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BRIEF COMMUNICATION

PRESSURE BROADENING OF THE 50.873 AND 83.469 cm^{-1} MOLECULAR OXYGEN LINES

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Abstract—We report pressure broadening measurements of the 50.873 and 83.469 cm^{-1} molecular oxygen lines at 293 K. Air broadening coefficients are determined with 13% accuracy. Published by Elsevier Science Ltd

We have used a tunable far-infrared (TuFIR) spectrometer to measure air pressure broadening coefficients of the $(N = 9,\ J = 9) \leftarrow (N' = 7,\ J' = 8)$ (50.873 cm^{-1}) and the $(15,14) \leftarrow (13,14)$ (83.469 cm^{-1}) transitions of O_2. In atmospheric applications, accurate linewidth parameters are needed for spectroscopic determination of the line-of-sight atmospheric mass and the tangent height pointing. Well mixed gases of known concentration have been used for this purpose previously (CO_2 in the mid-infrared[1] and O_2 in the far-infrared[2,3]).

TuFIR spectroscopy provides the very high resolution needed for accurate determinations of pressure broadening coefficients based upon well resolved line shapes. This technique has been used to measure the linewidth parameters of several transitions of HCl and OH to high accuracy.[4,5] The details of this technique, including the apparatus and precedures, have been presented previously.[6,7]

Since the molecular oxygen lines are weak magnetic dipole transitions, we used a 4 m long absorption cell. Also, we used an improved far-infrared sensor system built with a stressed Ge:Ga photoconductor element of high sensitivity and low noise[8] for the 50.873 cm^{-1} line. Self broadening coefficients were measured for both transitions to an accuracy of about 3%. However, nitrogen broadening was difficult to measure. The signal-to-noise ratio dropped sharply as N_2 was introduced. This deterioration is reflected in the 17% error for the N_2 broadening coefficient for

Table 1. Pressure broadening coefficients† of O_2 (10^{-7} cm^{-1} Pa^{-1}).

Broadening gas	50.873 cm^{-1} 293 K	83.469 cm^{-1} 293 K
Self	4.26 (13)	4.29 (13)
N_2	3.30 (57)	—
Air	3.50 (45)‡	4.35 (43)

†Half-width at half maximum; $1-\sigma$ uncertainties given.
‡$\gamma_{air} = 0.79\ \gamma_{N_2} + 0.21\ \gamma_{O_2}$.

(9,9 ← 7,8) line position = 1 525 130.648 (34) MHz

(15,14 ← 13,14) line position = 2 502 324.021 (39) MHz

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the 50.873 cm^{-1} line. We could not separately measure the N_2 broadening coefficient of the 83.469 cm^{-1} line. Consequently, we used bottled air to measure the air broadening coefficient directly. Our results are presented in Table 1.

The two measured self broadening coefficients are well determined and essentially equal. The poor signal associated with the N_2 broadening yields 10 and 13% errors in the air broadening coefficients. While this is an improvement over the previous values, the uncertainty is still too large to achieve the desired tangent height accuracy.[2]

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