Coherent control of Quantum Cascade Laser Frequency Combs via Optical- and RF-injection

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Quantum cascade laser (QCL) frequency combs are compact, all-electrically driven, broadband semiconductor laser sources operating in the mid-infrared spectral region that give access to fundamental vibrational bands of many molecular species of environmental and industrial importance. These lasers are being extensively used to perform dual-comb spectroscopy (DCS) and sensitive molecular sensing with high temporal resolution. However, unlike the metrological-grade frequency combs based on mode-locked lasers, free-running QCL-combs are susceptible to intrinsic phase and intensity noise, which makes applications to high-resolution spectroscopy relatively difficult. In this talk I will discuss techniques utilizing external cavity optical feedback injection as well radio-frequency (RF) electrical signal injection to achieve improved comb coherence for dual-com spectroscopy, as well as generate higher-order harmonic QCL comb-states with improved coherence and broader optical bandwidth. Experimental results demonstrating independent control of primary comb parameters (offset frequency , f_0, and repetition rate frequency, f_{rep}) via optical- and RF-injection, resulting in MHz-level frequency control and gapless DCS tuning, will be discussed in details.

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