

PHYS-334

Atomic, molecular physics and optics

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Cursus	Sem.	Type
Physics	BA6	Obl.

Language of teaching	English
Credits	5
Session	Summer
Semester	Spring
Exam	Written
Workload	150h
Weeks	14
Hours	5 weekly
Courses	3 weekly
Exercises	2 weekly
Number of positions	

Summary

This course presents the fundamental physics of atoms and molecules, their structure and their interaction with electromagnetic fields.

Content

- Hydrogen atom (reminders and complements)
- Fine and hyperfine structure of the hydrogen atom
- Hydrogen atoms in external fields, vector and tensor operators
- Alkali and Rydberg atoms
- Helium and two-electron atoms
- Many-electron atoms and the periodic table
- Atoms interacting with light
- Light propagation
- Elementary principles of the laser
- Chemical bonding in molecules
- Electronic and vibrational spectra of molecules
- Elements of organic chemistry - building blocks of life
- Elements of inorganic chemistry - crystalline materials
- From molecules to nanostructures

Keywords

Atoms, Molecules, Optics

Learning Prerequisites**Required courses**

Quantum Mechanics I and II, Classical electrodynamics

Recommended courses

Optics and photonics, Chemistry

Important concepts to start the course

Fundamentals of quantum mechanics, angular momentum, perturbation theory, dipoles and multipoles, dipolar radiation, chemical bonding, molecular structure

Learning Outcomes

- Analyze the structure of simple atoms and molecules
- Use quantum mechanics to solve problems of atomic physics
- Interpret observations in atomic, molecular and optical physics
- Apply quantum mechanics and classical electrodynamics to light-matter interactions problem

Transversal skills

- Continue to work through difficulties or initial failure to find optimal solutions.
- Use both general and domain specific IT resources and tools

Teaching methods

Ex-Cathedra, problem solving classes, numerical exercises

Expected student activities

Lecture participation, problem solving, numerical investigations

Assessment methods

Written exam

Resources

Bibliography

Atkins and Friedman, *Molecular quantum mechanics*
Bransden and Joachain, *Physics of atoms and molecules*
Walraven, *Atomic physics*
Van der Straten and Metcalf, *Atoms and molecules interacting with light*

Ressources en bibliothèque

- [Molecular quantum mechanics / Atkins](#)
- [Physics of atoms and molecules / Bransden](#)
- [Atoms and molecules interacting with light / Van der Straten](#)

Références suggérées par la bibliothèque

- [Atomic physics / Walraven](#)

Moodle Link

- <https://go.epfl.ch/PHYS-334>