UCLouvain

lphys2335

2023

Standard model and beyond

10.00 credits	52.5 h + 7.5 h	Q1

Teacher(s)	Maltoni Fabio ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	LPHYS2132. Having followed LPHYS2131 is an asset
Main themes	The Standard Model (SM) of particle physics : leptons, quarks and the electroweak and strong interactions. Global, gauge and discrete symmetries, explicit and hidden realizations. Perturbative and non-perturbative aspects. Effective field theory approach. Phenomenology of the SM at colliders. The open problems of the SM and the search for new physics.
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 (PHYS2M)** AA1: 1.1, 1.2, 1.6 AA2: 2.3, 2.5 AA3: 3.1, 3.2, 3.3, 3.4 AA6: 4.1 AA7: 7.2 AA8: 8.1, 8.2 1 b. **Specific learning outcomes of the teaching unit** At the end of this teaching unit, the student will be able to : 1. describe the main aspects of the phenomenology of elementary constituents of matter and their fundamental interactions ; 2. master and present the concepts, mechanisms and formalism at the base of the Standard Model of fundamental interactions ; 3. apply the theoretical formalism to cases of interest in high-energy physics and perform computations of relevant observables.
Evaluation methods	Individual oral exam with one question (theme to be chosen in the teaching unit) prepared by the student and two questions randomly taken in the teaching unit.
Teaching methods	Blackboard lectures. Exercises and problems to solve.
Content	1. Elements of the Standard Model of particle physics : leptons. quarks. fundamental interactions. 2. The idea of gauge invariance : abelian and non-abelian gauge theories and their quantization. 3. Hidden symmetries : spontaneous symmetry breaking of global and gauge theories, sigma-model spontaneous breaking of a non-abelian symmetry. 4. The electroweak interactions of leptons : Fermi theory, charged currents, neutral currents, the Standard EW theory of leptons, mechanism of mass generation, the Higgs boson, neutrino mixing and masses, CP-violation. 5. Electroweak interactions of quarks and CKM matrix. Electroweak gauge bosons. 6. Strong interactions at low energy : perturbative vs non-perturbative approaches, chiral symmetry and 1/Nc expansion, effective lagrangian approach and current algebra, U(1)A problem and T invariance, the quark model and hadrons. 7. Perturbative aspects of the strong interactions : QCD lagrangian, symmetries and beta function. 8. Phenomenology of the Standard Model at colliders : electron-proton annihilations, DIS, hadron-hadron interactions. 9. Symmetries of the standard model : custodial symmetry, gauge anomalies cancellation. 10. Beyond the Standard Model : left-right symmetry, simple extensions of the Standard Model and effective field theories.
Bibliography	Chris Quigg, “Gauge Theories of the Strong, Weak and Electromagnetic Interactions”, Princeton Press. Peskin and Schroeder, “An introduction to quantum field theory”, Addison-Wesley.

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		🔍