PX147-6 Introduction to Particle Physics

20/21

Department
Physics
Level
Undergraduate Level 1
Module leader
Steven Boyd
Credit value
6
Module duration
5 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

The elementary constituents of matter are classified into three generations of quarks and leptons (electrons and neutrinos), which interact with each other through the electromagnetic, the weak and the strong forces. An account of how to classify the elementary particles and their interactions, and a description of some of the experimental tools used to probe their properties, is the subject of this introductory module. The module discusses the relationship between conservation laws and the symmetry of the families of elementary particles. Understanding this relationship is the key to understanding how elementary particles behave. We look at which quantities are conserved by which interactions and how this allows us to interpret simple reactions between particles. We also study how elementary particles interact with matter. One example is that of neutrinos in cosmic rays and their interaction with the earth's atmosphere.

Module web page

Module aims

To provide an introduction to elementary particle physics including the naming and classification of particles, their detection and their interaction with matter

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. The Guiding Principles of Elementary Particle Physics: Simplicity, Composition, Symmetry, Unification
2. Quarks and Leptons as basic building blocks: Periodic Table of Quarks and Leptons; Basic compostion rules for hadrons
3. The four forces and their roles: Electromagnetism, Gravity, Strong nuclear force, Weak nuclear force
4. Symmetries and conservation laws: Introduction through simple examples, Qualitative treatment of relationship between symmetries and conservation Laws, Conservations Laws of EPP
5. Particle Physics in the natural world: Natural radioactivity, source of geothermal energy, Cosmic rays, Natural sources of neutrinos: radioactivity, solar, atmospheric
6. Charged particles in electric and magnetic fields, e/m of the electron, Mass spectrometry, Cathode ray tube, Particle accelerators
7. Interactions of particles with matter: Ionisation, Pair creation by photons and Bremsstrahlung, Hadronic interactions, Exponential probability of interaction: radiation and interaction lengths, Particle detectors
8. The Big questions: Origin of Mass and the Higgs, Grand Unification as a goal, Neutrino character and mass

Learning outcomes

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

- Classify the elementary particles giving the correct quantum number assignments to all quark and lepton flavours
- Discuss qualitatively the relationship between symmetries and conservation laws
- Explain the principles of cathode ray tubes, mass spectrometers and particle accelerators
- Characterise natural radioactivity, cosmic rays, solar and atmospheric neutrinos
- Describe the operation of common particle detectors

Indicative reading list

Chapter 44, of University Physics 11th Edition, HD Young and RA Freedman, Addison Wesley, 2004.

View reading list on Talis Aspire

Interdisciplinary

This module is taken by many students from within Mathematical Sciences (mainly Maths and Physics). Particle physics is about the fundamental laws governing how matter behaves. It is one of the great success stories of interdisciplinary collaboration between mathematics and physics - the Standard Model of particle physics is heavily based on concepts from algebra and differential geometry.

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 (25%)
Tutorials	(0%)
Private study	45 hours (75%)
Total	60 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

	Weighting	Study time	Eligible for self-certification
Assessment component			
In-person Examination Answer two questions	100%		No
Reassessment component is the same			

Feedback on assessment

Personal tutor, group feedback

Past exam papers for PX147

Availability

Courses

This module is Optional for:

- Year 1 of USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics
- Year 1 of UPXA-FG33 Undergraduate Mathematics and Physics (BSc MMathPhys)
- Year 1 of UPXA-GF13 Undergraduate Mathematics and Physics (BSc)
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
    - Year 1 of GF13 Mathematics and Physics
    - Year 1 of FG31 Mathematics and Physics (MMathPhys)
- Year 1 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- Year 1 of USTA-GG14 Undergraduate Mathematics and Statistics (BSc)
- Year 1 of USTA-Y602 Undergraduate Mathematics,Operational Research,Statistics and Economics
- Year 1 of UPXA-F300 Undergraduate Physics (BSc)
- UPXA-F303 Undergraduate Physics (MPhys)
    - Year 1 of F300 Physics
    - Year 1 of F303 Physics (MPhys)
- Year 1 of UPXA-F3N1 Undergraduate Physics and Business Studies
- Year 1 of UPXA-F3N2 Undergraduate Physics with Business Studies

This module is Option list B for:

- Year 1 of UMAA-G100 Undergraduate Mathematics (BSc)
- UMAA-G103 Undergraduate Mathematics (MMath)

    - Year 1 of G100 Mathematics
    - Year 1 of G103 Mathematics (MMath)
- Year 1 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
- Year 1 of UMAA-G1NC Undergraduate Mathematics and Business Studies
- Year 1 of UMAA-G1N2 Undergraduate Mathematics and Business Studies (with Intercalated Year)
- Year 1 of UMAA-GL11 Undergraduate Mathematics and Economics
- Year 1 of UECA-GL12 Undergraduate Mathematics and Economics (with Intercalated Year)
- Year 1 of UMAA-GV18 Undergraduate Mathematics and Philosophy with Intercalated Year
- Year 1 of UMAA-G101 Undergraduate Mathematics with Intercalated Year