KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI

Projekt współfinansowany przez Unię Europejską w ramach Europejskiego Funduszu Społecznego

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FUNDUSZ SPOŁECZNY

Course title	ECTS code
Quantum optics	13.2.0425

Name of unit administrating study

Faculty of Mathematics, Physics and Informatics

Studies

faculty	field of study		
Faculty of Mathematics, Physics and Informatics	Quantum Information Technology	type	all
		form	all
		specialty	all
		specialization	all

Teaching staff

prof. dr hab. Marek Żukowski

Forms of classes, the realization and number of hours

Forms of classes

Auditorium classes, Lecture

The realization of activities

classroom instruction, online classes

Number of hours

Lecture: 30 hours, Auditorium classes: 30 hours

ECTS credits

5
5 ECTS

The academic cycle

2022/2023 winter semester

Type of course

obligatory

Language of instruction

english

Teaching methods

- Tutorial classes
- discussion
- problem solving
- problem-focused lecture

Form and method of assessment and basic criteria for eveluation or examination requirements

Final evaluation

- Graded credit
- Examination

Assessment methods

- (mid-term / end-term) test
- written exam (test)

The basic criteria for evaluation

Exam: all students get two week earlier 30 problems, out of which 3 are chosen by the examiner for the given student (at the beginning of the exam), depending on student's bid for a given grade. Around 1 hour or more is given for written answers. After they are delivered the answers are immediately checked. If this is required, professor points to mistakes, or imprecise statements of the student. After that the student is given additional time for correction of the answers. Examination ends when all problems are properly solved/answered (the grade is the one the bid). Several iterations are possible. If the process does not end with correct answers, the student must sit one more examination at least one week later.
Test: standard criteria

Method of verifying required learning outcomes

established effect of education	test	exam	activity
W01		+	
W02			+
U01	+		
U02			+
K01			+
K02			+
K03			+

Required courses and introductory requirements

A. Formal requirements
NONE

B. Prerequisites
Advanced knowledge of quantum mechanics and at least classical electrodynamics.

Aims of education

Student would understand the basics of quantum optics, quantum optical demonstrations of paradoxes of quantum physics and of basic protocols of quantum information science. Student would be able to discuss with experimentalists.

Course contents

Brief overview of classical electrodynamics.
Quantum description of light. Review of essential quantum electrodynamics.
Interaction of light with atoms.
Quantum measurement theory/detection of light
Specific non-classical states of light. Entanglement effects
Classical versus quantum interference effects.
Case study: parametric down conversion process.
Basic tools in quantum optical lab.
Multiphoton quantum interferometry.
Case study: entanglement swapping.
Colloquia on related topics: on current advances, or on request of the students

Bibliography of literature

Optical Coherence and Quantum Optics, L. Mandel and E. Wolf, (Cambridge, 1995)
Introductory Quantum Optics, P. Knight and C.M. Gerry (Cambridge, 2004)
Multiphoton entanglement and interferometry, J.W. Pan, Z.B. Chen, C.Y. Lu, H. Weinfurter, A. Zeilinger, M. Żukowski, Reviews of Modern Physics 84 (2), 777 (2012)

The learning outcomes (for the field of study and specialization)

K_W01
K_W02
K_U01
K_U02
K_U08
K_K02
K_K05
K_K08

Knowledge

W01: Basic understanding of quantum optics and quantum theory of light, non-classical effects in interference of light, understanding of optical demonstration of quantum paradoxes, and of elementary demonstrations of quantum informational processes (K_W01, K_W02)
W02: Understanding elementary requirements for quantum technologies (K_W02)

Skills

U01: Theoretical techniques of quantum optics, with accent on an intuitive approach, and relation with (optical) experiments (K_U01, K_U02)
U02: Being able to discuss with experimentalists, and to design simple quantum optical interferometric demonstrations of highly non-classical phenomena.(K_U08)

Social competence

K01: Seeing the interplay between theory and experiment in quantum information science. (K_K02)
K02: Being able to attend quantum conferences with accent on experiment.(K_K08)
K03: Being able to popularize quantum optics. (K_K05)

Contact

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