Class-C Laser with Mutual Time-Delayed Optical Coupling

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10 ECTS (Bachelorarbeit)

Lasers can be divided into different classes, defining their dynamical behavior. Following the classification of Arecchi et al.,[ARE84] class A, B, and C designate lasers whose dynamics can be reduced to a one, two, or three-dimensional phase-space, respectively. For class C lasers, the dynamics are accurately described by the time evolution of the electric field amplitude E within the laser cavity, the optically induced polarization in the medium, P, and the charge-carrier inversion of the lasing transition, D. [HAK86, TAR98a] The resulting dynamic equations are formally identical to the well-studied Lorenz-system, and are therefore called the Lorenz-Haken equations. In contrast to the other laser classes, solitary class-C lasers can exhibit deterministic chaos. Their dynamics have only been recently investigated [WIE14, LIN18b].

In a class-C-laser the dynamic timescales of these three variables are within the same order of magnitude. Historically, this was only possible for peculiar laser types such as the He-Xe laser. Recently, the ongoing development and miniaturization pushed the dynamics of nanolasers into the class-C regime. For future applications, such nanolasers are embedded in photonic integrated circuits and coupled to on-chip waveguides. In this project, the dynamics of two or more optically coupled class-C lasers shall be investigated. The dynamics of class-B lasers under mutual delay-coupling has been thoroughly studied in the past, and opens up possibilities for novel applications [SOR13]. From a dynamical perspective this is of great interest due to the rich dynamics that can be induced by the mutual time-delayed interaction.

In the project, two or more class-C lasers under the influence of delayed optical coupling will be investigated. The following steps will be carried out:

- Background reading into semiconductor laser dynamics in general and class-C lasers in particular
- Analytical or numerical characterization of an existing simple class-C laser model without coupling
- Numerical bifurcation analysis in dependence on the various operation parameters
- Comparison with existing results on class-B lasers with time-delayed optical coupling

References

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