Physics MPhys

COURSE DETAILS

- A level requirements: AAB
- UCAS code: F303
- Study mode: Full-time
- Length: 4 years

KEY DATES

- Apply by: 29 January 2025
- Starts: 22 September 2025

Course overview

This programme is for those considering a career as a professional physicist in fundamental research or industrial research and development. It covers a wider range of topics than the Physics BSc and provides more research experience.

INTRODUCTION

This programme is intended for those considering a career as a professional physicist in fundamental research or industrial research and development. It covers a wider range of topics than the Physics BSc and provides more research experience.

The Department has an excellent track record of securing PhD studentships and, as a consequence, our graduates have a good opportunity to study higher degrees spanning the whole of physics. The research-led teaching will provide a core of experience that will make you an excellent researcher and also prepare you to excel in many other professions.

Anyone who is curious about the fundamental laws of nature will enjoy Physics. It is one of the few disciplines that really challenge our view of the world. For example, in relativity we find that space and time are entangled and that clocks run slowly under the influence of a gravitational field. When we examine the world on a microscopic scale, we are in the realm of quantum mechanics, where the predictions, such as wave-particle duality, even seem strange to the physicists who study its foundations.

Programme in detail

In addition to core physics modules, you will also take mathematics, computing and experimental physics modules. There is an advanced computer modelling project in the third year. There may be opportunities to carry out a major project at an international laboratory such as TRIUMF in Vancouver, CERN in Geneva or the Diamond Light Source in Oxfordshire during the summer vacation between the third and fourth years for three months. These projects are fully paid and can form the basis of a more substantial final-year project at the cutting-edge of research.

There are opportunities to work alongside our internationally renowned academics at projects at the LHC at CERN and in many international and national research centres in the USA, Canada, Japan, Korea and many European countries.

Our flexible programmes allow students to transfer up to the end of year two between any of the physics programmes.

WHAT YOU'LL LEARN

- How to explore and apply the fundamental priniciples of physics
- Numeracy skills
- Problem solving skills
- Ability to reason clearly and comunicate effectively

ACCREDITATION

This programme is accredited by the Institute of Physics, which means it satisfies the academic requirements for Chartered Physicist status.

Course content

Discover what you'll learn, what you'll study, and how you'll be taught and assessed.

YEAR ONE

The first year starts with a one week project to familiarise you with the staff and other students. There will be two maths modules in each of the first two years. These modules are designed to provide the Mathematical skills required by physics students.

COMPULSORY MODULES

DYNAMICS AND RELATIVITY (PHYS101)

Credits: 15 / Semester: semester 1

The module provides an overview of Newtonian mechanics, continuing on from A-level courses. This includes: Newton’s laws of motion in linear and rotational circumstances, gravitation and Kepler’s laws of planetary motion. The theory of Relativity is then introduced, starting from a historical context, through Einstein’s postulates, leading to the Lorentz transformations.

THERMAL PHYSICS AND PROPERTIES OF MATTER (PHYS102)

Credits: 15 / Semester: semester 1

Einstein said in 1949 that "Thermodynamics is the only physical theory of universal content which I am convinced, within the areas of applicability of its basic concepts, will never be overthrown." In this module, different aspects of thermal physics are addressed: (i) classical thermodynamics which deals with macroscopic properties, such as pressure, volume and temperature – the underlying microscopic physics is not included; (ii) kinetic theory of gases describes the properties of gases in terms of probability distributions associated with the motions of individual molecules; and (iii) statistical mechanics which starts from a microscopic description and then employs statistical methods to derive macroscopic properties. The laws of thermodynamics are introduced and applied.

ELECTRICITY, MAGNETISM AND WAVES (PHYS103)

Credits: 15 / Semester: semester 2

Electricity, Magnetism and Waves lie at the heart of physics, being phenomena associated with almost every branch of physics including quantum physics, nuclear physics, condensed matter physics and accelerator physics, as well as numerous applied aspects of physics such as communications science. The course is roughly divided into two sections. The first part introduces the fundamental concepts and principles of electricity and magnetism at an elementary level and develops the integral form of Maxwell’s equations. The second part involves the study of oscillations and waves and focuses on solutions of the wave equation, the principles of superposition, and examples of wave phenomena.

FOUNDATIONS OF QUANTUM PHYSICS (PHYS104)

Credits: 15 / Semester: semester 2

This module illustrates how a series of fascinating experiments, some of which physics students will carry out in their laboratory courses, led to the realisation that Newtonian mechanics does not provide an accurate description of physical reality. As is described in the module, this failure was first seen in interactions at the atomic scale and was first seen in experiments involving atoms and electrons. The module shows how Newton's ideas were replaced by Quantum mechanics, which has been critical to explaining phenomena ranging from the photo-electric effect to the fluctuations in the energy of the Cosmic Microwave Background. The module also explains how this revolution in physicist's thinking paved the way for developments such as the laser.

INTRODUCTION TO COMPUTATIONAL PHYSICS (PHYS105)

Credits: 7.5 / Semester: semester 1

The "Introduction to computational physics" (Phys105) module is designed to introduce physics students to the use of computational techniques appropriate to the solution of physical problems. No previous computing experience is assumed. During the course of the module, students are guided through a series of structured exercises which introduce them to the Python programming language and help them acquire a range of skills including: algorithm development; Manipulating and plotting data in a variety of ways; simple Monte Carlo techniques. The exercises are based around the content of the first year physics modules, both encouraging students to recognise the relevance of computing to their physics studies and enabling them to develop a deeper understanding of aspects of their first year course.

PRACTICAL PHYSICS I (PHYS106)

Credits: 15 / Semester: whole session

This module teaches the laboratory side of physics to complement the taught material from lectures and to introduce key concepts of experimental physics.

MATHEMATICS FOR PHYSICISTS I (PHYS107)

Credits: 15 / Semester: semester 1

This module aims to provide all students with a common foundation in mathematics, necessary for studying the physical sciences and maths courses in later semesters. All topics will begin "from the ground up" by revising ideas which may be familiar from A-level before building on these concepts. In particular, the basic principles of differentiation and integration will be practised, before extending to functions of more than one variable. Basic matrix manipulation will be covered as well as vector algebra and an understanding of eigenvectors and eigenvalues.

MATHEMATICS FOR PHYSICS II (PHYS108)

Credits: 15 / Semester: semester 2

This module introduces some of the mathematical techniques used in physics. For example, differential equations, PDE's, integral vector calculus and series are discussed. The ideas are first presented in lectures and then the put into practice in problems classes, with support from demonstrators and the module lecturer. When you have finished this module, you should: Be familiar with methods for solving first and second order differential equations in one variable. Be familiar with methods for solving partial differential equations and applications. Have a basic knowledge of integral vector calculus. Have a basic understanding of Fourier series and transforms.

OPTIONAL MODULES

INTRODUCTION TO MEDICAL PHYSICS (PHYS115)

Credits: 7.5 / Semester: semester 2

Medical Physics is a diverse field that applies many areas of physics to diagnose and treat people. The course devolves into the physics of the human body including the loading of the skeletal system, visual and audio defects and corrective techniques and how the heart generates an electrical signal that can be measured using an electrocardiogram (ECG). Different types of diagnostic imaging techniques using both ionising and non-ionising radiation is investigated along with therapeutic delivery and the effect radiation has on biological systems.

INTRODUCTION TO NUCLEAR SCIENCE (PHYS135)

Credits: 7.5 / Semester: semester 2

This module introduces underlying principles of nuclear science. The first three weeks will give an introduction to the structure of nuclei, their relative stability, how they decay and properties of different types of radiation. In the second half of the course, after studying nuclear reactions, we will look at various practical applications of nuclear science and the design of nuclear power stations in particular.

INTRODUCTION TO ASTROPHYSICS (PHYS155)

Credits: 7.5 / Semester: semester 2

Astronomy is the study of Universe – applying a broad range of physics (and indeed chemistry and even biology) to both understand the cosmos and our place in it, andit and improve our understanding of the underlying physics. In this module you will be introduced to the constituents of the Uuniverse – from our Solar System, through stars, exoplanets and galaxies, to the evolution of spacetime -– and study some of the observational techniques used to answer outstanding questions about the cosmos.

INTRODUCTION TO GEOPHYSICS (PHYS175)

Credits: 7.5 / Semester: semester 2

Geophysics is the study of the Earth using physics – applying a broad range of physics (along with geology and chemistry) to both understand our planet and our place on it, while improving our understanding of the underlying physics. In this module you will be introduced to the Earth as a physical system. The module will teach students about the structure and composition of the Earth, its gravitational and magnetic fields, and deep dynamics; the physics of Earth materials and the geological time scale; and plate tectonics.

Programme details and modules listed are illustrative only and subject to change.

YEAR TWO

In year two you will broaden your understanding of physics, with modules designed to ensure you have mastered the full range of physics concepts.

COMPULSORY MODULES

ELECTROMAGNETISM I (PHYS201)

Credits: 15 / Semester: semester 2

The study of classical electromagnetism, one of the fundamental physical theories. Several simple and idealised systems will be studied in detail, developing an understanding of the principles underpinning several applications, and setting the foundations for the understanding of more complex systems. Mathematical methods shall be developed and exercised for the study of physical systems.

CONDENSED MATTER PHYSICS (PHYS202)

Credits: 15 / Semester: semester 2

Condensed matter physics (CMP) is the study of the structure and behaviour of matter that makes up most of the things that surround us in our daily lives, including the screen on which you are reading this material. It is not the study of the very small (particle and nuclear physics) or the very large (astrophysics and cosmology) but of the things in between. CMP is concerned with the “condensed” phases of real materials that arise from electromagnetic forces between the constituent atoms, and at its heart is the necessity to understand the behaviour of these phases by using physical laws that include quantum mechanics, electromagnetism and statistical mechanics. Understanding such behaviour leads to the design of novel materials for advanced technological devices that address the challenges that face modern civilization, such as climate change.

QUANTUM AND ATOMIC PHYSICS I (PHYS203)

Credits: 15 / Semester: semester 1

The course aims to introduce 2nd year students to the concepts and formalism of quantum mechanics. The Schrodinger equation is used to describe the physics of quantum systems in bound states (infinite and finite well potentials, harmonic oscillator, hydrogen atoms, multi-electron atoms) or scattering (potential steps and barriers). Basis of atomic spectroscopy are also introduced.

NUCLEAR AND PARTICLE PHYSICS (PHYS204)

Credits: 15 / Semester: semester 1

This module introduces the basic properties of particles and nuclei, their stability, modes of decay, reactions and conservation laws. Recent research in particle physics is highlighted, and for nuclear physics some of the applications (such as nuclear power) are given. This module leads on to more specialist optional modules in Year 3, in particle physics, nuclear physics and nuclear power.

COMPUTATIONAL PHYSICS (PHYS205)

Credits: 15 / Semester: whole session

The "Computational Physics" (PHYS205) module is designed to further develop the computing skills Liverpool Physics students have acquired in their first year of study (in the "Introduction to Computational Physics module, PHYS105). The Python programming techniques covered in PHYS105 are first summarised and revised, then students apply these to a range of physics-based problems which they tackle by analysing data, carrying out small Monte Carlo simulations and using graphing and data presentation methods as appropriate. In the second section of the course, students work in small groups, each of which is given a project to tackle. The groups must first understand the problem they have been given and work out how they can use their computing skills to solve it. They must also manage their work, ensuring that together they develop the algorithms and code they need in the time available. Finally, each group presents their work to their peers and writes a report on their project.

PRACTICAL PHYSICS II (PHYS206)

Credits: 15 / Semester: whole session

The module "Practical Physics II" covers experimental techniques in broad range of physics phenomena which include measurements of fundamental constants, optics, nuclear physics and electronics. The experimental techniques and analysis methods are appropriate for Year 2 courses. Successful students will achieve improved practical skills and experience a detailed understanding of the fundamental physics behind the experiments, increased confidence in setting up and calibrating equipment, familiarity with IT package for calculating, displaying and presenting results, enhanced ability to plan, execute and report the results of an investigation, the skills to assemble, test and debug electronic circuits involving the use of both passive and active electronic components, the skills to write scientific papers

MATHEMATICS FOR PHYSICISTS III (PHYS207)

Credits: 15 / Semester: semester 1

This module extends the previous treatment of vector calculus and linear algebra (vectors and matrices). It provides essential mathematical tools for electrodynamics and quantum mechanics.

OPTIONAL MODULES

ACCELERATORS AND RADIOISOTOPES IN MEDICINE (PHYS246)

Credits: 15 / Semester: semester 2

This module provides an introduction to applications of accelerators and radioisotopes in medical imaging and tumour therapy. Concepts are developed from a simple physics perspective to provide an insight into the principles and practices of these modern medical applications. The lectures are complemented by workshops in which students can work collaboratively on problems to solve set problems. Experimental demonstrations to reinforce concepts also take place in the workshops. As well as being of interest to students considering careers in medical physics or nuclear-related industries, this module should also appeal to those curious to see how physics can be applied in a multidisciplinary approach to other areas of science.

MATHEMATICS FOR PHYSICISTS IV (PHYS208)

Credits: 15 / Semester: semester 2

An introduction to basic mathematic concepts and techniques. Following three semester math courses there the emphasis is on solutions of ordinary and partial differential equations with bits also on relativity, statistics and group theory

STELLAR PHYSICS (PHYS251)

Credits: 15 / Semester: semester 2

Why are some stars faint, while others are millions of times brighter than the Sun? Why do some stars appear blue, while others appear red? Why do some stars suddenly explode, while others slowly fizzle out on timescales longer than the age of the Universe? These questions can be answered once we understand the theory of the physics of stellar structure, and how stars of different masses change in appearance as they evolve.

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YEAR THREE

With the core physics modules completed in the first two years there is now considerable scope to choose amongst the optional modules available, mostly based around the research interests of the departmental staff.

COMPULSORY MODULES

COMPUTATIONAL MODELLING (PHYS305)

Credits: 15 / Semester: semester 2

Computational methods are at the heart of many modern physics experiments and mastering these techniques is invaluable also beyond fundamental research. In this module we introduce students to object-oriented concepts of a modern programming language (Python) and employ this to model experiments. A combination of Monte Carlo methods (based on random trials) and deterministic methods to solve differential equations are used. Students will then apply their knowledge in a small-group project connected to the state-of-the-art research done in the department. The project topics are taken from different areas of particle, nuclear or accelerator physics and range from analyses situated at the Large Hadron Collider to medical applications of proton beams.

QUANTUM AND ATOMIC PHYSICS II (PHYS361)

Credits: 15 / Semester: semester 1

This module concerns the study of quantum mechanics and its application to atomic systems. The description of simple systems will be covered before extending to real systems. Perturbation theory will be used to determine the detailed physical effects seen in atomic systems.

ELECTROMAGNETISM II (PHYS370)

Credits: 15 / Semester: semester 2

The module builds on first and second year modules on electricity, magnetism and waves to show how a wide variety of physical phenomena can be explained in terms of the properties of electromagnetic radiation. The module will also explore how these properties follow from the relationships between electric and magnetic fields (and their interactions with matter) expressed by Maxwell's equations, and how electromagnetism fits into the theory of Special Relativity.

STATISTICAL PHYSICS (PHYS393)

Credits: 7.5 / Semester: semester 2

The problem to understand blackbody radiation opened the door to modern physics. In this module an understanding of thermodynamics is developed from a quantum mechanical and statistical description of the three fundamental gases: The Maxwell-Boltzmann ideal gas in the classical limit, and the Fermi-Dirac and Bose-Einstein gases in the quantum limits for fermions and bosons, respectively. A statistical understanding of thermodynamic quantities will be developed together with a method of deriving thermodynamic potentials from the properties of the quantum system. Applications are shown in solid state physics and the Planck blackbody radiation spectrum.

PRACTICAL PHYSICS III (PHYS306)

Credits: 15 / Semester: semester 1

Year 3 Laboratory.

OPTIONAL MODULES

PHYSICS INTERNSHIP (PHYS309)

Credits: 15 / Semester: summer

The physics internship module is designed to give students the experience of working in a STEM related working environment or setting that is different from any project work that they undertake in the Department of Physics. It should provide an insight into how students may apply skills and experiences later in their career; whether working abroad or in any other non-UoL, off-campus scientific or secondary school setting.

NUCLEAR PHYSICS (PHYS375)

Credits: 7.5 / Semester: semester 1

This module gives an introduction to nuclear physics. Starting from the bulk properties of atomic nuclei different modes of radioactivity are discussed, before a closer look at the nucleon-nucleon interaction leads to the development of the shell model. Collective models of the nucleus leading to a quantitative understanding of rotational and vibrational excitations are developed. Finally, electromagnetic decays between excited states are introduced as spectroscopic tools to probe and understand nuclear structure.

PARTICLE PHYSICS (PHYS377)

Credits: 7.5 / Semester: semester 2

Introduction to Particle Physics. To build on the second year module involving Nuclear and Particle Physics. To develop an understanding of the modern view of particles, of their interactions and the Standard Model.

SOLID STATE PHYSICS (PHYS363)

Credits: 7.5 / Semester: semester 1

Condensed Matter Physics (CMP) is the largest subfield of physics with practical applications that has changed our everyday life such as semiconductor devices, magnetic recording disks, Magnetic resonance imaging. It deals with the study of the structure and physical properties of large collection of atoms that compose materials, which are found in nature or synthesized in laboratory. This particular module aims to advance and extend the concepts on solids introduced in Year 1 and Year 2 modules. Especially, it focuses on the atomic structure and behaviour of electrons in crystalline materials, which are essential for understanding of physical phenomena in complex systems.

MATERIALS PHYSICS AND CHARACTERISATION (PHYS387)

Credits: 7.5 / Semester: semester 1

Preparation and characterisation of a range of materials of scientific and technological importance.

MAGNETIC PROPERTIES OF SOLIDS (PHYS399)

Credits: 7.5 / Semester: semester 2

The magnetic properties of solids are exploited extensively in a wide range of technologies, from hard disk drives, to sensors, to magnetic resonance imaging, and the development of magnetic materials is a multi-billion pound industry. Fundamentally, magnetism in condensed matter also represents one of the best examples of quantum mechanics in action, even at room temperature and on a macroscopically observable scale. In this module we will explore how the interactions between electrons in solids can result in the magnetic moment, and how this relates to the quantum mechanical property of spin. We will use these tools to probe the complicated processes that allow spontaneous magnetism to exist within certain select materials, and their implications for future technologies and our theoretical understanding of the nature of solids.

SEMICONDUCTOR APPLICATIONS (PHYS389)

Credits: 7.5 / Semester: semester 1

This module develops the physics concepts describing semiconductors in sufficient details for the purpose of understanding the construction and operation of common semiconductor devices.

STATISTICS FOR PHYSICS ANALYSIS (PHYS392)

Credits: 15 / Semester: semester 1

Statistical Methods in Physics Analysis: Understanding Statistics and its application to data analysis

ENERGY GENERATION AND STORAGE (PHYS372)

Credits: 7.5 / Semester: semester 2

Producing sufficient energy to meet the demands of an expanding and increasingly power-hungry society, whilst striving not to exacerbate the impacts of climate change, is a significant challenge. This module looks at the key physical concepts which underpin a range of energy generation sources, from traditional fossil fuel fired turbine generation to photovoltaic solar cells. This builds on prior knowledge of thermodynamics, fluid behaviour and semiconductors to show how these concepts can be practically applied to power generation and storage systems.

NUCLEAR POWER (PHYS376)

Credits: 7.5 / Semester: semester 2

This module focuses on nuclear reactors as a source of energy for use by society. After reviewing the underlying physics principles, the design and operation and nuclear fission reactors is introduced. The possibility of energy from nuclear fusion is then discussed, with the present status and outlook given.

MEDICAL APPLICATIONS (PHYS384)

Credits: 15 / Semester: semester 2

In this module, students will develop an understanding of the principles of radiotherapy and treatment planning. Topics include interaction of radiation with biological matter, radiation transport, biological modelling, beam modelling, medical imaging, electron transport and treatment planning.

STELLAR ATMOSPHERES (PHYS352)

Credits: 7.5 / Semester: semester 2

This c ourse aims at providing students with a basic knowledge of the principles of radiation transport, the interaction of photons and matter, the computation of stellar atmosphere models, the application of radiation transport methods to expanding atmospheres such as stellar winds and Supernova envelopes. We also look at how stellar winds are created and at the properties of Supernovae.

PLANETARY PHYSICS (PHYS355)

Credits: 7.5 / Semester: semester 2

This course considers the application of physics to the study of planets, with a focus on the application of fundamental physical principles rather than providing detailed planetary descriptions. The first four weeks address the planets of our solar system, including what constraint is provided on their physics from studies of our own planet, Earth. We consider particularly insights from observations of orbits, gravitational field, rotation, thermal properties and magnetic field, with brief coverage of formation,composition, and seismology. The focus is on application of basic physical principles rather than detailed observational descriptions, and on methods that might (eventually) be of use in the study of exoplanets. The final two weeks considers exoplanets specifically, particularly the methods of their detection,and our current understanding of planetary systems in general.

PHYSICS OF GALAXIES (PHYS373)

Credits: 15 / Semester: semester 1

This module covers the physics and observational techniques of the field of Galactic Astrophysics

RELATIVITY AND COSMOLOGY (PHYS374)

Credits: 15 / Semester: semester 2

The course covers the concepts required to connect special relativity, Newtonian gravity, general relativity, and the cosmological metrics and dynamical equations. The main part of the course is focussed on cosmology, which is study of the content of the universe, structure on the largest scales, and its dynamical evolution. This is covered from both a theoretical and observational perspective.

PHYSICS OF SOUND AND MUSIC (PHYS321)

Credits: 7.5 / Semester: semester 2

Musical instruments are made up of a variety of simple physical systems: vibrating strings, membranes and shells. When combined, these simple systems generate the rich and varied spectra of the Stradivarius violin, a kettle drum, or a clarinet. This module looks at the physics underpinning the generation of the unique sounds of a variety of instruments (stringed, wind, percussion) and develops the tools needed to analyse sound. It builds on an understanding of Newtonian dynamics and waves, and explores how complexity emerges from simple building blocks.

SURFACES AND INTERFACES (PHYS381)

Credits: 7.5 / Semester: semester 2

This module gives a brief introduction into the physics of solid surfaces their experimental study. Surfaces and interfaces are everywhere and many surface-related phenomena are common in daily life (texture, friction, surface-tension, corrosion, heterogeneous catalysis). Here we are concerned with understanding the microscopic properties of surfaces, asking questions like: what is the atomic structure of the surface compared to that of the bulk? What happens to the electronic properties and vibrational properties upon creating a surface? What happens in detail when we adsorb an atom or a molecule on a surface? This module will mostly concentrate on simple model systems like the clean and defect-free surface of a single-crystal substrate.

Programme details and modules listed are illustrative only and subject to change.

YEAR FOUR

In the final year of the course you will have considerable flexibility to choose between the many optional modules based around various physics research areas. You will also undertake an extended project with a member of staff, normally in their research area.

COMPULSORY MODULES

PROJECT (MPHYS) (PHYS498)

Credits: 30 / Semester: whole session

This module involves the student engaging in a detailed project typically based in one of the research groups within the Department of Physics. The student will be conducting independent research under the supervision of one or more academic staff members. The output of the project will be written up in a project report and presented in the form of a poster.

OPTIONAL MODULES

CLASSICAL MECHANICS (PHYS470)

Credits: 15 / Semester: semester 1

The module will build on students' existing knowledge of Newtonian mechanics, and introduce important principles, concepts and techniques from Lagrangian and Hamiltonian mechanics. The core material will be based on systems of particles, but field theory will also be discussed. The focus will be on application of these topics to classical systems, but this will also give some insight into fundamental aspects of modern physics (including quantum mechanics). Delivery will be through lectures and tutorials/problems classes.

ADVANCED QUANTUM PHYSICS (PHYS480)

Credits: 15 / Semester: semester 1

Modern concepts and advanced quantum mechanics problems will be discussed in depth and supported by complex calculations. In the course it will be demonstrated that quantum mechanics is an extraordinary successful theory describing nature, i.e. part of the course emphasis is on applications of quantum physics and state-of-the art experiments, but not always in full detail.

ACCELERATOR PHYSICS (PHYS481)

Credits: 7.5 / Semester: semester 1

There are almost 50,000 particle accelerators in the world, ranging from the linear accelerators used for cancer therapy in modern hospitals to the giant 'atom-smashers' at international particle physics laboratories used to unlock the secrets of creation.

Accelerator and beam physics is a broad discipline that draws on concepts from linear and nonlinear mechanics, electrodynamics, special relativity, plasma physics, statistical mechanics, and quantum mechanics.

This course covers the fundamental physical principles of particle accelerators, with a focus on basic beam dynamics and beam diagnostics. It teaches the fundamental concepts of the most commonly used accelerator types, beam motion and diagnostics. The course links these concepts to the current research programmes of the Liverpool Accelerator Group, based at the Cockcroft Institute.

NANOSCALE PHYSICS AND TECHNOLOGY (PHYS499)

Credits: 7.5 / Semester: semester 2

This module introduces the current and active field of nanoscale physics and technology. It will cover basic physics at the nanoscale as well as nanoscale fabrication and characterisation techniques and will discuss a range of applications of nanostructures.

PHYSICS OF LIFE (PHYS482)

Credits: 7.5 / Semester: semester 2

This module begins with a description of the physical conditions necessary for the evolution of life in a universe. It gives an introduction to the physical principles that underpin the organisation and activity of living things including aspects of evolution and ecology. It also gives an introduction to current thinking of how life evolved on earth and of the sensitivity of the biosphere to changes in the earth's orbit and the composition of its atmosphere. It will provide physical insight into the drivers of climate change, the loss of biodiversity, the origin of disease and the spread of bacterial resistant to antibiotics.

ADVANCED NUCLEAR PHYSICS (PHYS490)

Credits: 15 / Semester: semester 2

The Advanced Nuclear Physics course introduces forms of the nucleon-nucleon interaction and the nuclear mean-field potential. Deformation (non-spherical nuclear shapes) is introduced via the deformed shell model (Nilsson model) and collective modes of excitation discussed. Exotic nuclear behaviour at the extremes of spin (angular momentum), isospin (proton-neutron imbalance) and charge/mass (superheavy elements) is presented. Various types of nuclear reaction are discussed, particularly in relation to the astrophysical creation of the elements.

NEUTRINOS AND DARK MATTER (PHYS492)

Credits: 7.5 / Semester: semester 2

Neutrinos are fundamental particles that were thought to be simple massless particles that only experienced the weak interaction. Recent measurements have shown that the neutrino is much more complex and these particles can potentially provide a window into new areas of physics. Observations of the structure of the universe require the existence of a new form of a new form of gravitationally interacting matter known as dark matter. Experiments to detect neutrinos and dark matter both have distinct features to achieve the extremely low backgrounds that are required to measure these particles. This course will discuss the field of neutrinos physics and dark matter and these low background techniques.

ADVANCED PARTICLE PHYSICS (PHYS493)

Credits: 15 / Semester: semester 2

This module looks at how basic calculations are done in particle physics.
Relativistic quantum mechanics and their limitations are introduced and applied to various particle physics problems. Feynman rules are discussed and examples of calculations of cross sections and particle lifetimes are given in the context of electromagnetic, weak and strong interactions. The development of the electroweak theory and the Higgs boson, as well some historical elements and description of current particle physics research are also covered.

STELLAR POPULATIONS (PHYS483)

Credits: 15 / Semester: semester 1

This module starts from our knowledge of stellar evolution, to describe methods employed by astrophysicists to determine chemical composition and ages of stellar populations in the universe. This is a crucial information needed to understand how galaxies form and evolve in time. Examples of applications of these techniques to real observations will be also shown.

ELEMENTS OF STELLAR DYNAMICS (PHYS484)

Credits: 7.5 / Semester: semester 2

Stellar clusters, galaxies, clusters of galaxies are held together by mutual gravity of their components: mainly stars and possibly dark matter. In this module, you will learn how systems containing millions and billions of point-like gravitating bodies sustain and evolve. Although only Newton's law shapes these systems, you will see that a lot can be implied from it when one employs sophisticated mathematical tools.

PHYSICS OF THE RADIATIVE UNIVERSE (PHYS485)

Credits: 15 / Semester: semester 2

This module will look at some of the many ways that matter and radiation interact, in relativistic and non-relativistic physical contexts. The aims of the module are:

To see how physical phenomena can be applied and used to explain the appearance and spectra of celestial objects
To provide an astrophysical context for statistical mechanics
To introduce Einstein's A and B coefficients
To understand the importance of the hydrogen 21cm line
To demonstrate how emission line ratios inform on physical properties.

TIME DOMAIN ASTROPHYSICS (PHYS453)

Credits: 7.5 / Semester: semester 2

Building on the content of the Stellar Atmospheres Module, Time Domain Astrophysics explores the transient Universe, in particular the explorive transients such as Novae, Supernovae, and Gamma Ray Bursts. This module is delivered by an ensemble of staff, all delivering content in which they are expert researchers.

CORRELATED ELECTRON MATERIALS (PHYS486)

Credits: 7.5 / Semester: semester 1

Some of the most intriguing properties of matter arise because of the mutual interaction between electrons, causing correlations between them. Materials which display electron correlations offer great potential for developing new materials for technological applications. However, attempts to explain such phenomena by considering electrons individually largely fail, and enormous effort has been dedicated to developing theories which can account for such unexpected properties of matter. Two of the most well-known and heavily investigated correlated electron phenomena include ferromagnetism and superconductivity. As key examples, here we will explore these effects, building up from phenomenological description to fundamental theory and eventually to describe and plan experimental observations. We will extend these ideas to contemporary strongly correlated electron materials, and the current limitations in our understanding of these materials.

PHYSICAL PRINCIPLES OF MATERIALS (PHYS487)

Credits: 7.5 / Semester: semester 1

This is an advanced module on understanding the behaviour of materials that is suitable for final year Physics undergraduate students. It covers the systematic basis of materials preparation, defects together with point defect and phase behaviour. There are case studies on important classes of materials. The module is complementary to, but does not duplicate, Physics modules about for example the electrical and magnetic properties of solids.

Programme details and modules listed are illustrative only and subject to change.

HOW YOU'LL LEARN

Our research-led teaching ensures you are taught the latest advances in cutting-edge physics research. Lectures introduce and provide the details of the various areas of physics and related subjects. You will be working in tutorials and problem-solving workshops, which are another crucial element in the learning process, where you put your knowledge into practice. They help you to develop a working knowledge and understanding of physics. All of the lecturers also perform world class research and use this to enhance their teaching.

Most work takes place in small groups with a tutor or in a larger class where staff provide help as needed. Practical work is an integral part of the programmes, and ranges from training in basic laboratory skills in the first two years to a research project in the third or fourth year. You will undertake an extended project on a research topic with a member of staff who will mentor you. By the end of the degree you will be well prepared to tackle problems in any area and present yourself and your work both in writing and in person. In the first two years students take maths modules which provide the support all students need to understand the physics topics.

HOW YOU'RE ASSESSED

The main modes of assessment are coursework and examination. Depending on the modules taken you may encounter project work, presentations (individual or group), and specific tests or tasks focused on solidifying learning outcomes.

LIVERPOOL HALLMARKS

We have a distinctive approach to education, the Liverpool Curriculum Framework, which focuses on research-connected teaching, active learning, and authentic assessment to ensure our students graduate as digitally fluent and confident global citizens.

Careers and employability

A physics degree is a great starting point for a physics related career, engineering and computing careers.

The knowledge, skills and experience that our you'll develop during your degree are in demand by employers. Graduates have gone on to explore careers in areas as diverse as:

- Telecommunications
- Microelectronics
- Nuclear power
- Instrumentation
- Cryogenics
- Astronomy
- Geophysics
- Medical physics
- Materials science
- Computing
- Teaching
- Business
- Finance
- Management.

Progressing to research

The Department of Physics attracts considerable research income, creating excellent opportunities to progress to a research degree, particularly in the fields of condensed matter physics, nuclear physics, particle physics, nanoscience and energy.

88% **OF PHYSICS STUDENTS FIND THEIR MAIN ACTIVITY AFTER GRADUATION MEANINGFUL.**

Graduate Outcomes, 2018-19.

Fees and funding

Your tuition fees, funding your studies, and other costs to consider.

TUITION FEES

UK fees (applies to Channel Islands, Isle of Man and Republic of Ireland)	
Full-time place, per year	£9,250
Year in industry fee	£1,850
Year abroad fee	£1,385

International fees	
Full-time place, per year	£27,200
Year in industry fee	£1,850
Year abroad fee	£13,600

Fees shown are for the academic year 2024/25. Please note that the Year Abroad fee also applies to the Year in China.

Tuition fees cover the cost of your teaching and assessment, operating facilities such as libraries, IT equipment, and access to academic and personal support. Learn more about paying for your studies..

ADDITIONAL COSTS

We understand that budgeting for your time at university is important, and we want to make sure you understand any course-related costs that are not covered by your tuition fee. This may include a laptop, books, or stationery. Additional costs for this course could include travel to placements.

Find out more about the additional study costs that may apply to this course.

SCHOLARSHIPS AND BURSARIES

We offer a range of scholarships and bursaries to provide tuition fee discounts and help with living expenses while at university.

Check out our Liverpool Bursary, worth up to £2,000 per year for eligible UK students. Or for international students, our Undergraduate Global Advancement Scholarship offers a tuition fee discount of up to £5,000 for eligible international students starting an undergraduate degree from September 2024.

Discover our full range of undergraduate scholarships and bursaries

Entry requirements

The qualifications and exam results you'll need to apply for this course.

Your qualification	Requirements About our typical entry requirements
A levels	AAB Applicants with the Extended Project Qualification (EPQ) are eligible for a reduction in grade requirements. For this course, the offer is **ABB** with **A** in the EPQ. You may automatically qualify for reduced entry requirements through our contextual offers scheme.
GCSE	4/C in English and 4/C in Mathematics
Subject requirements	For applicants from England: Where a science has been taken at A level (Chemistry, Biology or Physics), a pass in the Science practical of each subject will be required.
BTEC Level 3 National Extended Diploma	Applications considered alongside A levels. Please contact the University for further information.
International Baccalaureate	35 points that must include 6 points each from Physics and Mathematics at Higher level.
Irish Leaving Certificate	H1, H1, H2, H2, H2, H3 including Physics and Mathematics at H2 or above.
Scottish Higher/Advanced Higher	Advanced Highers accepted at grades AAB including Physics and Mathematics.
Welsh Baccalaureate	Accepted at grade B, including Mathematics and Physics A Levels at AA.

Your qualification	Requirements About our typical entry requirements
Advanced	
Access	45 Level 3 credits in graded units in a relevant Diploma, including 39 at Distinction and a further 6 with at least Merit
International qualifications	Many countries have a different education system to that of the UK, meaning your qualifications may not meet our entry requirements. Completing your Foundation Certificate, such as that offered by the University of Liverpool International College, means you're guaranteed a place on your chosen course.

ALTERNATIVE ENTRY REQUIREMENTS

- If your qualification isn't listed here, or you're taking a combination of qualifications, contact us for advice
- Applications from mature students are welcome.

THE ORIGINAL REDBRICK