BROADBAND CALIBRATION-FREE COMPLEX REFRACTIVE INDEX SPECTROSCOPY IN A CAVITY USING A COMB-BASED FOURIER TRANSFORM SPECTROMETER

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Fabry-Perot cavities provide high sensitivity to molecular absorption and dispersion since the mode position, width and amplitude are modified in the vicinity of molecular transitions. Moreover, the mode shift and broadening are directly proportional to the real and imaginary parts of the molecular complex index of refraction, but independent of cavity parameters, such as the cavity length and mirror reflectivity, which reduces the influence of systematic errors. Previous demonstrations of cavity enhanced complex refractive index spectroscopy were based on continuous wave lasers and limited to individual absorption lines[a,b]. Here we use an Er:fiber frequency-comb-based Fourier transform spectrometer with sub-nominal resolution[c,d] to measure a broadband transmission spectrum of a cavity filled with 1% of CO_2 in N_2 at 750 Torr. From Lorentzian fits to each cavity mode we retrieve mode positions and widths, which in turn yield high precision dispersion and absorption spectra of the entire $3\nu_1+\nu_3$ absorption band of CO_2 at 1.6 μm. Fits to these spectra yield line intensities that agree to within 0.6%. Thus comb-based Fourier transform spectroscopy enables broadband cavity mode characterization and calibration-free determination of both the real and imaginary parts of entire molecular absorption bands with high accuracy and precision.

[a]Cygan, A., et al., Opt. Express 21, 29744-29754 (2013).
[b]Cygan, A., et al.,Opt. Express 23, 14472-14486 (2015.
[c]Masłowski, P., et al., Phys. Rev. A 93, 021802 (2016).
[d]Rutkowski, L., et al., Opt. Express 25, 21711-21718 (2017).