UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Quantum Field Theory II

2324-1-F1701Q134

Aims

Complete the study of QFTs by developing the functional approach to gauge theories, which describe fundamental interactions. Deepen the knowledge of the main properties of QED and QCD. Become familiar with advanced topics in QFT.

Contents

Functional approach to gauge theories. Perturbative renormalization of QED and QCD. Renormalization group for gauge theories. Anomalies.

Detailed program

Wilsonian effective action. Classification of composite operators.

Introduction to Conformal Field Theory. Conformal group in d>2, rapresentations of conformal group. Radial quantization, state-operator correspondence. Consequences of conformal invariance on the structure of the correlators. Conformal Bootstrap. Conformal group in d=2 and Virasoro algebra.

Functional methods for fermions. Integration on grassmannian variables. Yukawa theory: one-loop renormalization.

Discrete symmetries: parity, time-reversal, charge conjugation. PCT theorem.

Gauge theories. Yang-Mills theories. Path integral formulation. Abelian and non-abelian cases.

Propagator of the gauge fields. Gauge fixing, Faddeev-Popov determinant and corresponding ghosts. BRST quantization.

Perturbative approach to path integral for gauge theories with scalar and fermionic matter. QED: Renormalization and beta functions for QED and QCD. Asymptotic freedom. Banks-Zaks fixed point.

Renormalizability of gauge theories with spontaneous symmetry breaking. Renormalizable gauges vs unitary gauge.

Symmetries, Ward-Takahashi and Slavnov-Taylors identities. The case of QED and QCD.

Anomalies in QFT. Axial and chiral anomalies. Triangle anomaly. Fujikawa's method.

Prerequisites

General Relativity, Theoretical Physics I,II, Quantum Field Theory I

Teaching form

Frontal lectures

Textbook and teaching resource

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

P. Ramond, Field Theory : A Modern Primer, 2nd Edition

M. Srednicki, Quantum Field Theory

T-P. Cheng and L-F. Li, Gauge Theory of Elementary Particle Physics

D. Anselmi, Renormalizazion

S. Weinberg, The Quantum Theory of Fields I, II

H. Osborn, Lectures on Conformal Field Theories in more than two dimensions

D. Simmons-Duffin, TASI Lectures on the conformal bootstrap

L.F. Alday, Conformal Field Theory

Semester

Second semester

Assessment method

Oral exam preceded by a short exercise to be solved in presence. The oral exam will include a discussion of the exercise and open questions on topics presented in class.
The final evaluation will take into account the level of comprehension of all the topics introduced in the course, the level of computational skills in QFT acquired, as well as scientific language skills and clarity of the answers.

Office hours

By appointment, sending an e-mail to silvia.penati@unimib.it

Sustainable Development Goals

QUALITY EDUCATION