Quantum Technologies Lab
Physics Department
Technical University of Munich

Master's thesis project

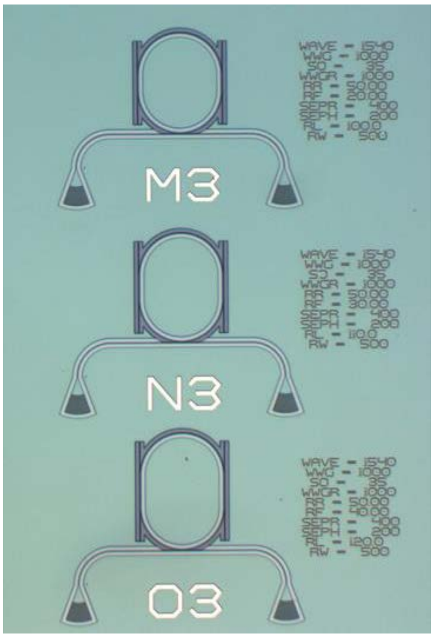
Synchronization and nonlinear dynamics of nanomechanical oscillators

Synchronization is a universal phenomenon that is known since the days of Huygens. When two or more oscillators with slightly different frequencies are coupled, they will start to move in phase. We can create nanoscale mechanical devices using advanced nanofabrication techniques here on campus: imagine a guitar string, but now 10 000x smaller! The strings are part of an optical cavity. Such an optomechanical system not only enables you to do very sensitive measurements, but we can also use the light to alter the dynamics of the mechanical device. By sending light with the right wavelength into the microring, the resonators start to oscillate. These so-called self-oscillations have very large amplitudes and their frequency is determined by the mechanical eigenfrequencies. Uncoupled resonators thus vibrate at slightly different frequencies. Interestingly, when increasing the optical power further, the optomechanical coupling can synchronizes them. Now they are completely locked and oscillate together at a common frequency. This is a highly nonlinear system with very rich dynamics.
The goal of this project is to synchronize devices made from silicon nitride, which is a special material with a lot of stress in it, and to increase the number of synchronized oscillators. From a single oscillator, you will synchronize two of them, then three, then four and then, well, many! The larger the system becomes, the richer the nonlinear dynamics will become. You will first make the devices in the cleanroom, then measure them, and analyze the data.

Project details

The project is perfectly suited for Applied and Engineering Physics (AEP) and Condensed Matter Physics (KM) students, but if you follow another track, we are still interested in hearing from you. The same applies if you are from a different department, or a different university. Being curious and wanting to get a feeling for what doing *real* research is about is the most important factor. 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 take a 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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