Incoherent Broadband Cavity Enhanced Absorption Spectroscopy with a Mid-Infrared Supercontinuum Source

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Broadband cavity enhanced absorption spectroscopy can be used to perform detection of gases with a very high sensitivity due to the very long optical path of the cavity [1]. Compared to coherent methods, cavity enhanced spectroscopy is simpler and more robust allowing to readily perform in-situ measurements. Supercontinuum sources on the other hand posses unique properties in terms of brightness and spatial coherence that make them particularly suitable for a wide range of applications ranging from spectroscopy to imaging and chemical sensing [2]. Here we demonstrate for the first time broadband cavity enhanced absorption spectroscopy in the mid-IR.

**Why mid-IR supercontinuum source for spectroscopy?**
- Ultra-broadband selectivity, multi-components
- High brightness high sensitivity
- High spatial coherence coupling to cavity and long interaction length
- Mid-IR stronger absorption lines, molecular fingerprint region

**Our supercontinuum source**
- ns pump pulses, kHz repetition rate
- Two-stage: DSF + ZBLAN fibers
- 1000-3700 nm wavelength range
- 160 mW average power

**Cavity enhanced absorption spectroscopy**
- Confocal cavity, 1 m long
- Mirrors reflectivity > 99.97 @3000-3500 nm
- Effective optical path length > 300 m
- Gas measured: acetylene and methane

**Measurement procedure**
- Differential optical absorption spectroscopy
  - Continuous gas flow in the cavity and transmitted spectrum measured
- Advanced fitting model that includes the gas absorption lines taken from HITRAN database, wavelength-dependence of mirrors reflectivity, spectrometer resolution, system drift during measurement

**Results**
- Minimum detectable concentration for acetylene <0.5 ppm
- Minimum detectable concentration for methane <0.25 ppm
- Multi-component detection over 450 nm bandwidth!
- Acetylene 5 ppm + methane 2 ppm

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