PHYS-207

# Quantum mechanics I

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| Cursus | Sem. | Type |
|---|---|---|
| Communication systems | BA4 | Opt. |
| Computer science | BA4 | Opt. |
| Physics | BA4 | Obl. |

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


## Summary

The objective of this course is to familiarize the student with the concepts, methods and consequences of quantum physics.


## Content

1. A bit of history: the crisis of classical physics. Black body radiation, photo electric effect, Compton effect.
2. Rutherford's experiment, Bohr atom, de Broglie hypothesis.
3. The Stern and Garlach experiment: quantum states and spin 1/2

4. The axioms of quantum physics: state vectors, operators, measurement, representations

5. Continuous degrees of freedom: translation operator and canonical quantization

6. Time evolution: Schrödinger's equation and Heisenberg's point of view

7. Some simple problems in one dimension

8. Central potentials, angular momentum and hydrogen atom
9. Addition of angular momentum

## Keywords

Quantum mechanics, Schrödinger equation, Heisenberg uncertainty principle, wave function, harmonic oscillator, hydrogen atom, spin, entanglement

## Learning Prerequisites

### Required courses

Basic physics and mathematics undergraduate courses

### Important concepts to start the course

Strong working knowledge of calculus and linear algebra (covered in basic math courses).

## Learning Outcomes

By the end of the course, the student must be able to:

- Compare Schrödinger's and Heisenberg's viewpoints on quantum physics

- Derive Heisenberg's uncertainty principle
- Characterize the amount of entanglement in a two-spin system
- Contextualise the postulates of quantum physics
- Explain the difference between classical and quantum physics
- Solve the quantum harmonic oscillator with the ladder operator method
- Interpret the measurement process in quantum physics
- Solve Schroendinger's equation for problems in 1,2 and 3 dimensions

## Teaching methods

Ex cathedra. Exercises prepared in class.

## Expected student activities

Students are expected to regularly attend the theory lectures and the exercise lectures. They are also expected to complete the exercises that are given on a weekly basis, as well as regularly study the learning material offered by the professor (lecture notes, exercises solutions etc).

## Assessment methods

Written exam

## Resources

### Bibliography

The key reference is :
1. "Concepts of Modern Physics" (5th edition), Arthur Beizer (McGraw-Hill Education)
2 "Modern Quantum Mechanics" (2nd edition), J.J. Sakurai, J. Napolitano (Cambridge University Press, 2017)
Other books can be occasionally consulted, most notably
3. "Mécanique Quantique I-II", Cohen-Tannoudji, Diu, Lahoë (Hermann) [Also available in English]

### Ressources en bibliothèque

- Concepts of Modern Physics / Beiser
- Mécanique Quantique / Cohen-Tannoudji
- Modern Quantum Mechanics / Sakurai

### Notes/Handbook

Lecture notes will be given at the beginning of the course

### Moodle Link

- https://go.epfl.ch/PHYS-207