UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Fisica Nucleare e Subnucleare - M-Z

2526-3-E3001Q048-T2

Aims

1. Knowledge and Understanding
The course provides an advanced understanding of the fundamental concepts of elementary particle physics and nuclear physics. Students will learn:

- the foundations of relativistic kinematics and covariant formalism;
- the characteristics and classifications of elementary particles;
- the main fundamental interactions: electromagnetic (QED), strong (QCD), and weak;
- Gauge symmetry, discrete and continuous symmetries;
- Parity and C-parity;
- decay and scattering phenomena;
- general properties of nuclei, radioactive decays, and nuclear reactions.

2. Applied Knowledge and Understanding
Students will develop the ability to:

- apply theoretical models to the quantitative description of subatomic phenomena;
- interpret Feynman diagrams;
- analyze particle-matter interaction phenomena and understand how particle detectors work;
- describe nuclear processes such as alpha, beta and gamma decays;
- explain decay chains and natural radioactivity;
- link theories and models to experimental results, such as those obtained in the Wu and Goldhaber experiments.

3. Independent Judgment
The course promotes the acquisition of critical tools to:

- assess the reliability and physical significance of theoretical models and experimental data;
- interpret results in the context of the Standard Model;

- recognize the limitations and strengths of different theoretical approaches.

4. Communication Skills
Students will be able to:

- communicate the fundamental concepts of subnuclear and nuclear physics with appropriate terminology;
- present and discuss theoretical or experimental content.

5. Learning Skills
The course aims to develop:

- the ability to independently study advanced scientific texts;
- the habit of consulting specialized literature;
- the methodological foundation for continuing studies in advanced courses or research activities in theoretical, experimental, and applied physics.

Contents

Elementary particles and relativistic kinematics. Experimental techniques for particle detection. Symmetries in particle physics. Electromagnetic interactions. Strong interactions and color charges. Lepton, quarks and hadrons. Weak interactions and the discovery of massive gauge bosons. Nuclei. Radioactive decays and nuclear models.

Detailed program

Point particles and elementary particles. Relativistic kinematics and covariant formalism. Natural units. Decays and scattering. Cross section and decay amplitudes. Particle interactions with matter. Particle detectors. Classical and quantum electrodynamics (QED). Gauge symmetry, discrete and continuous symmetries in QED. Parity and C-parity. Feynman diagrams and scattering in QED. Strong interactions. Quark and color charge. The gauge symmetry of QCD. Asymptotic freedom and confinement. Flavor symmetry and the 2 quark model. Mesons and baryons. Weak interactions. Elicity and chirality. The experiments of Wu and Goldhaber. The electroweak theory. The discovery of weak neutral currents and massive bosons. General properties of the nuclei. Nuclear forces. Nuclear models and reactions. General properties of radioactive decays. Decay chains and secular equilibrium. Natural radioactivity and applications. Alpha decays. Gamma decays. Beta decays.

Prerequisites

Non relativistic quantum mechanics and special relativity

Teaching form

lectures (8 CFU)

Textbook and teaching resource

F. Terranova, A Modern Primer in Particle and Nuclear Physics, Oxford University Press, 2021 (available from 20 october 2020). G. Krane, Introductory Nuclear Physics, Wiley, 1988 (3rd edition)

Semester

second semester

Assessment method

oral exam on Particle Physics and Nuclear Physics

Office hours

on demand

Sustainable Development Goals

QUALITY EDUCATION | AFFORDABLE AND CLEAN ENERGY | INDUSTRY, INNOVATION AND INFRASTRUCTURE