Paper 12141-17

Lateral mode switching in broader ridge waveguide Fabry-Perot quantum cascade laser frequency combs

In person: 6 April 2022 • 10:50 - 11:10 CEST | Etoile A, Niveau/Level 1

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Abstract | Authors

Radio-frequency (RF) modulation of FP-QCLs has been demonstrated to be a crucial tool for the control and manipulation of frequency comb states and internal synchronization mechanisms. Coherent injection locking of the repetition frequency, switching from the intrinsic anti-phase synchronized FM-state to the in-phase synchronized AM-state and spectral broadening are just a few examples of recent findings linked to RF injection as a means of control mechanism. We present the observation of controlled lateral mode switching in a two section, RF-modulation optimized, 12µm broad ridge FP-QCL. The mode switching is induced by strong RF modulation close to the free-running laser beatnote at the repetition frequency. It is shown that the anti-phase FM-comb state intrinsic to most free-running FP-QCLs, exceeding a certain ridge width, favors a higher order dual lobe state which can be observed in the far-field. Injecting an RF signal with a power of 35 dBm, 65 MHz above the free-running laser beatnote, the resulting comb state is shown to favor the fundamental, mode. The resulting single lobe far-field distribution was measured experimentally with a slow MCT detector mounted on a rotational stage. The lateral mode switching from the first higher order- to the fundamental mode can be observed over the entire laser operation current bias range of the gain section. 2D mode simulations yielding the fundamental and higher order mode group refractive indices show good agreement with the measured results. Furthermore RF modulation below the free-running laser beatnote shows the excitement of a second, higher order lateral mode, where three lobes are observed in the far-field. The results presented show the potential for reliable lateral mode control via strong RF modulation close to the repetition frequency of broader ridge FP-QCLs. This opens up the possibility for high power comb operation scaling with the ridge width, while still maintaining a single lobe far-field

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