PX395-7.5 The Standard Model

20/21

Department
Physics
Level
Undergraduate Level 3
Module leader
Steven Boyd
Credit value
7.5
Module duration
5 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

The Standard Model (SM) describes elementary particles (the quarks, leptons, and bosons) using gauge theories. Although a full quantitative description of the SM requires the machinery of quantum field theory and is not easily accessible, it is quite possible to develop a good qualitative understanding of what is meant by a gauge theory and how this constrains the predictions of the model. A lot follows from symmetry. We will look at Noether's theorem (for any continuous symmetry there is a conserved quantity, eg conservation of charge and invariance under gauge transformations are the same thing), flavour symmetry, parity (P) and others. The module shows how these aspects of the model are tested against experiment. It also looks at the reasons for quark confinement and the concept of a momentum-transfer dependent coupling, the Higgs mechanism, quark mixing and questions about unification.

Module web page

Module aims

To describe the Standard Model of particle physics

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, Preliminaries and Revision:
Particle content, roles of fermions and bosons, anti-particles and virtual boson propagators. The fundamental role of symmetry. Flavour symmetry, parity (P), helicity, charge conjugation (C), CP and CPT

Aspects of the Strong Interaction:
Quark model, evidence for quarks/colour. Running coupling, understanding of confinement, explanation of the OZI Rule, fragmentation/jet production.

Aspects of Weak Interactions:
Charged and neutral-current interactions; Cabibbo/GIM theory, quark mixing, CKM matrix; The phenomena of mixing and CP-violation.

The Structure of the Standard Model:
The Feynman Rules for spinless particle scattering and the calculation of cross-sections/decay rates based on Fermi's Golden Rule. Introduction to the fundamental interactions as local gauge theories of the interactions (QED, QCD and Electroweak).

Learning outcomes

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

- Explain qualitatively how elementary particles and their interactions are described by local gauge theories
- Demonstrate quantitatively important aspects of the model and quote experimental evidence that supports it
- Discuss the limitations of the established theory

Indicative reading list

Introduction to Elementary Particles, David Griffiths, Wiley ;
Modern Elementary Particle Physics, Gordon Kane, Addison Wesley;
Particle Physics, B.R. Martin and G. Shaw, Wiley;
Introduction to High Energy Physics, Donald Perkins, Addison Wesley

View reading list on Talis Aspire

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	15 sessions of 1 hour (20%)
Private study	60 hours (80%)
Total	75 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 B1

Assessment component	Weighting	Study time	Eligible for self-certification
In-person Examination Answer 2 questions out of 3	100%		No

Reassessment component is the same

Feedback on assessment

Personal tutor, group feedback

Past exam papers for PX395

Availability

Courses

This module is Option list A for:

- Year 3 of UPXA-F300 Undergraduate Physics (BSc)
- UPXA-F303 Undergraduate Physics (MPhys)
    - Year 3 of F300 Physics
    - Year 3 of F303 Physics (MPhys)
- Year 4 of UPXA-F301 Undergraduate Physics (with Intercalated Year)

This module is Option list B for:

- Year 3 of UPXA-FG33 Undergraduate Mathematics and Physics (BSc MMathPhys)
- Year 3 of UPXA-GF13 Undergraduate Mathematics and Physics (BSc)
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
    - Year 3 of GF13 Mathematics and Physics
    - Year 3 of FG31 Mathematics and Physics (MMathPhys)
- Year 4 of UPXA-GF14 Undergraduate Mathematics and Physics (with Intercalated Year)
- Year 3 of UPXA-F303 Undergraduate Physics (MPhys)