UCLouvain

lphys1231

2019

Special Relativity

In view of the health context linked to the spread of the coronavirus, the methods of organisation and evaluation of the learning units could be adapted in different situations; these possible new methods have been - or will be - communicated by the teachers to the students.

5 credits	30.0 h + 15.0 h	Q2

Teacher(s)	Gérard Jean-Marc ;
Language :	French
Place of the course	Louvain-la-Neuve
Prerequisites	LPHYS1111 or equivalent teaching unit from another programme. Having followed LPHYS1221 is an asset. *The prerequisite(s) for this Teaching Unit (Unité d'enseignement – UE) for the programmes/courses that offer this Teaching Unit are specified at the end of this sheet.*
Main themes	This teaching unit is a basic introduction to Einstein's **special relativity**. The main themes tackled are geometry in space-time, kinematics and relativistic dynamics.
Aims	1 **a. Contribution of the teaching unit to the learning outcomes of the programme** **AA1 :** 1.1, 1.3, 1.4 **AA2 :** 2.1, 2.4 **AA3 :** 3.2, 3.5 **b. Specific learning outcomes of the teaching unit** At the end of this teaching unit, the student will be able: 1. to handle the concepts of metrics and invariants (from Euclid to Minkowski); 2. to go beyond classical prejudices as simultaneity is currently entirely relative and the addition of non-linear velocities (from Galileo to Einstein); 3. to move from an algebraic approach (Lorentz transformation as applied to a four-vector) to a geometric interpretation (in Minkowski's space-time) to describe phenomena such as time dilation and length contraction; 4. to apply relativistic formalism to particle disintegrations (at rest or in motion) and to elastic collision processes (Compton scattering, etc.) and inelastic collision processes (Mossbauer effect, etc.); 5. to apply relativistic formalism to gravitation (starting from a uniform acceleration motion) and to electromagnetism (starting from the Lorentz force); 6. to fully appreciate the impact (in the very long term) of fundamental research that feeds today's applied research. - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** · Written exam including questions on the development of concepts in physics since Galileo and their experimental confirmation. · Written exam including a kinematics question and (or) a dynamics question referring to tensors. . Written exam including questions on the development of concepts in physics (from Euclid to Mikowski, from Galileo to Einstein, from Newton to Einstein) and their coherent mathematical formulation.

Teaching methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Apply physics and mathematics theories to resolve a problem. We start from the principle that physics is a coherent representation of reality whose truth value rests upon FACTS to illustrate systematically, through phenomena observed in nature, all concepts inherent to the theory of special relativity. Consequently, we choose: - lecture presentations of theory with, in parallel, many applications in physics; - exercise sessions covering other physics applications. Justify the choice of methods and analysis tools used to solve known problems in physics. Incoherence between Newton's mechanics and Maxwell's theory will lead to the development of a covariant theory with respect to the Lorentz transformations. Various exercises on the new mathematical objects that are the tensors will be proposed and solved. Construct a physics argument and formalize it. Development of concepts in physics and an introduction to new formalisms: - from space-time geometry to Lorentz transformations; - from relativistic kinematics to tensors; - from relativistic dynamics to interaction fields.
Content	The main themes addressed are: 1. Geometry in space-time: from rotation in a homogenous space to pseudo-rotation in causal space-time; 2. Relativistic kinematics: from Newton's first law (inertia) to conservation of the four-vector energy-momentum; 3. Relativistic dynamics: from Newton's second law (force) to the existence of electromagnetic (four-vector) and gravitational (tensor) fields.
Bibliography	« Relativité: Fondements et applications (avec 150 exercices et problèmes résolus) », J.-P. Perez (Dunod, Paris, 1999) ; « A student's guide to vectors and tensors », D. Fleisch (Cambridge, 2012).
Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Physical Engineering	FYAP2M	5		
Bachelor in Physics	PHYS1BA	5	LPHYS1111	
Minor in Physics	LPHYS100I	5		