Study: Physics

Type and level of studies: Bachelor studies

Course name: Fundamentals of Quantum Mechanics

Lecturer**: Tijana Kevkić**

Status: Compulsory

ECTS: 9

Attendance prerequisites: Mathematical Physics, Introduction to Theoretical Mechanics, Atomic Physics

Course aims

Introduction to the basic principles and postulates of quantum mechanics applied to the simplest systems and the study of quantum physics using higher abstract mathematical formalism.

Course outcome

By the end of the course, the student should:

- know the basic principles and postulates of quantum mechanics and their relationship with the laws of classical physics;
- know about the abstract mathematical rules of quantum mechanics.

Course content

Theoretical Part

Historical development of quantum mechanics. The principle of superposition. De Broglie's hypothesis. Heisenberg uncertainty principle. Postulates of quantum mechanics. Hilbert space. Physical quantity operators. The measurement problem in quantum mechanics. Schrödinger's equation. One-dimensional problems: potential well, threshold and barrier. Linear harmonic oscillator. Hydrogen atom. Problem of the momentum operator. Spherical harmonics. Electron spin. Stationary perturbation theory: nondegenerate and degenerate spectra. Identical particles. Pauli's principle. Interaction changes. Orthohelium and parahelium. Elements of classical statistical physics. The equipartition theorem. Classical oscillator and specific heat of solids. Rayleigh-Jeans law of radiation and ultraviolet disaster. Quantum statistical operator and entropy operator. Quantum Gibbs ensembles. Quantum oscillator. Einstein's and Debye's theory of specific heat of solids. Photon gas. Planck, Wien and Stefan-Boltzmann's law of black body radiation. Quantum ideal gases. Bose-Einstein and Fermi-Dirac distribution. Schrödinger, Heisenberg and Interaction pictures. Heisenberg equations of motion and correct quantization of classical systems. Measurement theory (in quantum mechanics). Representation theory. Kinetic moment and summation of moments. Variational principle. Nonstationary perturbations. S-matrix and transition probability. Systems of identical particles. Hartree-Fock methods of approximation. Scattering theory. Elastic and inelastic scattering. Scattering of identical particles. Elements of relativistic quantum mechanics. Dirac's theory of the electron and Pauli's equation. Introduction to quantum field theory. Second quantization of the electromagnetic field. Interaction of radiation with matter.

Practical Part

COMPUTATIONAL EXERCISES: Computational exercises follow the content of lectures, emphasising the problem of potential wells and obstacles, harmonic oscillator and the problems of scattering.

Literature

1. Драгиша М. Ивановић, Квантна механика, Научна књига Београд, 1974
2. Л. Шиф, Квантна механика, Вук Караџић, Београд, 1973.
3. C. Cohen-Tannoudji, B. Diu, F. Laloe: Introduction to quantum mechanics (I and II part), Wiley Interscience, 1992.
4. Bransden B.H. and Joachain C.J., INTRODUCTION TO QUANTUM MECHANICS, Longman Scientific & Technical, Burnt Mill, Harlow, 1990.
5. M. Nikolić, I. Mančev i A. Tančić., ZBIRKA ZADATAKA IZ KVANTNE MEHANIKE, Filozof. fakultet, Niš, 1997.

Number of active classes				Other classes
Lectures: 3	Practical classes: 3	Other forms of teaching:		

Teaching methods

Lectures (3 classes per week during the semester), computational exercises (3 classes per week during the semester).

Assessment (maximum 100 points)			
Course assignments	**points**	Final exam	**points**
Lectures	20	oral exam	30
Practical exercises	20	written exam	30
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Total	40		60