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Paper 12139-39

Demonstration of frequency-stabilized quantum cascade laser dual-comb spectroscopy

In person: 6 April 2022 • 08:40 - 09:10 CEST | Salon 2, Niveau/Level 0

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Abstract

Authors

Over the years, dual-frequency comb spectroscopy (DCS) has become available to a broad community. The fast developments in quantum-cascade lasers (QCLs) and their compactness have enabled building turn-key systems with little complexity. The emerging technology was successfully demonstrated in a variety of application fields such as combustion research, the study of irreversible processes in manufacturing and industrial R&D, stand-off detection of explosives and toxic materials, protein folding processes and research of heterogeneous catalysis among others. In DCS, two frequency combs with a slight detuning in their repetition rate are combined and the resulting heterodyne signal is acquired. QCLs typically have repetition rates in the 10-GHz range or higher. The multiheterodyne signal is acquired with a high-bandwidth detector and processed on a graphical processing unit. The relatively high repetition rate compared to optically-pumped fibre-based frequency combs results in a large radio-frequency spacing, which demands high-end equipment for acquisition and processing. In addition, the data stream of several GB/s limits the duty cycle of the instrument. Here we will present new approaches to circumvent those difficulties [1]. As QCL combs are not self-referenced, the heterodyne signal cannot be co-averaged over significant time durations because of their lack of mutual coherence. The methods we will outline are based on the stabilization of the heterodyne signal by establishing a master-follower relationship (mutual lock) between the two comb sources and an additional electronic noise reduction circuit which yields a periodic, co-averageable interferogram. This opens new opportunities for acquisition techniques and processing algorithm such as sub-sampling and coherent averaging. Techniques to lock the lasers and methods to evaluate the data will be presented. [1]: K. Komagata, A. Shehzad, G. Terrasanta, P. Brochard, R. Matthey, M. Gianella, P. Jouy, F. Kapsalidis, M. Shahmohammadi, M. Beck, V.J. Wittwer, J. Faist, L. Emmenegger, T. Südmeyer, A. Hugi, and S. Schilt, "Coherently-averaged dual comb spectrometer at 7.7 μm with master and follower quantum cascade lasers", *Optics Express*, 29 (12), 19126, (2021)

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Pitt Allmendinger studied Chemistry at ETH Zürich and conducted the Ph.D in the field of Physical Chemistry in group of Prof. Frederic Merkt where he studied low-temperature ion-molecule chemistry using a Rydberg-Stark deceleration on a chip. Following his Ph.D he is working at IRsweep as a senior engineer and develops dual-frequency comb spectrometers.




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