Faculty of Science

FYST83, Physics: Quantum Optics, 7.5 credits

Fysik: Kvantoptik, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2023-12-06. The syllabus comes into effect 2023-12-06 and is valid from the autumn semester 2024.

General information

The course is an elective course for second-cycle studies for a Degree of Master of Science (120 credits) with a specialisation in physics

Language of instruction: English

Main field of study	*Specialisation*
Physics	A1F, Second cycle, has second-cycle course/s as entry requirements

Learning outcomes

Quantized electromagnetic waves, called photons, are central for basic physical effects such as heat radiation or the spontaneous emission of light. Moreover, the quantum coherence between photons has confirmed the most astonishing predictions of quantum mechanics. This also revolutionized cryptography and sensing with high precision. The aim of the course is to develop the underlying theory and to provide in-depth knowledge on the interaction of photons with material, where applications in quantum technology are emphasized.

Knowledge and understanding

On completion of the course, the students shall be able to

- explain the quantization of electromagnetic waves
- distinguish between thermal and laser light
- describe the Hong-Ou-Mandel interferometer

- describe applications of photons for quantum technology
- describe the Jaynes-Cunnings model for the interaction between photons and materials
- discuss the origin and applications of parametric resonance.

Competence and skills

On completion of the course, the students shall be able to

- perform simple calculations for quantum interference of photons
- apply density matrices for the simulation of quantum systems with dephasing
- structure the course material in independently written text.

Judgement and approach

On completion of the course, the students shall be able to

- independently search for information beyond the course literature
- reflect over the general relevance of quantum mechanics.

Course content

The course deals with

- quantum properties of light
- squeezed photon states
- applications of entangled photons
- density matrices in quantum mechanics
- interactions between photons and material.

The material follows established textbooks as separately given in the literature list.

Course design

The teaching consists of lectures, laboratory sessions, and exercise sessions. Participation in the laboratory sessions together with related tasks is mandatory.

Assessment

Examination is arranged by written answers to exercises and question on the course content, which are handed out during the course. The independently formulated answers are collected in a portfolio from each student, which is handed in at the end of the course and has to be defended orally.

For students who have not passed are allowed to hand in a new portfolio and defend it at a later instance by mutual agreement.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
To pass the entire course, the requirement is a passed defense of the portfolio and participation in all compulsory components.

The marking scale for the portfolio is Fail, Pass, Pass with distinction.

The final grade is based on the grade for the portfolio together with its defense.

Entry requirements

Admission to the course requires 75 credits in physics and 45 credits in mathematics, or a scientific or Degree of Bachelor of Science - in both cases including knowledge equivalent to

- FYSB22 Physics: Basic Quantum Mechanics, 7.5 credits
- FYSC20 Physics: Electromagnetism, 7.5 credits
- FYSB24 Physics: Atomic and Molecular Physics, 7.5 credits.

In addition knowledge equivalent to FMFN01/FYSN27 Physics: Quantum Mechanics, 7.5 credits, is required.

English 6/B

Further information

The course is in full coordinated with FMFN30 Quantum Optics, 7.5 credits, which is a course given at Lund Institute of Technology, LTH.

The course is offered at the Department of Physics, Lund University