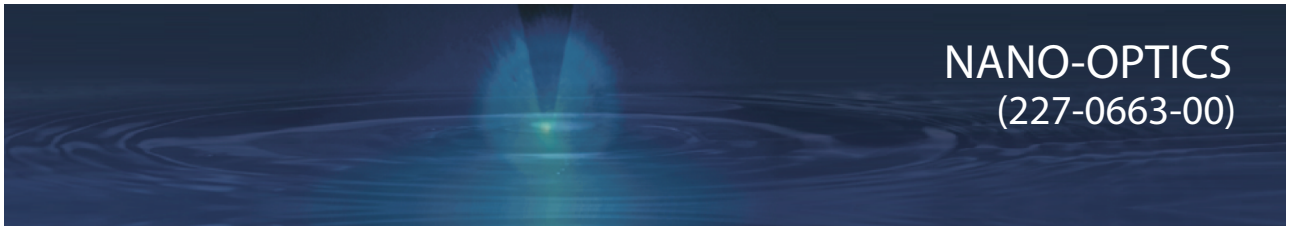
Fall Semester 2018



Nano-optics studies light-matter interactions on the sub-wavelength scale. The goal of this course is to quantitatively understand the fundamental concepts of nano-optics. We start with the angular spectrum representation to understand both the resolution limit of conventional optical microscopy, and the opportunities provided by evanescent fields. We discuss the principles of superresolution microscopy techniques. Our treatment of quantum light sources leads us to a discussion of the optical density of states. Finally, we turn to optical forces and understand their role in precision measurements and the opportunities they provide for manipulation of nanoscopic objects. All concepts are illustrated using recent research results or novel applications.

Time / Location : Lectures: Fridays 10:00 - 12:00 in ETZ E9
Laboratory Experiments: HPP M12 (Hönggerberg)

Instructor : Martin Frimmer (mfrimmer@ethz.ch)
Assistants : Dominik Windey (dwindey@ethz.ch)
Shadi Nashashibi (nshadi@student.ethz.ch)
Felix Tebbenjohanns (tefelix@student.ethz.ch)
Nikolaus Flöry (nfloery@student.ethz.ch)
Kilian Keller (kkeller@student.ethz.ch)

Requirements : Electromagnetics, Physics I + II

Notes : *Principles of Nano-Optics*,
L. Novotny and B. Hecht, 2nd ed. Cambridge (2012).
All lecture materials can be accessed electronically at:

https://www.photonics.ethz.ch/our-range/education/courses/nanooptics2/

Grading : 4 Homework Sets 25%, Project Report 25%, Final Exam (oral) 50%

Homework Sets : Homework sets have to be handed in on their respective due date at the beginning of the lecture in paper form.

Projects : Laboratory projects:
- Single-photon sources (Windey)
- Surface plasmon polaritons (Nashashibi)
- Laser tweezers and optical forces (Tebbenjohanns)
- Optical properties of low-dimensional materials (Flöry)

Theoretical research projects:
- Torque and angular momentum in optical fields (Frimmer)
- Design of a directional optical antenna (Frimmer)

AGENDA

Fri 21.09, 10:00:	No lecture! Please work on Homework 1.
Fri 28.09, 10:00:	Focusing and Localization of Fields sign up for lab experiments
Fri 05.10, 10:00:	Imaging and microscopy
Fri 12.10, 10:00:	Point-Spread Function, Resolution Limits **Homework 1 due**
Fri 19.10, 10:00:	Superresolution Microscopy
Fri 26.10, 10:00:	Green Functions, Local Density of States
Fri 02.11, 10:00:	Spontaneous emission control **Homework 2 due**
Fri 09.11, 10:00:	Optical antennas
Fri 16.11, 10:00:	Point scattering theory
Fri 23.11, 10:00:	Photon statistics
Fri 30.11, 10:00:	Optical Forces **Homework 3 due**
Fri 07.11, 10:00:	Optical Forces
Fri 14.12, 10:00:	Cavity Optomechanics
Fri 21.12, 10:00:	Cavity Optomechanics **Homework 4 due**

Each student chooses either one laboratory project or one theoretical research project and works on it in a group of 3–5 students. The total time investment for the lab work is estimated to be three afternoons, excluding data analysis and report preparation. Each group delivers a final project report (3 single pages maximum for lab projects, 4 single pages maximum for research projects). Lab project reports have to be handed in within two weeks of completing the experiment. An oral exam will test the understanding of the course material and of the project. The final oral exam will be held during the first 3 weeks of January 2019.