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### Absolute Intensities of Spectral Lines in the Q-Branch of the CH<sub>3</sub>D at Low Temperature

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## **Absolute Intensities of Spectral Lines in the Q-Branch of the CH<sub>3</sub>D at Low Temperature.**

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**ABSTRACT:** We report the absolute intensities of 38 lines of the Q branch of the  $\nu_2$  band of CH<sub>3</sub>D near 2200 cm<sup>-1</sup>, obtained at 98.3 K, using a Fourier Transform spectrometer with a resolution of 0.006 cm<sup>-1</sup>.

### **INTRODUCTION**

This study reports the experimental measurement of absolute intensities for individual lines of the Q branch in the  $\nu_2$  band of CH<sub>3</sub>D near 2000 cm<sup>-1</sup> at low temperature.

High resolution infrared spectroscopy is a powerful tool for understanding the composition and dynamical structures of planetary atmospheres. In fact, CH<sub>3</sub>D has been detected in the atmospheres of Jupiter, Saturn and Titan, so accurate intensities for individual ro-vibrational lines are needed for determining CH<sub>3</sub>D abundance and the D/H ratio in planetary atmospheres.

Although several studies of this species have been published with results reported for the P and R branches, the very complex structure of the spectra at room temperature made the precise determination of intensities of the Q branch practically impossible or incomplete<sup>1</sup>. On the contrary, at the low temperature of 98 K we have worked, the spectra is greatly simplified and becomes easier to analyze, providing accurate data for this case.

### EXPERIMENTAL CONDITIONS

The spectra analyzed here were recorded with a Bomem DA 3.002 Fourier Transform spectrometer with actual resolution of  $0.006\text{ cm}^{-1}$ , in the spectral region of  $2000\text{--}2220\text{ cm}^{-1}$ , using an InSb detector cooled at liquid-Nitrogen temperatures and scanning typically 30 times. The absorption cell of 5.7 cm in length, made of stainless steel with Sapphire windows and Indium gaskets, was cooled with an Air Products Cryotip down to 98.3 K, at the pressure of 0.94 torr. The temperature was measured by means of a calibrated thermo couple and was simultaneously monitored on a strip chart recorder. The pressure was measured with a MKS Baratron capacitance manometer.

The spectral intensities and wavenumbers were obtained by means of non-linear least-squares fitting techniques of each individual lines or multiplets, as appropriate, as described in ref. 1.

### RESULTS AND CONCLUSION

With the experimental setup described we recorded the whole region specified, but we report only the intensities of 38 individual lines of the Q

TABLE 1  
Wavenumbers and Absolute Intensities of the Q-Branch of  
CH<sub>3</sub>D band at 2200 cm<sup>-1</sup>

cm <sup>-1</sup>	cm <sup>-1</sup> /cm.atm	cm <sup>-1</sup>	cm <sup>-1</sup> /cm.atm
2196.814	0.01378	2198.865	0.28601
2197.128	0.01460	2198.920	0.21030
2197.157	0.01878	2199.110	0.83447
2197.319	0.05392	2199.205	0.40024
2197.575	0.03787	2199.231	0.11712
2197.586	0.03579	2199.344	0.45308
2197.699	0.00657	2199.374	0.65152
2197.720	0.00640	2199.515	0.19166
2197.813	0.03591	2199.533	1.70657
2197.928	0.05328	2199.569	0.23454
2198.003	0.14630	2199.620	0.81576
2198.066	0.02181	2199.683	0.89481
2198.269	0.11540	2199.714	0.82313
2198.296	0.02463	2199.797	1.33255
2198.345	0.12065	2199.823	0.48581
2198.410	0.08991	2199.871	3.02070
2198.600	0.38118	2199.936	1.57851
2198.628	0.01964	2199.992	1.04730
2198.806	0.05811		
2198.835	0.06733		

branch at 98.3 K, as shown in Table 1. In our model we can reproduce the whole spectrum and compare point by point with the experimental data, showing that the goodness of the fit is much better than one percent, with the only exception of lines 2198.600 and 2198.628, probably because of too much blending of both components.

Summarizing, we have completely resolved the spectrum in the vicinity of 2200 cm<sup>-1</sup> which is an important observational window, obtaining accurate absolute intensities of individual lines of the Q branch of CH<sub>3</sub>D at low

temperature, more relevant to planetary conditions, which previously went unreported because of inaddecuate experimental conditions.

### ACKNOWLEDGMENT

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### REFERENCE

1-Chackerian Jr. C., and Guelachvili G., Direct Retrieval of Lineshape Parameters: Absolute Line Intensities for the  $\nu_2$  Band of  $\text{CH}_3\text{D}$ . J.Molec. Spectroscopy, 1983; **97**: 316-332 (and references therein).

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