PHYS-313

Quantum physics I

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Cursus	Sem.	Type
Electrical and Electronical Engineering	BA5	Opt.
Minor in Quantum Science and Engineering	H	Opt.
Physics	BA5	Obl.
Quantum Science and Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
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
2. The Stern and Garlach experiment: quantum states and spin 1/2

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

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

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

6. Some simple problems in one dimension

7. Central potentials, angular momentum and hydrogen atom
8. Composite systems: entanglement and Bell's inequalities
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:

- Explain the difference between classical and quantum physics

- Compare Schrödinger's and Heisenberg's viewpoints on quantum physics
- Derive Heisenberg's uncertainty principle
- 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
- Characterize the amount of entanglement in a two-spin system
- Contextualise the postulates of quantum physics

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. "Modern Quantum Mechanics" (2nd edition), J.J. Sakurai, J. Napolitano (Cambridge University Press, 2017)
Other books can be occasionally consulted, most notably
2. "Mécanique Quantique I-II", Cohen-Tannoudji, Diu, Lahoë (Hermann) [Also available in English]

Ressources en bibliothèque

- Quantum Mechanics
- Mécanique Quantique
- Modern Quantum Mechanics

Notes/Handbook

Lecture notes will be given at the beginning of the course

Moodle Link

- https://go.epfl.ch/PHYS-313