UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

ELECTRODYNAMICS AND RELATIVITY	
Enrollment year	2020/2021
Academic year	2020/2021
Regulations	DM270
Academic discipline	FIS/02 (THEORETICAL PHYSICS, MATHEMATICAL MODELS AND METHODS)
Department	DEPARTMENT OF PHYSICS
Course	
Curriculum	Fisica teorica
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	CARFORA MAURO (titolare) - 6 ECTS
Prerequisites	Introductory courses in Mechanics and Electrodynamics, Calculus. Advanced topics in tensorial analysis, topology, and differential geometry will be introduced during the lectures.
Learning outcomes	This is an advanced course in special relativity and electrodynamics, aimed to provide a thoughtful introduction to the subject at the level of a beginning graduate student. The level of physical and mathematical sophistication is quite high. Differential forms and advanced calculus are thoroghly used without apology. The objective is that the student can appreciate the nature and character of special relativity and how this theory fits into the general scheme of modern Physics.
Course contents	Introduction to relativity, an overview. Deduction of the Lorentz transformations and their properties. Connecion with group theory. The role of the speed of light. The Lorentz group and the Poincaré group.

Spinorial representation. The universal covering of the Lorentz group: Sl(2,C). Topological properties. Minkowski vector spaces and Minkowski spacetime. Timelike, spacelike, nulllike 4-vectors. The light-cone. Meaning of spacetime separation between events. Causality in Minkowski spacetime: Cronological and causal past and future of an event. Acronal sets. Tensor algebra over a Minkowskian vector space. Vector bundles over Minkowski spacetime. Tensor fields. Differental forms and their properties. Exterior derivative, integration, Stokes theorem and codifferential. Manifestly covariant formulation of electromagnetism: the Faraday 2-form. Examples. Gauge invariance and the 4-potential. The Lorenz gauge. Gauge invariant quantities and topology. The wave equation and retarded Green functions. The Lorentz force and the energy-momentum tensor of the electromagnetic field. Variational deduction of Maxwell equations in manifestly covariant form. Introduction to field theory on Minkowski spacetime. Relativistic kinematics and dynamics. Proper time, 4-velocity and 4-acceleration. Local inertial frames. Proper mass. 4-forces in special relativity. Heat type forces. Conservation laws. Relativistc particle mechanics. 4-momentum conservation and its meaning. Equivalence of energy and mass. Compton and inverse-compton effect. Threshold energies for subnuclear reaction. Inclusive and exclusive processes and their relativistic kinematics. The center of momentum frame. Examples.

Teaching methods

DUE TO THE PRESENT EMERGENCY SITUATION RELATED TO THE COVID19 PANDEMIC, LECTURING WILL BE ONLINE (ZOOM). IF THE SITATION IMPROVES LECTURES WILL RESUME ACCORDING TO THE USUAL WAY AS DESCRIBED BELOW:
Lectures are going the way of the blackboard.
I think that a projector lecturing is unsuitable for mathematics and physics. As a teacher I am not just conveying information, I teach to think mathematically, by example. Calculations are inevitable in our discipline, and it is crucially important to let students feel the subtle play of rhythms, and to highlight recursion and reduction to simpler cases.

Reccomended or required readings

W. Rindler: "Relativity, Special, General and Cosmological" Oxford University Press.
Selected chapers from:
(1) C. Misner, K. Thorne, J. A. Wheeler: "Garvitation", Freeman
(2) I. Madsen, J. Tornehave: "From Calculus to Cohomology", Cambridge Univesrity Press.
(3) S.W. Hawking & G.F.R. Ellis:" The large scale structure of space-time", Cambridge Univ. Press;
(4) J. D. Jackson: "Classical Electrodynamics", John Wiley&Sons;
(5) C. Cattaneo: "Appunti di meccanica relativistica" La Goliardica (Roma)
(6) V. Barone: "Relatività", Boringhieri
R. Penrose and W. Rindler "Spinors and space time" (Vol.1), Cambridge

Assessment methods

The final oral examination is aimed to find out what students have understood of the topics of the course rather than just what they know and can recite. The exam will assess the acquired knowledge of special relativity and electrodynamics, the ability to express and communicate

	as well as the ability to analyze the question posed during the examination, break it down into the relevant key points and work through to provide an acceptable answer. All of these will help me in assessing the success of the student in transitioning from a "knowledge-acquirer" to a practicing physicist who can synthesize and attack complex problems as well create new knowledge by carrying out original research.
Further information	This is an English-Friendly course, and upopn request (even by a small fraction of the students attending the lectures) lectures will be delivered in English.
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile