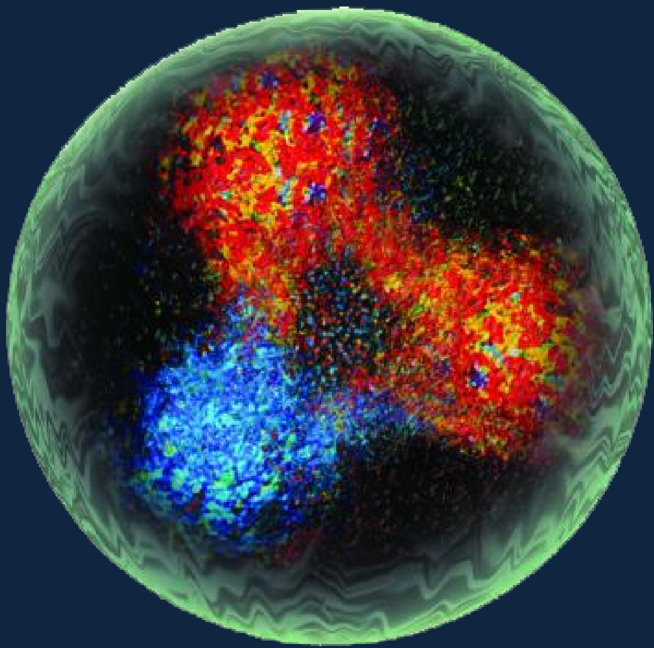
University of Glasgow | School of Physics & Astronomy



PHYS4016 Nuclear Physics

1 Course Details

PHYS4016 Nuclear Physics is a level 4 elective honours physics course, which can also be taken by students at level 5. It is composed of 18 lectures and 2 class tutorials and is normally offered in Semester 2.

Lecturer: Dr David Hamilton
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Recommended Texts:
Part I: Kenneth S. Krane, "Introductory Nuclear Physics", (Wiley),
Part II: E. Henley and A. Garcia, "Subatomic Physics" (World Scientific).

2 Assessment

The course will be assessed via an examination in the April/May diet. It provides 10 H-level credits.

3 Required Knowledge

Students are expected to have completed the Level 4 core course on PHYS 4015 Nuclear and Particle Physics. They should be familiar with the basics of the quark model of hadrons and the shell mode of nuclei. They should also have completed and retained information from the Level 3 PHYS4025 Quantum Mechanics course and be familiar with operators and the applications of the Schrödinger Equation to simple potentials.

4 Intended Learning Outcomes

By the end of the course, students will be able to demonstrate a knowledge and broad understanding of nuclear and hadron physics. They will be familiar with the intrinsic properties of nucleons, nuclei and the nucleon-nucleon force. They should be able to make calculations for the deuteron and understand and be able to operate with the meson-exchange interpretation of the nucleon-nucleon force. They should be familiar with the main models for heavier nuclei: the liquid drop model, the Fermi gas model and the shell model, and be able to explain nuclear structure in their terms. They should understand and be able to operate with the mathematical formalism of scattering, both using electrons and nucleons as a probe, and understand what can be learned from it.

The students should be familiar with the quark model and understand hadrons as bound states of quarks and gluons in low-energy Quantum Chromodynamics (QCD). They should have a basic understanding of quantum field theory in the context of the strong interaction, and be able to describe its main features. They should understand particle decay and the significance of the hadron resonance spectrum. They should be familiar with different types of electron scattering as a probe of quark distributions inside nucleons and be able to explain what has been learned from each. They should be able to perform calculations involving the kinematics of decay and scattering in a relativistic framework.

5 Course Outline

5.1 Nuclear properties

The first part of the course outlines the properties of nuclei and their structure. It provides an introduction to the intrinsic properties of nucleons, nuclear quantum numbers and measurable quantities.

5.2 Scattering experiments

The formalism of scattering will be introduced in this section, covering both nucleon-nucleon scattering (which also gives insight into the nucleon-nucleon force) and electron-nucleus scattering, with examples of what can be learned from it.

5.3 Nucleon-nucleon interaction

The nucleon-nucleon force will be introduced in some detail by considering the simplest bound state, the deuteron.. The meson-exchange interpretation of the force will also be covered.

5.4 Nuclear structure models

The three main historical nuclear structure models (the liquid drop model, the Fermi gas model and the shell model) will be discussed, with examples of their uses and limitations.

5.5 Quarks and hadrons

This section introduces the study of nucleons and other hadrons in terms of their fundamental degrees of freedom. The quark model will be reviewed in terms of its underlying symmetry.

5.6 The strong interaction

This section begins with a general overview of quantum field theory, and highlights some key features and differences between QED and QCD. The link between quark-gluon dynamics and hadron properties is then discussed.

5.7 Hadron spectroscopy

This section covers the hadron resonance spectrum, including what information it carries about nucleon structure and the the strong force. Particle decay is reviewed before discussing the study of charm and exotic hadrons.

5.8 Hadron structure

Starting with a review of relativistic kinematics, the final part of the course covers electron scattering from nucleon targets and what has been learned about parton (quark and gluon) distributions from these types of experiments.