UNIVERSITÀ DI PISA

QUANTUM AND CONDENSED MATTER PHYSICS

GIUSEPPE CARLO LA ROCCA

Anno accademico	2022/23
CdS	MATERIALS AND NANOTECHNOLOGY
Codice	259BB
CFU	9

Moduli	Settore/i	Tipo	Ore	Docente/i
QUANTUM AND CONDENSED MATTER PHYSICS	FIS/03	LEZIONI	72	GIUSEPPE CARLO LA ROCCA

Learning outcomes

Knowledge
Become familiar with the basic concepts of quantum mechanics and learn how to make use of the Schroedinger equation. Use these tools for an elementary microscopic description of the properties of atoms, molecules and solids.

Prerequisites
General physics and calculus.

Syllabus
1. Introduction to quantum mechanics
Waves and particles. Wave-particle duality and uncertainty principle. Wave function. Schroedinger equation and stationary states. Expectation values. Examples: potential well and harmonic oscillator. Transition probability and selection rules.
2. Atomic physics
First atomic models and their shortcomings. Hydrogen atom: energy spectrum, angular momentum and eigenfunctions. Electron spin. Pauli exclusion principle. Helium atom, singlet and triplet states. Many-electron atoms, periodic system of elements. Atomic spectroscopy.
3.Molecular physics
The ionized hydrogen molecule. The hydrogen molecule. Homonuclear and heteronuclear diatomic molecules. Polyatomic molecules. Molecular vibrations. Molecular Spectroscopy.
4.Solid state physics
Structure of liquids, amorphous solids and crystals. X-ray diffraction. Types of crystals: molecular, ionic, covalent and metallic. Boltzmann distribution, equipartition of energy. Quantum statistics: bosons and fermions. Phonons and specific heat of solids. Free electron model of metals: electrical conductivity and specific heat. Bloch functions and electronic bands.

Bibliography
hand-out notes
Alonso-Finn: “Fundamental university physics, vol. 3: quantum and statistical physics”
Landshoff-Metherell-Rees: “Essential Quantum Physics”, Cambridge
Kittel: “Introduction to Solid State Physics”, Wiley

Non-attending students info
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Assessment methods
oral exam

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