



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## SYLLABUS DEL CORSO

### Teoria Quantistica dei Campi I

2021-1-F5801Q042

---

#### Aims

To give the basic conceptual and theoretical tools for studying the quantum theories of the fundamental interactions

#### Contents

Path integral formulation of relativistic quantum field theories

#### Detailed program

Identical particles, Fock space, creation and annihilation operators.

Poincaré transformations. Local field operators, S matrix, causality, spin-statistic theorem, discrete symmetries and CPT invariance.

Path integral quantization. Wick rotation and Euclidean field theories: scalar, spinor and vector fields. Faddeev-Popov prescription. Interacting theories and their perturbative expansion.

N-point connected correlation functions, proper vertices, generating functional, effective action. Loop wise expansion.

Gauge invariance, Quantum Electrodynamics (QED). Yang-Mills theories, BRST invariance, Quantum Chromodynamics (QCD).

Symmetries in the path integral formalism. Ward identities: charge conservation, energy-momentum tensor, chiral symmetry and associated currents.

Kallen-Lehmann and Lehmann-Symanzik-Zimmermann formulas.

Two and four point functions in  $\lambda\phi^4$  theory at one and two loops, UV divergences, renormalization.

QED at one loop: photon self-energy and quark propagator, electron-photon vertex,  $g-2$ . UV divergences and their renormalization.

## Prerequisites

Quantum mechanics and Theoretical physics I and II

## Teaching form

Lessons and recitations at the blackboard.

During the Covid-19 emergency, lectures will be in video-conference off-line with some events in video-conference online.

## Textbook and teaching resource

S. Weinberg, *The Quantum Theory of Fields*, vol. 1 e 2, Cambridge University Press

M. LeBellac, *Quantum and Statistical Field Theory*, Oxford Science Publications

F. Mandl and G. Shaw, *Quantum field theory*, Wiley

M.E. Peskin and D.V.Schroeder, *An Introduction To Quantum Field Theory*, Perseus

J. Zinn-Justin, *Quantum field theory and critical phenomena*, Oxford Science Publications

## Semester

Second semester, eight hours per week

## Assessment method

Oral exam concerning the topics discussed during the course. The first question is chosen by the student, the others by the examiner.

During the Covid-19 emergency exams will be in video conference only via the software *WebEx*.

## **Office hours**

Students may come to my office any time, preferably Monday 12:30-14:30 . If needed, send an e-mail to fix an appointment.

---