Universitat Autònoma de Barcelona

Advanced Quantum Field Theory

2019/2020

Code: 44082
ECTS Credits: 6

Degree	Type	Year	Semester
4313861 High Energy Physics, Astrophysics and Cosmology	OT	0	2

Contact

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Use of Languages

Principal working language: english (eng)

Teachers

Pere Masjuan Queralt

Prerequisites

It is recommended to have followed the course of introduction to Quantum Field Theory of the Master, or at least basic courses on Quantum Field Theory during the undergrate courses.

Objectives and Contextualisation

The main goal of the course is twofold: 1) on one side, to develop a different approach to Quantum Mechanics and Quantum Field Theory based on the Path Integral approach and 2) on the other, to understand and be proficient in the renormalization of a theory. This is a fundamental requisite to arrive to any physical result involving loop diagrams. Besides understanding the concept and renormalization procedure we will focus on its interaction with symmetries and we will conclude by establishing the renormalization group equations.

Competences

- Formulate and tackle problems, both open and more defined, identifying the most relevant principles and using approaches where necessary to reach a solution, which should be presented with an explanation of the suppositions and approaches.
- Understand the bases of advanced topics selected at the frontier of high energy physics, astrophysics and cosmology and apply them consistently.

Learning Outcomes

1. Apply the mechanisms of renormalisation systematically.
2. Calculate transition widths using lagrangians of effective theories.
3. Understand the foundations of functional formalism in quantum field theory.

Content

1. Functional Methods

1.1 Path Integral in Quantum Mechanics.

1.2 Functional Quantization and Path Integral in Quantum Field Theory

1.3 Symmetries in the functional formalism language

2. Renormalization Theory

2.1 Ultraviolet Divergences, conceptual meaning.

2.2 Classification of theories according to their renormalization properties

2.2 Renormallzed perturbation theory

3. Renormalization and symmetry

3.1 Spontaneus Symmetry Breaking and linear sigma model: how they should be renormalized.

4. Aspects of non abelian gauge theories

5. Renormalization Group Equations

Methodology

The course will be organized in teaching lectures where the theory of Path Integrals and Renormalization will be developed in full detail.

Students will be encouraged to ask questions during the theory lectures but they also will be asked questions.

Along the lectures a list of problems will be proposed.

It is recommended to follow the course daily including work at home to fully profit and completely understand the concepts discussed.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Theory lectures	45	1.8	1, 2, 3
Type: Autonomous			
Study of theoretical concepts and solution of exercises	82	3.28	1, 2, 3

Assessment

The evaluation of the course will consist of three blocks:

- A written exam that will count 50% of the note, and with the right to a recovery exam (for 50%).

- Deliveries of problems will be proposed that will count the remaining 40% of the mark.

- Attendance and active participation in class will count 10% of the mark.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Active participation in class	10%	2	0.08	1, 2, 3
Delivery of Solved Problems	40%	15	0.6	1, 2, 3
Final Exam	50%	3	0.12	1, 2, 3
Recovery Exam	50%	3	0.12	1, 2, 3

Bibliography

M. Peskin and D. Schroeder, An introduction to Quantum Field Theory

Lewis H. Ryder, Quantum Field Theory.

Stefan Pokorski, Gauge Field Theories.

C. Itzykson and J. Zuber, Quantum Field Theory

Ta-Pei Cheng and Ling-Fong Li, Gauge theory of elementary particle physics.