Coupled Semiconductor Mode-Locked Lasers
Betreuer und Diskussionspartner: Stefan Meinecke, Kathy Lüdge
10 ECTS (Bachelorarbeit)

Passively mode-locked (ML) semiconductor lasers are a relatively inexpensive source of ultra-short pulses at very high repetition rates. This makes them attractive for applications in a wide range of fields. To utilise these devices there is however a hurdle to overcome. Passively ML lasers have a relatively large timing jitter due to the absence of an external reference clock. This has lead to extensive research into methods of timing jitter suppression. Both experimental and theoretical studies of ML lasers subject to optical feedback [OTT12a, OTT14b, ARS13, DRZ13, LIN10, AVR09, SIM12, SIM14, BRE10, JAU17a] have shown that under certain resonance conditions optical feedback can lead to a substantial reduction in the timing jitter. This is achieved through locking of the pulses traveling in the laser and external cavities. A similar locking effect is to be expected for two optically coupled ML lasers. The aim of this bachelor project is to investigate the dynamics and locking behavior of such a system in dependence on the laser parameters and coulping setup.

The model that will be used to investigate this system of coupled MLLs will be based on the MLL model presented in [VLA04, VLA05, JAU17a]. In this approach the laser is modeled by a two section ring cavity and the dynamics are described by a set of three coupled delay differential equations. Extending this model to the coupled MLL system will require a set of dynamical equations for each laser and an added optical coupling term in the electric field equation for each laser. These coupling terms will be similar to the optical feedback term in [OTT12a, OTT14b, JAU17a].

MLL subject on optical feedback have been extensively researched in this group [OTT12a, OTT14, OTT14b, JAU14a, JAU17a]. For this system simulations of numerical bifurcations reveal constraints on the the feedback delay time and feedback strength for achieving constructive feedback. Similar investigations into numerical bifurcations scenarios are to be carried out for the coupled MLL system in dependence of the delay time between the lasers, the coupling phase and the coupling strength. Additionally, the coupled MLLs need not be identical, thus the impact of small differences in e.g. the repetition rate or mean lasing frequency of the MLL are also to be investigated.

In the project the following step should be carried out:

- Backround reading into semiconductor lasers, mode-locking and non-linear dynamics
- Extension of DDE model for MLLs to coupled MLLs
- Numerical simulations to investigate the various dynamical regimes that rise in dependence of the laser and coupling parameters

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