PHYS-431

Quantum field theory I

Riva Francesco

Cursus	Sem.	Type
Ing.-phys	MA1, MA3	Opt.
Physicien	MA1, MA3	Opt.

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

Summary

The goal of the course is to introduce relativistic quantum field theory as the conceptual and mathematical framework describing fundamental interactions.

Content

This introductory course stresses the importance that quantum fields play in the description of relativistic particles, and vice versa.

The course starts with a quantum-field theoretical description of particles of spin-0, described by scalar fields; it focusses on:

- The notion of relativistic scalar field, introduced as a trivial representations of the Lorentz group
- Field dynamics, discussed first in classical field theory (e.g Noether theorem, action principle and Euler-Lagrange equations)
- Field quantization: Fock space, the existence of anti-particles, causality
- Perturbation theory, S-matrix, LSZ formalism, Feynman diagrams
- Applications to the computation of scattering and decay processes
- Introduction to Renormalization theory

Depending on time, the course will include other topics relevant for the description of spin-0 particles (e.g. Goldstone theorem and effective field theories)

Learning Prerequisites

Required courses

Classical Electrodynamics, Quantum Mechanics I and II, Analytical Mechanics, Mathematical Methods

Recommended courses

General Relativity and Quantum Mechanics III warmly recommended.

Learning Outcomes

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

- Expound the theory and its phenomenological consequences
- Formalize and solve the problems

Transversal skills

- Use a work methodology appropriate to the task.

Teaching methods

2 hours of the course will be given online (zoom)
1 hour course + exercices will be on site

Assessment methods

Oral, consisting of one theoretical question and one exercise, picked randomly and for which the candidate is allowed a 30 minute preparation

Resources

Bibliography

- "An introduction to quantum field theory / Michael E. Peskin, Daniel V. Schroeder". Année:1995. ISBN:0-201-50397-2
- "The quantum theory of fields / Steven Weinberg". Année:2005. ISBN:978-0-521-67053-1
- "Quantum field theory / Claude Itzykson, Jean-Bernard Zuber". Année:1980. ISBN:0-07-032071-3
- "Relativistic quantum mechanics / James D. Bjorken, Sidney D. Drell". Année:1964
- "A modern introduction to quantum field theory / Michele Maggiore". Année:2010. ISBN:978-0-19-852074-0

Ressources en bibliothèque

- An Introduction to Quantum Field Theory / Peskin
- The Quantum Theory of Fields / Weinberg
- A Modern Introduction to Quantum Field Theory / Maggiore
- Relativistic Quantum Mechanics / Drell
- Quantum Field Theory / Itzykson

Websites

- https://www.epfl.ch/labs/lptp/wp-content/uploads/2022/05/NewQFTLectureNotes.pdf

Moodle Link

- https://go.epfl.ch/PHYS-431

Prerequisite for

Recommended for Theoretical Physics and for Particle Physics