Measurement of Absolute $^{12}C^{16}O_2$ Transition Frequencies in (30013)-(00001) Band

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Abstract

The linear triatomic structure of CO_2 gives strong spectroscopic transitions in IR region, which can serve as a benchmark for spectroscopic measurements. In this case, high precision measurement of absolute transition frequency of spectroscopic transitions is needed.

Focus on the (30013)-(00001) band of $^{12}C^{16}O_2$ near 1.6 μm, absolute transition frequency of 72 lines from P(70) to R(72) with uncertainty from 0.7 to 29 kHz were measured by an optical frequency comb locked cavity ring-down saturated absorption spectrometer [1]. Transitions with rotational quantum number up to 72 (line intensity 6.4×10-27 cm/molecule) is measured with S/N ratio up to 4. This result can help to improve the upper level spectroscopic constants for more accuracy calculation.
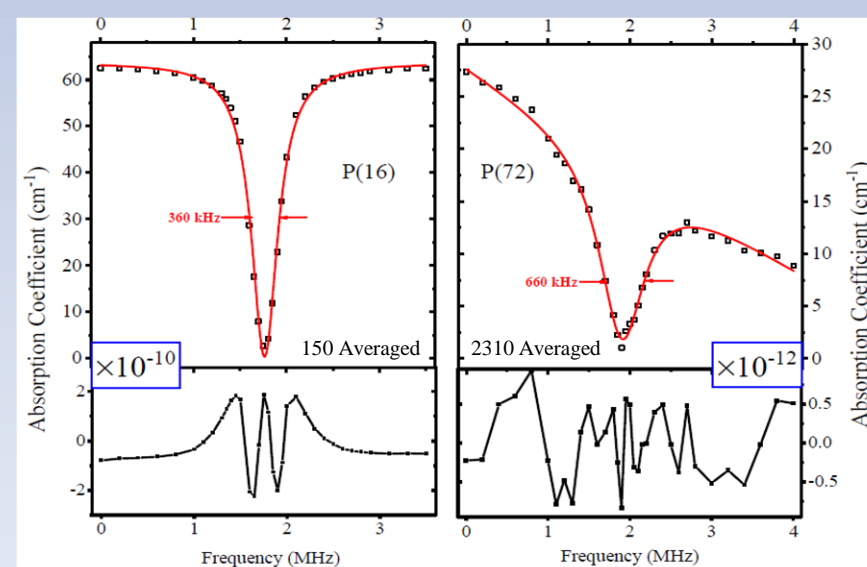
Experimental Setup

Saturated Spectroscopy
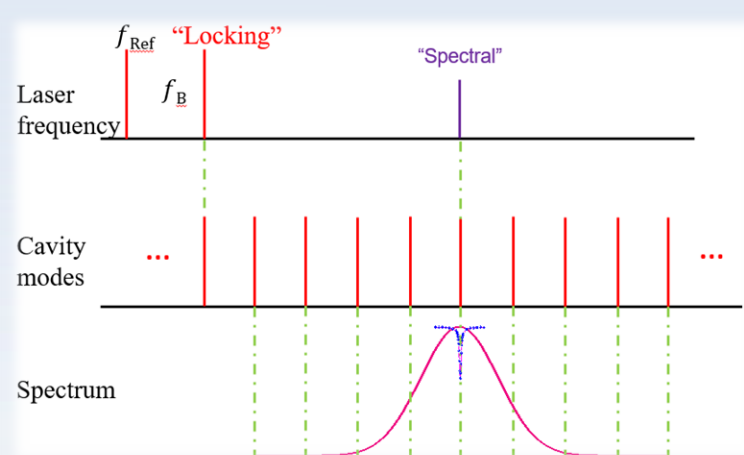
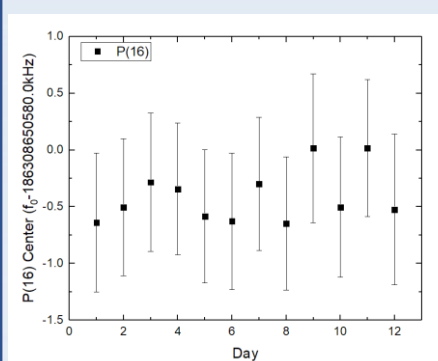### Comb-Locked Cavity Ring-down Spectrometer
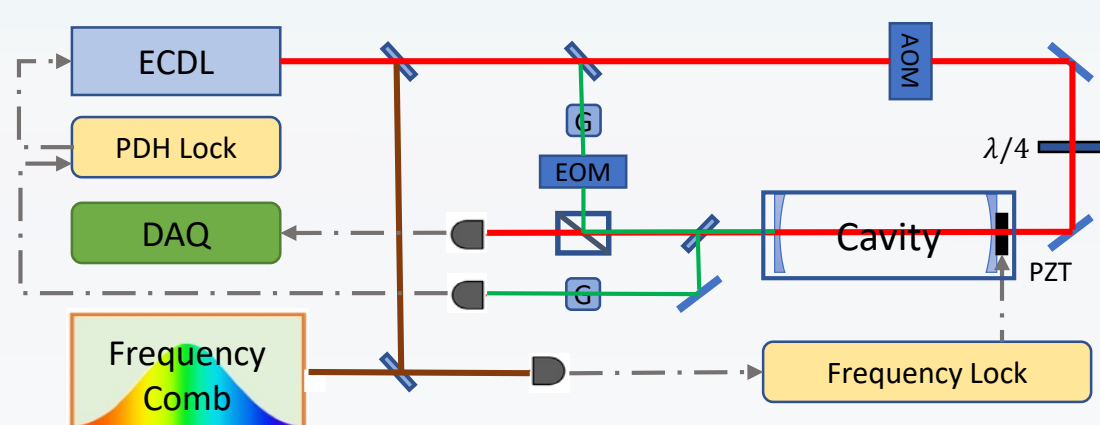
Experimental condition

Line Intensity: P(16) 1.61E-23 cm/molecule
                      P(72) 6.44E-27 cm/molecule
Input Power: ~1.5 mW
Sample Pressure: 0.25-2.2 Pa
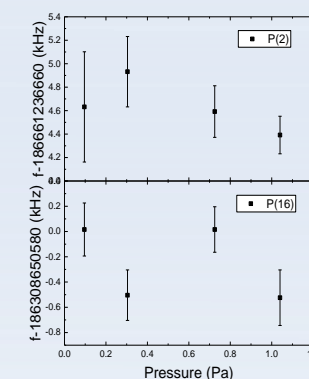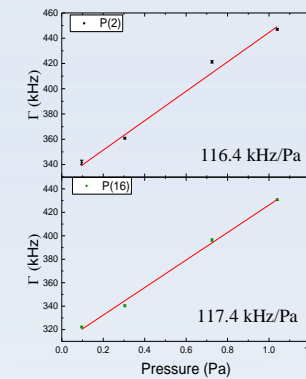
Results

Typical spectrum of lines with different intensity

Stability   Pressure Shift of P(2) P(16) No Shift Observed   P(2) P(16) Pressure Broadening $\gamma_p \sim 117\ kHz/Pa$

Source	Frequency Shift	Uncertainty		
		I (2.2 Pa)	II (1.5 Pa)	III (0.25 Pa)
Statistical		1.4~11.7	0.2~2.3	0.1~0.4
Frequency Comb		0.4	0.4	0.4
Line profile asymmetry		1.4 ~ 24.9	1.6 ~ 2.2	0.2 ~ 0.8
Cavity locking servo		0.4	0.4	0.4
EOM frequency		0.001	0.001	0.001
AOM frequency		0.05	0.05	0.05
Pressure shift	0.0	0.40	0.20	0.15
Power shift	0.0	0.37	0.37	0.37
Second-order doppler	0.18	<0.01	<0.01	<0.01
Total	0.18	1.9 ~ 28.4	0.9 ~ 2.6	0.7 ~ 1.1
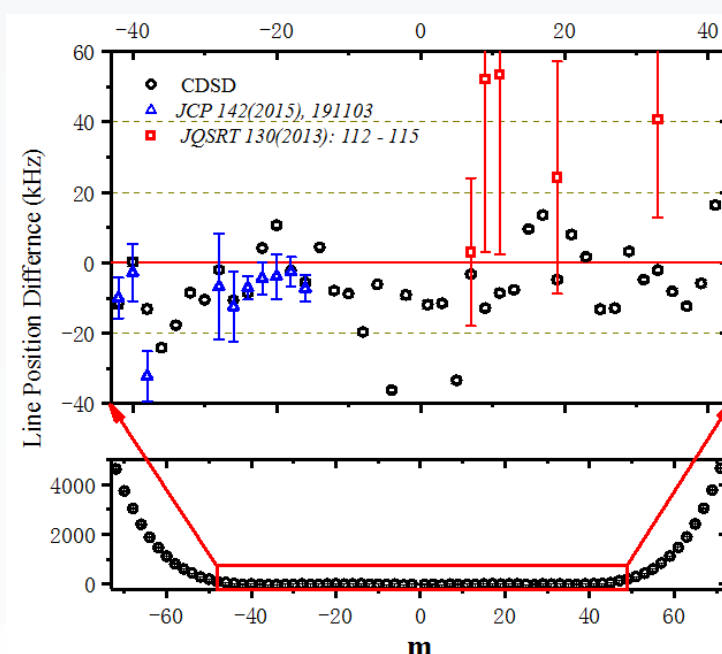
Line position difference compared with a. CDSD database, b. Burkart et al.[2], c. Long et al.[3]. With the rotational quantum number J of the lower state, m is defined as –J for P-branch and J+1 for R-branch transitions, respectively.

References and Acknowledgement

[1] L.-G. Tao, T.-P. Hua et al., *J. Quant. Spectrosc. Radiat. Transfer,* **210:** 111-115 (2018).
[2] J. Burkart, T. Sala et al., *J. Chem. Phys*, **142,** 191103 (2015).
[3] D. Long, G.-W. Truong et al., *J. Quant. Spectrosc. Radiat. Transfer,* 130, 112 (2013).