Quantum Technologies Lab
Physics Department
Technical University of Munich

Master's thesis project

Quantum Optics on a Chip

Quantum optics is an extremely powerful approach towards quantum communication, quantum sensing, and quantum computing. In particular, quantum information stored in photons has very low decoherence and can be transmitted over large distances through optical fibers. To date, most experiments in quantum optics use optical tables full with mirrors and beam splitters that all have to be carefully aligned and stabilized. This may be good enough for initial demonstrations, but in order to bring quantum *science* into the realm of quantum *technology*, a more scalable approach is required.

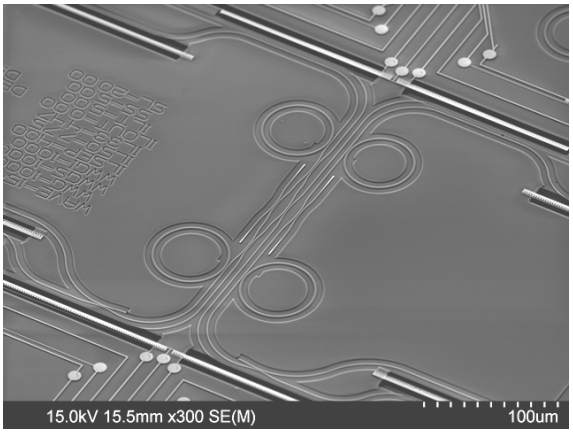
With our expertise in making photonic chips using advanced nanofabrication, we are putting these exciting quantum optics experiments on chips. Here, light is routed via optical waveguides. Furthermore, by bending a waveguide, one gets the equivalent of a free-space mirror; a beam splitter cube becomes a directional coupler and so on. By combining these elements, we can make all the building blocks for e.g. an optical quantum computer. With that, the possibilities are almost unlimited.

For such large-scale optical quantum circuits we also want to incorporate single-photon sources, superconducting single-photon detectors, and optomechanical phase shifters. This all happens on a single chip. Making and characterizing the components is the first step and from there on, you are making more and more complex quantum chips. You will be doing the nanofabrication in the cleanroom, and then use our optical measurement setups to see how each device is performing. Depending on your preference, it may also be possible to add a modelling component to the project.

Project details

The project is primarily targeting students in Applied and Engineering Physics (AEP) and Condensed Matter Physics (KM). Still, if you follow another track or come from a different department (e.g. electrical engineering) we can always discuss if this project is a good match for you. Being curious and wanting to get a feeling for what doing *real* research is about is more important than your exact background. Hence, there are no formal requirements on courses taken. The project has the following components:

- Nanostructures (experimental) ~70%
- Optics (experimental) ~30%



What do we offer?

Our group works on experiments for quantum technology in the broadest sense. In particular, we focus on nano- and optomechanics, as well as on on-chip photonics for integrated quantum optics experiments. We are relatively small, so you will be working together with almost all group members. For more information about us, also look at our website: www.qtech.ph.tum.de.

Interested?

We love to hear from you and will be more than happy to answer any questions that you may have on this project. The first step is to contact us, so that we can discuss this (or other) projects with you in person; just come by in Rm. 3071 or send an e-mail to menno.poot@tum.de.

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