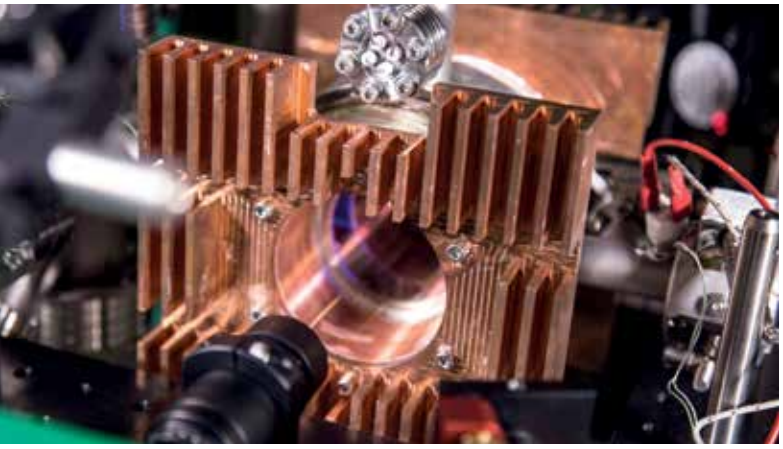
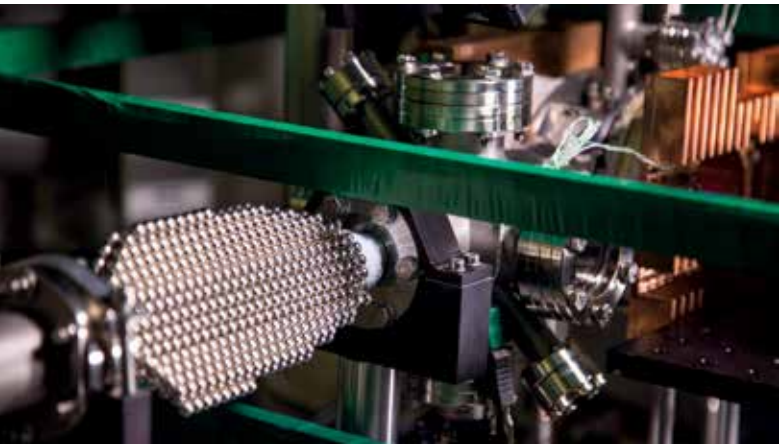
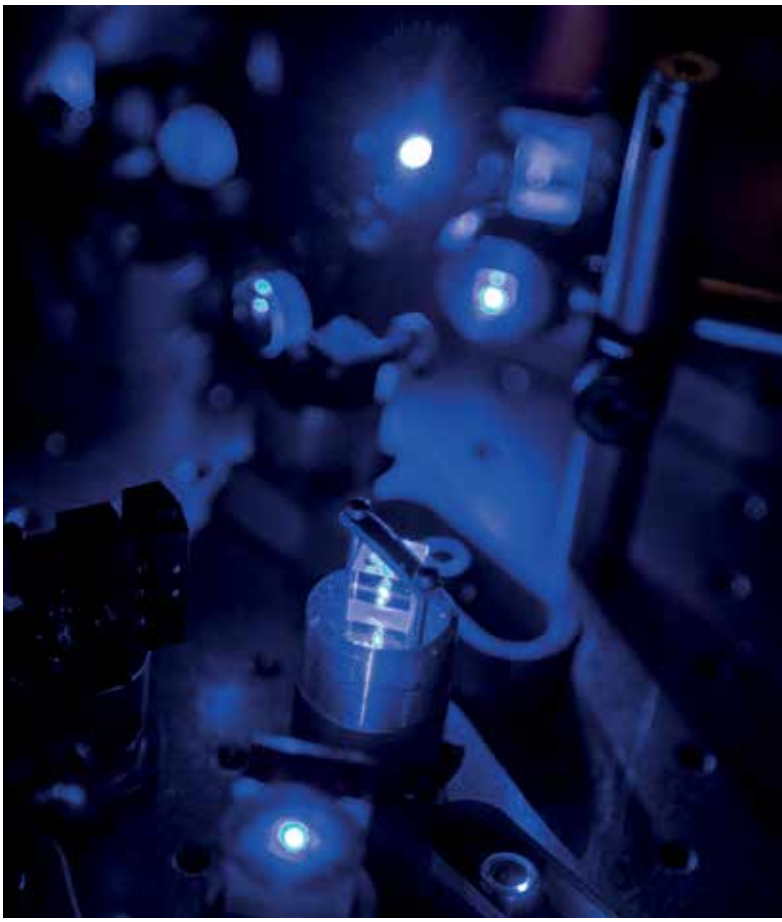
UNIVERSITY OF BIRMINGHAM | SCHOOL OF PHYSICS AND ASTRONOMY

UNDERGRADUATE PROGRAMMES IN PHYSICS AND ASTRONOMY







Welcome

Why is there a supermassive black hole at the centre of the Milky Way and what happens when black holes and neutron stars merge? What happened at the time of the Big Bang? What happens to quantum matter at the lowest temperatures in the Universe? Why can we never isolate a quark? Why is there a matter-antimatter asymmetry in the Universe? What makes a superconductor have no electrical resistance? Can we make invisibility cloaks? What is the future for nuclear energy? Can we find planets like Earth that could sustain life?

In the School of Physics and Astronomy, we are working to answer many of the fundamental questions of our time and as a student in the School, you will take your first steps in becoming part of this endeavour too. You'll be taught by experts across many areas of physics that reach from the fundamental to the applied. Plus, you can take advantage of some of the fantastic scientific facilities the School hosts. This includes our own particle accelerator, the MC40 cyclotron, and laboratories used for the construction of the detectors and electronics used in the experiments at the LHC, CERN. If you choose to take an MSci course, in your fourth year you will become a member of a research group for your final-year research project. You will benefit directly from our research by being taught by internationally acknowledged experts at the research frontiers of physics and, crucially, by taking part in the research itself.

Joining the School of Physics and Astronomy at Birmingham means you will become a part of a community with a long history of scientific innovation. The School was founded in 1890 by John Henry Poynting, who developed the Poynting vector, which describes the direction and magnitude of electromagnetic energy flow. He also performed a measurement of Newton's gravitational constant with great precision. Birmingham was the home of developments of the proton synchrotron, led by Oliphant, and in the 1950s had a 1 GeV proton accelerator. A synchrotron is a type of cyclic particle accelerator, which was first conceived by Oliphant, and is the forerunner of the Large Hadron Collider at CERN. Other research of historical significance at Birmingham includes the work of Randall and Boot, which led to the development of the cavity magnetron and applications such as airborne radar and the microwave oven.

Physics research at Birmingham has contributed to many internationally recognised discoveries, including those awarded Nobel Prizes. We were part of the discovery of the Higgs boson with the ATLAS detector at CERN, which led to the 2013 Nobel Prize. Our scientists are part of the LIGO collaboration which detected gravitational waves, winning the founders of the experiment the 2017 Nobel Prize. Two of the three 2016 Physics Nobel winners, Mike Kosterlitz and David Thouless, did their prize-winning research on topological phases of matter at Birmingham. The particle physics group's work led to the precision measurements of the W and Z, communicators of the weak interaction, which won the 1984 Nobel Prize.

Building on this rich heritage of scientific discovery, we continue to push the boundaries of scientific knowledge across a very wide spectrum of research areas, which includes astronomy, chemical physics, condensed matter experiment and theory, gravitational waves, helio- and astero-seismology and exoplanets, metamaterials, nanophysics, pure and applied nuclear physics, particle physics, quantum physics and ultra-cold atoms. We have some of the leading researchers in these fields, who will pass their cutting-edge knowledge on to you during lectures, tutorials, labs and project work.

We are home to one of the four UK Quantum Technology Hubs, which at Birmingham is developing state-of-the-art quantum sensors. The Quantum Technology Hub has engaged with more than 100 companies and has a portfolio of projects of around £75 million. The Hub is set to transform how quantum science is applied in industry. In 2019, we were awarded a Centre for Doctoral Training, by the Engineering and Physical Sciences Research Council. This flagship centre will train 50 PhD students in the subject of Topology, which relates to the 2016 Nobel Prize. It is a field which is related to geometry, but links physics and mathematics to engineering and applications. The University of Birmingham has world-leading expertise in this area.

Here in the School of Physics and Astronomy we place a strong emphasis on small-group, personalised, teaching. You'll find significant contact hours are given over to small-group teaching, from Year 1 and 2 weekly tutorials involving no more than four students, to detailed discussion of research project results in later years. These small-group interactions help you to build confidence in talking the language of physics, and develop skills to offer reasoned arguments. You'll leave Birmingham able to apply these skills in physics or a range of other fields and industries.

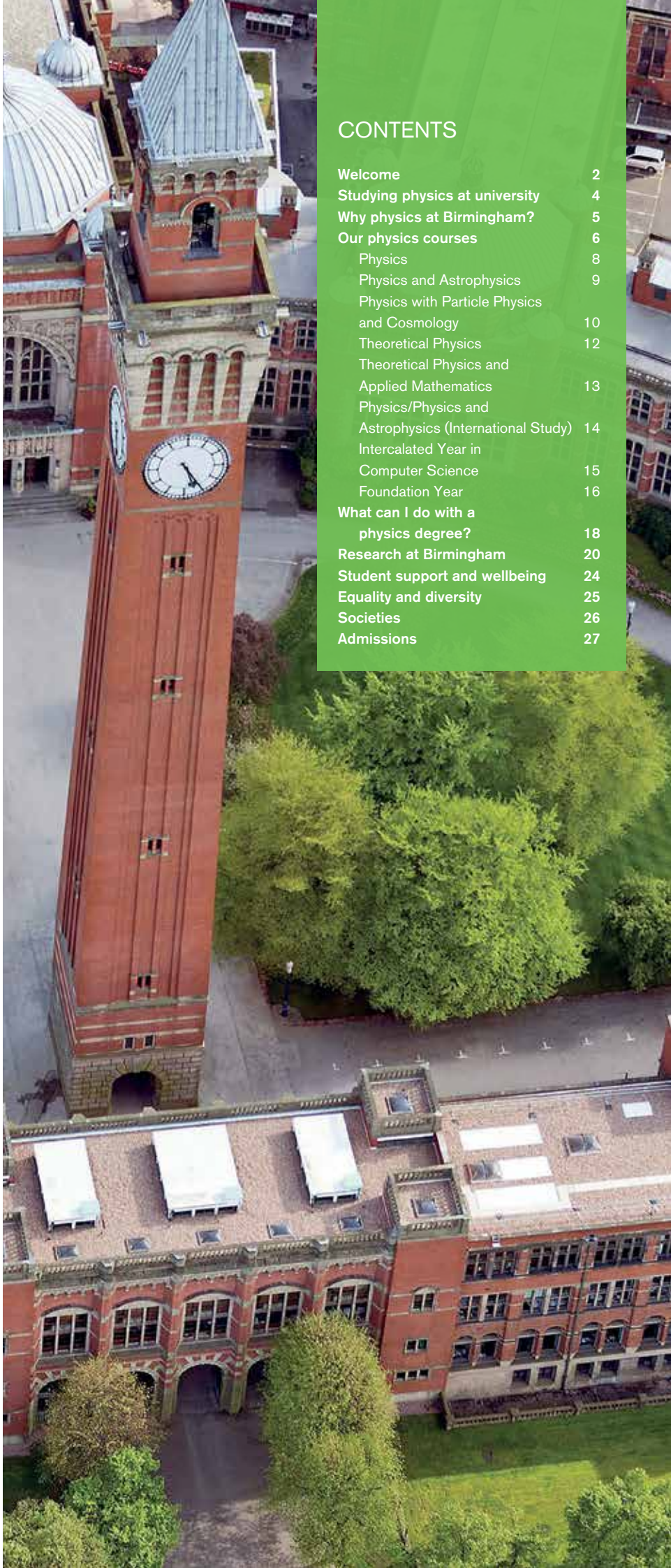
Our degree programmes contain all the transferable skills which employers desire, including team-working, communication skills and independent working in projects. Combined with the training you'll receive in problem-solving, experimental skills, mathematics and computing, you will have excellent preparation for careers in areas such as fundamental research and technology as well as finance and management. In 2017, the School of Physics and Astronomy was the top performing physics department in the UK for graduate employability. As measured nationally, 94% of our graduates had graduate level careers within six months of completing their degree. The School works hard to create success for all of our students and has a comprehensive programme of careers advice and development throughout the degree programme.

Finally, we are proud of the fact that our students find their time with us fulfilling and enjoyable. We include the students in the development of the teaching and the operation of the School. There is a well-developed student representative system which allows you to have input into the School's teaching on a weekly basis. We are extremely fortunate to have highly motivated student societies. They do a great job of organising everything from social to outreach events. They really are the heart of the School, which means that in addition to working hard, students also have great fun.

We will be very pleased to welcome you to the School to find out more about our degrees and the University in general. Details of Open Days and Offer-Holder Days are on our web page or available by phone or email from the Admissions Team. We look forward to meeting you during your visit.

Cover Image: Vacuum chamber and optical set-up for laser cooling and trapping of strontium atoms.

We lead the Quantum Technology Hub for Sensors and Metrology, which is creating sensors and clocks with new levels of sensitivity, to improve navigation and underground surveying. The apparatus shown on the cover is used to trap strontium atoms and cool them to almost absolute zero, using lasers. At these temperatures the quantum nature of matter is fully revealed. All atoms vibrate at a very precise optical frequency and behave like an incredibly stable clock. By making the atoms vibrate collaboratively, known as quantum entanglement, we will make the atomic clock even more stable.



CONTENTS

Studying physics at university

During the study of physics, you will investigate some of the biggest questions imaginable, learning about our universe and everything in it. You will find some of these questions have widely accepted answers, some have been partially answered and some are open areas being researched by physicists today. If you have a curiosity for these big questions and the drive to find the answers based in scientific study, mathematics, computing and experimental work, then physics is for you.

Picking a physics degree can be a big decision and we hope the information in this brochure can help you decide. There is also a lot of information online compiled by independent organisations such as the Office for Students or various newspapers. Some things you might want to consider while choosing which courses to apply to are given below.

What are the entry requirements?

We suggest applying for courses with a range of entry requirements. Bear in mind that you'll want to be able to make an insurance choice with a lower offer than your firm choice.

What will I learn?

Many physics courses will have a similar core content in the first couple of years, so pay close attention to the variety of optional courses that are available in later years. Investigate how easy it is to swap between specialist courses, in case you change your mind. Who will be teaching you, are they active physics researchers and what are their areas of expertise?

How will I learn?

What is the breakdown of lectures, classes and experimental work? How does the tutorial system work and what are the class sizes? Ask what project work will look like. Is there a chance to be involved in real research projects in the final year?

How satisfied are the students with the course?

The National Student Survey is an independent survey of final-year students across the country. It can give you an idea of how happy students are on your chosen course. Don't be afraid to ask to chat to current students too, they are your best source of information!

What are the employment prospects?

The Destination of Leavers from Higher Education survey can give you an idea of the demand for physics graduates. Research which transferable skills are taught during the course, such as presentation skills and computing. Ask what career support is available at the University.

What is the wider university and city like?

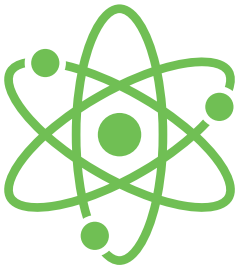
It's important to remember that you have to live at the university for three or four years. Pick somewhere you feel comfortable. Ask current students where they live in later years and what the student life is like outside of their studies.

If you are made an offer to study with us, you will be invited back to the School for a visit day. From our experience these visits are invaluable in making your final decision between universities. Even if you have already attended an open day, this visit will provide a chance to see the School during term time. You will have the opportunity to have in-depth conversations with academic staff and students as well as seeing the School, campus and student accommodation. If you have received an offer from us but are unsure of how to register for a visit day, please contact the admissions tutor. The admissions tutor is also available to answer questions about anything relating to choosing a university course and the admissions procedure.

Why physics at Birmingham?

There are many reasons to choose physics at Birmingham. If you study here, you will become a member of a leading research department that gives you choice and flexibility to tailor your degree to your interests. We will make you feel welcome and at home while providing a challenging and stimulating learning environment and preparing you for your future career. You'll learn on our beautiful green Edgbaston campus, with excellent and modern facilities, situated just ten minutes from the centre of the second biggest city in the UK.

MANY OPTIONAL MODULES TO CHOOSE FROM TO TAILOR YOUR DEGREE TO YOUR INTERESTS

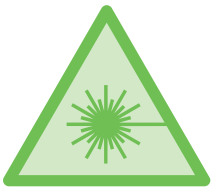


FINAL-YEAR PROJECTS ON REAL RESEARCH PROBLEMS

FRIENDLY AND SUPPORTIVE ENVIRONMENT – ELECTED STUDENT REPRESENTATIVES MEET WEEKLY TO RESOLVE ANY ISSUES

95% OF STUDENTS ARE IN EMPLOYMENT OR FURTHER STUDY SIX MONTHS AFTER GRADUATION

(DESTINATION OF LEAVERS FROM HIGHER EDUCATION 2016/2017)



TAUGHT BY LECTURERS WHO ARE ACTIVE RESEARCHERS IN A WIDE VARIETY OF PHYSICS

WEEKLY SMALL GROUP TUTORIALS

RANGE OF DEGREE PROGRAMMES WITH LOTS OF FLEXIBILITY

EXCELLENT FACILITIES INCLUDING SPECIALISED LABORATORIES AND OUR OWN OBSERVATORY

HIGH EMPLOYABILITY RATE – TRANSFERABLE SKILLS EMBEDDED IN EACH YEAR

4TH IN THE UK

THE GUARDIAN, 2020

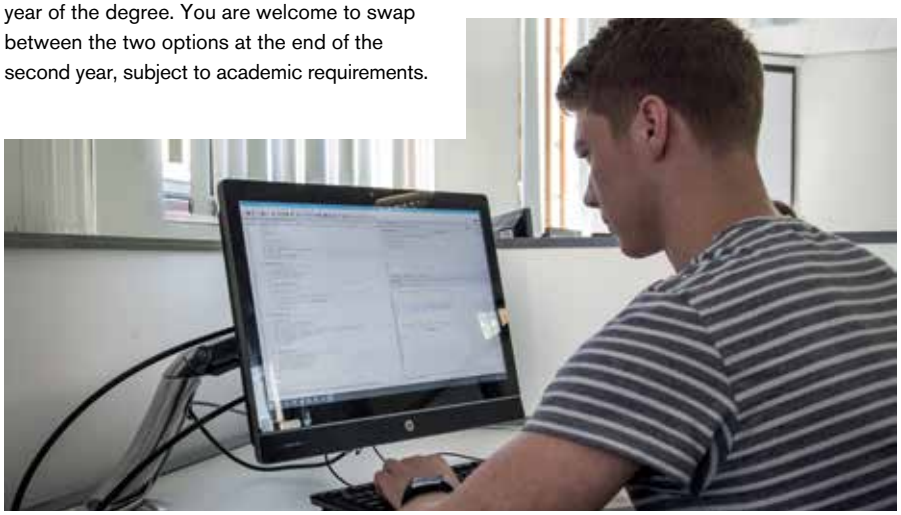
Our physics courses

All of our physics courses are designed to give you a firm grounding in core physics, to allow you to choose areas of advanced study that interest you and to prepare you for a career after university. Flexibility is important to us and in most cases, it is possible to swap between courses during the application year or after the first year of study, subject to academic achievement.

COURSES

We offer a range of general and specialised physics courses including ones with a year abroad or a preliminary foundation year.
You can explore our courses on pages 8–15.
Most of our courses are available as a three-year BSc or four-year MSci. The BSc gives you a strong foundation in physics and is widely respected by employers. If you are thinking of pursuing a career outside of science or want to take a specialised postgraduate Masters, you may want to choose the BSc course.
The undergraduate Masters, MSci, gives you a chance to take more in-depth and specialised modules in your fourth year. Additionally, a large focus of the final year is a research project where you can become part of a research group and tackle a real physics research problem.
The MSci is the degree of choice if you wish to have a career in science, apply for a PhD, or simply just enjoy the challenge of studying advanced physics topics.

You might not know what your future career plans are at this time and you might change your mind during your studies. Therefore, we have designed the courses such that the BSc and MSci are identical until the end of the second year of the degree. You are welcome to swap between the two options at the end of the second year, subject to academic requirements.



THEMES

Core Physics

There is a core of physics modules that everyone must study. This covers the fundamentals of the subject that every physicist should know. Studying this core will ensure you are prepared for a variety of advanced courses and are employable as a scientist across a range of areas. This core initially dominates each of our courses and grows smaller each year to give way to more specialised optional modules. Some of the topics covered include: Quantum Mechanics, Classical Mechanics, Special Relativity, Electromagnetism, Statistical Physics and Optics.

Specialised modules

Courses specialised to different areas of physics start to appear in the first year and expand in later years to let you tailor the degree to whichever areas interest you. It's possible to specialise in one or two areas or keep your options broad. Some options may be restricted depending on which degree programme you are on or which previous modules you have chosen. There is plenty of support in planning your route through your degree and to help you decide which modules to pick.

Mathematics

Mathematics is the language of physics so it is vital you have a good grounding in this area. Mathematics is compulsory in the first two years and is supported by guided study sessions where you will be able to work through problems with teaching assistants.

Problem-solving

Physicists are excellent problem-solvers and you'll naturally learn how to solve problems through many of your modules and projects. We support this learning through our skills development sessions, where you'll practice how to approach problems which don't fit into a single well-defined subject area. These skills ensure you will be highly employable in a variety of fields.

Experimental work

Laboratory work is an integral part of your degree if you are studying a Physics, Physics and Astrophysics or Physics with Particle Physics and Cosmology course. Five hours a week in the first year and eight hours a week in your second year are spent working in our state-of-the-art laboratories. Lab work is conducted in pairs and is assessed continuously throughout the term. Later years' lab work will depend on the exact modules you take and projects can be experimental in nature if you choose so.

Computing

Programming is a key skill for physicists and learning to code will make you successful in a variety of other fields too. We don't assume you have any prior knowledge of coding and will teach you Python in Years 1 and 2 as part of the Physics and Communication Skills module.

TEACHING METHODS

Lectures

Most modules are delivered in a traditional lecture format by an active physics researcher. Lectures last 50 minutes and are all held on the Edgbaston campus. Lecture material, in the form of notes, slides or recordings are available to you on our online virtual learning environment, allowing you to review the material in your own time and at your own pace. Lecturers are happy to discuss the content of their lectures either at the end of class, in their set office hours or at any mutually convenient time. Most lecture courses are assessed through a mixture of problem sheets throughout the term and an end-of-module examination.

Tutorials

During your first and second years you will meet once a week with your personal tutor in a group of no more than four students. These hourly tutorials are an excellent opportunity to discuss the content of the previous week's lectures, practice problems and discuss areas of physics that interest you. Your tutor is your first point of call for any problems you have and they are supported by a wider welfare system (see page 24).

In Year 3 you will still have a personal tutor for pastoral support as needed but, as courses become more specialised, weekly tutorials are not held in this year and you are encouraged to talk to specific lecturers about your modules as needed. In your fourth year, the project supervisor will take on the role of personal tutor.

Example classes

Mathematical and skills modules are supported by example classes or guided study. These classes are a chance to work through example problems alone or in small groups as guided by teaching assistants.

Laboratories

Laboratories are overseen by lecturers and supported by teaching assistants. In experimental laboratories, you will work in pairs and in early years you are guided by detailed experiment outlines. As the years progress the lab work becomes more self-guided and open-ended. In computing laboratories, you'll work alone to undertake programming tasks related to physics. Experimental and computing labs are continually assessed as each piece of work is completed. For experimental work this entails keeping a lab book which is marked each week.

Project work

You will have the opportunity to undertake plenty of project work in your degree. For those who take laboratories, this will be as part of your lab work in the first two years. A project develops a wide range of skills including planning and report writing. Group studies in your third year is a major project which is undertaken in groups of 10–20 students. The task requires the group to work as a team and enables you to solve a problem of much greater magnitude than could be attempted by an individual. The teamwork skills learnt here are invaluable for success in a future career. If you study for the MSci, a large part of your time in the fourth year will be devoted to an independent research project. As well as learning great detail about the area of physics you have chosen, you will also learn vital project management and communication skills during this project.

Physics

BSc (F300)/MSci (F302)

Flexibility is the essence of our standard physics degree, allowing you to select a range of modules to suit particular interests, covering a broad spectrum of cutting-edge topics.

The Physics course has the largest range of options and its variety attracts the largest group of our students. It is ideal if you want to keep your studies broad, want to specialise in an area that we don't offer a specific programme for, or are unsure what you might want to focus on in the future. At the end of the BSc or MSci, you will have gained a broad understanding of the essential concepts of physics, ranging from entropy to quantum mechanics and beyond. The transferable skills you'll learn will make you very employable; including problem-solving, computing and giving presentations.

Compulsory modules

In your first year, most of the year is compulsory and common across all our courses, this will give you the grounding in the basics you need to succeed in future years. Topics covered include quantum mechanics, classical mechanics, special relativity, electromagnetism, statistical physics and optics. Additionally, you will take enabling modules in Mathematics and Physics and Communication Skills. This core is continued into the second year where you begin to learn more advanced topics. In your third year, the compulsory modules become fewer, and all lecture modules are optional courses in the fourth year.

Optional modules

The Physics course is designed to let you tailor the course around your interests. Our module portfolio is regularly reviewed and updated to make sure it is serving our graduates well and to reflect the full research interests of the School. Topics include particle physics, astrophysics, nuclear physics, mathematical physics, quantum physics and many more. As well as traditional physics topics, you'll find more applied modules to choose from such as Physics Teaching in Schools or Images and Communication.

Group studies

You will undertake a group project in your third year. This is a large piece of work which teaches vital teamworking and project skills. Working in groups allows you to tackle a larger problem than you could alone or in pairs. Recent topics have included Atom Interferometry, Radar and Remote Sensing, Medical Physics and Nanoscale Physics.

Year 4 Projects

All students who stay for the MSci year will undertake a research project, which makes up a large proportion of your final year. During this time you will become a member of one of our research groups and tackle a real open-ended research problem. You can explore our areas of expertise on pages 20–23.

ALEX FRYER,
Physics MSci

'The MSci Physics course really caught my attention when applying due to the quality of teaching which shone through at the Open Days. The best points of my course are learning from the excellent lecturers and using the best equipment in labs while constantly having my mind stretched and challenged by other students who love the subject as much as me. Physics is special because it's so broad yet you can specialise in whatever you want. The course here is unbelievably personal which, combined with the expert staff in every possible field, means physics at Birmingham is a unique and extremely rewarding experience.'

PROFESSOR PETER JONES
Programme co-ordinator
Head of Education

Teaching

As Head of Education, I am responsible for organising all the teaching that is done in the School. My own teaching spans core physics modules, such as Quantum Mechanics, through to specialist optional modules, such as Fission and Fusion (Nuclear Energy). In Years 3 and 4, I offer specialist supervisions in Nuclear and Particle Physics. As an experimental physicist, I am also involved in laboratory teaching and project work.

Research

My research sits at the interface between nuclear and particle physics. I am a member of the ALICE collaboration at the CERN Large Hadron Collider, where I have a particular interest in studying jets, which is what you get when a quark or gluon is knocked out sideways in a high energy nuclear collision. I am also involved in preparatory work for a future electron-ion collider facility in the United States. I am designing a precision inner tracking system based on pixelated silicon detectors, which will be used to reconstruct the trajectories of particles coming from these collisions.

Physics and Astrophysics

BSc (FF35)/MSci (FFH5)

Astrophysics is the application of physics to understanding the universe at large. This programme is for those who are fascinated by astronomy, and want to study it in-depth whilst gaining a good grounding in physics and boosting their employment prospects after graduation.

The Physics and Astrophysics courses allow you to focus on astrophysics and related topics through your lecture courses, laboratory and project work. You will still gain a broad understanding of the fundamentals of physics and a wealth of transferable skills allowing you to be just as employable as a standard physics graduate.

Compulsory modules

For Physics and Astrophysics students the first two years are made up of compulsory modules. This will give you the grounding in the basics of general physics and you will learn vital tools from modules in Mathematics and Physics and Communication Skills. Additionally, a strong basis in astrophysics is taught in modules on Introductory Astrophysics, Astronomical Observing and Structure in the Universe.

In the first year lab work, you will spend half the year on general Physics Laboratories and the other half in Astro-lab. Similarly, in the second year, you will take general Physics Laboratories and then an Astrophysics lab project. This could be observation based, using the University Observatory, just outside the city. Alternatively, you can use data already collected or catalogued by telescopes such as Kepler.

Optional modules

In the third and fourth years, you have space to tailor the course to your own interests, including many modules outside of astrophysics in topics such as particle physics, nuclear physics, quantum physics and many more. There are specialised astrophysics modules to choose from too including Observational Cosmology, Relativistic Astrophysics and Black Holes, The Life and Death of Stars and Asteroseismology and Exoplanets.

ABBIE NICHOLLS,
Physics and Astrophysics MSci

'I've always been interested in physics, but the thing that stood out most for me when applying to university was the atmosphere here. It was very friendly and vibrant, and the location is perfect for getting the most out of a big city without the concrete jungle. The best part about the course here is the mixture of lectures and smaller classes. It gives students the opportunity to learn in different ways, and practise skills in different settings. Labs are a good example of this. Those on the Astronomy course start astrolabs in the first year, which personally I found great, as I was learning something totally new which I was very interested in.'

PROFESSOR BILL CHAPLIN
Programme co-ordinator

Teaching
The combination of teaching with research is one of the main strengths of a university like Birmingham. I enjoy bringing my own research interests into my teaching, and getting students actively involved in developing the skills required by astrophysicists.

Research
I study the Sun and stars by observing their natural oscillations, the field of asteroseismology. My research group runs a network of observatories that observe the Sun's global oscillations, and I also lead international research collaborations on other stars as part of the NASA Kepler, K2 and TESS Missions. I am particularly interested in the characterisation of newly discovered exoplanet systems, where knowing as much as we can about the host star is crucial.

Group studies

All Physics and Astrophysics students will undertake a group project in their third year. This is a large piece of work which teaches vital teamworking and project skills. Working in groups allows you to tackle a larger problem than you could alone or in pairs. Astrophysics students will get first choice of the Astro-related projects, ensuring you can specialise in an area of interest to you.

Year 4 projects

All students who stay for the MSci year will undertake a research project, which makes up a large proportion of their final year. During this time, you become a member of one of our research groups and tackle a real open-ended research problem. Astrophysics students will get first choice of the Astro-focused projects on topics such as Asteroseismology, Exoplanets and Gravitational Waves.

Physics with Particle Physics and Cosmology

BSc (F372)/MSci (F373)

Particle physics is the study of the smallest particles and their fundamental interactions. While at the other end of the length scale, the study of how the Universe began and may develop is intrinsically linked to an understanding of particle physics. This programme is for those who want to focus on these fundamental areas of physics, while still covering a broad range of physics topics.

The Physics with Particle Physics and Cosmology courses are for students who want to focus on the fundamental building blocks of our universe. The course draws on the expertise of Birmingham particle physicists and astronomers engaged in cutting-edge research at CERN and other international laboratories and observatories. You will study the same core of modules as on the Physics courses and your later years are focused on specialised modules in Particle Physics and Cosmology. As a student on this course, you'll have the opportunity to visit CERN and have a tour of the laboratory guided by Birmingham physicists who work there. Having studied a broad range of physics, you will have gained a wealth of transferable skills on top of specific knowledge related to Particle Physics and Cosmology, allowing you to be just as employable in a wide range of careers as a standard physics graduate. Additionally, many of our students go on to study PhDs in Particle Physics and continue as research scientists in the field.

Compulsory modules

The first year is made up of compulsory modules, this will give you the grounding in the basics you need to succeed in future years. Alongside a core of physics, you will take enabling modules in Mathematics and Physics and Communication Skills. This core is continued into your second year, where you begin to learn more advanced topics. Alongside this core, you will study compulsory Particle Physics and/or Cosmology modules in each year. In the first year, you are introduced to detection techniques used in particle physics experiments, the latest ideas about the structure and evolution of the Universe, and how the evidence for dark matter and dark energy link back to outstanding questions in particle physics. Then, in the second year, you will learn about the neutrino, what it tells us about the weak nuclear force, and how recent measurements of neutrino oscillations imply that neutrinos must have a very small but finite mass.

Optional modules

In the third and fourth years you can tailor the course to your own interests, including many modules outside of your specialism such as Astrophysics, Nuclear Physics, Quantum Physics and many more. As well as traditional physics topics, you'll find more applied modules to choose from such as Physics Teaching in Schools or Images and Communication.

Group studies

All Physics with Particle Physics and Cosmology students will undertake a group project in their third year. This is a large piece of work which teaches vital teamworking and project skills. Working in groups allows you to tackle a larger problem than you could alone or in pairs. Particle Physics students will get first choice of the particle-related projects, ensuring you can specialise in an area of interest to you, for example, designing an experiment to study the Higgs boson.

Year 4 projects

All students who stay for the MSci year will undertake a research project, which makes up a large proportion of their final year. During this time, you will become a member of one of our research groups and tackle a real open-ended research problem. Again, Particle Physics students will get first choice of the particle-focused projects on topics, recent topics included searching for new Physics at the LHC, testing electronics for detector upgrades and searching for dark matter.

DR CHRIS HAWKES
Programme co-ordinator

Teaching

My teaching includes both core physics and specialist particle physics lecture courses and tutorials. I supervise final-year undergraduate particle physics projects as well as PhD students. My wide experience in particle physics research provides ideas and examples to inform my teaching and allows me to develop projects that provide useful training in the skills necessary for successful research work.

Research

I have worked on a number of different experiments at large particle physics colliders, mainly based at the CERN Laboratory and at the SLAC Laboratory. My research work includes precise tests of electroweak theory, from measurements of the production and decay of Z and W particles, and studies of the differences between matter and antimatter (CP Violation) in the decays of heavy mesons. I am currently a member of the ATLAS Collaboration at the Large Hadron Collider at CERN, where we are analysing high energy proton–proton collisions to look for possible signs of physics beyond the Standard Model of Particle Physics.

THOMAS MACFADYEN, Physics with Particle Physics and Cosmology MSci

'The Physics course at Birmingham was the first course I read about that really excited me when making my UCAS application, and I haven't been disappointed since! Every day is filled with new and interesting topics to learn about, taught by lecturers who are truly experts in their fields. I particularly like how the first two years are designed to give you a solid, broad understanding of a wide variety of physics, before being able to choose which topics you want to specialise in and delve further into in your later years. I have also found the small group teaching sessions – whether that be labs, computing, examples classes or tutorials – to be really useful if there's something you're struggling to understand and want extra support in.'

Theoretical Physics

BSc (F342)/MSci (F343)

Theoretical physics is the study of the fundamental theories behind all areas of physics. This programme is for those who wish to explore the profound concepts of modern physics with a firm mathematical focus.

The Theoretical Physics programmes are designed for students who would like to focus on the mathematical side of physics. On this course, you will study a range of mathematical physics modules and also have choice from a wide range of optional courses across all areas of physics. The course is especially suited for those who enjoy the challenging nature of understanding the mathematical framework upon which modern physics study depends.

The Theoretical Physics course comes in a 'lab' and a 'no-lab' flavour, which can be decided between on arrival to the University. Both cover the essential core of theoretical physics with the 'lab' option allowing you to undertake experimental work too. Choosing 'no-lab' means you will take courses in data analysis and some additional mathematical physics courses instead. By the end of the second year, the two flavours combine with neither at aw disadvantage.

Compulsory modules

You will study a core of compulsory modules in the first two years including Quantum Mechanics, Classical Mechanics, Special Relativity, Electromagnetism, Statistical Physics and Optics, as well as learning vital tools for future study in mathematics and Physics and Communication Skills. In your second year, you will take compulsory modules in Lagrangian and Hamitonian Mechanics and in Eigenphysics. Both of these modules teach mathematical frameworks enabling students to solve a wide variety of physical problems. Later years include advanced mathematically focused modules such as Complex Variable Theory and Radiation and Relativity.

Optional modules

As a Theoretical Physics student, you will have a lot of space to tailor your optional modules to your own interests, and can keep your choices broad or focus on a couple of areas of physics if you wish. There are plenty of physics topics to choose from such as Astrophysics, Particle Physics, Nuclear Physics, Quantum Physics and many more. Additionally, some modules from the School of Mathematics are open to you, giving a wealth of choice.

Current Topics in Theoretical Physics

All Theoretical Physics students will take Current Topics in Theoretical Physics in their third year. As part of this module, you will receive a number of seminars from theoretical physics research staff on cutting-edge topics being researched today. You can then choose a topic of interest to study further and produce a research poster to summarise your findings. This method of communication is widely used in academia and is also a chance to develop transferable communication skills which are useful for all career paths.

Year 4 projects

All students who stay for the MSci year will undertake a research project, which makes up a large proportion of your final year. During this time, you will become a member of one of our research groups and tackle a real open-ended research problem.

PROFESSOR MIKE GUNN
Programme co-ordinator

Teaching

I teach a variety of courses, from those designed specifically for Theoretical Physics students through to those available to all physicists. In addition to conveying a physical picture of the subjects, I use the lectures as a vehicle to explain a number of mathematical ideas and methods that I have found particularly useful. The approachable staff and friendly atmosphere of the School is what helps to make teaching on the Theoretical Physics programme so enjoyable and rewarding, for both the students and for myself.

Research

As a member of the Theoretical Physics group, I work on the remarkable quantum phenomena found in gases when they are cooled to a few thousand millionths of a degree above absolute zero. The corresponding experiments are performed using refrigerators made out of light and magnetic fields!

LAURA COAKLEY, Theoretical Physics MSci

'I think one of the best parts of my course are the weekly small group tutorials in the first and second years. These are a really great opportunity to both attempt some more challenging physics problems, and to get to know members of academic staff and other students. Because Theoretical Physics has a small cohort, it has a very friendly atmosphere. Our timetable has a good mixture of lectures and smaller group teaching.'

Theoretical Physics and Applied Mathematics

BSc (FG31)/MSci (F3DG)

Mathematics is the language of physics and as such applied mathematics and physics are intrinsically linked fields of study. Modern Mathematics has provided many concepts that have revolutionised physical thought in unexpected directions. This is a programme for those who are equally drawn to studying for a degree in mathematics and a degree in physics.

The Theoretical Physics and Applied Mathematics (TPAM) courses are joint honours degrees between the School of Physics and Astronomy and the School of Mathematics. Initially, your time is split evenly between the two Schools and in later years you can choose to focus on one or keep options from both. As the two Schools are physically located next door to one another and the subjects themselves are close neighbours too, this joint honours course is unique in providing a cohesive programme of study for its students.

Compulsory modules

The first two years are made up of compulsory modules for TPAM students. This allows you to gain the firm grounding that you need in both physics and mathematics. The Physics core modules include Quantum Mechanics, Optics and Waves, Electromagnetism and Temperature and Matter. Mathematics includes Real Analysis and Calculus, Vectors, Geometry and Linear Algebra.

Optional modules

In later years you will have a very large choice of optional modules as many courses are available to you from both the Schools of Physics and Astronomy and Mathematics. Physics options span topics such as Astrophysics, Particle Physics, Nuclear Physics, Quantum Physics and many more. Mathematics modules are available in subjects like Mathematical Biology, Perturbation Theory and Partial Differential Equations.

Year 4 projects

All students who stay for the MSci year will undertake a research project, which makes up a large proportion of your final year. During this time you will become a member of one of our research groups and tackle a real open-ended research problem.

SANDEEP SHIRGILL, Theoretical Physics and Applied Mathematics MSci

'The MSci Theoretical Physics and Applied Mathematics programme is an amazing opportunity for students who want to study topics in both physics and maths from lecturers who are genuinely passionate about their research. Whilst the course has been academically challenging, I found that the members of staff were always happy to help with any questions I had. Additionally, weekly tutorials in the first two years of the programme allowed me to work through any problems I had with my tutor. As the cohort for the programme was small, I found it easy to build friendships with other students. This was helpful as it meant that there was an environment where everyone could approach and help each other out.'

DR MARTIN LONG
Programme co-ordinator

Teaching

My teaching involves mathematics, computational physics, the theory of chaos and problem-solving for beginners. I am a mathematician by training but am drawn towards the use of mathematics in understanding physical systems. My favourite style of teaching is project work, where even the best students' talents can be stretched!

Research

Electrons in solids are easy to describe with the assumption that they do not notice each other. I am interested in the opposite situation, when electronic motion is dominated by an electron waiting for other electrons to move out of the way – an example of 'many particle physics'. How to generate models for strongly correlated systems, how to simplify those models and finally, how to solve them are all interesting but poorly understood issues. The systems of most current interest to my PhD students and myself are high-temperature superconductors and heavy fermions, systems where the electrons have to wait so long that they are almost stationary.

Physics/Physics and Astrophysics (International Study)

BSc (F301)/MSci (F302)/BSc (FF3M)

Choosing to study abroad as part of your degree course is an amazing opportunity to enhance your learning and test your limits but above all, experience incredible cultures and meet new people. We have designed our year abroad programmes carefully to ensure that our students still receive an outstanding physics education while embarking on this exciting journey.

These four-year degree programmes with International Studies provide a sound training in physics, together with the opportunity to study at a university in another country. Although you may enter the University on one of these programmes, the final decision and application to study abroad is not made until the second year of study, and as such you may swap to and from these programmes no later than the beginning of your second year.

BSc or MSci?

For students following the BSc course of study, the emphasis during the year abroad is on developing an understanding of the cultural, historical and social aspects of the host country, in addition to improving language skills if going to a non-English speaking country. For students on the MSci programme, the emphasis is on physics – the institution and modules must be chosen carefully to cover material needed to enable the student to perform well in their fourth year of study in Birmingham. Thus MScistudents taking an exchange in a foreign speaking country need to be able to speak the language of that country fluently.

Language requirements

To undertake an exchange to a non-English speaking university, BSc students must hold a GCSE (grade B or above) and MSci students must hold an A level (grade B or above) in an appropriate language.

Where can I go?

Europe

If you wish to study in Europe you must pick one of our European partners, you are guaranteed an exchange programme with these partners which are: Leopold-Franzens-Universität Innsbruck (Austria); Université Paul Sabatier Toulouse III and Université Joseph Fourier Grenoble 1 (France); Gottfried Wilhelm Leibniz Universität Hannover and Ruprecht-Karls-Universität Heidelberg (Germany), and Universidad de Murcia (Spain).

Worldwide

Students wishing to study outside of Europe are not guaranteed an exchange. This is because any allocation depends on academic achievement. However, all of our students who have achieved above 65% first-year average have been successful in recent years in getting one of their chosen destinations. For exchange outside of Europe, students must list seven universities in order of preference, with the first three choices being from three different countries. International university placements have been undertaken in many countries, including Australia, Canada, Japan, New Zealand and the United States of America. Please see our website for the latest partners and possible destinations www.birmingham.ac.uk/studyabroad

KOUSHA WRIGLEY, Physics MSci (International Study)

'My favourite part about my time studying physics at the University of Birmingham has been through the incredible opportunities I have been provided with, mainly the chance to complete my third year through a year abroad in the United States. Whilst it was hard leaving Birmingham where I'd had such an incredible first two years, my year abroad was probably the best year of my life and, as I was taking the MSci course, it all counted towards my degree!'

PROFESSOR CHRIS MAYHEW
Programme co-ordinator

Teaching

As an experimentalist, I enjoy teaching in the undergraduate laboratories and guiding and supervising students in their project work.

Research

I have a joint position with the University of Innsbruck, Austria. At the University of Birmingham, I am a Professor in Molecular Physics and Head of the Molecular Physics group. In Innsbruck, I am the director of the Institute for Breath Research and Professor of Analytical Chemistry. My research interests include investigations of gas phase ion-molecule reactions over a wide range of physical conditions. These studies underpin many technologies and natural phenomena, and have, for example, been used to develop techniques for the detection of trace substances of relevance to homeland security and medical devices.

Intercalated Year in Computer Science

All students on our single honours BSc courses can apply to do an intercalated year in computer science. Building on the skills already learnt in the Physics course, a year in Computer Science will expand your skills in this highly in-demand area.

You will take computing classes in your first two years of physics study and there are optional courses in your third year, alongside the option to focus on computing work during your group studies. However, some students may wish to develop their skills even further by taking a whole year to focus solely on computer science.

In a degree with a Year in Computer Science, the additional year is 'sandwiched' between the second and final years of your original BSc degree. In the additional year you will study the core of Computer Science, and in your final year you will return to take the third year of your physics course. You can sign up to the Year in Computer Science during your second year of study and will be admitted if you fulfil all of the necessary entry requirements. Once admitted, you will follow modules offered by the School of Computer Science and, for that year, all tutoring and monitoring requirements will become the sole responsibility of the School of Computer Science.

You will take both practical programming classes and theoretical modules on the fundamentals of Computer Science. This includes aspects of how software is specified, designed and constructed, and how to design and use databases. You will also be able to study two options from the standard Computer Science second- and third-year modules.

Successful students will graduate with a degree in their chosen physics course, with the addition of 'with a Year in Computer Science'. A full transcript of your marks on the year you spend in Computer Science will also be available to you, and can be supplied to potential employers.

The Year in Computer Science is assessed on a pass/fail basis. Credits gained during the year will not contribute to the credits required for your main degree, nor will marks contribute towards your degree classification in the main subject.

ZANE ALI,
BSc Physics with year in Computer Science

'I opted-in for the Year in Computer Science at the end of the second year of my course; it was a great opportunity to pursue an interest and develop my programming skills. When I returned to my final year in Physics, I used my newfound knowledge in my final-year projects and labs. The best part about this course was choosing from so many optional modules and specialising towards the end of the degree.'

DR ROB SMITH
Programme co-ordinator

Teaching
I currently teach superconductivity, statistical physics and relativistic electrodynamics, and tutor first- and second-year students.

Physicists are basically problem-solvers at heart, and in my teaching I stress this outlook. Before we can solve any problem it is important to know what a solution looks like, and whether we should use pen and paper or the computer to find it. I also teach fourth-year projects based on my research; these are open-ended with the student deciding which problems are to be solved.

Research
I am interested in mesoscopic systems whose size lies between the microscopic (atoms) and macroscopic (chairs) range. At low temperatures such systems, containing many millions of atoms, can behave in a quantum coherent manner as a single 'superatom'. Modern fabrication techniques allow these low-dimensional systems (films, wires and dots) to be made to order, and they act as a testing ground for quantum theories of condensed matter. Impurities strongly affect their properties, and some of my work focuses on the destruction of metallic and superconducting behaviour by disorder.

Foundation Year

If you are not taking the correct type of qualifications for entry to the first year, our integrated Foundation Year is a preliminary year which will give a solid grounding in physics, mathematics and computing to allow access to our undergraduate degrees.

FOR HOME STUDENTS

The Physical Sciences Foundation Year (FGI0) is an integrated foundation degree which gives access to our Physics, Physics and Astrophysics or Physics with Particle Physics and Cosmology degrees. It is designed for students who have not taken the qualifications necessary to apply directly for first-year entry, specifically for those who have not taken A level Mathematics. Students with and without A level Physics are welcome to apply. Upon successful completion of the Foundation Year, you will automatically progress to your chosen first-year course, as long as you meet the progression criteria.

The Foundation Year is multidisciplinary and offers a broad programme of study, providing you with a solid level of knowledge across science, engineering and mathematics. As mathematics is essential for success within Physical Sciences, we place a great emphasis on it with around a quarter of the modules focused specifically on maths. The skills you learn there will allow you to enter the first year on an equal footing to those who have taken A level Mathematics.

You will also take modules in Physics, Engineering and Computer Science. As well as learning skills essential for specific degree routes, these modules develop many transferable skills including teamwork, building your confidence in technology and numeracy and developing computer literacy and presentation skills.

Entry requirements

Applicants taking A level Mathematics or equivalent are not considered for this course. We require applicants to hold GCSE English 4/C and Maths 6/B and do consider retakes. Core Maths grade B may be considered if you do not have GCSE Maths.

We accept a range of level 3 qualifications, in general they must be equivalent to at least three A levels but qualifications are considered individually, not on a UCAS point system. If you have any questions, please contact the admissions tutor to discuss your qualifications before applying.

For our current typical offer grades, please see our website or contact the admissions tutor.

FOR INTERNATIONAL STUDENTS

For applicants who are taking international qualifications which are not accepted for the first year, our foundation pathway in Engineering and Physical Sciences provides a year of study equivalent to the last year of the UK school system. This is a course run by the Birmingham International Academy, who are experts in supporting international students in the UK. This course accepts a wide range of qualifications which can be explored on the website. Applications to this course can be made via our website.

Please contact **foundation@contacts.bham.ac.uk** for more details.

ROBYN FLETCHER, Physics BSc with Foundation Year

'I have always been interested in maths and science, however, I was unsure of which pathway I wanted to take. Therefore, I decided to do a Physics Foundation Year to give me an insight into what studying physics at university would be like. After attending the Birmingham open day and seeing what an amazing atmosphere the Physics department had, I knew I wanted to study there. All of the staff and students were so friendly and welcoming and made you feel like part of the community. During the foundation year, I was taught a broad range of introductory physics and engineering, and I also gained experience doing lab work every week, which has proved very useful in my first year. It was also a great way to ease myself into university life, which can be very daunting. I have really enjoyed my first year so far, and although it has challenged me a lot, I feel like I am part of a very welcoming community. I also like that the course is not only made up of lectures, but also small group workshops and tutorials that allow you to meet other people and learn in different ways.'

What can I do with a physics degree?

Physics graduates are highly employable and their career options are very wide. You may go on to apply your physics knowledge directly in a scientific or engineering environment, or might use your mathematical knowledge in finance, your computing skills in software or your problem-solving skills in business.

What makes physics graduates employable?

A fundamental understanding of the wide range of core and specialised physics topics will make you highly employable. You can apply this knowledge directly at graduation to a range of careers including scientific research, defence, medical physics, energy or telecommunications. Alternatively, you can combine this physics expertise with other skills to work in careers such as science communication, patent law or teaching. The physics courses at Birmingham are all accredited by the Institute of Physics so employers are confident in our graduates' scientific knowledge.

Mathematics is the language of physics, so as one of our graduates you will be an excellent mathematician as well. Many graduates decide to apply this mathematical understanding to careers outside of physics, in sectors including meteorology, statistics or financial services.

Physicists are problem-solvers at heart and throughout your degree you will learn how to tackle a variety of problems and develop the breadth of understanding to apply this to many different areas. As such, employers from a wide range of industries wish to employ physics graduates for these analytical skills. You might end up working in operational research, business or consultancy.

You will gain a firm grasp of programming during the first two years of your physics degree, and if you have a particular interest in this area you can choose projects and modules based on data analysis, simulation or numerical studies that allow these skills to be developed further. Many of our graduates are employed in careers that depend on computing skills such as software engineering or data analysis.

As well as all of these specific skills our graduates are equipped with a variety of transferable skills, ensuring that you will be highly employable whichever field you enter. For example, writing reports, essays and seminars develops evaluation and communication skills. The project work you will undertake demonstrates organisation, planning and teamwork.

Further study

Over 40% of our students go on to further study after graduating, with around two-thirds of those being research leading to a PhD, a route open directly after completing an MSci degree. As well as being the main route into academic research, a PhD also opens the door to many careers that need specific advanced scientific knowledge. The most compelling reason to do a PhD is love of the subject, and the high number of our graduates choosing this route illustrates the satisfaction of students who study with us.

The remaining third of students who carry on to further study either take a specialised postgraduate Masters in subjects such as a very specific branch of physics, or engineering or computing, or they are pursuing a postgraduate teaching qualification such as a PGCE or PGDipEd.

Career support

There are many, many options open to physics graduates so we work hard to ensure that you can find the right one for you and to provide any support you might need in securing the career you want. The School has an academic careers tutor who oversees the careers support within the School. This includes organising an annual Physics careers fair, talks, and running career-focused activities in the Physics and Communication Skills module.

The University Careers Network is a team of specialist careers advisors who will support you throughout your studies and up to two years after you graduate. They provide support, guides, workshops and one-on-one sessions in areas such as CV writing, interview preparation, finding an internship and mentoring.

EMILY AVEYARD, Trainee Clinical Scientist, NHS – Physics BSc 2017

'I now work in the exciting field of medical physics as a Trainee Clinical Scientist at University Hospitals Coventry and Warwickshire NHS Trust. I am on a three-year graduate-level programme called the NHS Scientist Training Programme. My training spans across the medical physics disciplines of radiotherapy, diagnostic radiology and nuclear medicine.

'I learned about the applications of physics in medicine and healthcare during my degree and in my final year chose modules that really supported my knowledge and strengthened my interest in the area. The Medical Imaging module and Medical Imaging group study afforded me the opportunity to investigate nuclear medicine technologies currently used in hospitals, whilst the Physics Critique module allowed me to look to the future, and explore potential advances in external beam radiotherapy and proton therapy. My degree has given me a strong grounding in core physics and excellent numerical, practical and problem-solving skills, which are vital in my work today as a practising scientist.

'The School's connections with local hospitals helped me to secure vital clinical work experience and patient-facing volunteering opportunities. The support of the University's Careers Network proved invaluable when making applications for these opportunities, and ultimately for my current role.

'I really enjoy getting to use knowledge from my BSc Physics degree every day for patient and public benefit, knowing I am directly contributing to advancements in patient diagnosis and treatment. It's an incredibly rewarding role – I can't imagine myself doing anything else!'

DWAYNE SPITERI, Particle Physics PhD student, University of Glasgow – Physics with Particle Physics and Cosmology MSci, 2016

'At secondary school, I had been interested specifically in particle physics for a few years ever since I learned about radioactivity at GCSE level. When I saw that the University of Birmingham offered an undergraduate Particle Physics course, and had an excellent reputation, I leapt at the chance and didn't look back.

'I felt everything I learnt here would be useful to me later on in someway. All the core modules introduce you to the staples of physics our forefathers derived that give us our understanding of all the amazing processes that we see around us. The optional modules allow you to expand your knowledge into places you are interested in and there is so much choice. For the practical part, the laboratory experiments I did throughout the degree gave me a lot of transferable skills. You learn to become scientifically rigorous, structure a scientific lab report, design your own experiments, cope when things go wrong and practically apply the physics you have learnt in lectures to experiments. It really distinguishes you from others who haven't done it and gives you a competitive edge. For my Masters project I worked with the members of the Particle Physics research group who were in the ATLAS collaboration. The ATLAS experiment at the LHC is in the process of being upgraded and I was part of the effort in testing prototypes of the new silicon sensor technology that is to replace the existing sensors in the ATLAS tracker. It was great for giving me a taste of what real research is like and inspired me to stick with the collaboration as I went on to do further study.'

THOMAS DACK, Graduate Trainee within Scientific Computing, Science and Technology Facilities Council – Physics BSc 2015

'I am working at the STFC (Science and Technology Facilities Council) working on a Graduate Scheme within the organisation's Scientific Computing Department (SCD). SCD provides large-scale computing facilities, computing data services and infrastructure in order to support some of UK's most advanced scientific facilities.

'I made my application to Birmingham after visiting for an open day. After being able to explore and see the campus and meeting the staff within the School of Physics and Astronomy, I left with the feeling that there was no other university I could see myself spending the next few years at more than Birmingham. After that, it was a simple decision where to apply. The atmosphere of learning within an institution that contributes to my subject area on the global stage was a huge inspiration to me. Learning from lecturers who worked as part of the Large Hadron Collider experiment at CERN or who were involved in advances in the early days of home computing was incredibly inspirational.

'Some of my fondest memories are the time I spent as a committee member for the Poynting Physical Society, PPS. As President in my third year and as a year rep for my other three years at Birmingham, it was immensely rewarding knowing that the events you worked so hard to organise – such as the annual Spring Ball – could be some of your fellow students' fondest memories of Birmingham. The sense of family within the department was incredible, and something I will never forget.'

Research at Birmingham

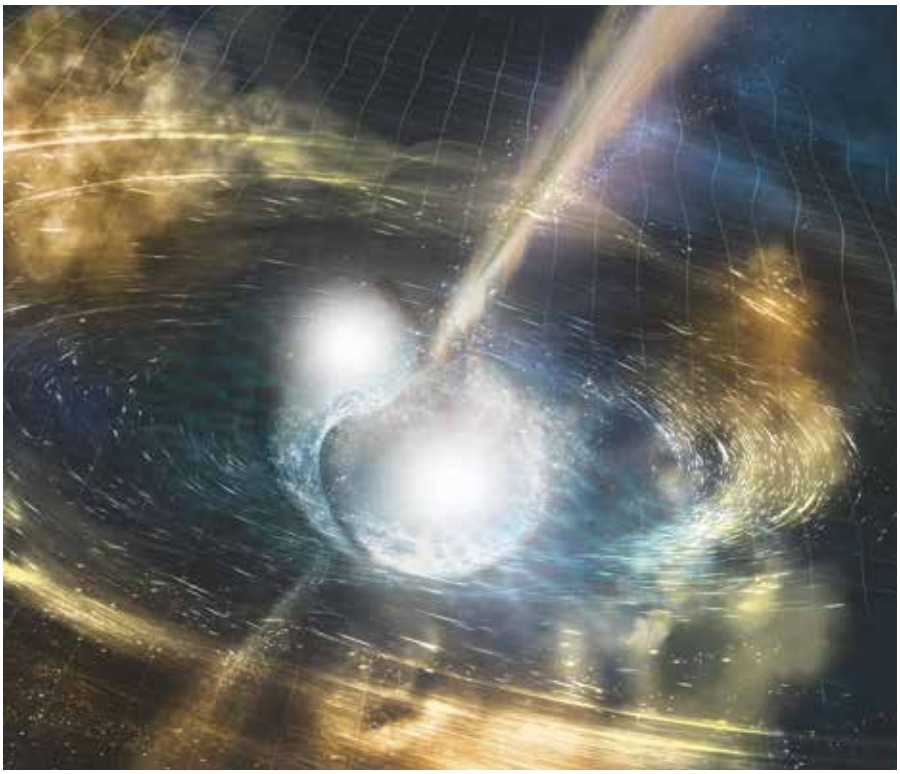
As a Birmingham student, you will benefit from our nationally and internationally leading expertise in a broad range of physics areas. The researchers here will teach your lectures, lead your labs, act as your personal tutors and supervise your projects. This means you will always be able to find an expert to answer your questions and you will work alongside those pushing the frontiers of scientific knowledge.

As an undergraduate student in physics, you will benefit from our researchers' expertise throughout your degree, your greatest interaction will be during the Year 4 research project. This project will be a focus of the fourth year of your degree at Birmingham alongside advanced lecture courses. You will become a member of the research group for the duration of the project, working on a real area of interest to our academics. The choice of research projects reflects the broad research portfolio of the School, which you can explore in these pages. As our research is constantly pushing frontiers the research here is just a snapshot, you'll be able to work on the latest research being carried out in the School during your fourth year.

COLLIDING GALAXIES BLACK HOLES AND GRAVITATIONAL WAVES

Astrophysics and Space Research Group

On 14 September 2015 at 10.50:45 BST, an international team of scientists, with a strong participation from members of the University of Birmingham, detected gravitational waves for the very first time. They used the twin LIGO instruments in the USA and observed radiation generated by a pair of black holes about 30 times the mass of the sun that collided 1.3 billion years ago. The direct detection of gravitational waves has provided the final missing piece of the experimental confirmation of Einstein's theory of general relativity, 100 years after its formulation. Possibly more importantly, this marks the dawn of gravitational-wave astronomy and the opportunity of studying the Universe and its most violent phenomena in a radically new observational window. We have now observed several binary black hole mergers, and learnt that every 15 minutes somewhere in the Universe two stellar-mass black holes collide. On 17 August 2017, the LIGO-Virgo team observed for the first time gravitational waves from the merger of a binary neutron star. Electromagnetic radiation emerging from this collision was then detected across the entire electromagnetic spectrum in one of the most intense observational campaigns in the history of astronomy. This first multi-messenger observation solved long-standing puzzles in astrophysics: neutron star mergers are the engine powering at least some gamma-ray flashes in the Universe, and an important site for production of heavy elements, such as gold. The Birmingham group has been at the forefront of this whole effort, developing new technologies and building instrumentation for LIGO, and developed the techniques to tease out from the data the signatures of gravitational wave sources, unveiling previously unknown populations of black holes and testing gravity in its most extreme regime. We also study the nature of gravity at very short scales, using ultra-high precision measurements to search for quantum gravity effects in the laboratory. Astronomers at Birmingham also study the distant Universe, and its building blocks – galaxies, supermassive black holes at their centre, and groups and clusters of galaxies – using the most powerful telescopes at radio, infrared, optical, ultraviolet and X-ray wavelengths. Their goal is to understand how the Universe evolved into the structures we observe today, and shed new light on its mysterious components, the so-called dark energy and dark matter.



SOUNDING STARS AND SEARCHING FOR OTHER WORLDS

Sun, Stars and Exoplanets Group

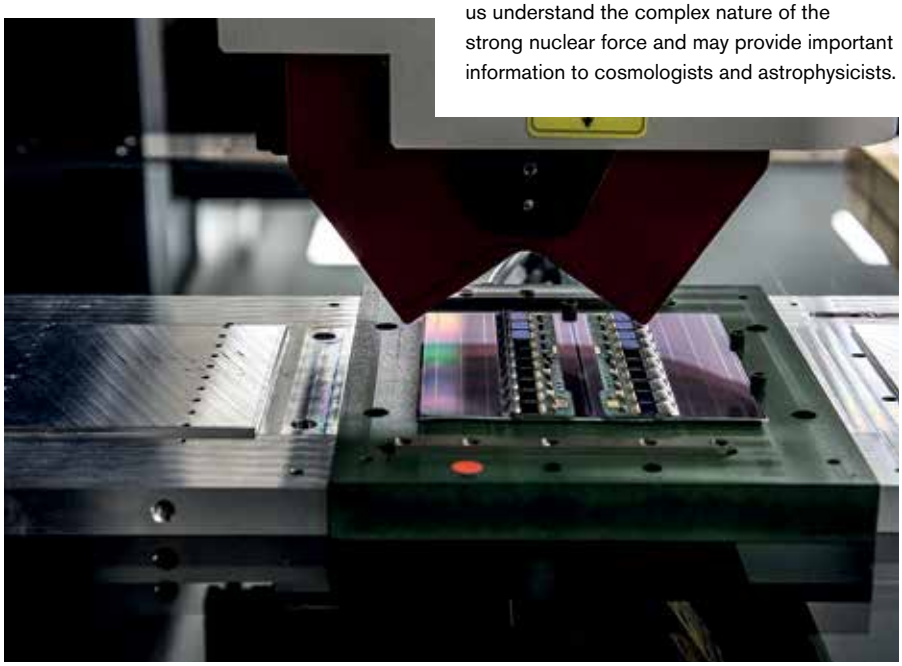
Astronomers at Birmingham pioneered helioseismology, using oscillations of the Sun to probe its previously hidden interior. They continue to monitor the Sun, using the Birmingham Solar-Oscillations Network (BiSON), and are now leading major international collaborations that are using exquisite data from a new generation of space telescopes, including the NASA Kepler Mission, and the recently launched TESS Mission to observe oscillations in other stars. Kepler has found thousands of planets orbiting other stars in our Galaxy, and TESS will do so around even brighter stars. Astronomers at Birmingham are also searching for exoplanets, using both ground-based telescopes and space missions. They are using oscillations detected in old suns (red giants) as 'Galactic rulers and time-pieces' to perform Galactic archaeology of our Milky Way Galaxy. Finally, they are also leading international teams preparing for the upcoming European Space Agency PLATO space mission.

EXPLORING THE FRONTIERS OF PARTICLE PHYSICS AT CERN

Particle Physics Group

The Particle Physics group is making central contributions to the exploration of the landscape of fundamental physics at the energy frontier as revealed by the Large Hadron Collider (LHC) and other facilities at CERN. As well as analysing the data produced, our group has a long tradition of building the state-of-the-art electronics required to select the most interesting events within a few microseconds of collisions taking place. We also host a large clean-room facility, where we are building some of the highest precision detectors ever as part of the LHC upgrade programme. Our largest activity is with the ATLAS experiment, where we played a major role in the recent discovery of the Higgs boson. We are now hard at work on understanding the properties of the Higgs boson and searching for further signs of previously unknown phenomena.

We are also expert in the study of ultra-rare processes involving heavy flavour quarks. Our work on the LHCb and NA62 experiments is concerned with beauty and strange quarks, respectively, and is addressing the question of why the Universe contains so much more matter than antimatter. With a view to the future, we are developing ideas for possible new electron-positron, electron-proton and proton-proton colliders, which will shed further light on the Higgs boson and other new physics, as well as revealing the details of the innermost structure of matter and of the strong force which holds it together.



NEW STATES OF MATTER

Nuclear Physics and Particle Physics Groups

When nuclei collide at sufficiently high energies, the protons and neutrons inside them are hit so hard that their constituent quarks are momentarily freed. In the aftermath of these collisions a new state of matter is created, known as a quark-gluon plasma, which replicates the conditions of the early Universe shortly after the Big Bang. Birmingham nuclear and elementary particle physicists were involved in the first experiments at CERN and the RHIC accelerator at Brookhaven in the USA that first identified this new state of matter. They now play a leading role in ALICE, an experiment at the Large Hadron Collider that has been optimised to study the highest energy nuclear collisions ever achieved in the laboratory. Our team of physicists and engineers are responsible for the experiment's trigger system, which is designed to select the most interesting events. The study of the quark-gluon plasma will help us understand the complex nature of the strong nuclear force and may provide important information to cosmologists and astrophysicists.

Research at Birmingham

Continued

GETTING TO THE HEART OF THE MATTER

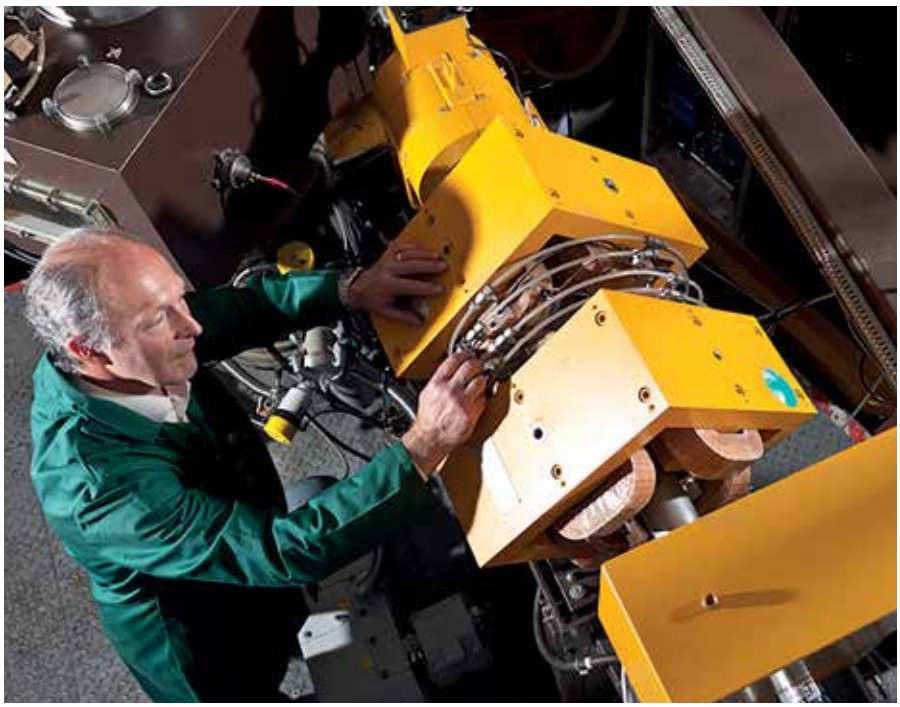
Nuclear Physics Group

Atomic nuclei account for more than 99% of the visible matter in the Universe. The atomic nucleus is a quantum mechanical system where the effects of the strong force can be studied alongside the weak and electromagnetic forces. The understanding of nuclei and their interactions plays a key part in the research conducted by the Nuclear Physics group and it is relevant to many other aspects of human endeavour such as archaeology, astrophysics, the environment, medicine, nuclear power and many more. Nuclei come in all sorts of shapes and sizes and far from being just an amorphous collection of protons and neutrons can exhibit fascinating ordered behaviour such as molecular-like clustering. The major challenge of the next decade will be to extend the study of nuclear physics into the realm of highly unstable exotic nuclei, which are key to understanding the astrophysical processes responsible for the creation of the elements. Birmingham nuclear physicists are leading experiments at new radioactive beam facilities that will ultimately help to explain where the stuff of which we are all made of came from.

INVISIBILITY IS PHYSICS, NOT MAGIC!

Metamaterials Group

Birmingham scientists created a working invisibility cloak using a crystal that manipulates light to hide objects as big as a paperclip. Previous studies had demonstrated cloaking by using metamaterials (fabricated composites that interrupt the flow of light), which limits the size of the area being cloaked. Using calcite as an alternative allowed the team to cloak larger areas, thousands of times bigger than the wavelength of light, with the cloaking size being limited only by the size of the crystal itself. Calcite has birefringent, or double-refraction, properties, which means that light entering the crystal splits into two rays having different polarisations that travel at different speeds and in different directions. It is this process that effectively bends the light, rendering objects invisible. Birmingham scientists are now exploiting the underlying ideas behind cloaking and metamaterials to create optical and acoustic illusions, to explore and tailor quantum phenomena and to realise a 3D graphene analogue, which opens exciting new scientific avenues and applications.



ARCHITECTURE WITH ATOMS

Nanoscale Physics Research Laboratory

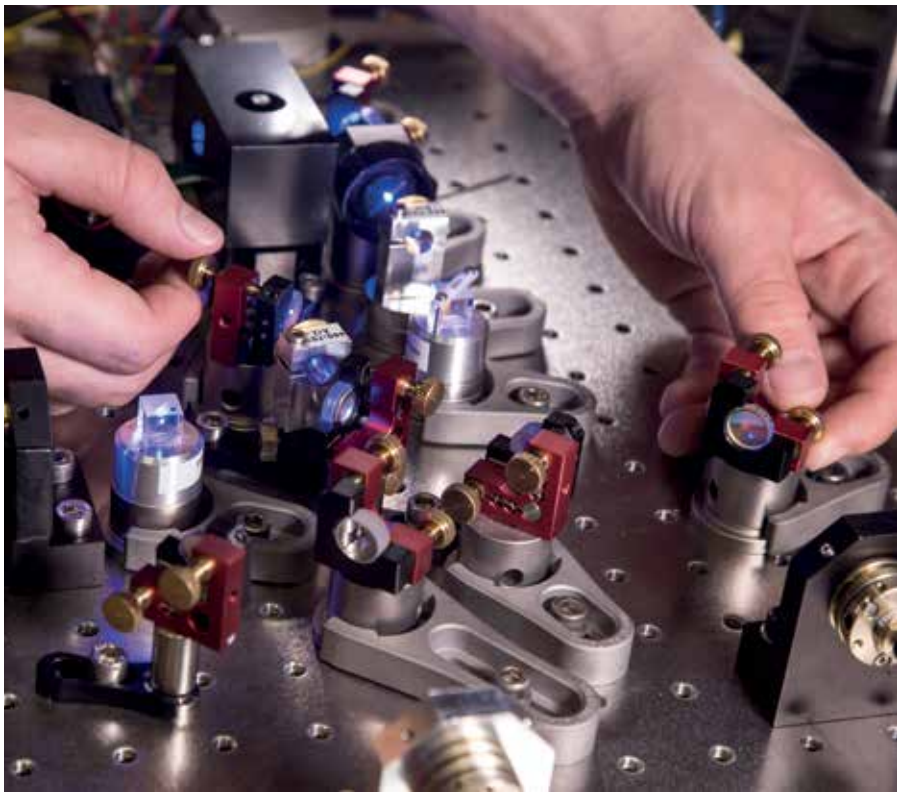
Spectacular feats of architecture are now possible on the scale of atoms, from the dissection of individual molecules with an electronic scalpel to the assembly of practical materials such as catalysts from nanoclusters of a selected size. We can use the Scanning Tunnelling Microscope (STM) to trigger molecular reactions and the Scanning Transmission Electron Microscope (STEM) to image fluctuating 3D atomic assemblies in real time. Birmingham's Nanoscale Physics Research Laboratory performs fundamental experiments like these, across the range from quantum physics to molecular biology, and also translates them into working technological prototypes, whether nanoporous silicon and metal alloy particles for malaria prevention and cancer treatment, an optical modulator for high speed communications or a catalyst to create clean hydrogen fuel from water.

THE COLDEST SPOT IN THE UNIVERSE

Cold Atoms Group and Quantum Technology Hub

When cooled close to absolute zero, matter unveils its intimate wave-like nature and quantum mechanical laws replace those of classical mechanics. By using lasers and controlled magnetic and electric fields, Birmingham scientists are able to cool small ensembles of atoms down to the lowest temperatures in the Universe – just a few billionth of degrees above absolute zero – and thus to access the realm of fully quantum mechanical motion. All the essential parameters of the atomic samples, including the temperature, the shape and the forces between the atoms can be efficiently controlled, making these clean almost ideal systems for discovering new quantum behaviour and new states of matter. The Cold Atoms group exploits these exceptional systems to study a number of quantum phenomena ranging from the super fluidity to the light-matter interaction, from quantum thermodynamics to the creation of light with exotic properties. Building on the expertise gained, scientists in the Birmingham Quantum Hub for Sensors and Metrology are

now able to exploit the exceptional properties of quantum matter to realise real-world applications like ultra-precise atomic clocks and 'gravitational cameras', which can unveil the underworld – from modern urban infrastructure to the buried secrets of Stonehenge.



Condensed Matter Group

Quantum physics defies our common sense. Electrons behave not only as point-like particles but also waves spread out into a space; they can follow two different paths at the same time as well. We explore how these counter-intuitive, 'quantum-mechanical' effects manifest themselves in a large scale, in real materials. The most widely known example is a super-conductor, where the electrons collectively form a macroscopic quantum condensate and flow without experiencing any resistance. The superconductors are just a tip of the iceberg called Quantum Materials with exotic electronic and magnetic properties that are of our research interest.

In order to explore collective quantum phenomena in condensed matter, we employ a variety of experimental tools. For instance, we fire off subatomic particles such as neutrons or x-rays onto the materials, thereby unravelling their internal structure and dynamics. We also apply electromagnetic fields into materials which give rise to resonance phenomena. We perform the experiments at ultralow temperatures (down to a few hundredths of a degree above absolute zero) and a strong magnetic field (a thousand times stronger than a fridge magnet) as quantum effects would become more apparent at such extreme conditions.

FROM STARS TO BREATH

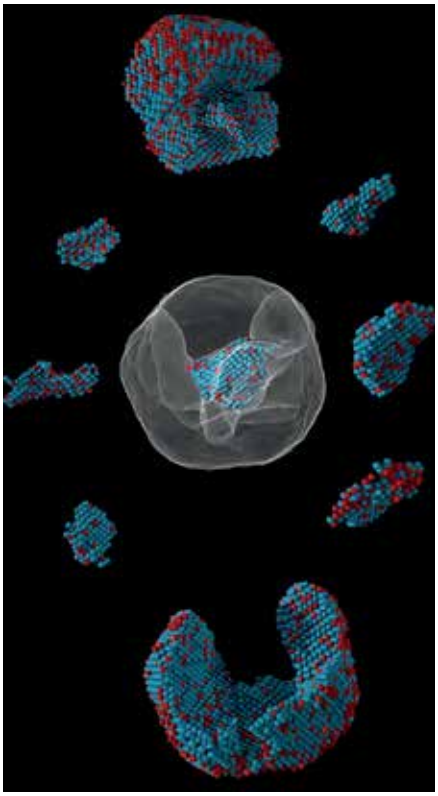
Molecular Physics Group

Our research is directed towards the study and applications of the reactions of ions with neutral molecules. Multidisciplinary research programmes cover topics from the formation ofmolecules in interstellar space through to analytical chemistry, with the latter predominantly focusing on Homeland Security and Health Science issues. Our analytical programmes use sensitive probes for the detection of trace compounds in complex surroundings, including applications to detecting volatiles in exhaled breath for the health sciences.

HOW SAND FLOWS AND CRISPS ARE COATED

Positron Imaging Centre

Does sand flow like an ordinary liquid? When you watch sand flowing through your fingers, all that you observe is the surface of the sand. However, to be able to tell if it is flowing the way water would, you need to look at individual grains. Birmingham's Positron Imaging Centre allows us to examine flows in such opaque materials. These include crisps being coated in drums, flowing ice cream for the food industry, and lubricants in engines. All of these materials are often in a no-man's land between the solid and liquid phases and the study of the pure physics involved is a rapidly developing and very important field.



Student support and wellbeing

University is an exciting, formative and sometimes challenging experience. At Birmingham, we work hard to ensure you have all the support you need both in your academic studies and in your personal transition to independent adult life. We understand you are an individual with your own specific needs and, as such, provide a range of services to ensure you can get the most from your studies.

Personal tutors

As a physics student, you will be assigned a personal tutor for each of the first two years, who you will meet once a week, in a group of no more than four students. Tutorials are a chance to chat through any areas of confusion from the previous week's studies and an opportunity to review feedback on marked assessed work. By staying on top of the week's learning and then raising any problems in the weekly tutorial, you will be able to feel confident in your understanding of the course material and know you are on track to succeed. Personal tutors are also your first point of call for pastoral support. Meeting your tutor once a week means you will always have a familiar face in the academic staff to speak to if you need.

Wellbeing Officer

Sometimes circumstances arise which you may wish to chat through with someone other than your personal tutor. We have a Wellbeing Officer specifically to meet this need. They are able to provide practical and emotional support if you experience any personal problems that interfere with your academic work. They can also recommend sources of professional help or assist with any University procedures, such as reasonable adjustments or extenuating circumstances.

Learning support and reasonable adjustments

The Disability, Mental Health and Learning Support Service can arrange reasonable adjustments and additional academic related support if you have a disability, including long-term mental or physical health conditions and autistic spectrum conditions.

The services include:

- Putting in place a Reasonable Adjustments Plan to inform the School of Physics and Astronomy of your requirements
- Arranging exam adjustments, for example, extra time or rest breaks
- Advice on applying for the Disabled Students Allowance (DSA) and support to set up DSA funded support
- Arranging non-DSA funded support such as non-specialist note-taking support
- Advice and guidance on screenings for if you think you might be dyslexic, dyspraxic or dyscalculic

Mental health support

The Mental Health and Wellbeing Service can provide confidential psychological support during your studies. They provide a range of support, run by experienced wellbeing practitioners and counsellors. This includes self-help guides written by clinical psychologists with simple suggestions in which you can make positive changes; workshops and groups on a range of common issues; short drop-in appointments to discuss emotional and personal concerns, or learn more about the services. Other personalised support is available on assessment of your needs if you register with the service.

Financial advice and support

The University's Funding, Graduation and Awards team are available to provide you with financial advice and support throughout your studies. They can provide hints and tips on effective budgeting, advice on applying for funding and administer the Student Support Fund for those who are struggling financially.

Support for international students

The International Students Advisory Service (ISAS) exists to help and support international students at the University of Birmingham. They can provide advice on visas and immigration. ISAS also provides welcome guides and events for international students who are moving to the UK for their studies. The Birmingham International Academy provides support for students whose first language is not English, including English language classes.

Equality and diversity

Equality and diversity is a core principle both within the School of Physics and Astronomy and the University of Birmingham at large. We acknowledge that academia cannot reach its full potential unless it can benefit from the talents of all.

The School of Physics and Astronomy's Equality and Diversity (E&D) committee is composed of representatives from all parts of the School. It meets regularly to address any issues faced by staff or students and to develop new initiatives that ensure everyone can study and work here without obstacle. As an undergraduate student, you are able to represent your peers on the committee as an E&D rep and everyone is welcomed to submit suggestions to be considered.

Our efforts in ensuring gender equality within the School have been recognised by two recent awards; we are an Institute of Physics Juno Champion and hold an Athena Swan Silver Award. The goal of the Juno initiative is to address gender equality in physics and to encourage better practice for everyone in the school, while also working towards developing an equitable working culture in which all students and staff can achieve their full potential. The Athena Swan charter commits to advancing gender equality in academia, including considering the intersection of gender and other factors within higher education and academia.

There are a number of student groups and societies which promote the representation of minority groups within Science, Technology, Engineering and Mathematics (STEM). Student societies are run by students for students, this means if you see a gap in provision you are welcome to create your own society to fill the need.

oSTEM

oSTEM (Out in STEM) at Birmingham is an organisation with the aim of supporting LGBTQ+ students studying STEM subjects at the University. They welcome undergraduates and postgraduates from all STEM backgrounds and organise a range of events including socials, careers events and talks from LGBTQ+ professionals in STEM fields.

WISE

WISE (Women in Science and Engineering) at Birmingham is a University organisation with the aim of supporting and promoting women within STEM at the University of Birmingham. They welcome undergraduates and postgraduates from all STEM backgrounds and organise a range of events including socials, industrial visits, talks and outreach activities.

BEaMS

BEaMs is a student society to represent black and minority ethnic (BME) scientists. They are here to create a network of BME students across the science and engineering departments at Birmingham and provide a safe space for scientists and engineers of colour. They also aim to give support, improve the BME student experience and advocate for equality and diversity in the sciences.

STUDENT REP SYSTEM

In the School of Physics and Astronomy at the University of Birmingham we are proud of the ways in which we prioritise our students' needs. A major part of this is our Student Representative System. Each year group in the School elects a group of their peers to be their representatives to the staff. The job of these reps is to gather feedback, issues or concerns from their fellow students and report it to the weekly student rep meeting. In this way, you can be sure to have a friendly system of anonymous feedback in to the teaching of the School. Any comments are fed back to the staff straight away and the next meeting will include updates on how they have been addressed. It's also an opportunity for positive feedback: reps nominate a 'lecturer of the week' to thank a staff member who has gone above and beyond. Student reps also have a number of sub-committees, for example, a charity committee and a mental health awareness committee, which work on that specific project throughout the year.

LAURA COAKLEY,
Second Year Student Rep

'The department really does care about the student experience and the reps system allows changes to be made to ensure that the teaching methods are effective.'

Societies

University is a time to meet new people and try new things and joining a student society is the easiest way to do just that. We have three student societies based in the School of Physics and Astronomy and hundreds more across the University to suit every interest imaginable. On the off chance there's not one yet for your particular hobby or interest, you can start your own!

POYNTING PHYSICAL SOCIETY

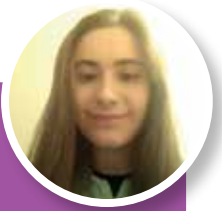
Poynting Physical Society (PPS) is the oldest student society at Birmingham with a history that pre-dates the University and goes back to the first ever Head of School, Professor Poynting. The Society is for all the students and staff in the School of Physics and Astronomy and is a part of the excellent community feel which permeates the School. PPS organises a wide range of events throughout the year which are inclusive for all types of physics student. Recent social activities include quizzes, laser quest, trampolining and bowling. PPS also organises academic-related events such as the annual internship fair and a recent trip to Edinburgh for the UKSEDS National Student Space Conference. PPS runs an annual spring ball, which is the culmination of the year's social activities in the School. The formal evening of dinner and dancing is the highlight of the year for many students and staff.

GRAND UNIFIED THEORIST SOCIETY (GUTS)

The Grand Unified Theorist Society brings together theorists from all stages of their careers. They hold termly socials for undergraduates, postgraduates and research staff, where everyone (ie, not exclusively theorists!) is welcome. This is a great opportunity to meet with other year groups, researchers and lecturers in an informal and relaxed environment.

UNIVERSITY OF BIRMINGHAM ASTRONOMICAL SOCIETY (ASTROSOC)

AstroSoc is the oldest society that is affiliated with the Guild of Students. They organise sessions to view the night skies through the society's telescopes as well as talks by experts from all aspects of astronomical-based backgrounds. AstroSoc are also very active in working to share astronomy with a wider audience. They help run the regular 'Astronomy in the City' events held in the School for the local community. In recent years they've also run events for local school children to learn more about all sorts of astrophysics-related topics.



ASHLEIGH HURST, Physics MSci

'I'm currently a member of the University Royal Naval Unit. Being a member of the unit has been one of the best parts of my experience at Birmingham and I can't recommend it highly enough. Through this group, I have participated in: rock scrambling, canoeing, orienteering, mountain biking, team sports, boat piloting and parading at the National Memorial Arboretum in the last year alone! By joining committees, you can also take on positions of responsibility. I am the charities secretary, and I organise volunteering and fundraising events for the group. This includes events such as the Birmingham half marathon and volunteering at Crufts.

'If that isn't really your thing, there are many other societies you can choose from. These range from drama groups, such as the Guild Musical Theatre Group (GMTG), to the baking society. You can even gather a group and start up your own. The experiences and friends you make along the way are incredible, and I thoroughly encourage everyone to get involved!'

Admissions

All applications to the undergraduate physics courses at the University of Birmingham must be made via UCAS and the deadlines set by UCAS must be observed. Applications should be made in the year proceeding entry to the University, in the autumn and winter for Home students and throughout the year for International students. We are happy for students to defer their application for one year and this will not affect our likelihood in making you an offer. For information on the UCAS procedure, precise deadlines and to make an application, please visit www.ucas.com

Accepted Qualifications

Applicants must be studying or have studied either:

- Three A levels including Mathematics and Physics
- International Baccalaureate including Higher Level Mathematics and Higher Level Physics
- Three Cambridge Pre-U courses (or in combination with A levels) including Mathematics and Physics
- BTECs, where studied alongside Mathematics and Physics A levels or Pre-U courses
- Other international qualifications equivalent to A levels, please contact the admissions tutor for more information

We consider Further Mathematics as a separate A level to Mathematics and welcome applications from those who are only studying Physics, Mathematics and Further Mathematics. However, students who are not studying Further Mathematics will not be penalised in the offer-making process. Use of Mathematics is not accepted in place of Mathematics. General Studies is only considered as a fourth A level and Critical Thinking is never considered. We consider the Welsh Baccalaureate as equivalent to an A level.

We will not consider students for the first year who are taking only BTEC qualifications, A levels without Maths and/or Physics, or Access to Higher Education courses. You may be eligible for Foundation Year entry instead, please see page 16.

Decision making process

Wherever possible, your school or teacher should supply predicted grades and an academic reference. This, along with your personal statement and rest of your UCAS application will be used to make a decision on your application. No interviews or additional tests are used.

Please do not worry if you do not hear back from the School straight away, we sometimes keep applications for a few months before making a decision, so that we can compare all the applications we receive.

The School of Physics and Astronomy will only use unconditional offers in the case of students who have already achieved the required qualifications for entry to the course.

Alternative offer conditions

Our standard offers are based on grades in A levels in Mathematics, Physics and one other subject, or their equivalent in other qualifications. Some students may receive alternative offer conditions which depend on their personal circumstances or additional qualifications. This could include those who:

- Are taking four A levels and have applied for a BSc course;
- Are taking an extended project qualification;
- Have spent time in local authority care;
- Attend a school or college where GCSE or A level performance is below the national average AND whose home postcode is in a low progression to higher education neighbourhood;
- Are part of a Pathways to Birmingham Scheme.

For more information on any of these, please get in touch with the admissions tutor.

Entry to later years

We only accept transfers into later years in very exceptional circumstances or from specific international university partners. Please contact the admissions tutor before applying to discuss your situation.

Visiting the University

The best time to visit the university pre-application is one of the University's Open Days. This will provide an opportunity to visit all parts of the University, including a range of accommodation, and to meet many current students and lecturers.

If you are made an offer to study physics with us you will be invited back to an Offer-Holder Visit day, run between November and March. From our experience, these visits are invaluable in making your final decision between universities. Even if you have already attended an open day, this visit will give you extra layer of depth and a chance to see the School during term time. Our visit days are specific to Physics and all tours and talks will be conducted by Physics staff and students. You will have the opportunity to have in-depth conversations with academic staff and students as well as seeing the School, campus and student accommodation. If you have received an offer from us but are unsure of how to register for a visit day, please contact the admissions tutor.

If it is impossible for you to visit one of our set open days or visit days but would still like to see the campus and School, please get in touch with the admissions tutor.

Help and advice

The Physics admissions tutor is always happy to answer questions and queries regarding applying to Physics at Birmingham, please use the contact details below. There is guidance on how to apply on the UCAS website. You can find more information on our website www.birmingham.ac.uk/applicantinformation

LEARN MORE

The admissions tutor can be contacted at:

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Tel: +44 (0)121 414 4563
Email: physics-adms@bham.ac.uk
www.birmingham.ac.uk/physics-ug

This leaflet was written several months in advance of the start of the academic year. It is intended to provide prospective students with a general picture of the programmes and courses offered by the School. Please note that not all programmes or all courses are offered every year. Also, because our research is constantly exploring new areas and directions of study some courses may be discontinued and new ones offered in their place.

Please note the information in this brochure is correct at time of publication but may be subject to change (June 2019).

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