PHYS-432

Quantum field theory II

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Cursus	Sem.	Type
Ing.-phys	MA2, MA4	Opt.
Physicien	MA2, MA4	Opt.

Language of teaching	English
Credits	6
Session	Summer
Semester	Spring
Exam	Oral
Workload	180h
Weeks	14
Hours	**5 weekly**
Courses	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

8. Quantized Electromagnetic field. Gauge Invariance. Gauss Law and physical degrees of freedom. Quantization in the Coulomb and Lorenz gauges.
9. Massive vector field. Non-linearly realized gauge symmetry. Higgs mechanism. Quantized massive vector field. The action of the Lorentz group on the spin polarization.
10. Discrete symmetries: P, C, T and CPT.
11. Causality with classical and with quantum fields.
12. Interacting fields. Formal theory of relativistic scattering. Asymptotic states. Lippmann-Schwinger equation. The S-matrix and its symmetries. The S-matrix in perturbation theory: Wick theorem and Feynman diagrams. Cross sections and decay-rates.
13. Quantum electrodynamics. Feynman rules and fundamental processes (Compton scattering, electron positron annihilation). Ward identities and gauge invariance.
14. Non-Abelian gauge theories and the Standard Model. Gauge group structure and field content of the Standard Model**.** Electroweak unification and the Higgs mechanism. Low energy phenomenology of electroweak interactions. Parity violation. Precision electroweak tests and the Higgs boson.

Learning Prerequisites

Required courses

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

Recommended courses

Quantum Mechanics III and IV, General Relativity, Cosmology

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

Exam: oral, consisting of one theoretical question and one exercise, picked randomly and for which the candidate is allowed a 60 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
- "Théorie quantique des champs / Jean-Pierre Derendinger". Année:2001. ISBN:2-88074-491-1

Ressources en bibliothèque

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

Websites

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

Moodle Link

- https://go.epfl.ch/PHYS-432

Prerequisite for

Prerequisite for Theoretical Physics