UCLouvain

lphys1332

2022

General Relativity

4.00 credits	30.0 h + 22.5 h	Q1

Teacher(s)	Ringeval Christophe ;
Language :	French > English-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	It is recommended that students master the notions of classical mechanics including in particular the notions of special relativity as developed in the course LPHYS1231.
Main themes	This teaching unit is a basic introduction to Einstein's **general relativity**.
Learning outcomes	**At the end of this learning unit, the student is able to :** **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** 1 At the end of this teaching unit, the student will be able: 1. to think critically about Newton's universal gravitation; 2. to look at familiar phenomena (inertia, free fall, tides, etc.) from a different angle; 3. to understand gravitation as an apparent force that manifests itself through a space-time curvature; 4. to visualize the expansion of the universe on the basis of a Copernican principle; 5. to fully appreciate the impact (in the very long term) of fundamental research that feeds today's applied research.
Evaluation methods	Written exam including questions on the development of concepts in physics in connection to universal gravity (from Newton to Einstein) and their coherent mathematical formulation (from vectors to tensors).
Teaching methods	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 general relativity. Consequently, we choose: - lectures on the theory with, in parallel, many applications in physics; - exercise sessions covering other physics applications. The incoherence between Newton's theory of instantaneous gravity and Einstein's special relativity leads to general relativity. Many exercises will be posed and solved with the Riemannian geometry as a background that underlies this theory. Inductive approach, essentially based upon physical observation, and an introduction to new mathematical formalisms: - from the displacement of Mercury's perihelion to a relativistic theory of gravitation; - free fall of bodies in Riemann's geometry; - recession of galaxies in the Friedmann-Lemaître dynamical models.
Content	1. Difficulties in Newton's theory. 2. From Newton's to Einstein's mechanics. 3. Einstein's equivalence principle. 4. Some features of Riemannian geometry. 5. Einstein's equations in the vacuum. 6. Classic tests of general relativity. 7. Black holes. 8. Einstein's equations in the presence of matter. 9. The cosmological principle. 10. The Friedmann-Lemaître equations.

Bibliography	Unité d'enseignement entièrement basée sur des notes (280 pages avec de nombreuses références) mises à la disposition des étudiant(e)s.
Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Minor in Physics	MINPHYS	4		🔍
Bachelor in Physics	PHYS1BA	4		🔍