KAPITAŁ LUDZKI
NARODOWA STRATEGIA SPÓJNOŚCI
Projekt współfinansowany przez Unię Europejską w ramach Europejskiego Funduszu Społecznego
UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ SPOŁECZNY

Course title

Paradoxes of quantum mechanics

ECTS code

13.2.0418

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. Michał Horodecki

Forms of classes, the realization and number of hours

Forms of classes

Lecture

The realization of activities

classroom instruction, online classes

Number of hours

Lecture: 15 hours

ECTS credits

2

2 ECTS

The academic cycle

2022/2023 winter semester

Type of course

obligatory

Language of instruction

english

Teaching methods

- multimedia-based lecture
- problem-focused lecture

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

Final evaluation

Graded credit

Assessment methods

- written exam with open questions
- written exam (test)

The basic criteria for evaluation

Half of maximal number of points is needed to pass the exam

Method of verifying required learning outcomes

Required courses and introductory requirements

A. Formal requirements

none

B. Prerequisites

knowledge on linear algebra, (quantum mechanics course welcome, but not necessary)

Aims of education

Basic knowledge about striking quantum mechanical effects that contradict “classical” common sense.

Course contents

quantum interference and superposition, quantum eraser
uncertainty principle (measurement one and preparation one)
no-cloning, its relation with uncertainty
quantum teleportation and dense coding. Theoretical scheme and experimental realizations
Elitzur-Vaidman bomb tester
Entanglement, and Schrodinger paradox

local realism, GHZ paradox
Bell inequalities, nosignaling boxes and monogamy of quantum (and -supraquantum) correlations
contextuality and Peres-Mermin paradox
applied philosophy: communication complexity from Bell inequalities

Bibliography of literature

Literature: Nielsen and Chuang, Quantum Computation and Quantum information;
John Preskill, Lecture notes;
John Watrous, Lecture notes;
Buhrman et al, Non-locality and communication complexity, https://arxiv.org/abs/0907.3584v1

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

K_W01
Student has extensive knowledge of general physics and advanced knowledge in the area of quantum information theory; knows the history of the development of quantum information theory and its importance for the progress of science, world cognition and social development
K_W02
Student has in-depth knowledge of advanced mathematics, mathematical and computer methods necessary to solve physical problems of medium complexity and advanced in the area of quantum information and its technological aspects
K_W04
Student knows the advanced methods of theoretical and mathematical physics necessary in creating models of quantum mechanics
K_W06
Student has knowledge of the current trends in the development of physics, in particular within the quantum information theory

K_U01
Student is able to apply the scientific method and physical knowledge in solving problems formulated in the theory of quantum information, carrying out experiments and making conclusions

K_U02
Student can apply mathematical knowledge to formulating, analyzing and solving problems related to information theory

Knowledge

W01: Student knows basic quantum mechanical paradoxes (K_W01, K_W06)
W02: Student understand main features of quantum fenomena and knows the diffreneces to classical mechanics (K_W01, K_W04)
W03: Student knows the basic mathematical tools used in quantum mechanics (K_W02, K_W03)

Skills

aU01: students will be able to derive the paradoxes basing on quantum formalism (K_U01)
U02: Students can prove basic results concerning paradoxes of quantum mechanics (K_U02)

Social competence

Contact

michał.horodecki@ug.edu.pl