EPFL

PHYS-314

Quantum physics II

Holmes Zoë

Cursus	Sem.	Type
Physics	BA5	Obl.
Quantum Science and Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	6
Session	Winter
Semester	Fall
Exam	Written
Workload	180h
Weeks	14
Hours	**5 weekly**
Courses	3 weekly
Exercises	2 weekly
Number of positions	

Summary

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

Content

1. A recap of basic quantum mechanics (from a more information theoretic perspective)
2. No-go theorems to understand the difference between classical and quantum physics
3. Identical particles: fermions and bosons
4. Elements of theory for multi-electron atoms and molecules
5. Mixed states, reduced states, measurement and decoherence
6. Elements of quantum information theory
7. Symmetries and conservation laws in quantum mechanics
8. Elements of group representation theory and its application to quantum mechanics
9. Elements of continuous group theory and Lie algebras and their application to continuous symmetries.
10. Time-independent perturbation theory
11. Time-dependent perturbation theory
12. Variational principle
13. Hartree-Fock theory for multi-particle systems

Keywords

Quantum mechanics, Schrödinger equation, Heisenberg's uncertainty principle, wave function, harmonic oscillator, spin, angular momentum, perturbation theory, quantum entanglement, Bell's theorem, identical particles, second quantization, density operator, density matrix, quantum information, Hartree-Fock.

Learning Prerequisites

Required courses

INDICATIVE PREREQUISITE COURSES Quantum Physics I
Basic undergraduate physics and mathematics courses

Important concepts to start the course

Solid and practical knowledge of analysis and linear algebra (covered in basic mathematics courses) is required.

Learning Outcomes

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

- Explain the difference between a pure state and a mixed state
- Compute the reduced density matrix on a subsystem of a state
- Argue against local realism
- Compute physical quantities using time-independent perturbation theory.
- Compute physical quantities using time-dependent perturbation theory.
- Explain the difference between fermions and bosons
- Infer conservation of physical quantities from the properties of invariance
- Interpret a basic quantum circuit

Teaching methods

Lectures and exercise classes.

Expected student activities

Attendance in class. Solving exercise sets during exercise hours. Regularly reviewing lecture notes at home.

Assessment methods

Final written exam

Resources

Moodle Link

- https://go.epfl.ch/PHYS-314