ULTRA-LOW PHASE NOISE, HIGH RESOLUTION SPECTROMETER USING COMB-ASSISTED QUANTUM CASCADE LASERS

ANDREW A. MILLS, CHRISTIAN MOHR, JIE JIANG, *IMRA America, Ann Arbor, MI*; DAVIDE GATTI, MARCO MARANGONI, *Dipartimento di Fisica del Politecnico di Milano, Milano, Italy*; LIVIO GIANFRANI, *Dipartimento di Matematica e Fisica della Seconda Universita Di Napoli, Caserta, Italy*; INGMAR HARTL, *Deutsches Eleketronen-Synchrotron, Hamburg, Germany*; MARTIN FERMANN, *IMRA America, Ann Arbor, MI*.

In recent years, optical frequency combs have been used extensively to stabilize solid state cw lasers for high resolution spectroscopy, enabling the acquisition of absorption profiles of a gas sample with an absolutely calibrated, repeatable and linear frequency axis. This uniquely defined and repeatable frequency axis allows for the retrieval of highly accurate and traceable spectroscopic parameters and the ability to obtain physical insights regarding the influence of collisional processes on the absorption line shapes. The highly accurate frequency axis has can be used in precision spectroscopy applications such as resolving hyperfine transitions or cavity enhanced spectroscopy for trace gas detection.

To simplify such precision spectroscopy systems in the future, the use of quantum cascade lasers (QCL) as a spectroscopic tool is highly desired. Here we report on the precision phase locking of a 9 μm QCL to a 2 μm low-noise thulium frequency comb. Utilizing a coherent lock with a MHz-level feedback bandwidth, we line narrow a QCL with a 1 MHz linewidth and achieve an in-loop beatnote measurement with 70 dB S/N at 1 Hz RBW. As an application, we demonstrate the interrogation of sub-Doppler features of ammonia spectra at 9 μm. It is expected that the system is further compatible with line narrowing of widely tunable external cavity QCL's, opening new measurement avenues in precision spectroscopy.