PHYS-503

Quantum field theory III

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

Language of teaching	English
Credits	8
Session	Winter
Semester	Fall
Exam	Oral
Workload	240h
Weeks	14
Hours	**4 weekly**
Courses	3 weekly
Exercises	1 weekly
Number of positions	

Summary

The course builds on QFT1-2 and develops in parallel to The Standard Model course. After briefly revisiting the notions of particle, field and S-matrix, the course fully develops the theory of Renormalization and closes on the quantization of non-abelian gauge theories.

Content

1) Brief foray into "axiomatic" QFT
-Unitary representations of the Poincaré group
- Fields, relativistic wave equations
- Cluster property and LSZ formula for the S-matrix

2) Path Integral approach to QFT
- Functional methods, Effective action
- Equations of motion, Ward identities, Goldstone theorem

3) Renormalization
- loop corrections and regularization methods
- renormalization with examples of its systematics
- applications to QFTs with scalars, fermions and Abelian gauge fields, in particular to Quantum Electrodynamics

4) The renormalization group
- asymptotic freedom and fixed points
- Callan-Symanzik equation
- renormalization of composite operators

5) Quantization of non-abelian gauge theories
- path Integral in gauge theories and Faddeev-Popov method
- ghosts and BRST symmetry
- physical states and unitarity
- Slavnov-Taylor identities and basics of renormalization

5) Infrared divergences (time permitting)
- soft photons and soft gravitons
- Lorentz invariance and current conservation (Weinberg)
- real and virtual emission of soft photons, cancellation of IR divergences

Keywords

Quantum Fields, LSZ Reduction, Renormalization, Renormalization Group, Composite Operators, Fixed Points, Gauge Theories, BRS symmetry

Learning Prerequisites

Required courses

QFT1, QFT2, QM3, QM4

Recommended courses

General Relativity and Cosmology 1

Learning Outcomes

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

- Formulate
- Analyze
- Reason
- Model
- Solve
- Illustrate
- Compute
- Demonstrate

Transversal skills

- Use a work methodology appropriate to the task.

Teaching methods

A mix of inverted class, based on recorded lectures from previous years, and of ex cathedra lectures

Expected student activities

Weekly take home exercises, with weekly assessment

Assessment methods

Weekly exercises during the semester: 20% of evaluation
Take home written exam: 30% of evaluation
Oral exam: 50% of evaluation

Resources

Bibliography

- The Quantum Theory of Fields I and II, Steve Weinberg
- An Introduction to Quantum Field Theory, Peskin-Schroeder

Ressources en bibliothèque

- Find the references at the Library

Notes/Handbook

Handwritten Notes

Moodle Link

- https://go.epfl.ch/PHYS-503