UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Particle Physics III

2122-1-F1701Q109

Aims

Provide a wide overview of flavour physics phenomenology in both the hadronic and leptonic sectors. Insight in the experimental aspects (connection between experimental measurements and theory) and searches for physics beyond Standard Model

Contents

Part A)

Production of heavy quarks at different accelerators. Decays and lifetimes of heavy hadrons. The Flavour Structure in the Standard Model. Flavour transitions: the CKM matrix and the measurements of its elements. Oscillations of neutral mesons (K, D, Bd, Bs), measurement of the oscillation parameters. The violation of the CP symmetry(CPV). Measurements of CPV in the B systems. Time reversal. Measurement of rare decays and search for New Physics in flavour transitions. Examples of measurements at e+e-colliders and at hadronic colliders.

Part B)

Experimental observations of neutrino oscillations. The neutrino mixing matrix and the measurement of its parameters. Extension of SM to include neutrino mass terms. Present and future experiments to measure neutrino mass hierarchy and oscillation parameters. Neutrinos and Dark Matter in Astrophysics and Cosmology

Detailed program

Part A)

First observations of heavy quarks. Production of heavy quarks at different accelerators. Bound states, quarkonia, spectroscopy of heavy hadrons. Decays and lifetimes of heavy hadrons. The flavour structure in the Standard Model. Flavour transitions: the CKM matrix and the Unitarity Triangles. Measurements of CKM elements. Oscillations of neutral mesons (K, D, Bd, Bs), measurement of the oscillation parameters. The violation of the CP symmetry (CPV). Measurements of CPV in the B systems: CPV in mixing and in decay. Measurements of the UT angles. Time reversal symmetry. Measurement of rare decays and search for New Physics in flavour transitions. Search for charged lepton flavour violations.

Exemples of measurements performed by experiments at e+e- colliders at Y(4S), at Z^0 and at hadron colliders. e ai collisori adronici.

Part B)

1. Why and how the Standard Model looks incomplete: from dark matter to massive neutrinos. Direct detection of dark matter.

2. Dirac and Majorana massive neutrinos. Lepton number violation and Double Beta Decay. An experiment (CUORE).

3. Vacuum oscillation with 2 neutrinos. Measurements at SuperKamiokande.

4. Vacuum oscillations with 3 neutrinos .Reactor measurements (KamLAND). Hierarchy determination.

5. Matter effect. Solar neutrinos. Measurements at SNO.

6. Neutrino beams. Hyerarchy determination and investigation of CP violation. Sterile neutrinos.

7. Direct measurement of the neutrino mass.

Prerequisites

Basic knowledge of quantum mechanics and basics of particle physics (eg from the course of Particle Physics 1)

Teaching form

Frontal lectures.

Textbook and teaching resource

Slides with lectures' notes available on the e-learning platform.

Mark Thomson, "MODERN PARTICLE PHYSICS", Cambridge University Press, 2013.

A. Bettini, “Introduction to Elementary Particles Physics”, Cambridge University Press; D. Griffiths, “Introduction to Elementary Particles”, 2nd ed. Wiley;

M. Sozzi, "Discrete Symmetries and CP Violation, from experiment to theory" Oxford University Press;

K. Zuber, “Neutrino Physics”

Semester

Second semester

Assessment method

Oral examination about the content of the lectures and the experimental measurements that were presented.

Office hours

By appointment