


Teacher(s)	Delaere Christophe ;Gérard Jean-Marc ;Lemaitre Vincent ;
Language :	English
Place of the course	Louvain-la-Neuve
Prerequisites	No prerequisites for students who have obtained a Bachelor's degree in physics and who therefore already have a basic knowledge of classical gravitation (G_N), relativistic mechanics (c), quantum mechanics (h) and, ideally, relativistic gravitation ($G_N + c$).
Main themes	<p>Introduction to the concept of unification based on gauge invariance and description of the sometimes surprising rules governing our universe both at the microscopic level ($\sim 10^{-20}$ m) and at the macroscopic level ($\sim 10^{+26}$ m), through the interactions of its content in matter and energy, namely: ordinary matter, antimatter, extraordinary matter, dark matter and dark energy.</p> <p>Introduction to the major experiments that led not only to the construction of the Standard Model but also to its validation and discussion of the difficulties encountered in their achievements</p>
Learning outcomes	<p>At the end of this learning unit, the student is able to :</p> <p>a. Contribution of the teaching unit to the learning outcomes of the programme (PHYS2M and PHYS2M1) AA1: A1.1, A1.4 AA3: A3.1 AA5: A5.3 AA7: A7.2</p> <p>b. Specific learning outcomes of the teaching unit</p> <p>1 At the end of this teaching unit, the student will be able to:</p> <ol style="list-style-type: none"> 1. formulate the theoretical concepts associated with fundamental interactions (including gravitation) by highlighting a unifying principle, gauge invariance and a separating mechanism, symmetry breaking ; 2. present the great experiments at the base of the Standard Model describing the fundamental interactions (strong, weak and electromagnetic) between the elementary particles (quarks, leptons and bosons of gauges, Higgs boson) ; 3. integrate experimental and data analysis techniques used in modern experiments in particle physics.
Evaluation methods	<ul style="list-style-type: none"> • Oral exam on the whole teaching unit during the exam session. • Preparation of a question of your choice to present orally (either during the examination or during presentation sessions that will eventually be scheduled at the end of the semester). • A "laboratory" report (on the observation of the W and Z bosons at the LHC) and / or a more theoretical project report, to be defended orally.
Teaching methods	Lectures (presentation on the blackboard and projection of transparencies). Integrative project. Practice sessions on analysis of LHC events.
Content	<ol style="list-style-type: none"> 1) Theoretical and experimental introductions to fundamental interactions <ol style="list-style-type: none"> a) long-range (electromagnetism and gravitation) : from classical potentials to relativistic fields ; b) short range (subnuclear) : from confinement (gluons) to spontaneous break (W, Z and h bosons) ; and the properties distinguishing them in processes involving the constituents of matter (quarks and leptons) : <ul style="list-style-type: none"> • conservation of baryonic and leptonic numbers ; • Zweig rule in hadron transitions ; • preservation of flavor in neutral currents ; • violation of flavor in charged currents ; • violation of invariance under spatial and temporal inversion. 2) Description of these processes in terms of observables such as cross sections and life time using simple Feynman diagrams.

Bibliography	High Energy Physics, 4th Edition, D.H. Perkins.
Other infos	Following the sanitary conditions, the modalities of the teaching AND the examination could be reassessed according to the situation and the rules in force.
Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Physics	PHYS2M	10		
Master [60] in Physics	PHYS2M1	10		