

Due to the COVID-19 crisis, the information below is subject to change, in particular that concerning the teaching mode (presential, distance or in a comodal or hybrid format).

4 credits

30.0 h + 22.5 h

Q1

Teacher(s)	G�rard Jean-Marc ;
Language :	French
Place of the course	Louvain-la-Neuve
Prerequisites	<i>The prerequisite(s) for this Teaching Unit (Unit� d'enseignement – UE) for the programmes/courses that offer this Teaching Unit are specified at the end of this sheet.</i>
Main themes	This teaching unit is a basic introduction to Einstein's <b>general relativity</b> .
Aims	<p><b>a. Contribution of the teaching unit to the learning outcomes of the programme</b>  <b>AA1</b> : 1.1, 1.3, 1.4  <b>AA2</b> : 2.1, 2.4  <b>AA3</b> : 3.2, 3.5</p> <p><b>b. Specific learning outcomes of the teaching unit</b></p> <p>At the end of this teaching unit, the student will be able:</p> <ol style="list-style-type: none"> <li>1. to think critically about Newton's universal gravitation;</li> <li>2. to look at familiar phenomena (inertia, free fall, tides, etc.) from a different angle;</li> <li>3. to understand gravitation as an apparent force that manifests itself through a space-time curvature;</li> <li>4. to visualize the expansion of the universe on the basis of a Copernican principle;</li> <li>5. to fully appreciate the impact (in the very long term) of fundamental research that feeds today's applied research.</li> </ol> <p>-----</p> <p><i>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".</i></p>
Evaluation methods	<p><b>Due to the COVID-19 crisis, the information in this section is particularly likely to change.</b></p> <p>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).</p>
Teaching methods	<p><b>Due to the COVID-19 crisis, the information in this section is particularly likely to change.</b></p> <p>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.</p> <p>Consequently, we choose:</p> <ul style="list-style-type: none"> <li>- lectures on the theory with, in parallel, many applications in physics;</li> <li>- exercise sessions covering other physics applications.</li> </ul> <p>The incoherence between Newton's theory of instantaneous gravity and Einstein's special relativity leads to general relativity.</p> <p>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:</p> <ul style="list-style-type: none"> <li>- from the displacement of Mercury's perihelion to a relativistic theory of gravitation;</li> <li>- free fall of bodies in Riemann's geometry;</li> <li>- recession of galaxies in the Friedmann-Lema�tre dynamical models.</li> </ul>
Content	<ol style="list-style-type: none"> <li>1. Difficulties in Newton's theory.</li> <li>2. From Newton's to Einstein's mechanics.</li> <li>3. Einstein's equivalence principle.</li> <li>4. Some features of Riemannian geometry.</li> <li>5. Einstein's equations in the vacuum.</li> <li>6. Classic tests of general relativity.</li> </ol>

	<ol style="list-style-type: none"><li>7. Black holes.</li><li>8. Einstein's equations in the presence of matter.</li><li>9. The cosmological principle.</li><li>10. The Friedmann-Lemaître equations.</li></ol>
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	Aims
Bachelor in Physics	<a href="#">PHYS1BA</a>	4	<a href="#">LPHYS1231</a>	
Minor in Physics	<a href="#">MINPHYS</a>	4	<a href="#">LPHYS1231</a>	