

## UE Quantum Physics I

C

Level Baccalaureate +4 ECTS 3 credits

Ⅲ

Component UFR PhITEM (physique, ingénierie, terre, environnement, mécanique) Semester Automne

- > Teaching language(s): English
- > Open to exchange students: Yes
- > Code d'export Apogée: PAX7NQAB

# Presentation

### Description

*Goal*: This course is a deepening of the quantum mechanics concepts introduced in the undergraduate courses. The fundamental principle of quantum mechanics are illustrated by applications to nanoscale condensed-matter systems taken from recent research works and by discussing prospects for quantum information technologies. The concepts presented in this course are prerequisites for many second-year courses related to nanophysics and quantum engineering. A good knowledge in quantum mechanics is indeed more and more essential for technological research and development of nanoscale quantum devices.

#### Content

• Chapter 1: Introduction and recalls on the quantum mechanics postulates and formalism (Dirac notation, Hilbert space). Twolevel system, Zeeman effect, spin Hamiltonian. Tensorial product notation for states and operators. Many-body quantum states (bosons and fermions).

Exercices: Basics of quantum mechanics formalism.

- **Chapter 2**: Recalls on confinement problem. Electron bound states in a potential. Exercises: Example of 1D confinement problems, quantum harmonic oscillator.
- **Chapter 3**: Introduction to atomic physics. Spherical symmetry, angular and spin kinetic momenta. Mean field approximation, central potential, many electrons atoms, Hund rules, spin-orbit coupling, optical transitions. Exercises: Grotrian diagrams, spin-orbit coupling, fine and hyperfine structure.
- Chapter 4: Approximation methods for eigenstate calculations, perturbation theory, variational method.





Exercises: Application to electronic systems.

• **Chapter 5**: Time evolution. General equation for the time evolution, two-level systems, perturbation theory, Fermi golden rules. Exercises: Application to Rabi oscillations.

Prerequisites: Basics of quantum mechanics.

Bibliography: Quantum mechanics, C. Cohen-Tannoudji, Vol. 1, ISBN-13: 978-0471164333, Vol. 2, ISBN-13: 978-0471569527.

### Course parts

UE Quantum Physics I - CMTD

Lectures (CM) & Teaching Unit (UE)

24h

Period : Semester 7

# Useful info

### Campus

> Grenoble - Saint-Martin d'Hères

