UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Quantum Field Theory II

2021-1-F1701Q134

Aims

To give the conceptual and technical tools of relativistic quantum field theories for studying fundamental interactions

Contents

Path integral formulation of relativistic quantum field theories

Detailed program

Basics of renormalization theory, renormalization of composite operators, operator product expansion (OPE).

Renormalization group: Callan-Symanzik equations and their solution, running of the masses and coupling constants, anomalous dimensions. Asymptotic freedom in non-abelian gauge theories.

Spontaneous symmetry breaking, Goldstone bosons. Current algebra in QCD, pions as Goldstone bosons. Banks-Casher relation and calculation of the chiral condensate on the lattice. Chiral effective theory.

Anomalous breaking of symmetries: anomalies, axial Ward identities in QCD, Witten-Veneziano mechanism, computation of the topological susceptibility on the lattice.

Standard model of the fundamental interactions: gauge group, Higgs mechanism, quark and

lepton masses, see-saw mechanism for neutrino masses. Chiral anomaly cancellation, ‘t Hooft matching.

Effective Hamiltonians for weak decays, Delta I=1/2 rule.

Prerequisites

Quantum mechanics, Theoretical Physics I and II, Quantum field theory I

Teaching form

Lecures 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 Thursday 14:00-16:00 . If needed, send an e-mail to fix an appointment.