Quantum Nanophotonics 118148 – Course Information

Introduction and motivation

Can light be confined more strongly than the diffraction limit? The answer is yes – with nano-optics, the interaction of light with nanostructures. This advanced course introduces this fascinating and rapidly evolving field, and is designed with graduate and excellent bachelor students in mind. What makes nano-optics so interesting is the fact that it is a discipline that interfaces to many other fields in physics. Here we will particularly focus on quantum nanophotonics. For example, we will see how nano-scale particles will influence the emission of single photons from a quantum emitter.

Purpose of the course

The purpose of this course is to expose the student to the principles of nano-optics and its application in selected fields of physics. At the end of the course the student will be able to:

- Understand in depth the principles of nano-optics from classical and quantum perspectives
- Know the experimental and theoretical methods of nano-optics
- Get acquainted with modern applications of nano-optics in quantum physics
- Understand scientific articles on this rapidly evolving topic

Syllabus

- Review: Maxwell equations and optical properties of materials
- Plasmons at planar interfaces and nanoparticles, applications of surface plasmons,
- Near-field optical microscope
- Theoretical and numerical methods of nano-optics, Green's functions in electrodynamics
- Quantum systems in nano-optical fields
- Interaction of electron beams and plasmonic particles
- Introduction to microscopic and macroscopic quantum electrodynamics, Lamb shifts and Casimir forces, nonlocality in nano-optics
- Nonlinear nano-optics and strong-field interactions

Schedule

- Time: Thursday, 13:30-16:30, with two breaks
- Room: 300 Physics, also known as Seminar B
- Face to face lecture (recording & Zoom only if needed)

Important dates

- First lecture Thursday, May 30.

Grade

Grading will be based on home assignments (70%) and a final presentation (30%).

- Assignments: There will be 3-4 assignments, composed of questions, numerical work and reading and understanding journal papers. It is important to explain clearly every step in the solution - simply writing the final answer will not be credited with points. While working in groups is acceptable and encouraged, the assignments have to be written individually and independently by each student. Each assignment will have a deadline and has to be submitted before it will be graded.

- Final presentation: Every student will prepare a presentation about a topic or scientific paper related to the topic of the course. The details will be discussed in class.

Any violation of these rules or other misconduct will be treated as described in the Technion's code of conduct.

Literature

- Main book: U. Hohenester, Nano and Quantum Optics, Springer 2020 (link)
  → This book can be accessed for free within the Technion.
- Additional book: L. Novotny and B. Hecht, Principles of Nano-Optics, Cambridge 2013 (available in the Physics Library and in my office)

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I have no official office hours. Please get in touch with me and will set a meeting!