# Broadband terahertz gas spectroscopy through multimode self-mixing in a quantum cascade laser

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In the terahertz (THz) frequency range, CBRN agents and explosives have unique spectral signatures, which can be used for their identification and analysis. Quantum cascade lasers (QCLs) are important sources for spectroscopy within the 2–5 THz range, and self-mixing (SM) interference in a laser cavity enables the laser device to act both as a radiation source and as a coherent detector. This technique removes the need for additional detectors [1, 2]. Here, we present a SM spectroscopy technique, with an integrated frequency monitoring system and demonstrate the measurement of methanol spectral features simultaneously from two modes of a multi-mode THz QCL over a 17 GHz bandwidth.

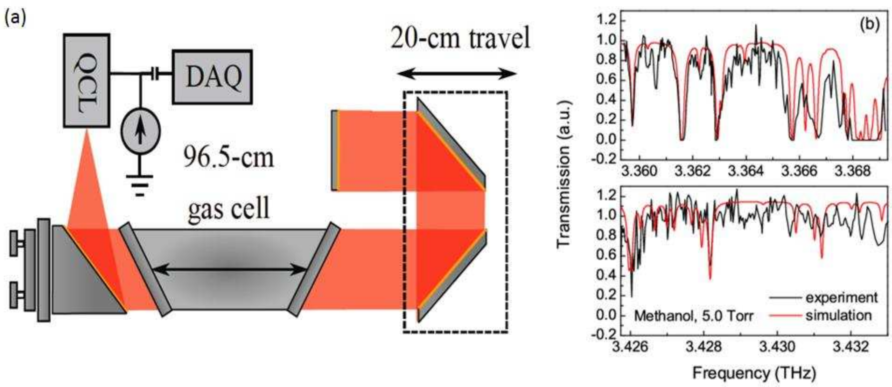


Fig1. (a) Schematic illustration of the configuration of the gas spectroscopy system. (b) Transmission spectra of 5.0-Torr methanol.

The optical configuration of the spectroscopy system is illustrated in Fig. 1(a). The emitted radiation from the QCL was directed through a 96.5-cm-long gas cell and was reflected back using a mechanically-adjustable optical delay-line into the QCL along the same optical path. The SM-perturbations to the QCL voltage were measured as a function of the optical delay time, and a Fast Fourier Transform (FFT) was used to infer the full-band emission spectra of the QCL. Normalized transmission spectra of methanol at a pressure of 5.0 Torr are shown in Fig. 1(b). More than seven absorption peaks were resolved within a 17-GHz range, among which the absorption at 3.3597 THz, 3.3616 THz, 3.3629 THz, and 3.4282 THz were the most clearly resolved.

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## References

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