New Developments in Mid-IR Direct Frequency Comb Spectroscopy

Optical frequency comb spectroscopy has blossomed into a versatile tool for the broad-bandwidth and high-spectral-resolution study of molecules in the visible and near-infrared. Cavity-Enhanced Direct Frequency Comb Spectroscopy (CE-DFCS) enables measurements with a simultaneous bandwidth of up to hundreds of nm at a frequency resolution comparable to stable cw light sources. With our mid-IR frequency comb we have demonstrated Time Resolved Frequency Comb Spectroscopy (TRFCS). We study the transient radical DOCO, which plays a crucial and not yet fully understood role in combustion processes.

Furthermore, we have introduced buffer gas cooled molecules with CE-DFCS. This allows us to explore large molecules and drastically reduce the spectral complexity while improving resolution. This enables detailed high-resolution analysis of the infrared spectra of relatively heavy and complex molecules whose spectral features are irresolvable at room temperature. Here we show comb spectroscopy of cooled acetylene (C2H2) molecules down to a translational temperature of 10 K, which corresponds to a Doppler broadened linewidth of 90 MHz for the 1.5 µm CH stretch overtone transition.