Description of Nanolasers using a Stochastic Simulator

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Nanolasers [NIN10] are characterized by a very small volume of the laser mode, leading to photon numbers well below a hundred above the lasing threshold. Important effects of the minituarization of lasers are the local field enhancement [SUH12] and Purcell enhancement of the spontaneous and stimulated emission, possibly enabling so-called "thresholdless" lasing [CHO14b]. The reduction in size then leads to a strong increase of the spontaneous emission rate of photons.

The theoretical description of nanolasers can be done semiclassically, based on Maxwell's equations [RED16], or fully quantum-mechanically by solving coupled equations of motion for the expectation values of observables and higher correlation operators [LEY13]. An intermediate approach is a description based on a so-called stochastic simulator [PUC15], in which the transition, absorption, and emission processes are described by discrete changes in the photon and electron numbers, following classical probability distributions. From long-time simulations, the photon statistics inside the nanolaser can be gathered.

In the project, a model for nanolasers based on a stochastic simulator will be investigated. The following steps will be carried out.

- Background reading into photon statistics and nanolasers.
- Derivation of a stochastic simulator model for describing a nanolaser.
- Numerical implementation of the derived model using C++ or other programming language.
- Extensive parameter studies and extraction of photon-statistical quantities from the simulations.
- Comparison with existing results on semiconductor micropillar lasers.

References

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