THE CYCLIC CO_2 TRIMER: OBSERVATION OF TWO PARALLEL BANDS AND DETERMINATION OF INTER-MOLECULAR OUT-OF-PLANE TORSIONAL FREQUENCIES

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Previously, two distinct isomers of the CO_2 trimer have been identified by means of infrared spectroscopy. The first is a symmetric top with a cyclic planar structure and the second is an asymmetric top barrel-shaped structure with C_2 symmetry. We have observed two new parallel (ΔK = 0) bands of the cyclic CO_2 trimer at 2364 and 2370.5 cm^{-1} which are each assigned as a combination of an intramolecular CO_2 monomer ν_3 stretch and an intermolecular out-of-plane torsion, giving the torsional frequencies of 12.3 and 18.8 cm^{-1}, respectively. The band at 2364 cm^{-1} is surprisingly strong and completely unperturbed, providing a rare and near perfect example for a parallel band of a symmetric top molecule with C_{3h} symmetry and zero nuclear spins. The second band at 2370.5 cm^{-1} is somewhat weaker and has not been fully analysed because of spotty coverage of our diode lasers. However, it is still easily assigned as the second anticipated combination band involving an out-of-plane torsional mode of the cyclic CO_2 trimer. The trimers are generated in a pulsed supersonic expansion from a slit-jet nozzle and probed with a tunable infrared diode laser.