UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

NUCLEAR PHYSICS II

Enrollment year	2020/2021
Academic year	2020/2021
Regulations	DM270
Academic discipline	FIS/04 (NUCLEAR AND SUBNUCLEAR PHYSICS)
Department	DEPARTMENT OF PHYSICS
Course	
Curriculum	Fisica nucleare e subnucleare
Year of study	1°
Period	1st semester (05/10/2020 - 20/01/2021)
ECTS	6
Lesson hours	48 lesson hours
Language	Italian
Activity type	ORAL TEST
Teacher	RADICI MARCO (titolare) - 6 ECTS
Prerequisites	It is recommended to attend the course after Quantum Electrodynamics and Quantum Field Theory.
Learning outcomes	Introduction to phenomenology of hadrons (in particular of the proton, as the prototype of nuclei) in the context of the Strong Interaction of the Standard Model: the Quantum Chromodynamics (QCD). During the course, an overview and a critical discussion are given about the applicability limits of techniques for QCD perturbative calculations. New tools are introduced that are suitable to study the dynamics of confined partons inside hadrons. The ultimate goal, which is still under active investigation in the forefront research in this field called Hadronic Physics, is to try to reconstruct the macroscopic properties of the proton (charge, mass, spin,..) from the microscopic contributions of its elementary constituents. The aim of the course is to provide the student with a general and introductive overview on the phenomenology of Hadronic Physics, with particular emphasys on the spin dynamics, and

	transfer to him the basic skills that are necessary to tackle (maybe in a later step, for example during the Ph.D. studies) more specific topics that are subject of current forefront research.
Course contents	Introduction to phenomenology of low-energy Strong Interactions: the Quantum Chromodynamics (QCD) and the problem of confinement. QCD symmetry groups and the meson and baryon spectroscopy. Young tableaux; G-parity and mesonic nonets; mixing and the OZI selection rule. Color SU(3) group and confinement. Theory of lepton-hadron scattering. Scaling of structure functions. The Parton Model and the partonic densities. The Callan-Gross relation. Phenomenology of inelastic (electroweak) processes, both inclusive and semi-inclusive, with or without polarization. Sum rules. Beyond the Parton Model: scaling violations and Altarelli-Parisi equations. Hints about the Operator Product Expansion (OPE); OPE definition of the partonic densities. The “spin crisis” and the orbital motion of partons inside the parent hadron.
Teaching methods	Traditional lectures projecting Keynote slides and personal notes. All material is available to students on the e-learning framework Kiro either in original format (Keynote) or in PDF. Each lecture is structured as to look as much as possible like an independent seminar, namely a presentation and critical discussion of a specific argument, because this is what the oral examination does consist of.
Reccomended or required readings	- F. Close, "An Introduction to Quarks and Partons" (Academic Press, 1979) - R.K. Bhaduri, "Models of the Nucleon: from Quarks to Soliton" (Addison-Wesley, 1988) - M.E. Peskin and D.V. Schroeder, "An Introduction to Quantum Field Theory" (Addison-Wesley, 1995) - M. Guidry, "Gauge Field Theories - An Introduction with Applications" (John Wiley & Sons, 1991) - R.G. Roberts, "The Structure of the Proton - Deep Inelastic Scattering" (Cambridge Univ. Press, 1990) - C.T.E.Q. Collaboration, "Handbook of perturbative QCD", http://www.phys.psu.edu/~cteq#Handbook Other material available at the e-learning framework Kiro.
Assessment methods	Oral examination. It consists in delivering a seminar, followed by discussion, about deepening the knowledge on a subject to be chosen among those ones listed in the Programme. The main goal is to verify how deep is the student's knowledge of the chosen topic, and to test his/her skills in delivering a clear and effective message in an enjoyable way. In other words, the goal is to educate the student through a professional approach to a problem or to a unknown topic, by developing those skills that are necessary in the academic research activity as well as outside it.
Further information	Oral examination. It consists in delivering a seminar, followed by discussion, about deepening the knowledge on a subject to be chosen among those ones listed in the Programme. The main goal is to verify how deep is the student's knowledge of the chosen topic, and to test

	his/her skills in delivering a clear and effective message in an enjoyable way. In other words, the goal is to educate the student through a professional approach to a problem or to a unknown topic, by developing those skills that are necessary in the academic research activity as well as outside it.
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile