MID-INFRARED FREQUENCY COMB SPECTROSCOPY WITH TWO Cr^{2+}:ZnSe FEMTOSECOND OSCILLATORS

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The mid-infrared part of the electromagnetic spectrum is the so-called molecular fingerprint region because gases have tell-tale absorption features associated with molecular rovibrations. It also contains windows (in particular 2.0-2.4 μm, 3-5 μm and 8-13 μm) where the atmosphere is relatively transparent. These regions can be for instance exploited to detect small traces of environmental and toxic vapours down to sensitivities of parts-per-billion in atmospheric and industrial applications. Novel Fourier transform spectroscopy without moving parts, based on time-domain interferences between two comb sources, can in particular benefit optical diagnostics and precision spectroscopy. To date, high-resolution and -sensitivity proof-of-principle experiments have only been reported in the near-infrared region where frequency comb oscillators are conveniently available. However, as most of molecular transitions in this region are due to weak overtone bands, such techniques can hardly be harnessed for sensitive trace gas detection. Developing mid-infrared dual comb Fourier transform spectroscopy is therefore a demanding but highly desirable task.

Here we present a proof-of-principle experiment of frequency comb Fourier transform spectroscopy with two Cr^{2+}:ZnSe femtosecond oscillators directly emitting in the 2.4 μm mid-infrared region. Spectra of acetylene in the region of the $\nu_1 + \nu_5^1$ band extend from 3970 cm^{-1} to 4200 cm^{-1}. With 0.4 cm^{-1} resolution, the acquisition time of the corresponding interferograms is 10 μs, without averaging. This demonstrates the feasibility of our approach.