Quantum Technologies Lab
Physics Department
Technical University of Munich

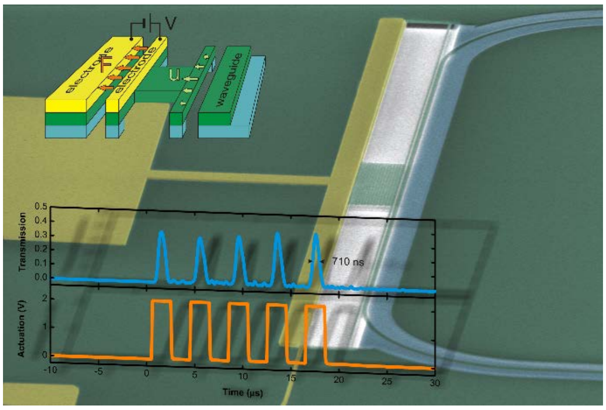
Master's thesis project

Strong electrostatic effects in optomechanical devices

Optomechanics uses light to measure the displacement of mechanical device. This is an extremely sensitive method: within one second, one can determine the position of a mechanical resonator with an accuracy that is smaller than the size of the *nucleus* of an atom! However, in optomechanics the forces are much smaller than in nanoelectromechanical systems (NEMS).
The goal of the project is to design, make, and measure opto-electromechanical devices, which have strong electrostatic interactions. These interactions can be made so large that the restoring force $F = -k\,x$ is no longer mechanical, but mainly electrostatic in nature! Measuring this so-called electrostatic spring effect, where the resonance frequency strongly depends on the applied voltage, is the first goal. The next step is to observe the electrostatic potential that the mechanical device experiences by measuring the ringdown of a strongly driven resonator back to its equilibrium position. By doing this for different mechanical modes you will not only determine how this potential depends on the voltage and displacement, but also how it varies with position.
Your nanomechanical devices will be made out of silicon nitride, which is a perfect material for mechanics, due to its high stress and excellent quality factors. Using advanced nanofabrication techniques such as electron beam lithography and reactive ion etching you will make these exciting devices in the cleanroom. For your measurements, we have a vacuum chamber, tunable lasers, high-speed detectors, and a variety of other measurement equipment, such as spectrum and network analyzers, and oscilloscopes available. All of these devices are computer controlled, allowing complex measurement with the single click of a mouse button.

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.

Professorship for Quantum Technologies
Physics Department
Technical University of Munich

James-Franck-Str. 1
85748 Garching
Germany

www.qtech.ph.tum.de
www.ph.tum.de
www.tum.de
office.eqt@ph.tum.de