Observation of combination bands involving intermolecular vibration of N_2O-N_2, N_2O-OCS and N_2O-CO_2 complexes using an external cavity quantum cascade laser

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Spectra of the weakly-bound N_2O-CO_2, N_2O-OCS, and N_2O-N_2 complexes in the region of the N_2O ν_1 fundamental band (~2224 cm^{-1}) are observed in a pulsed supersonic slit jet expansion probed with a quantum cascade laser. One new band is observed for each complex: two combination bands involving the intermolecular in-plane bending mode for N_2O-CO_2 and N_2O-N_2 complexes, and the out-of-plane torsional vibration for N_2O-OCS. The resulting intermolecular frequencies are 34.17, 17.10 and 22.33 cm^{-1} for N_2O-CO_2, N_2O-OCS, and N_2O-N_2, respectively. The intermolecular vibrations provide clear spectroscopic data against which theory can be benchmarked. These results will be discussed, along with a brief introduction of our pulsed-jet supersonic apparatus which has been retrofitted by an infrared cw external-cavity quantum cascade laser (QCL) manufactured by Daylight Solutions. The QCL is used in the rapid-scan signal averaging mode. Although the repetition rate of the QCL is limited by its PZT scan rate, which is 100 Hz, we describe a simple technique to increase the effective repetition rate to 625 Hz. In addition, we have significantly reduced the long term frequency drift of the QCL by locking the laser frequency to the sides of a reference line. As well, we are now implementing a tunable optical parametric oscillator (OPO) source (Lockheed Martin Aculight Argos) which also operates at room temperature, has even more power, and a much wider tuning range. Our recent results using the OPO will be briefly described.