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Quantum dot micropillar lasers: A model system to approach the quantum regime of non-linear dynamics and synchronization

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Wiedner Hauptstr. 8, 1040 Vienna, Seminar room DB Gelb 03 (DB03E11), 3rd floor.

Host: S. Rotter

Abstract

Semiconductor lasers are highly interesting structures to investigate non-linear dynamics on a bench-top platform. In the last decades they allowed for instance to study a wide range of non-linear phenomena such as broadband chaos in the presence of time-delayed self-feedback. Also, optical injection and synchronization of chaotic lasers have been extensively explored in the classical regime using standard semiconductor lasers with output powers in the mW range.

In this talk, I will report on our recent activities towards exploring the quantum regime of non-linear dynamics. We access this novel and highly interesting regime by using quantum dot micropillar lasers. These lasers operate in the regime of cavity quantum electrodynamics (cQED) and feature spontaneous emission coupling constants close to unity as well as a gain medium consisting of only few quantum dots [1]. As such, they are ideal nanophotonic systems to address non-linear dynamics at ultra-low light-levels when quantum effects become important. Using such structures, we were able to demonstrate chaotic lasing under optical self-feedback [2], optical injection [3] and synchronization of micropillar lasers at sub-µW light levels. Beyond that, I will present a nanophotonic concept for fully integrated on-chip electro-optical feedback based on two laterally coupled micropillar cavities [4].

[1] S. Kreinberg et al., Light: Science & Applications 6, e17030 (2017)
[2] F. Albert et al., Nat. Commun. 2, 233 (2011)
[3] E. Schlottmann et al., Phys. Rev. Applied 6, 044023 (2016)
[4] P. Munnelly et al., Optica 4, 303–306 (2017).

FWF Der Wissenschaftsfonds.

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