PX454-15 Theoretical Particle Physics

26/27

Department
Physics
Level
Undergraduate Level 4
Module leader
Paul Harrison
Credit value
15
Module duration
10 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

The Standard Model (SM) of Particle Physics is a quantum field theory with local gauge symmetries. We describe these symmetries and show how to calculate cross sections (experimental observables). We will discuss the Higgs mechanism and spontaneous symmetry breaking, which explain the origin of mass in the SM. Finally, we will look beyond the group structure of the current Standard Model to discuss possible mechanisms for unification of the strong process with the electroweak interaction.

Module web page

Module aims

To develop ideas used in gauge theories and apply these to the field of particle physics. To describe the theory underpinning the Standard Model of Particle Physics and to highlight the symmetry properties of the theory. To discuss the formulation of the Standard Model, including the concept of spontaneous symmetry breaking, and consider further model extensions.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be

covered. Actual sessions held may differ.

Introduction and revision of relativistic quantum mechanics

The mathematical description of symmetries

The gauge principle and implications of gauge invariance

Quantum Field Theory and the generation of Feynman Rules

The gauge structure of QED, QCD and the Electroweak forces

Electroweak unification, predictions and experimental validation

Spontaneous Symmetry Breaking and the Higgs Mechanism

Extensions of the gauge structure of the Standard Model

Learning outcomes

By the end of the module, students should be able to:

- Explain the gauge principle, the mathematical description of symmetry, and the symmetry properties associated with gauge invariance
- Describe how the quarks and leptons, and the bosons that mediate their interactions, can be described by local gauge theories
- Derive Feynman rules from the Lagrangian description of quantum fields
- Use the gauge structure of each of the three interactions, to calculate basic processes in QED
- Explain how the electromagnetic and weak forces were unified and how the concept of spontaneous symmetry breaking (and the Higgs Mechanism) can account for massive gauge fields
- Describe some of the current ideas for extensions of the Standard Model

Indicative reading list

Reading lists can be found in Talis

Specific reading list for the module

Subject specific skills

Knowledge of mathematics and physics. Skills in modelling, reasoning, thinking.

Transferable skills

Analytical, communication, problem-solving, self-study

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Private study	120 hours (80%)
Total	150 hours

Private study description

Working through lecture notes, solving problems, wider reading, discussing with others taking the module, revising for exam, practising on past exam papers

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B

	Weighting	Study time	Eligible for self-certification
Assessment component			
Centrally-timetabled examination (On-campus) Answer 3 questions	100%		No

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- Students may use a calculator
- Answerbook Pink (12 page)

Reassessment component is the same

Feedback on assessment

Personal tutor, group feedback

Past exam papers for PX454

Availability

Courses

This module is Optional for:

- Year 4 of UPXA-F303 Undergraduate Physics (MPhys)

This module is Option list B for:

- Year 4 of UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
- Year 4 of UPXA-F3FA Undergraduate Physics with Astrophysics (MPhys)