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Invited Article

Absolute frequency measurements of CO_2 transitions at 4.3 μm with a comb-referenced quantum cascade laser

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Abstract

The infrared spectrum of the ($01^{1}1$–$01^{1}0$) ro-vibrational band of $^{12}C^{16}O_2$ in the range 2306–2312 cm^{-1} is investigated with saturated-absorption sub-Doppler spectroscopy. The absolute frequencies of six transitions belonging to the P-branch of this band are measured by recording their Lamb-dip features in a pump-probe detection scheme employing a room-temperature quantum cascade laser. The laser is phase-locked to a subkilohertz-linewidth difference-frequency-generated radiation source, which is referenced to an optical frequency comb synthesiser. The achieved relative uncertainties range from 1×10^{-11} to 5×10^{-11}, improving by three to four orders of magnitude the previous tabulated values for such frequencies. Moreover, thanks to this

precision level, self-pressure-shift coefficients due to collisional processes of CO_2 molecules are reported for the first time.

Keywords:

carbon dioxide | saturated-absorption spectroscopy | Lamb dip | quantum cascade laser | optical frequency comb

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Notes

aComparison with the HITRAN database [3–4]. The uncertainty reported by the original database for each transition is between 3 and 30 MHz.

bComparison with Ref. [29], corrected by the calibration factor 0.999 999 817, as reported in table 3 of Ref. [30].