Exploring possibilities of regular self-pulsing in monolithic and external cavity mid-IR QCLs

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Mid-IR Quantum cascade lasers (QCLs), at a low pump excess above threshold [1], show features of Risken-Nummedal-Graham-Haken (RNGH) instabilities [2,3] related to the excitation of coherent Rabi oscillations in the gain medium and therefore might exhibit self-pulsations (SP). The difficulties for practical use of RNGH SP in monolithic mm long QCLs originate from the quasiperiodic chaotic behavior of the pulse train when the coherence length is smaller than the length of the sample, while in the monolithic short cavity (100 μm) QCLs very high pulse repetition rate prohibit practical applications [4-6].

Nevertheless, it was demonstrated both theoretically and experimentally that a QCL in an external Fabry-Pérot cavity (EC) is capable of producing regular self-pulsations of the output intensity at frequencies of approximately 75 GHz [7]. The propagation delay in EC provides QCL with a "memory" mechanism to preserve the regularity and coherence of the pulse train on the time intervals which significantly exceed the sub-picosecond gain coherence and gain recovery times. Our results may point to novel practical approaches to produce regular time-domain SPs and pulse trains in the Mid-IR QCLs.

ACKNOWLEDGMENTS: This work was supported by COST ACTIONs MP1406, BM1205, MP1204, Swiss National Science Foundation (SNF) project FastIQ, ref. no. IZ73Z0_152761, Ministry of Education, Science and Technological Development (Republic of Serbia), ref. no. III 45010, European Union's Horizon 2020 research and innovation programme (SUPERTWIN, ref. no. 686731), by the Canton of Neuchâtel and partially in the framework of state targets N 0035-2014-0206.

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