PX445-15 Advanced Particle Physics

21/22

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) is the basis of our understanding of particle physics. In this module we will look at its successes and at electroweak unification in some detail. We will also discuss some of the unresolved issues with the SM and whether it can be extended to unify all the forces. To date, the SM has been tested over a large range of energies and to considerable precision; for example, the mass of the Z is determined more precisely than G, the gravitational constant. The Standard Model cannot be the final theory since it predicts neither the particle masses nor the strengths of their interactions. Nevertheless, if these parameters are fed in by hand, the SM accounts for all experimental results most impressively. We are in the tantalising situation of having a Model which works surprisingly well but which requires other unknown ingredients in order to turn the Model into a consistent theory.

Module web page

Module aims

To present the theoretical framework, that underpins the Standard Model of particle physics, and use it to make calculations of basic fundamental particle interactions.

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.

1. Introduction.
   Solutions to the Dirac equation, gauge theories, the role of symmetry and group theory.
2. The Feynman Rules.
   Particles with spin and calculations of some lowest order processes in quantum electrodynamics. Extensions to account for the characteristics of the strong and weak interactions.
3. The Electroweak Interaction.
   Advanced topics in weak interaction. Unification of electromagnetism and the weak interaction to give a predictive quantum field theory of the weak interaction at high energies – the electroweak interaction.
4. Beyond the Standard Model (SM).
   The inadequacies of the SM. Unifications of the fundamental forces. Extensions to the SM.

Learning outcomes

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

- Explain how quarks and leptons, and the bosons that mediate their interactions, are described by local gauge theories
- Calculate some lowest order processes in Quantum Electrodynamics.
- Explain the Feynman Rules needed to account for the characteristics of the Strong and Weak interactions
- Explain how spontaneous symmetry breaking and the Higgs Mechanism can account for massive gauge fields
- Discuss the limitations and inadequacies of the Standard Model and where progress in the field is thought likely to come

Indicative reading list

Introduction to Elemenatry Particles, David Griffiths, Wiley; Modern Elementary Particle Physics, Gordon Kane, Addison Wesley; Quarks and Leptons, F. Halzen, A.D. Martin, Wiley; Gauge Theories in Particle Physics I.J.R. Aitchison, A.J.G. Hey, Taylor and Francis (3rd Edition)

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	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 B2

	Weighting	Study time
In-person Examination Answer 3 questions	100%	

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

Feedback on assessment

Personal tutors, group feedback

Past exam papers for PX445

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-FG33 Undergraduate Mathematics and Physics (BSc MMathPhys)
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
    - Year 4 of FG31 Mathematics and Physics (MMathPhys)
    - Year 4 of FG31 Mathematics and Physics (MMathPhys)