PHYS-702

Advanced Quantum Field Theory

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Cursus	Sem.	Type
Physics		Opt.

Language of teaching	English
Credits	4
Session	
Exam	Multiple
Workload	120h
Hours	**56**
Lecture	42
Exercises	14
Number of positions	

Frequency

Every year

Remark

Next time: Fall 2023

Summary

The course builds on the course QFT1 and QFT2 and develops in parallel to the course on Gauge Theories and the SM.

Content

The course is essentially divided into two parts. The first smaller part is a revisitation of the notions of field and particle in QFT, starting from fundamental principles of symmetry and locality. The central result is the classification of single particle and multiparticle states according to the unitary representations of the Poincaré group. The second and main part concerns the study of quantum effects. In perturbation theory, these are associated to Feynman diagrams with loops. The concepts of ultraviolet divergence and renormalization are introduced. Non-abelian gauge theories are also discussed. Skills developed in the course include the use of the Path integral formalism, methodologies to perform loop calculations and renormalization. Applications to particle physics are also illustrated.

1) Brief foray into axiomatic QFT

- Unitary representations of the Poincaré group
- Fields and the cluster property
- LSZ formula for the S-matrix

2) Path Integral approach to QFT

- Quantization of non-abelian gauge theories

3) Regularization and Renormalization

- Applications to QFTs with scalars, fermions and Abelian gauge fields, in particular to Quantum Electrodynamics
- Effective action and Effective Potential

5) The renormalization group

- asymptotic freedom and fixed points

Keywords

Path integral formalism, divergences renormalization, Gauge theories
Renormalization group, Anomalies

Learning Prerequisites

Required courses

Quantum mechanics 1,2 - Quantum Field theory 1,2

Recommended courses

Conformal Field theory and gravity
Gauge theories and the Standard Model

Learning Outcomes

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

- Study a quantum field theory at quantum level
- Understanding and interpreting loop effects in a quantum field theory
- Performing loop calculations in gauge theories

Resources

Bibliography

An introduction to Quantum Field Theory, by Peskin and Schroeder
The quantum theory of Fields, Vol 1,2 by Weinberg

Ressources en bibliothèque

- An introduction to Quantum Field Theory / Peskin, Schroeder
- The quantum theory of fields / Weinberg . Vol2
- The quantum theory of fields / Weinberg . Vol1

Moodle Link

- https://go.epfl.ch/PHYS-702