

Pressure-broadened line widths and pressure-induced line shifts coefficients of the (1-0) and (2-0) bands of $^{12}\text{C}^{16}\text{O}$

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Abstract

This work presents, for the 1-0 band of CO, the measurements of air and H₂-broadened line widths and H₂-induced line shifts coefficients. These values were retrieved using a multispectrum fitting procedure on spectra recorded with the Fourier transform spectrometer at Reims. These results provide confirmation of other similar measurements previously published. In addition, we present the results for self and H₂ broadened line widths for the 2-0 band.

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1. Introduction

The work presented here was initiated by recommendations done during ASA meeting, held in Moscow, August 2002. During that meeting, an unexplainable discrepancy between two sets of results was presented by prof. P. Varanasi, concerned with the broadening coefficients of CO by H₂. The measurements obtained for the (2-0) band by Devi et al. [1] showed a variation with the rotational quantum number m (data vary between 0.0475 and 0.0795 cm⁻¹ atm⁻¹ for (2-0) band at 296 K), she observed rather the same evolution with m as for the air-broadening coefficients. In

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addition, Devi asked one of us (Barbe) to record new spectra in beginning by the (1-0) band and to measure air and H₂-broadening coefficients in order to try to solve this question. The idea of this work is that the knowledge of the real absolute accuracies could be established by comparing results presented by various experimentalist groups.

2. Experiment and data reduction procedure

The spectra were recorded with the Fourier transform spectrometer [2] built in Reims, which operates in stepping mode like Connes' type interferometer [3]. For these records, we have used a globar source, a CaF₂ beamsplitter, and only one output of our interferometer is fitted out with a liquid-nitrogen-cooled InSb detector. The signal-to-noise ratio is about 300. The CO gas was supplied by "Air Liquid Company" with a 99.997% purity. The temperature was measured with a platinum probe. For the gas pressure, we used two "Baratron" manometers, ranging respectively from 0–10 Torr and 0–1000 Torr.

For the study of (1-0) band of CO, ten spectra were recorded each during 2 h, the experimental conditions being reported in Table 1. The volume mixing ratio ($\frac{P_{\text{CO}}}{P_{\text{Total}}}$) was always lower than 0.6%, in order to have negligible contribution of the self-broadening coefficients.

Note that, in order to eliminate small fringes appearing in the experimental spectra, these ones were divided by a "reference" spectrum, recorded in the same experimental conditions, with an empty cell, before treatment of spectra.

Then, to analyse these spectra, we used our multispectrum fitting software described in Ref. [4], to derive simultaneously intensities, pressure-broadening coefficients and pressure-shift coefficients. To start our multfit procedure, we use existing line parameters found for this study in HITRAN database [5]; more details in the spectral analyses are given in Ref. [4]. Fig. 1 shows an example of a multi-spectral line fitting procedure for the five spectra of CO broadened by H₂

Table 1
Experimental conditions of the spectra recorded for the study of the (1-0) band of CO

	Unapodized resolution (cm ⁻¹)	Pressures of CO (Torr)	Pressures of foreign gas (Torr)	Temperature (K) (±0.5 K)	Length of the cell (cm)
CO	2.48×10^{-3}	4.9 ₉	758.4 ₂	298.0	5.14
Broadened	"	2.4 ₀	379.2 ₁	297.4	"
by air	"	1.2 ₁	189.6 ₆	297.3	"
	"	0.6 ₁	94.8 ₃	297.2	"
	"	0.3 ₃	47.4 ₀	297.3	"
CO	2.48×10^{-3}	5.1 ₆	746.8 ₂	297.3	"
broadened	"	2.5 ₇	373.3 ₁	297.1	"
by H ₂	"	1.2 ₈	185.2 ₆	297.2	"
	"	0.6 ₄	92.8 ₀	297.4	"
	"	0.3 ₂	45.9 ₂	297.6	"

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