UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Fisica e Chimica - Emilio Segrè
ACADEMIC YEAR	2023/2024
MASTER'S DEGREE (MSC)	PHYSICS
SUBJECT	RADIATION-MATTER INTERACTION
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50338-Astrofisico, geofisico e spaziale
CODE	15308
SCIENTIFIC SECTOR(S)	FIS/05
HEAD PROFESSOR(S)	DI SALVO TIZIANA Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	102
COURSE ACTIVITY (Hrs)	48
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**DI SALVO TIZIANA** Tuesday 15:00 17:00 Sede di via Archirafi 36Ufficio presso il secondo piano Thursday 15:00 17:00 Sede di via Archirafi 36Ufficio presso il secondo piano

DOCENTE: Prof.ssa TIZIANA DI SALVO

PREREQUISITES	This is a course of the first year of the master degree in Physics, addressed to all the students independently of their specializations, so the prerequisites for profitable achieving the learning objectives are the knowledge of mathematics and physics required for enrollment in the Master Degree course in physics, and in particular the knowledge of Physics II and the Special Theory of Relativity.
LEARNING OUTCOMES	Knowledge and understanding: The student must learn the fundamental concepts and results of the interaction between electromagnetic radiation and charged particles or atoms/molecules, and in particular the natural spectrum of the radiation emitted by matter and how the interaction with matter can alter the incident radiation spectrum through scattering, absorption and/or emission processes. Applying knowledge and understanding: The student must know how to use and apply the methods of classical electrodynamics, as well as concepts of special relativity and basic quantum mechanics, in the study of radiation-matter interaction processes. The student will also learn to infer some important physical properties of matter on the basis of the modifications that this causes on the spectrum of the incident radiation (diagnostics). Making judgments: The student must know how to analyze rigorously and critically the fundamental aspects of a problem concerning the interaction of radiation with matter, and he should be able to solve it independently. Communication skills: The student must be able to single out, focus and explain the essential aspects of a specific problem concerning the radiation-matter interaction processes. The student must also be able to explain why some observations have led to the formulation of important physical laws regarding electromagnetic radiation and how it interacts with matter (think for example of the photoelectric effect and the Einstein coefficients, which opened the way to the quantum-mechanical treatment of radiation). Learning ability: The student must be able to independently investigate specialized topics concerning the interaction between electromagnetic radiation and matter.
ASSESSMENT METHODS	The final assessment consists of an oral examination-interview concerning the formulation and discussion of the studied physical laws and their application to infer the properties of matter on the basis of the spectrum of the radiation that interacts with it. This test allows to evaluate, in addition to the knowledge acquired by the candidate and his/her ability to apply it, also his/her use of an appropriate scientific language as well as the ability of a clear and direct presentation. The final assessment, properly graded, will be formulated on the basis of the following conditions: a) Basic knowledge of the studied physical laws and limited ability to apply them in situations similar to those studied, sufficient capability of analysis of the presented phenomena and sufficient ability of a clear presentation of the logical approach (18-21 rating); b) good knowledge of the studied physical laws and ability to apply them independently in situations similar to those studied, fair capability of analysis of the presented phenomena and fair ability of a clear presentation of the logical approach (22-25 rating); c) In-depth knowledge of the studied physical laws and ability to apply them to any proposed physical phenomenon, but not always readily and following a linear approach, good ability of analysis of the presented phenomena and good ability of a clear presentation of the logical approach (26-28 rating); d) deep and widespread knowledge of the studied physical laws and ability to apply them promptly and correctly to any proposed physical phenomenon, excellent analytical skills of the presented phenomena and excellent communication skills (29-30L vote).
EDUCATIONAL OBJECTIVES	The training objective of this course is to give students a master-degree level knowledge of the interaction between electromagnetic radiation and matter. The student learns how to use in this framework not only classical physics and the classical theory of electromagnetism, but also special relativity and some concepts of quantum mechanics. The student learns how the interaction with matter can alter the spectrum of the incident radiation and which physical properties of matter can be deduced from these changes (diagnostics of the physical properties of matter). Some experiments which were particularly significant are also described and explored in the development of twentieth-century physics, some of which have paved the way for important physical theories such as quantum mechanics.

TEACHING METHODS	The didactic activity is developed through frontal lectures, also including figures and videos, in which the teacher illustrates and explains the various topics that are part of the syllabus. During the lectures the teacher is used to stimulate interaction with the students, asking them questions or prompting contributions and questions.
SUGGESTED BIBLIOGRAPHY	Testi di base/Basic Textbooks: - G.B. RYBICKY, A.P. LIGHTMAN, Radiative Processes in Astrophysics - ISBN-10: 0471827592 - ISBN-13: 978-0471827597 - M.S. LONGAIR, High Energy Astrophysics (Part II - Physical Processes) - ISBN-10: 0521756189 - ISBN-13: 978-0521756181 Testi di approfondimento/Supplementary Textbooks: - LANDAU & LIFSHITZ, The Classical Theory of Fields - ISBN: 9780750627689 - MARMIER, Physics of Nuclei and Particles Vol 1 - ISBN: 0124731015, 9780124731011 - Dispense curate dal docente/lecture notes by the teacher

SYLLABUS

Hrs	Frontal teaching
3	Review of special relativity, relativistic treatment of the electromagnetic field.
6	Radiation emitted by an accelerated charge: Larmor formula, relativistic effects on the emitted radiation, relativistic generalization of the Larmor formula.
2	Reviews on the preliminary concepts: cross sections; attenuation; absorption coefficient; mean free path; optical depth.
5	Processes of diffusion and absorption of electromagnetic radiation: Thomson / Rayleigh / harmonic oscillator scattering.
5	Direct and inverse Compton; saturated and unsaturated Comptonization; equilibrium spectra.
4	Physical processes of absorption of the electromagnetic radiation. Review of stimulated and spontaneous emission and Einstein coefficients. Rate equations. Saturation.
5	Photoelectric effect, fluorescence emission and gain, and Auger effect; pair production.
5	Loss of energy through ionization of matter: braking power.
6	Bremsstrahlung emission process; thermal bremsstrahlung; bremsstrahlung absorption; Cherenkov radiation.
5	Cyclotron and synchrotron emission; synchrotron self-absorption.
2	Notes on detectors for high-energy radiation: CCDs, proportional counter, photomultipliers, scintillator crystals, Compton detector, spark chamber.