UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Theoretical Physics I

2526-1-F1703Q053

Aims

Knowledge and understanding: The student will learn the fundamental concepts of Relativistic Quantum Field Theory.

Applying knowledge and understanding: The student will learn to apply Relativistic Quantum Field Theories to the study of Fundamental Interactions.

Making judgments: The student will develop critical thinking and judgment skills in selecting the most appropriate tool, among those provided during the course, to solve a specific problem, for example for the calculation of a cross section.

Communication skills: The student will be expected to acquire a correct and appropriate scientific language suited to the topics covered in the course.

Learning skills: The student will be able to deepen their understanding of specific concepts not covered during the course and to independently pursue advanced study using specialized scientific texts.

Contents

Formulation of a relativistic quantum field theory in terms of particles and fields. Perturbation theory, Feynman diagrams and the main processes of quantum electrodynamics.

Detailed program

- Classification of fields/particles in terms of representations of the Poincarè group.
- Scalar, fermion and vector fields.
- Relativistic equations of motion.
- Symmetries, conservation laws and Noether theorem.
- Canonical quantization of fields.
- Covariant perturbation theory.
- Feynman propagator.
- Relativistic kinematics, cross sections, decay rates.
- S-matrix and time-ordered products.
- Gauge invariance. Quantum Electrodynamics (QED).
- Spin and statistics. Wick's theorem.
- Feynman rules and Feynman diagrams.
- Tree level processes in Quantum Electrodynamics (QED)

Prerequisites

Deep knowledge of Classical Physics and Quantum Mechanics at the level of a Bachelor in Physics is required. Basic familiarity with Special Relativity, Lorentz transformations and relativistic kinematics.

Teaching form

Lectures in person

Textbook and teaching resource

M.D. Schwartz, Quantum Field Theory and The Standard Model, Cambridge Univ. press
M.E. Peskin, D.V. Schroeder, An Introduction to Quantum Field Theory, Avalon publishing
F. Mandl, G. Shaw, Quantum Field Theory, II Edizione, Wiley ed.

Advanced lectures:
S. Weinberg, Quantum Theory of Fields vol I and II, Cambridge Univ. press
P. Ramond, Field Theory: a modern primer, Avalon publishing

Very good lecture notes are freely available in internet:

Niklas Beisert, Quantum Field Theory (ETH, Zurich)
David Tong, Quantum Field Theory (Cambridge)
Riccardo Rattazzi, Quantum Field Theory (EPFL Lausanne)
Sidney Coleman, Notes on Quantum Field Theory, https://arxiv.org/abs/1110.5013

Semester

First semester, eight hours per week, first half of the semester.

Assessment method

Oral exam based on the discussion of the arguments presented in class: the exam covers the whole program of the course, including exercises and insights carried out during the lessons, which are an integral part of the course. It will be also required to solve a simple exercise related to the arguments discussed (ex: computation of a cross section or mathematical manipulations related to a quantum field theory).

Office hours

Any time upon appointment. Please, send an email to fix the date.

Sustainable Development Goals

QUALITY EDUCATION