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Letter abstract

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Cavity-enhanced dual-comb spectroscopy

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The sensitivity of molecular fingerprinting is dramatically improved when the absorbing sample is placed in a high-finesse optical cavity, because the effective path length is increased. When the equidistant lines from a laser frequency comb are simultaneously injected into the cavity over a large spectral range, multiple trace gases may be identified[1] within a few milliseconds. However, efficient analysis of the light transmitted through the cavity remains challenging. Here, a novel approach —cavity-enhanced, frequency-comb, Fourier-transform spectroscopy—fully overcomes this difficulty and enables measurement of ultrasensitive, broad-bandwidth, high-resolution spectra within a few tens of microseconds without any need for detector arrays, potentially from the terahertz to ultraviolet regions. Within a period of just 18 μs, we recorded the spectra of the ammonia 1.0 μm overtone bands comprising 1,500 spectral elements and spanning 20 nm, with a resolution of 4.5 GHz and a noise equivalent absorption at 1 s averaging of 1×10^{-10} cm^{-1} $Hz^{-1/2}$, thus opening a route to time-resolved spectroscopy of rapidly evolving single events.

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