EPFL

PHYS-431	**Relativistic quantum fields I**
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Cursus	Sem.	Type
Ing.-phys	MA1, MA3	Opt.
Physicien	MA1, MA3	Opt.

Language of teaching	English
Credits	4
Session	Winter
Semester	Fall
Exam	Oral
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

The goal of the course is to introduce relativistic quantum field theory as the framework to describe fundamental interactions.

Content

1. Introduction
Conceptual foundations. Overview of particle physics. Units of measure in high energy physics.
2. Classical Field Theory
Lagrangian and Hamiltonian formulation. Noether's theorem.
3. Symmetry Principles
Elements of group theory and group representations. Lie groups. Lie Algebras. Lorentz and Poincaré groups. Parity, time reversal and charge conjugation.
4. Free Quantum Fields
Canonical quantization. Creation and annihilation operators. Fock space. Free relativistic particles. Bosons and Fermions. Symmetries in the quantum theory. Causality.
5. Classification of quantum fields
Real and complex scalar fields. Spinor field. Quantized electromagnetic field. Massive vector field.
6. Interacting fields
Formal theory of relativistic scattering. Asymptotic states. Lippmann-Schwinger equation. S-matrix and Feynman diagrams. Cross sections and decay-rates.
7. Fundamental interactions
Quantum electrodynamics. The weak force and parity violation. The strong force. Overview of the Standard Model.

Learning Prerequisites

Recommended courses

Electrodynamics, Special relativity, Quantum Mechanics I and II.
Mathematical Physics 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

Ex cathedra and exercises in class

Assessment methods

oral

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
• "Théorie quantique des champs / Jean-Pierre Derendinger". Année:2001. ISBN:2-88074-491-1

Ressources en bibliothèque

• The Quantum Theory of Fields / Weinberg
• An Introduction to Quantum Field Theory / Peskin
• A Modern Introduction to Quantum Field Theory / Maggiore
• Relativistic Quantum Mechanics / Drell
• Quantum Field Theory / Itzykson
• Théorie quantique des champs / Derendinger

Websites

• http://itp.epfl.ch/page-60677-en.html

Prerequisite for

Recommended for Theoretical Physics and for Particle Physics