar medium and it therefore plays an important role in the physics and chemistry of the interstellar gas. The cool gas component of H_2 can only be studied through UV absorption lines near 1000 Å. Its presence in the Milky Way has been demonstrated with the *Copernicus* satellite in the early seventies (Spitzer et al. 1974). Owing to the limited sensitivity of former UV satellites, the measurement of H_2 in the Magellanic Clouds via UV spectroscopy had not been possible until the ORFEUS space shuttle mission in 1996.

Studies of cool H_2 in the Magellanic Clouds are of importance because of the lower metal content of these galaxies compared to the Milky Way and the different gas to dust ratios.

2. Data

The LMC star LH 10:3120 is located in the association LH 10 in the H II region N11B in the northwest corner of the LMC. It has a spectral type O5.5Vf with $V = 12.80$ and $E(B-V) = 0.17$ (Parker et al. 1992). LH 10:3120 was observed with a total observing time of 6000 s with the ORFEUS echelle spectrograph during the ORFEUS II mission in Nov./Dec. 1996. A wavelet algorithm has been used to smooth the data and to suppress the noise in the spectra.

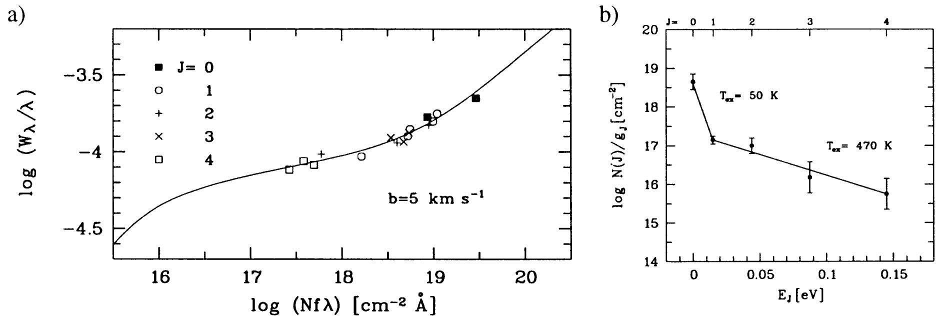

Figure 1. a) Empirical curve of growth for H_2 in the LMC gas towards LH 10:3120; b) Excitation temperatures for $J \leq 2$ and $2 \leq J \leq 4$

3. Results

All in all, we found 17 blend-free H_2 absorption lines from the lowest 5 rotational states near LMC velocities at 270 km s^{-1} for further analysis. For each rotational state curves of growth had been used to determine the individual column densities. From this analysis we derive individual column densities between 10^{17} and 10^{19} cm^{-2} and a total H_2 column density of $N_{J\leq 4} = 6.6 \times 10^{18}$ cm^{-2} for the gas in the LMC. Moreover, we derived equivalent excitation temperatures for the H_2 gas by fitting the population of the rotational states with theoretical Boltzmann distributions. The lowest two rotational states can be fitted with $T_{ex} \leq 50$ K, indicating a low kinetic temperature of the gas. Such low gas temperatures for the LMC also have been found in LMC H I 21 cm observations (Marx-Zimmer et al. 1999). For $2 \leq J \leq 4$ we derive a value of $T_{ex} \simeq 470$ K, similar to the temperatures found in the Milky Way for higher rotational states. This temperature is not the kinetic temperature of the H_2 gas, but gives the population of the excitation states due to the effect of UV pumping (Spitzer & Zweibel 1974). Our results represent not only the first qualitative detection of H_2 absorption profiles in LMC gas, but also show that the properties of the H_2 gas in the LMC along this individual line of sight are very similar to those found in the Milky Way. The full data analysis can be found in de Boer et al. (1998).

In closing we note that these findings represent, together with the detection of H_2 in the SMC (Richter et al. 1998), the first studies of cool molecular hydrogen in the Magellanic Clouds.

References

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