# Frequency Comb Spectroscopy from 1 THz to 1 PHz

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Frequency comb spectroscopy across terahertz to UV has evolved into a powerful technique that simultaneously provides broad spectral coverage, high spectral resolution, high data acquisition rates, and an absolute frequency referencing to an atomic clock, and provides unique insights into the structure of matter with applications ranging from testing fundamental laws of nature to chemical analysis, trace gas sensing, astronomical observations, and biomedical applications [1].

I will present our results on high-resolution dual comb spectroscopy (DCS) based on a new laser platform with unprecedented spectral coverage. We start from two mutually coherent frequency combs based on mode-locked Cr:ZnS lasers with center wavelength 2.35 µm. For producing MIR-THz frequency combs we use subharmonic optical parametric oscillation [2] or optical rectification combined with electro-optic sampling [3], and for the UV-visible combs generation we use high harmonics of the driving laser [4].

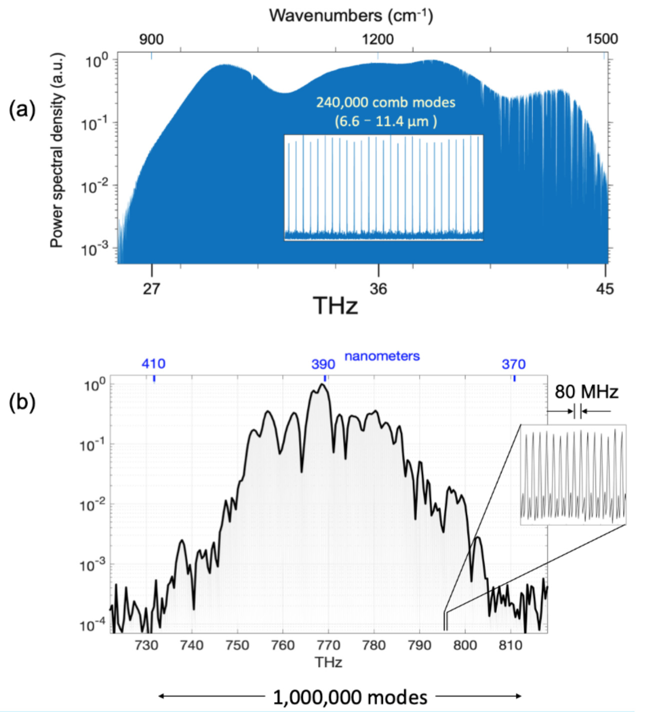


Figure 1: (a) MIR comb containing 240,000 comb-mode-resolved spectral lines spaced by 80 MHz; (b) UV comb with some million comb modes

The low intensity and phase noise of our dual-comb system allows us to capture a large amount of spectral information (*e.g.* 240,000 comb-mode-resolved spectral lines, Fig. 1a) in the MIR at up to a video rate [5]. Fig. 1b, on the other hand, shows a comb-mode resolved spectrum of the UV comb containing some million comb teeth.

Overall, our approach provides the basis for high-resolution (down to <1 MHz with spectral interleaving) highly precise spectroscopic measurements with frequency coverage from 1 THz to 1 PHz. This opens new avenues for fundamental spectroscopy and for generating spectral line lists for various molecules to help characterize exoplanetary atmospheres and study the interstellar and circumstellar environment.

## References

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