

## EXPERIMENTAL VALIDATION OF CO<sub>2</sub> LINE LISTS IN THE SPECTRAL RANGE NEAR 0.69 μm

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We conducted an attempt to measure CO<sub>2</sub> lines in the spectral range between 0.687 and 0.699 μm. The predicted line intensities are below  $2.1 \times 10^{-30}$  cm/molecule. To detect these weak lines we employed a cavity ring-down spectroscopy (CRDS) technique. It was already shown that our spectrometer has sufficient sensitivity to measure a CO line having intensity of  $1.807 \times 10^{-30}$  cm/molecule with a signal-to-noise ratio of 36 if very high-reflectivity ring-down cavity mirrors are used<sup>1</sup>.

CO<sub>2</sub> lines having intensities of up to  $2.076 \times 10^{-30}$  cm/molecule are predicted by the ExoMol<sup>2</sup> line list and available in the HITRAN 2020<sup>3</sup> database. Also, the Ames-2021 line list<sup>4</sup> contains lines located in this spectral range having intensities up to  $1.819 \times 10^{-31}$  cm/molecule. We probed altogether five spectral ranges corresponding to relatively strong lines among ones predicted by both line lists. Within these ranges, there are expected more than twenty CO<sub>2</sub> lines. Our estimated detection limit in the case of each probed spectral range is between 2 and above 10 times lower than the expected peak absorption level. However, none of these lines was detected in our experiment. Our result is in contrast to recent FTS measurements<sup>5</sup> for two orders of magnitude stronger CO<sub>2</sub> bands at slightly higher wavelengths. However, in the case of the HITRAN database, lines detected with the FTS are predicted by a different set of calculations than the ones that we intended to measure.

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<sup>1</sup>A.A. Balashov *et al.*, Measurement and calculation of CO (7–0) overtone line intensities, accepted in *J. Chem. Phys.*

<sup>2</sup>[doi:10.1093/mnras/staa1874](https://doi.org/10.1093/mnras/staa1874), S.N. Yurchenko *et al.*, ExoMol line lists - XXXIX. Ro-vibrational molecular line list for CO<sub>2</sub>, *Mon. Not. R. Astron. Soc.* 496, 5282-5291 (2020).

<sup>3</sup>[doi:10.1016/j.jqsrt.2021.107949](https://doi.org/10.1016/j.jqsrt.2021.107949), I.E. Gordon *et al.*, The HITRAN2020 molecular spectroscopic database, *J. Quant. Spectrosc. Radiat. T.* 277, 107949 (2022).

<sup>4</sup>[doi:10.1021/acs.jpca.2c01291](https://doi.org/10.1021/acs.jpca.2c01291), X. Huang *et al.*, Ames-2021 CO<sub>2</sub> dipole moment surface and IR line lists: toward 0.1% uncertainty for CO<sub>2</sub> IR intensities, *J. Phys. Chem. A* 126, 5940-5964 (2022)

<sup>5</sup>[doi:10.1016/j.jqsrt.2023.108595](https://doi.org/10.1016/j.jqsrt.2023.108595), O.M. Lyulin *et al.*, The absorption bands of <sup>12</sup>C<sup>16</sup>O<sub>2</sub> near 718 nm, *J. Quant. Spectrosc. Radiat. T.* 303, 108595 (2023).