Computational Photonics Group
Department of Electrical and Computer Engineering
Technical University of Munich

Simulation of Quantum Cascade Lasers

Master's thesis, Bachelor's thesis

starting immediately

Motivation

The quantum cascade laser (QCL) is a novel type of semiconductor laser. Here, the optical transitions occur between quantized energy levels within the conduction band, rather than between the conduction and valence bands (see Fig. 1).

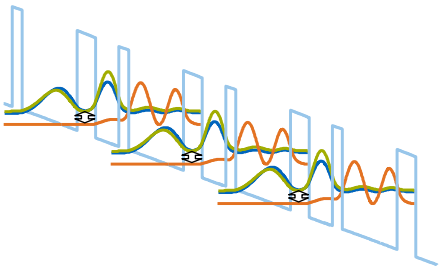

Figure 1 Conduction band profile and probability densities of a quantum cascade laser.

The unique features of those structures can be exploited for a wide range of optoelectronic applications. For example, QCLs hold great promise as compact solid state sources for coherent radiation in the infrared and terahertz regime. In our research group, we focus on the simulation of the electronic and optical processes in QCLs, as needed for a deeper understanding and further improvement of these devices. Of special interest are innovative types of QCL designs, such as QCLs based on unconventional material systems or exploiting nonlinear optical effects, which open the door to a variety of novel applications.

Objectives

The main goal of this project is to perform simulations of QCL devices, using the existing simulation tools (see Fig. 2) to comprehend experimental results. Furthermore, the simulation tools should be extended (e.g., inclusion of additional effects) and optimized (e.g., with respect to computational performance). This thesis project will give you hands-on experience in device physics, programming and numerical methods. The emphasis can be put on theory, programming or design optimization.

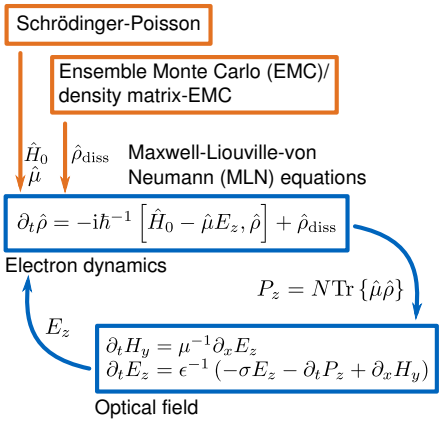

Figure 2 The existing Schrödinger-Poisson solver and (density matrix) EMC tool provide the input data for the dynamical simulations with the MLN solver.

Requirements

- Interest in simulation and theoretical work.
- Knowledge of MATLAB and (ideally) C++
- Experience with OpenMP or CUDA (optional)

Duration

The research scope can be adapted to a Master's thesis (6 months) or Bachelor's thesis (9 weeks).

Contact

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