UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Modern Physics I

2223-2-E2701Q043

Aims

The course aims at introducing and developing the basic concepts of quantum mechanics employed to model the properties of matter at the atomic level.

Contents

CRISIS OF THE CLASSICAL PHYSICS

QUANTUM PARTICLE

SCHRÖDINGER EQUATIONS

ATOMS

Detailed program

CRISIS OF CLASSICAL PHYSICS
Black body spectrum, classical theory and Planck's proposal; the quantum of energy. Photoelectric effect, apparatus and experimental observations; classical interpretation and quantum interpretation. Corpuscular model of light; the photon. Compton effect: experimental aspects and interpretation. Production and annihilation of e-and + pairs. Spectrum e.m. and photon-matter interaction. Bohr model: construction and results; consequences. Transitions and spectra. Franck-Hertz experiment and interpretation. Hypothesis of De Broglie; Davisson and Germer and Thomson's experiments.

QUANTUM PARTICLE
Wave function ? and wave equation for matter waves. ? as a harmonic wave or as a package. Advantages of the package; uncertainty principles. Recalls on wave packet, group velocity, Fourier transform, Gaussian packet. Discussion and consequences of the uncertainty principles. Born's probabilistic interpretation of the wave function ?. Measurement and expectation values. Operators and representation rules; examples.

SCHRÖDINGER EQUATION
Schrödinger's equation: derivation, meaning, properties. Current density of probability and conservation. Separation of variables, eq. Schrödinger's at stationed states. Eigenstats and eigenvalues of H. Probability and energy of a stationary state. Probability and energy of non-stationary states; charge density. Solution of eq. Schrödinger's 1D: the quantum particle in a well of infinite potential. Eigenstates and energies. Examples of an infinite hole; consequences. The quantum particle in a 3D infinite hole. Degeneration. Finite potential hole: odd and even solutions and energies; solutions and continuum states; reflection and transmission. Characteristics of infinite and finite hole, with discussion of problems. Potential step and potential barrier 1D. Reflection and transmission coefficients, probability current density. Tunnel effect. 1D harmonic oscillator: solution of Eq. Schrödinger's, stationary states, energies. Potential with a minimum: bound and continuum states.

ATOMS
Schrödinger equation for a particle in the central field; angular and radial equation. Radial and angular probability density. Solution of Eq. radial; functions Rnl (r), principal quantum number n and energies En. Solution of Eq. angular; the spherical harmonics Ylm (?, ?) and their properties. Quantum numbers orbital l and magnetic m. The general solution ?nlm = Rnl (r) Ylm (?, ?). Electric dipole transitions and selection rules. Angular momentum and its quantization; eq. to the eigenvalues of L and Lz, classical limit. Hydrogen-like atom

Prerequisites

Suggested prepararation:
Physics I, Physics II, Matematics I, Matematics II and Matematics III

Teaching form

Frontal lesson and exercises. The course language is Italian.

Textbook and teaching resource

Notes and suggested textbooks.

ELEMENTI DI STRUTTURA DELLA MATERIA
CRISI DELLA FISICA CLASSICA E FONDAMENTI DI FISICA MODERNA. MECCANICA QUANTISTICA. STRUTTURA ELETTRONICA DEI SOLIDI
COLOMBO LUCIANO , HOEPLI

Introduzione alla fisica dei quanti
Franco Ciccacci Editore: Edises

Physics of atoms and molecules

B. H. Bransden, C. J. Joachain Editore: Pearson Education Limited

The Physics of Atoms and Quanta
Introduction to Experiments and Theory
Haken, Hermann, Wolf, Hans Christoph Editor: Springer

Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles
Robert M. Eisberg, Robert Resnick Editore: John Wiley & Sons Inc

Semester

2° semester.

Assessment method

Written and oral examination.

Students must first demonstrate in a written test – usually composed by three exercises – to possess the formal tools for the management and use of the basics concepts of quantum mechanics.

After the written test, the exam includes an interview aimed at assessing the level of knowledge acquired on the entire program.

Office hours

On demand.
Please wirte directly to the lecturer at the address: angelo.monguzzi@unimib.it

Sustainable Development Goals