WIDE-BANDWIDTH COMB-ASSISTED SPECTROSCOPY IN THE FINGERPRINT REGION AND APPLICATION TO THE ν_1 FUNDAMENTAL BAND OF $^{14}N_2{}^{16}O$

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Most spectroscopic data available in databases such as HITRAN are retrieved from FTIR measurements and suffer from uncertainties at the MHz level. Much more accurate data, by up to four orders of magnitude, can be achieved using an optical frequency comb to calibrate the frequency axis of a cw laser source. Actually, in the mid-infrared region, at least beyond 5 μm, the only available commercial solution for a widely tunable cw laser is represented by extended cavity quantum cascade lasers (EC-QCLs), whose locking to an optical frequency comb has been so far inhibited by a large amount of frequency noise, leading to linewidths of about 20 MHz [a].

In this work we overcome this limitation and describe a spectrometer that relies on the frequency locking of an EC-QCL tunable in the 7.55-8.2 μm range to a 1.9 μm Tm fiber comb [b]. It is applied to the first comb-calibrated direct characterisation of the ν_1 fundamental band of N_2O, specifically of nearly 70 lines in the 1240 – 1310 cm^{-1}range, from P(40) to R(31). The spectroscopic constants of the upper state are derived from a fit of the line centers with an average rms uncertainty of 4.8x10^{-6} cm^{-1}(144 kHz). The coupling of the spectrometer to a high-finesse optical cavity to the purpose of enhancing its sensitivity and addressing weaker absorbers, is also discussed.

[a] Knabe K., Williams P. A., Giorgetta F., Armacost C. M., Crivello S., Radunsky M., and Newbury N., Opt. Express 20, 12432-12442 (2012)
[b] Lamperti M., Alsaif B., Gatti D., Fermann M., Farooq A., and Marangoni M., Sci. Rep. 8,1292 (2018)