Narrow linewidth quantum dot lasers with optical feedback for coherent communication systems

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10 ECTS (Bachelorarbeit/Masterarbeit)

The combination of advanced modulation formats and coherent detection are the key technologies in coherent communication systems to overcome the limitations of the currently fiber infrastructure by increasing the spectral efficiency [SEI08][KIK16]. However, to reach high-order modulations, narrow spectral linewidth lasers are highly demanded for coherent detection. Aside from the spectral linewidth, the laser devices must be single-frequency, low cost and low power consumption.
Promising candidates are lasers including quantum dot (QD) nano-crystals as the laser gain media [CRO12], due to their excellent characteristics such as the low inversion threshold and the good temperature stability [BIM08]. Their dynamics can be theoretically modeled by microscopic multi-level rate-equations [LUE09][LIN14]. The numerical model includes the Coulomb scattering, which is highly desirable to understand the key-mechanisms controlling the spectral linewidth. As recently explained [RED17] the minimum achievable linewidth remains strongly limited by the rebroadening mechanism that is due to carrier scattering and gain nonlinearities. On that account proper external nonlinear control (optical feedback) is considered in order to stabilize the laser and narrow further the optical linewidth. In order to understand the influence of the feedback on the dynamics of the QD laser an analytical model as well as numerical calculations will be performed in order to identify the right operating conditions for quantum dot lasers. For excellent students it will also be possible to take part in the exchange program with our experimental cooperators in Paris (Grillot group at Telecom ParisTech).

The following steps will be carried out during the project:

- Backround reading regarding the topic of quantum dot lasers subject to optical feedback.
- Developing an analytical model for the linewidth of quantum dot lasers subject to optical feedback.
- Numerical calculation of the linewidth of a quantum dot laser subjecto to optical feedback
- Comparison of the analytical and numerical results.

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