UCLouvain

lphy2223

2017

Strong interactions and symmetries

5 credits	30.0 h	Q1

Teacher(s)	Gérard Jean-Marc ;Maltoni Fabio ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	This lecture is an introduction to Quantum ChromoDynamics (the theory of strong interactions). Only the perturbative aspects of the theory will be covered in the lecture. Students are assumed to be already familiar with the concept of quantum field theories and (ideally) its application to QED. The lecture introduces some calculation techniques for QCD (Feynman rules, color factors, sum over polarization states, ...) which are later used to explain several notions (factorization principles, renormalization, ...). The emphasis is put on the physical interpretation of QCD rather than on the technical challenges behind the derivation of scattering amplitudes beyond the Born level. However, techniques and notation adopted in the lecture are in close connection with the commonly-used framework in p-QCD studies. In particular the choice of dimensional regularization is favored as opposed to other regularization schemes. The objective of the lecture is two-fold. a) To understand the theoretical notions underlying the cross section predictions for processes governed by the strong interactions. In particular, the lecture will clarify the concepts of fragmentation functions, parton distribution functions, factorization and renormalisation scales, large log resummation, ... to give students an access to a proper interpretation of theoretical results reported in the literature. b) To acquire skills in QCD computation rules by means of explicit calculations (beyond the Born level).
Aims	*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	Written exam + oral defense
Teaching methods	blackboard lecture, suggested exercises on a regular basis
Content	The lecture is organized in 4 parts, covering the aspects summarized below. <u>1. QCD Lagrangian</u> Introduction to non abelian gauge theories. <u>2. Calculation techniques</u> - Heuristic derivation of QCD Feynman rules, and their application. - Gluon polarization states and introduction of the Ghost fields. - Color algebra (decomposition into partial amplitudes, computation rules for the color factors) - Dimensional regularization <u>3. Renormalization (UltraViolet regime)</u> - Structure of the divergences in the UV regime - Renormalization of the fields, the strong coupling constant and the quark masses, (MS-bar scheme vs OnShell scheme). - QCD beta function and asymptotic freedom. - Large log resummation via the evolution of the coupling constant. <u>4. Factorization principles (InfraRed regime)</u> - Structure of divergences in the IR regime. - Renormalization of the parton distribution function/ the fragmentation functions in the MS-bar scheme - DGLAP evolution equation. - Jet production.
Bibliography	1) Introduction to QCD Michelangelo L. Mangano https://cp3.irmp.ucl.ac.be/projects/madgraph/attachment/wiki/QCDUCL/mangano.pdf 2) An introduction to quantum field theory Michael E. Peskin, Dan V. Schroeder 3) QCD and collider physics R.K. Ellis, W.J. Stirling and B.R. Webber

Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Aims
Master [120] in Physics	PHYS2M	5		