Quantum Field Theory, extension

3 EC | Semester 1, period 3 | 5354QFTE3Y

Owner	Master Physics and Astronomy (joint degree)
Coordinator	dr. Juan Rojo Chacon
Part of	Master Mathematical Physics, year 1 Master Physics and Astronomy, track Theoretical Physics, year 1 Master Physics and Astronomy, track GRAPPA, year 1

Course manual 2017/2018

Course content

This course is the natural continuation of the Quantum Field Theory course of Daniel Baumann, and we will assume here that all students have already followed it. The course is divided into two main parts. The first one is an introduction to the renormalisation procedure of QFTs, with the explicit example of lambda Phi^4 theory at some loop. This will include a discussion of a powerful mechanism in QFTs to related phenomena at different scales, the Renormalisation Group flows. The second part of the course is focused on the quantisation of abelian gauge theories. Building upon a review of the properties of Maxwell's electromagnetism, we present the canonical quantisation of the photon field and derive the interaction rules for electrons and photons in Quantum Electrodynamics (QED). If time permits, we will present a first glimpse to QFTs based on non-abelian gauge theories such as Quantum Chromodynamics (QCD).

Study materials

The topics covered in this course are inherited from three main textbooks, namely:

- *Quantum Field Theory*, Mark Srednicki, Cambridge University Press. This textbook is freely accessible online as a .pdf file here
- *Quantum Field Theory and the Standard Mode*l, Matthew D. Schwartz, Cambridge University Press.
- *An introduction to Quantum Field Theory*, Michael E. Peskin and Daniel V. Schroeder, Westview Press.

In addition to these textbooks, the material presented during the course is also available in a somewhat extended version in dedicated lecture notes, which will be made available to the students.

For the interested students, other related online lectures notes that they might consider to also study are the following ones:

- David Tong's lecture notes on Quantum Field Theory
- Sidney Coleman's Harvard Quantum Field Theory course
- Michael Luke's QFT lecture notes:

Objectives

At the end of the course, the student will be able to

- Understand the physical origin of the infinities that arise in calculations of scattering processes in Quantum Field Theory beyond the Born approximation.
- Calculate finite one-loop processes in QFT by removing these infinities using the renormalisation method in the case of the scalar λφ4 theory.
- Relate physical phenomena at different scales by using the renormalisation group flows.
- Quantise electromagnetism and perform calculations involving spin-1 photon fields.
- Understand what are the implications of electromagnetism's classical symmetries at the QFT level. • Become familiar with simple interaction processes in Quantum Electrodynamics.

Teaching methods

› Lecture

The course is divided into eight 2-hour lectures and four 2-hour tutorial sessions.

Learning activities

Activity	Hours	
Hoorcollege	16	
Werkcollege	8	
Self study	60	
Total	84	(3 EC x 28 uur)

Attendance

Requirements concerning attendance (OER-B).

- In addition to, or instead of, classes in the form of lectures, the elements of the master's examination programme often include a practical component as defined in article 1.2 of part A. The course catalogue contains information on the types of classes in each part of the programme. Attendance during practical components is mandatory.

Assessment

Item and weight	Details
Final grade	

Fraud and plagiarism

The 'Regulations governing fraud and plagiarism for UvA students' applies to this course. This will be monitored carefully. Upon suspicion of fraud or plagiarism the Examinations Board of the programme will be informed. For the 'Regulations governing fraud and plagiarism for UvA students' see: www.uva.nl/plagiarism

Course structure

Weeknummer	Onderwerpen	Studiestof
1		
2		
3		
4		

Timetable

The schedule for this course is published on DataNose.

Additional information

Quantum Field Theory

Contact information

Coordinator

› dr. Juan Rojo Chacon

My office is H353 in the Nikhef building. I can be contacted by email using j.rojo@vu.nl. The lecture notes of the course and additional material will also be posted online in my personal webpage http://juanrojo.com/teaching