OPTICAL FREQUENCY COMB FOURIER TRANSFORM SPECTROSCOPY WITH RESOLUTION EXCEEDING THE LIMIT SET BY THE OPTICAL PATH DIFFERENCE

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Fourier transform spectrometers (FTS) based on optical frequency combs (OFC) allow detection of broadband molecular spectra with high signal-to-noise ratios within acquisition times orders of magnitude shorter than traditional FTIRs based on thermal sources[a]. Due to the pulsed nature of OFCs the interferogram consists of a series of bursts rather than a single burst at zero optical path difference (OPD). The comb mode structure can be resolved by acquiring multiple bursts, in both mechanical FTS systems[b] and dual-comb spectroscopy[c]. However, in all existing demonstrations the resolution was ultimately limited either by the maximum available OPD between the interferometer arms or by the total acquisition time enabled by the storage memory. We present a method that provides spectral resolution exceeding the limit set by the maximum OPD using an interferogram containing only a single burst. The method allows measurements of absorption lines narrower than the OPD-limited resolution without any influence of the instrumental lineshape function. We demonstrate this by measuring undistorted CO_2 and CO absorption lines with linewidth narrower than the OPD-limited resolution using OFC-based mechanical FTS in the near- and mid-infrared wavelength ranges. The near-infrared system is based on an Er:fiber femtosecond laser locked to a high finesse cavity, while the mid-infrared system is based on a Tm:fiber-laser-pumped optical parametric oscillator coupled to a multi-pass cell. We show that the method allows acquisition of high-resolution molecular spectra with interferometer length orders of magnitude shorter than traditional FTIR.

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[a] Mandon, J., G. Guelachvili, and N. Picque, *Nat. Phot.*, 2009. **3**(2): p. 99-102.

[b] Zeitouny, M., et al., *Ann. Phys.*, 2013. **525**(6): p. 437-442.

[c] Zolot, A.M., et al., *Opt. Lett.*, 2012. **37**(4): p. 638-640.