Course Syllabus

PHOT445 INTRODUCTION TO QUANTUM OPTICS

2024 Spring

Instructor

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Office: door on the right of Z5

Office hours: 9:00 – 17:00 (via appointment)

Teaching Assistant

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Office hours: TBA

Course Schedule

Tuesday 13:30 – 16:15 Building F, lecture room D-4

Course Fundamentals

Course Description

This course aims to introduce the fundamental concepts within quantum optics and photonics to the students. We will start by reviewing classical optics and quantum mechanics. After having a good understanding of basics, photon statistics, coherent and squeezed states, quantization of light and atom-photon interaction will be discussed. At the end of the term, some contemporary problems will be introduced.

Course Objectives (Learning Outcomes)

At the end of the course, you should be able to:

1. Describing the quantization of the electromagnetic field.
2. Discussing the properties of mixed and pure optical quantum states.
3. Discuss different mathematical representations of quantum states of light.
4. Recognizing the fundamental atom-light interaction using the semi-classical and the fully quantum mechanical approach.
5. Identifying the radiative transitions.
6. Discuss and perform calculations on modern applications of quantum optics.

Prerequisites

There are currently no official prerequisites for this course. However, knowledge of quantum mechanics (Quantum Photonics PHOT 301 or equivalent), and classical optics is required.

Textbooks

Course Textbook:

M. Fox, **Quantum Optics: An Introduction**, Oxford Series

Supplementary Materials:

C.C. Gerry and P.L. Knight, **Introductory Quantum Optics**, Cambridge

G. Grynberg et al., **Introduction to Quantum Optics**, Cambridge

Course website and announcements

You will find all announcements relevant to the course (homeworks, grades, etc.) on MS-Teams. Syllabus and course schedule may be subject to change during the semester.

Class structure

Course material will be presented on the whiteboard and on the screen. All lecture notes and class materials can be reached from Teams.

Course schedule (tentative)

Week 1	Classical optics
Week 2	Quantum mechanics
Week 3	Radiative Transitions in Atoms
Week 4	Photon Statistics
Week 5	Photon Antibunching
Week 6	Coherent and Squeezed States
Week 7	Quantization of the Electromagnetic Field
Week 8	Photon Number States (second quantization)
Week 9	Resonant Light atom Interactions

Week 10	Resonant Light atom Interactions (cont'd)
Week 11	Atoms in Cavities
Week 12	Cold Atoms
Week 13	Quantum Information Processing
Week 14	Quantum Information Processing (cont'd)
Week 15	Quantum Information Processing (cont'd)

Course Policies

Attendance and class behavior

Students who attend the lecture are expected to actively participate (in listening, taking notes, understanding, problem solving sessions, etc.).

Homework assignments

Individual projects will be assigned during the term. These can be performed with help from others (fellow students, course instructors, etc.), but the solutions should have unique reports and are to be defended (±20 minutes oral explanation of the report) during the exams. Homework solutions/reports can be uploaded to Teams on the indicated due date until 23.59. Late homework may be turned in, but 10 points will be deducted from the full score (100 points) for each day that it is late.

Quizzes

Non-graded quizzes can be given during specific lectures (TBA), these do not influence your grades and scores will only be given to the individual students for him/her to understand what type of questions he/she might expect on the exam.

Examinations and Grading

To be announced according to Senate regulations.

Examination Dates

TBA

Disabilities

Students with certified disabilities requiring special accommodations are urged to contact the instructor at the beginning of the semester so that suitable arrangements may be made.

Academic Integrity

Students who violate University rules on academic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or suspension from the University. Forms of academic dishonesty include copying homework assignments (from a fellow student or internet), cheating on exams, use of unauthorized materials for exams, and changing solutions to returned assignments and exams.