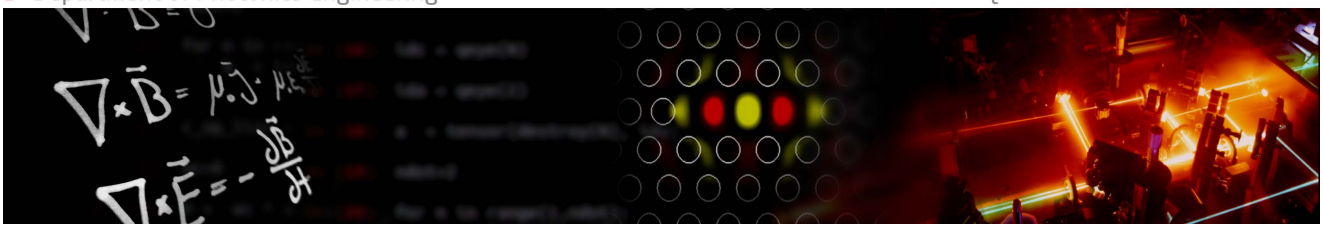


B.Sc. (including Fagprojekter) **or M.Sc. project**

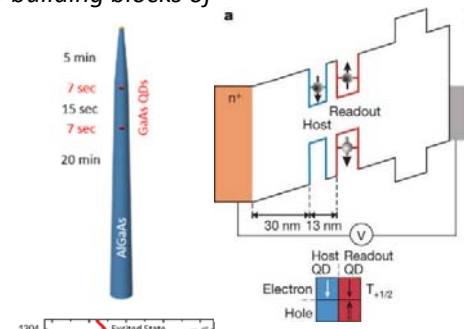
the level of the project can be adapted to the study program

Quantum Gates: Experiments and/or modelling

The aim of this project is to create quantum gates. Quantum gates are one of the key building blocks of forthcoming quantum computers. For instance, they can be used to entangle qubits.

One of the ways to realize a quantum gate is by coupling quantum dots together. Two quantum dots coupled together, a quantum dot molecule, can be operated with electric fields and function as quantum gates. Quantum gates are essential components in quantum circuits which are again the fundamental parts of quantum computers.

We already have the both the working experimental setup and working numerical simulations, in addition to high optical quality samples consisting of two GaAs quantum dots grown inside an AlGaAs nanowire. Quantum dots grown in nanowires provide a promising structure for quantum gates, as the quantum dot molecule is protected from the environment by the nanowire, and the structure allows for electrical contacting of the quantum dot molecule.



A. N. Vamivakas et al, Nature 467, 297 (2010)

http://sites.udel.edu/otygroup/resarch/quantum-dot-molecules/

Goals of the project

- Simulate the operation of quantum gates based on quantum dot molecules and/or experimentally realize quantum dot molecules for quantum gates.

Skills/knowledge acquired through the project:

- If experimental: Hands on experience of working in an experimental quantum optics lab, for instance, photoluminescence measurements and electric field measurements on nanowire quantum dot molecules.
- If numerical: Configuration-interaction post-Hartree-Fock method in envelop function and effective mass approximation to model many particle states like excitons in nanowire quantum dots. This model will also be used for designing and implementing quantum gates.

Background requirements:
Knowledge of quantum mechanics (e.g. from 10112 Advanced Quantum Mechanics) is an advantage.

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References: L. Robledo, Conditional Dynamics of Interacting Quantum Dots, *Science* Vol. 320, 5877, pp. 772-775 (2008), DOI: 10.1126/science.1155374