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# Collisional Induced Absorption (CIA) bands of $CO_2$ and $H_2$ measured in the IR spectral range

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## Abstract

In this paper we present the results on the Collisional Induced Absorption (CIA) bands of $CO_2$ and $H_2$ measured employing two different experimental setup. Each of them allows us to reproduce typical planetary conditions, at a pressure and temperature from 1 up to 50 bar and from 298 up to 500 K respectively. A detailed study on the temperature dependence of the $CO_2$ CIA absorption bands will be presented.

## 1. Introduction

Linear symmetric molecules such as $CO_2$ and homonuclear such as $H_2$ possess no dipole moment, and in principle should not absorb light in the infrared, but exhibit collisional induced absorption bands even at a pressure of few bars. This absorption results from a short-time collisional interaction between molecules. The band integrated intensity shows a quadratic dependence versus density opposed to the absorption by isolated molecules, which follows the Beer's law [1]. This implies that absorption is due to the interaction of two molecules than by individual isolated molecules. These processes are very relevant in the relatively dense planetary atmospheres, such as those of planets, like Venus and Jupiter. More recently in extrasolar planets have been found to own very dense atmospheres which in principle mat exhibit significant CIA. A detailed knowledge of these contributions can be very important to include this effect in the radiative transfer calculations.

## 2. Experimental setup

The experimental set-up is based on a Fourier Transform InfraRed (FT-ITIR) interferometer operating in a wide spectral range, from 350 to 25000 cm−1 (0.4 to 29 μm ) with a relatively high spectral resolution, from 10 to 0.07 cm-1. Two dedicated gas cells have been integrated with the FT-IR. An High Pressure High Temperature (HPHT) absorption gas cell, shown in figure 1a, is characterized by an optical path of 2 cm and can sustain pressures up to 300 bar, temperatures up to 597 K. Another one, represented in figure 1b, is a Multi-Pass absorption cell (MP), designed to have a variable optical path, from 2.5 to 30 m, can be heated up to 300 K and work with pressures up to 10 bar.

## 2.1 Results and discussions

The $CO_2$ has been inserted into the HP-HT varying the pressure from 1 up to 50 bar and the temperature from 298 up to 600 K. The results are shown in figure 2a). The data are in agreement to [2] and the bands observed in the spectral range 1200-1400 $cm^{-1}$, are due to the strong Fermi- couplet doublet ($\nu_1$,$2\nu_2$). The peak intensity of the CIA bands increases with the pressure and decreases with the temperature. The bands integrated intensities show a quadratic dependence vs density as reported in figure 2b, suggesting an absorption by pairs of molecules. Inserting the $H_2$ into the MP gas cell and maintaining the temperature @ 294K, the pressure has been varied from 1 up to 5 bar. In order to recorded the small absorption band, we fixed the optical path @ 15 m and, each absorption coefficient has been recorded with a resolution of 2 $cm^{-1}$. The spectra obtained in the spectral range of interest are shown in figure 2c). A preliminary comparison shows a good agreement with the results obtained by Borysow et al. [3].

## 3. Figures

a b

Figure 1: experimental setup used to measure the CIA bands.

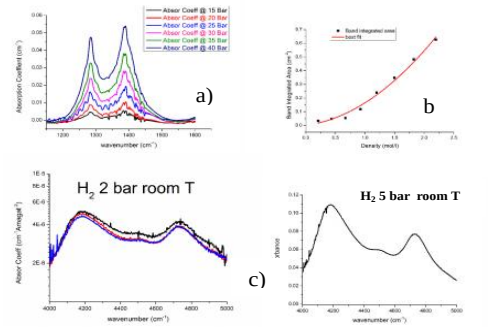


Figure 2: Absorption coefficients recorded using our experimental setups.

## 6. Summary and Conclusions

The $CO_2$ spectra have been measured for a wide range of temperatures, pressures and for a large spectral range. The quadratic component measured varying the pressure from 1 up to 50 bar is in good agreement with analyses performed by [4] on the band shape of the carbon dioxide in the region of the Fermi doublet. For what concerns the temperature dependence, the band integrated area seems not to have a strong dependence but future investigations are planned. The preliminary $H_2$ spectra recorded at different pressures are in good agreement with the model of Borysow [3].

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