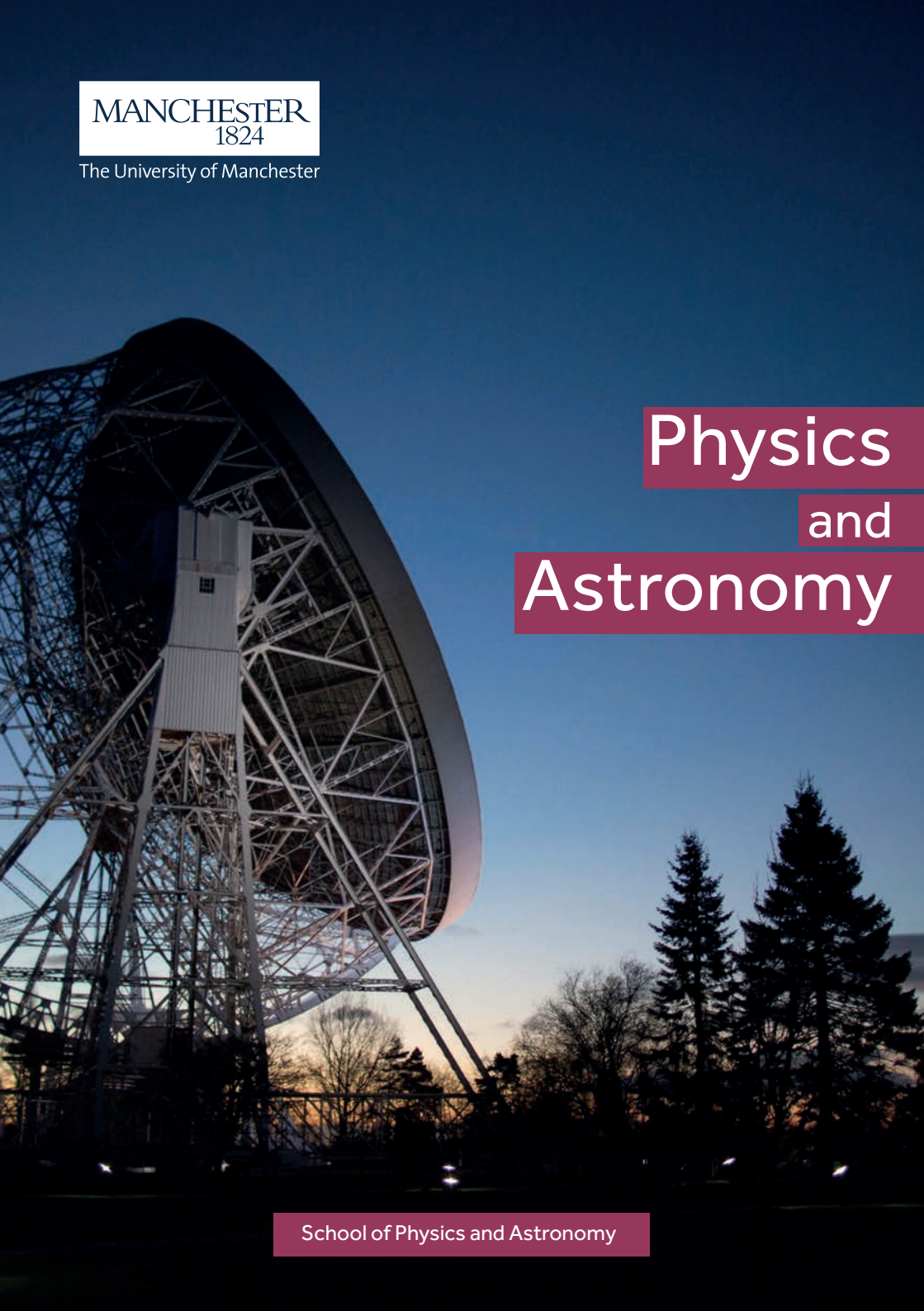
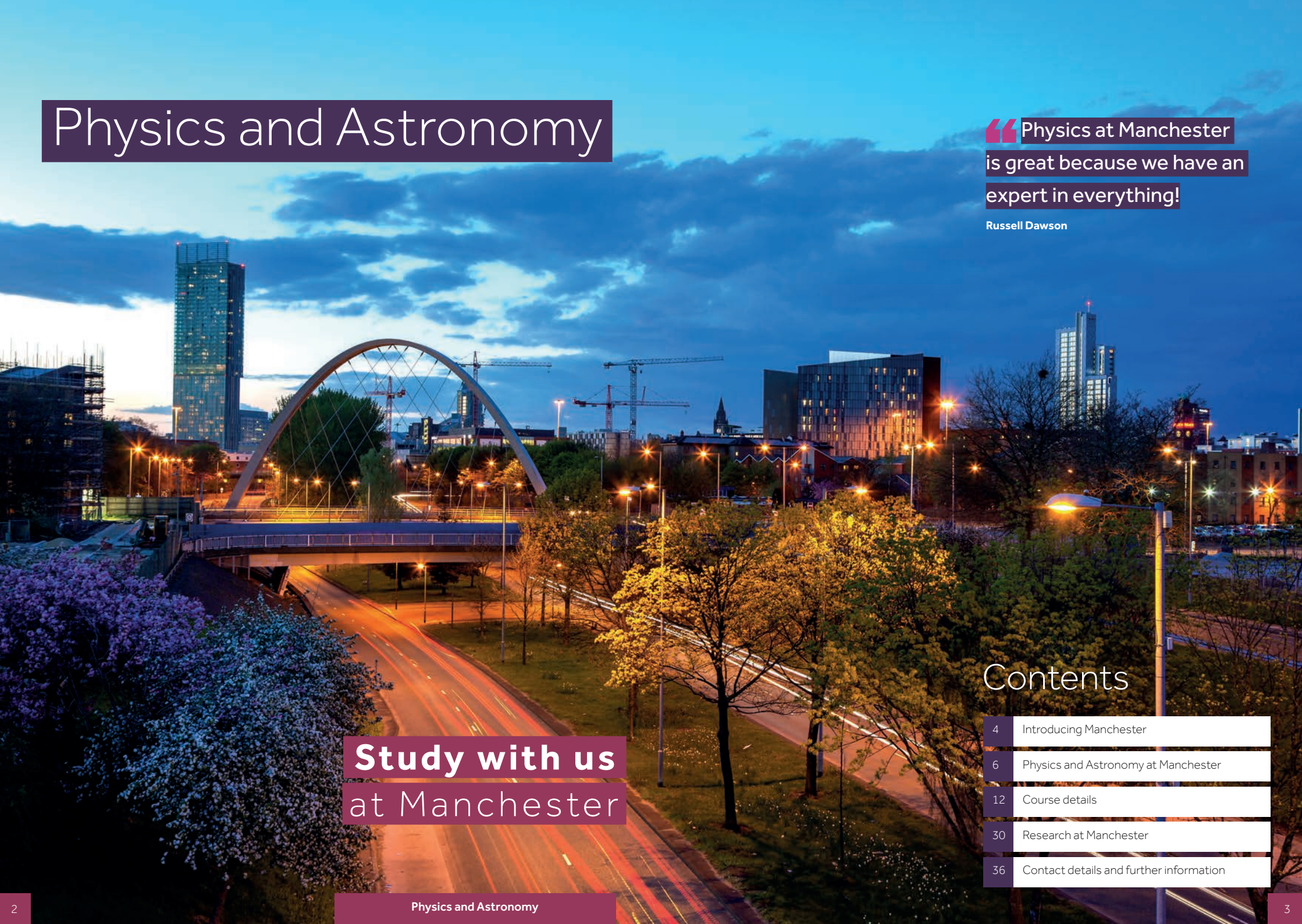
MANCHESTER
1824
The University of Manchester

Physics and Astronomy



School of Physics and Astronomy

Physics and Astronomy



> Physics at Manchester is great because we have an expert in everything!
>
> **Russell Dawson**

Study with us at Manchester

Contents

Manchester

The University of Manchester

Making things happen

Influential, forward-thinking and down-to-earth, we'll give you an amazing university experience rooted in a rich academic heritage. We turn enthusiasm into achievement and ground-breaking theory into innovative practice.

We accomplish feats of global significance, from splitting the atom, to giving the world graphene—the two-dimensional wonder material that is one atom thick, but 200 times stronger than steel.

With strong links to industry and public services, we vitalise our undergraduate courses with pioneering research.

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www.manchester.ac.uk

The University of Manchester

Making things happen

Manchester thrives on innovation and creativity, always a step ahead in science, industry, media, sport and the arts. The Mancunian character—exemplified by the city's central role in the Industrial Revolution—stands for excellence and originality in all walks of life.

All corners of the world meet in Manchester. It is a cosmopolitan magnet for students and professionals who are eager to experience our can-do attitude, independent spirit and cultural wealth. Never content to live on past glories, Manchester has a passion for progress. Join us at the heart of Britain's most popular student city.

Discover what makes Manchester unique:

Learn more about us:
www.manchester.ac.uk/city

Your experience

More than just a degree

Whether you prefer to work in the ultra-modern surroundings of the Alan Gilbert Learning Commons, or if you get your inspiration from the neo-gothic grandeur of the John Rylands Library, we've got it covered with our impressive range of flexible study environments and support services for a truly personal learning experience.

And that's not all. Outstanding sport facilities, over 450 student societies, supported community volunteering, study abroad pathways, career development programmes and mentoring are all ways in which we support you to grow and develop outside the lecture hall. Make the most of what we have to offer and you'll enjoy a well-rounded university experience that prepares you for life after graduation.

Hear from some of our students:
www.manchester.ac.uk/study/experience

Your future

On a course to success

We are one of the UK's most targeted universities by employers, thanks to courses and careers services designed with your employability in mind.

Our problem-based approach to learning inspires you to think critically, creatively and independently. Taking part in activities to enhance your academic record, such as volunteering, personal development and interdisciplinary learning can give you a broad perspective and a competitive edge, shaping you into a socially responsible leader of tomorrow.

Our award-winning careers service provides a wealth of tools, advice and development opportunities, and connects you with employers to put you a step ahead on the path to success.

Take control of your career:
www.manchester.ac.uk/careers

Physics and Astronomy at Manchester

We are proud of Manchester's outstanding historical record of achievements in science and engineering. Arguably the first of these was the discovery of the atomic nucleus by Ernest Rutherford, who was the Langworthy Professor of Physics here in the early 20th century. During his time at Manchester, Rutherford also performed the first 'artificial' nuclear reaction, which marked the beginning of nuclear physics.

Today, we remain a leading centre for research in nuclear and particle physics. For example, Manchester physicists are helping to run experiments at the Large Hadron Collider at CERN, which have recently discovered the Higgs boson, revealing the mechanism responsible for the origin of mass, and which will go on to solve some of the mysteries of antimatter.

Astronomy also has an illustrious heritage and vibrant current research programme here. Jodrell Bank Observatory, including the world-famous Lovell Telescope, is part of our School and has been used to discover the first gravitational lens, the first celestial maser and more pulsars than any other telescope.

Jodrell Bank is also host to the international headquarters of the Square Kilometre Array, which will be the world's largest telescope when it commences observations in the 2020s.

Our condensed matter physicists lead the world in studying two-dimensional materials such as graphene, a single layer of carbon atoms – the production of this material and characterisation of its unusual properties led to the 2010 award of the two Nobel prizes. Physicists play an important role in the National Graphene Institute, a £61 million investment on campus creating the ideal environment for world-class graphene research.

Being a large school, our research covers a very rich portfolio over most of the subfields of physics, ranging from fundamental areas to interdisciplinary projects that reach beyond the academic subject and more applied research programmes. We have internationally leading research programmes that include atomic, nuclear, particle and accelerator physics; condensed matter and soft matter physics; laser and photon physics; low temperature physics; biological physics; complexity and nonlinear physics; and astronomy, astrophysics and cosmology.

Experimental and theoretical physicists work together on many of these research activities.

Study with us and you'll benefit from a tradition of excellence established by many eminent teachers and researchers, including 13 Nobel Prize winners, such as Rutherford, Bohr, Bragg and Blackett. Our most recent Nobel laureates are Sir Andre Geim and Sir Kostya Novoselov, who were awarded the honour in 2010 for their pioneering work on graphene.

We combine excellence in research with excellence in teaching. Our research was ranked 13th in the World since in 2012 and has recently been graded in the top three in the UK for world-leading elements of our research profile. The School has an average overall satisfaction rate of 93% over all ten years of the National Student Survey.

Jodrell Bank Observatory, internationally renowned centre for radio astronomy, is part of our School

The School has a consistently very high rating for student satisfaction

One of Britain's largest and most respected schools of Physics and Astronomy, with top ratings for teaching and research, and two Nobel Prize winners in 2010

Well-equipped laboratories, including rooftop optical and radio telescopes

A new £10M extension enlarges our state-of-the- art teaching facilities

Physics and Astronomy at Manchester

Our international reputation rests equally on our teaching and our research; in fact, the diversity and excellence of our research boosts the quality of our teaching and the range of topics we make available to our undergraduates. We have a steady influx of new research physicists and teachers, and continually revise our teaching and research activities to keep our courses and research at the cutting edge.

Staff from our School have written the popular Manchester Physics Series, a set of 15 undergraduate textbooks published by Wiley; these are used by university physics departments around the world and have sold over a quarter of a million copies.

We were ranked 13th in Academic World Ranking of Physics Departments for our research since 2012. In the recent UK Research Excellence Framework (REF), we were in the top three for the world-leading elements of our research profile.

Over the ten years of the National Student Survey we have an average overall satisfaction score of 93%. We also listen to our students, who take active roles on all School committees that supervise our teaching activities. We also encourage you to join in the social, sporting, musical and other events that are organised by active student societies within our School. Such events encourage excellent working relationships through informal staff-student contact.

Our research and teaching excellence led to the award of a Regius Professorship by the Queen in 2013. It was one of twelve chairs created to celebrate the Queen's Jubilee and is the only Regius Professor of physics. It is currently held by one of our Nobel Prize winners, Andre Geim.

Brian Cox, presenter of many different scientific programmes, was an undergraduate and postgraduate student at Manchester and is currently a professor in our School, teaching one of our first- year core modules on Quantum Physics and Relativity.

The School has a broad research portfolio that covers most of modern physics. Our undergraduate course reflects our broad research portfolio, providing a thorough grounding in the fundamentals of physics and the breadth of our expertise gives you significant freedom to follow your own interests with a large variety of options, laboratory experiments and final-year projects and dissertations.

We provide a variety of teaching methods, from large group lectures to small group tutorials. Our regular small group teaching activities ensure that we meet the academic needs of each individual student. Our pastoral system of personal tutors and peer mentors gives each student support throughout their programme.

Contact with industry is an important priority for us and our research activities regularly attract industrial support. We were therefore proud to be ranked top in the UK for the non-academic impact of our research activities in the recent Research Excellence Framework assessment of physics.


Professor Brian Cox

Women in science

The School has a strong commitment to diversity and women in science. We hold both an Athena Swan Silver Award and Institute of Physics JUNO Champion status. The Athena SWAN Charter is owned by the Equality Challenge Unit and the awards recognise and celebrate good practice in recruiting, retaining and promoting women in science, technology, engineering, mathematics and medicine. The aim of the Institute of Physics Juno Scheme is to recognise and reward departments that can demonstrate they have taken action to address the under-representation of women in university physics and to encourage better practice for both women and men.

Visit days

Where practical, promising applicants are invited to attend one of our visit days, which are held regularly between October and March. These start with a short tour of the central campus and a welcoming buffet lunch. You will have the opportunity to see our School at first hand, ask questions and meet members of staff and current students.

Athena SWAN Silver Award

You will also have an informal, 25-minute interview with a member of staff, so we can get to know you and determine the most. Your parents, or guardians, are also welcome to attend our visit days, and we arrange a separate programme for them.

Scholarships and bursaries

For the latest updates on course fees and financial support, check our website:
www.manchester.ac.uk/studentfinance

Teaching, learning and assessment

Physics is a living subject, offering you all the excitement of new discoveries and new ideas. You can enjoy the intellectual satisfaction of understanding the difficult concepts of quantum theory and relativity, the challenge of comprehending everyday physical phenomena and the practical experience of using scientific apparatus and analysing complex data.

Our courses provide a secure foundation in the basic principles of classical and quantum physics from both a theoretical and an experimental viewpoint. Thanks to our size and breadth of expertise, we can also offer you a wide range of options, from cosmology to particle physics, including computing, theoretical physics and experimental modules. An undergraduate physics degree at Manchester therefore embraces a broad range of topics that are both practically useful and intellectually stimulating.

We monitor all aspects of our teaching programme via student comments at regular teaching review meetings and course questionnaires, which provide valuable feedback both to individual teachers and to the School as a whole. As a large School, we can deploy our teaching resources in many ways; whenever possible, we use this flexibility to enhance and improve your courses.

Physics and Astronomy at Manchester

Timetables

Our academic year at Manchester starts in late September and is divided into two semesters, each with 12 weeks of teaching, with additional weeks for study and examinations. Most lecture course units comprise 22 lectures over a single semester. Exams normally take place in late January and in May/June.

A typical teaching week in your first year consists of a physics tutorial, a mathematics tutorial, a problem-solving workshop, laboratory work and around 10 hours of lectures.

A well-organized routine of private study is essential if you are to fully understand in depth the new ideas that emerge as your course develops. To encourage this, we issue you problem sheets at regular intervals, which often form the basis for discussions in tutorials.

Assessment

In the early stages of the degree, you are mainly assessed by written examinations, with about 25% of your total marks coming from continuous assessment. The percentage of continually assessed work normally rises in your final year.

Lectures

Most students find our lectures indispensable to acquiring a good understanding of the subject. Your lecturers will describe the basic principles of the topic, show you interesting examples and applications and provide the information essential for its proper understanding. Most modules have extensive additional support via bespoke electronic resources. At Manchester, each subject gets a regular 'spring clean', thanks to our policy that members of staff lecture a particular subject up to a maximum of six years.

Tutorials

A tutorial is a weekly meeting between 4 to 5 students and a member of our academic staff, or a research scientist. It is an informal setting for an exchange of views, problems, opinions and information; an occasion when you can discuss physics problems with your tutor and with fellow students. In particular, tutorials deal with the problem sheets on the lecture course units. In the first year, you have tutorials in both physics and mathematics.Within such a small group, your tutor will be able to tailor their teaching to your specific needs.

Tutorials are therefore an important part of your education but also help establish good student-staff relationships. These are augmented by our 'Teaching Help Service', which allows you to have additional one-on-one tuition with a member of staff as and when the need arises. As well as tutorials, we have weekly workshops or classes where you work in groups with the support of a member of staff and assistants.

Personal tutors

Each new undergraduate student is allocated a personal tutor who usually takes care of them for their entire undergraduate career. Your personal tutor is on call to give academic advice, help with module choices, review academic progress, assist with career choices and help with any problems that you encounter as a student. Your personal tutor acts as one of your two academic tutors in the first year; that way they get to know you well, facilitating their pastoral role. Whilst you will get to know many members of the academic staff during your time in Manchester, your personal tutor usually knows you best; students often ask their personal tutor for references when making applications in their final year. The School also runs a peer-mentoring scheme where students in later years assist first-year students to settle down to university life.

Laboratory work

Students work in pairs in our teaching laboratory and may choose from a wide range of experiments. Some develop practical skills and experimental techniques, while others demonstrate the existence of physical phenomena. You have the opportunity to gain experience with modern equipment such as lasers, sensors and low-temperature cryostats. Above all, you are encouraged to think for yourself . Demonstrators provide guidance and encouragement to explore the various facets of the experiment. Your ability to communicate clearly and persuasively is also important and, to encourage this, you will discuss the results of each experiment with a member of staff and present several of the experiments as written reports. In your first year, experiments generally last two or three working days. By your third year, they become more extensive and sophisticated projects, which typically take around 10 days. Fourth-year MPhys projects involve working with our School's research groups; these projects can extend to 40 days and may, on occasion, lead to the publication of a research paper. Thus, there is ample opportunity for you to develop the skills of a good experimental physicist.

Computing and study facilities

As part of your laboratory work, we teach you how to use computers to help analyse data and write essays and reports. We also run core course units on computing and programming, with further optional course units available if you want to gain additional expertise.

Our School has more than 350 computers for student use. You will be given an account allowing you to use School and University facilities for student services, email, text preparation, mathematical modeling, programming and to access the internet.

Most of the lab and small group teaching you will experience happens in the Schuster Building and neighbouring Alan Turing Building. The Schuster Building has a physics library and study areas with extended opening exclusively for physics students. These compliment the extensive facilities available in the University Library and the Alan Gilbert Learning Commons.

In 2018, we are due to open a new annex to the Schuster Laboratory. This is a £10M investment in both research and teaching facilities. It includes a new undergraduate teaching laboratory, additional space and facilities for student projects and new teaching areas specifically designed for active learning and skills training.

Course details

Physics BSc 3yrs
UCAS Code F300

Physics MPhys 4yrs
UCAS Code F305

Physics with Astrophysics BSc 3yrs
UCAS Code F3F5

Physics with Astrophysics MPhys 4yrs
UCAS Code F3FA

Physics with Philosophy BSc 3yrs
UCAS Code F3V5

Physics with Philosophy MPhys 4yrs
UCAS Code F3VM

Physics with Study in Europe MPhys 4yrs
UCAS Code F301

Physics with Theoretical Physics BSc 3yrs
UCAS Code F345

Physics with Theoretical Physics MPhys 4yrs
UCAS Code F346

Mathematics and Physics BSc 3yrs
UCAS Code FG31

Mathematics and Physics MMath&Phys 4yrs
UCAS Code FG3C

Entry requirements

Our entry requirements and the offer we make to you are designed to ensure that you have the necessary background knowledge, together with the skills and ability to succeed on the course.

Applications for all our first-degree courses should be made through the Universities and Colleges Admissions Service (UCAS). In most cases, a conditional offer is made on the basis of the information supplied in your UCAS application, together with the result of an interview.

The most common route into our degree courses is through A-levels, but we welcome students holding any equivalent qualifications. Each application is considered separately, on its own merits.

Students returning to education

We welcome applications from mature students; we would look for evidence that you would be able to achieve success on a demanding, full-time course. You may find it helpful to contact our admissions tutor for advice before submitting an application through UCAS.

Deferred entry

Some students benefit from a year away from academic work between school and university. Accordingly, we welcome applications from prospective students who wish to defer entry to us for one academic year.

Professional accreditation—Institute of Physics

Our courses are all accredited by the Institute of Physics, the professional body for physicists in the UK.

Typical offer for all physics degree programmes:
A-level A*A*A-A*AA
IB 39-38
For full details visit:
www.manchester.ac.uk/ugcourses

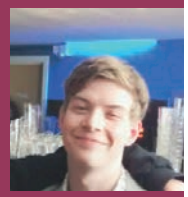
"I moved to the UK from Germany to study Physics with Philosophy at the University of Manchester and making that decision has paid off immensely ever since. The Physics department at Manchester has supported me throughout all stages of my undergraduate career.

Manchester comes with the most academically exceptional and friendly researchers I have come across and everyone is very eager to help each other.

Thanks to the guidance and help I received from the department, I was able to found my own society and to organise a nationwide conference for physics undergraduates. I was amazed to find how much effort the university puts into caring for students as individuals and it was great to feel this sense of community ever since my first day at Manchester.

Malin Litwinski

"I arrived at Manchester with a keen interest in "Physics" but after that I wasn't exactly sure. Thankfully, the course here perfectly balances core modules— which are great at cementing a fundamental understanding— with topics that push your interests to the boundaries of research. Not many other courses allow you to specialise in quite the same way. When it comes to the social stuff Manchester really does have it all! Brimming with societies which celebrate everything from scuba diving to sky diving, chess to burlesque or Yu-Gi-Ho to Taekwondo, the Manchester Students' Union is the perfect place to fuel your passion. If the 300 different societies right on your doorstep still don't take your fancy, the University loves to help individuals set up new groups.



Samuel Ward

Which course?

At Manchester, we offer a wide variety of degree courses, allowing you to choose between a degree with Honours in Physics and a combination of physics with some other specialisation. However, all courses include considerable flexibility and a large range of option course units, particularly in the later stages of the degrees.

We have four-year courses leading to the degree of MPhys with Honours (Master of Physics), which run alongside our three-year BSc Honours courses. The MPhys and BSc courses have identical structures in Years 1 and 2.

The UCAS codes for our courses are shown in the list on page 12. You need not apply for more than one degree course, since it is possible to transfer applications between them at any stage up to the start of the course. On entry, students often register for the four-year course, but keep the option of graduating after three years with a BSc degree. This decision is often taken at the beginning of the third year, with progression to MPhys dependent on good academic performance.

The **Physics** course and all '**Physics with**' courses are based on a core of course units, plus supplementary units related to the individual course. Because the core is common, students on both 'Physics with' courses have the option of transferring to Honours Physics at the beginning of any academic year.

The 'Physics with' courses comprise approximately two thirds core physics, and one third of content relating to the specialisation.s

Mathematics and Physics is a **Joint Honours** course, split approximately 50:50 between the two subjects. Transfer from our Mathematics and Physics degree course into straight Honours Mathematics or Physics is possible at the end of your first year, provided that you have achieved a sufficient standard in that subject.

All our degree courses prepare you for employment as scientifically aware graduates in research, industry, commerce and education. You will develop the ability to communicate clearly and confidently, to analyse complex problems, to describe events using precise terms, to use modern equipment with confidence and to demonstrate an understanding of the principles underlying technology.

The BSc Degree

The three-year Bachelor of Science degree (BSc) in physics provides a thorough grounding in undergraduate physics leading to a wide range of different careers. It also provides entry to specialised postgraduate master's degrees suitable for particular career paths and for progression to higher degrees. As part of the final year, the BSc dissertation gives students the opportunity to explore in depth a topic of interest in the physical sciences.

The MPhys Degree

The four-year Master of Physics degree (MPhys) combines a thorough grounding in undergraduate physics with the opportunity to develop research skills. It provides significant breadth and depth in physics knowledge and skills leading to a wide range of different careers. It is also ideal preparation for students wishing to start a PhD directly after graduation. In the final year of the MPhys course, research skills are developed in projects that are based within the School's research groups.

Study abroad

Students on all four-year physics-based degree courses have the opportunity of studying for the third year of their course at one of several universities abroad. The University has exchange partners across the world and students build up valuable experience spending time at these universities.

There is a wide range of partner universities in many different counties with Canada, United States of America and Singapore being popular destinations.

There is no need to specify this option on your UCAS application form as applications are made once you are here. Availability of places is competitive and decisions are normally made in the during the second year of study.

Career opportunities

In designing our degree courses, we strike a balance between training for industry and research, and a general education in the most fundamental of the sciences. Our intellectually demanding courses remain sufficiently flexible to meet the needs of a wide range of future careers. We work closely with our University's Careers Service in helping our undergraduates to explore the job market.

More employers visit our campus than any other UK university; indeed, the Graduate Market Survey has placed the University of Manchester in the top three most targeted UK universities by top graduate employers every year since 2007.

Many of our graduates make direct use of their scientific skills and knowledge in their future employment. Others find that highly-valued transferrable skills help them secure careers in non-scientific areas; physics graduates are particularly skills in numerical analysis and interpretation and work in finance, banking and management.

The table below gives the most recent statistics for destinations of our graduates from 2012 to 2015, at six months after graduation. Usually about 20% of our graduates go directly to scientific, technical and computing posts; 30% to finance and management; 40% to postgraduate training and research; and about five percent go overseas. Usually well over 90% of our graduates find permanent employment soon after graduation.

Career Destinations		BSc	MPhys
Scientific, Technical and Computing		**16%**	**24%**
For example: Amec, BAE Systems, BP, British Gas, British Telecom, Cisco Systems, ESSO, IBM, Meteorological Office, NHS, QinetiQ, RAF, Sharp, TDK, UK-AEA, Vodafone			
Finance Banking and Management		**34%**	**19%**
For example: Accenture, Bank of England, British Airways, Delloitte, Deutsche Bank, JP Morgan, KPMG, Lloyds Bank, Merrill Lynch, Price Waterhouse Coopers, Coop Bank, Barclays, HSBC, Schroders			
Research and Further Training		**34%**	**48%**
of which	PhD	(1%)	(35%)
	MSc	(18%)	(8%)
	Other PG diplomas	(15%)	(5%)
Other Destinations		**16%**	**9%**

Physics

The study of physics is an attempt to understand everything that we can observe and measure in the universe: from the infinitesimally small, to the infinitely large; from the beginning of the universe in the Big Bang, to its ultimate fate.

What you study

Our physics degree has a 'core plus option' structure, which allows you to devote about 20% of your time in the first three years to topics chosen from a wide range of options made available by both our School of Physics and Astronomy and other schools of the University.

In your **first** and **second years**, the physics core provides a foundation in classical physics through course units in dynamics, waves, electromagnetism and thermodynamics. At the same time, you are introduced to concepts such as the unification of space and time, the wave-like behaviour of particles and the relation between entropy and disorder. This introduction is taught through course units in special relativity, quantum mechanics, cosmology and statistical mechanics.

These concepts and the techniques of classical physics are essential for the understanding of molecules, atoms, nuclei, quarks and leptons, condensed matter, solid-state electronic devices, electromagnetic radiation, lasers, stars and general relativity, all of which can be studied in detail in your third and fourth years.

Course units are grouped together into various 'streams', to allow you to choose either a coordinated set of units on a particular theme, or to mix and match to sample a wider range of topics. The table on pages 18 and 19 shows how the core and option course units fit into the streams.

Physics students typically choose option units from different streams to suit their interests. Generally speaking, any suitable course unit from any school of the University may be taken as an option, provided that the timetable allows it and that the student has the prerequisite knowledge and skills to succeed in it. The newly established University College also offers a range of courses from disciplines across the University aimed at non-specialists. Your personal tutor—a member of our staff dedicated to advising and supporting you through the course of your degree—helps you to select options. Guidance is also available from the results of student questionnaires on the course units. You are usually free to change any option course unit choice within the first two teaching weeks of the semester.

In the **third year** of the BSc course, the final-year dissertation gives you the opportunity to explore in depth a topic of your interest in the physical sciences. These have included: quantum dot solar cells, asteroseismology, biomechanics of the heart, the future of neutrino physics and the physics of traffic jams.

In the **fourth year** of the MPhys course, research skills are developed by work on research projects hosted by our research groups. We usually offer a choice of more than 100 different fourth-year projects, and in previous years they have included topics such as: measurements of radon from air samples in Derbyshire caves, cosmic-ray air showers, simulating the human heart, quantum chaos, calibration of the jet energy scales at the LHC, and optical properties of graphene.

The rich and varied research profile of Manchester physics generates an exciting and wide undergraduate curriculum with lots of choice in option modules allowing you to develop your own interests in physics. The wide range of world-leading experts in many different areas of physics also results in a large range of experiments in our teaching labs, a large choice of BSc dissertations and a similarly wide choice of MPhys projects.

"One of the things I enjoy most about the course is discovering how apparently unrelated concepts interlink with each other. From this, I feel that I've gained a better understanding of how the world works in general, not just in physics.

Matt Garrod

Course details

The following table shows the course units that are normally available

A range of business and Management courses are avialbe as options through The Manchester Business School

Core course units | Optional course units

Stream / Semester	Classical and Quantum Mechanics	Electricity and Magnetism	Theoretical Physics	Condensed Matter Physics	Nuclear Physics	Particle Physics	Astro-physics	Techno-logical Physics and Photonics	Mathematics		Computing	Laboratory	Other Physics	Earth and Atmospheric Science	Biological Science	History of Science	Economics	Enterprise	Wider curriculum
S1	Dynamics Quantum Physics and Relativity	Light and Optics	Random Processes in Physics				InIntroduction to Astrophysics and Cosmology	Digital Electronics Physics in Everyday Life	Mathematics 1		Computing and Data Analysis	First Year Laboratory	Special Topics in Physics	Planet Earth		Science and the Modern World	Micro-economic Principles UK Micro-economics		
S2	Vibrations and Waves	Electricity and Magnetism	Advanced Dynamics	Properties of Matter	Physics of Energy Sources		Physics of the Solar System	Circuits	Mathematics 2			First Year Laboratory	Statistical Methods	Introduction to Planetary Science			Macro-economic Principles UK Macro-economics		
S3	Introduction to Quantum Mechanics	Electro-magnetism	Lagrangian Dynamics				Galaxies	Amplifiers and Feedback	Mathematics of Waves and Fields		Introduction to Programming for Physicists	Second Year Laboratory		Atmospheric Physics and Weather			Economics for Environmental Management		Professional Skills University College Courses
S4			Complex Variables and Vector Spaces	Thermal and Statistical Physics Fundamentals of Solid State Physics			Astrophysical Processes	Wave Optics Introduction to Photonics	Introduction to Geometry Propositional Logic Fluid Mechanics		Computational Physics Theory Computing Project	Second Year Laboratory Additional Laboratory Project		Earth Resources	Introduction to Current Topics in Biology	The Information Age	Introduction to Financial Mathematics Macro-economic Principles	Entrepreneurial Skills	Manchester Leadership Programme
S5	Applications of Quantum Mechanics Mathematical Fundamentals of Quantum Mechanics	EM Radiation Electro-dynamics	Introduction to Nonlinear Physics	Thermal Physics of Bose and Fermi Gases	Introduction to Nuclear and Particle Physics		Nuclear Fusion and Astrophysical Plasmas	Lasers and Photonics	Viscous Fluid Flow			Third Year Laboratory		Meteorology and Atmospheric Physics		Frankenstein to the Matrix: Science Fiction and Film	Operational Research Business Economics 1A	Tools and Techniques for Enterprise	Inter-diciplinary Sustainable Development
S6				Solid State Physics Semi-conductor Quantum Structures	Nuclear Physics Applied Nuclear Physics	Particle Physics	Cosmology Stars and Stellar Evolution		Mathematical Methods for Physics Waves		Object Oriented Programming in C++ Quantum Computing	Third Year Laboratory	Physics and Reality Dissertation (BSc)	Climate and Energy	Physics of Medical Imaging Physics of Living Processes	The Nuclear Age: From Hiroshima to Nuclear Terrorism	Mathematical Modelling of Finance Business Economics 1B	Advanced Technology Enterprise	Manchester Leadership Programme
S7	Quantum Field Theory		Advanced Statistical Physics	Soft Matter Physics Super conductors and Superfluids	Nuclear Structure and Exotic Nuclei	Frontiers of Particle Physics 1	Radio Astronomy Gravitation	Laser Photomedicine Laser Technology					Project			Climate Change and Society		Enterprise Strategy and Marketing Technology Enterprise	
S8	Physics of Fluids Gauge Theories			Frontiers of Solid State Physics	Reactor Systems	Frontiers of Particle Physics 2	Early Universe Galaxy Formation	Frontiers of Photon Science					Project		Biomaterials Physics			Advanced Technology Enterprise	

Physics with Astrophysics

Physics with Astrophysics is ideal if you want to obtain a solid grounding in physics, but are also fascinated by astronomy and want to pursue this interest at university level. Each year, about 50 students join this course.

Astrophysics involves the application of the laws of physics to distant regions that cannot directly be accessed by man-made apparatus, and in which the physical conditions can only be inferred from the electromagnetic radiation that is emitted.

What you study

You learn about our Sun and Solar System, the stars and our Galaxy, distant galaxies and quasars and the beginning of the Universe in the Big Bang. You learn how to apply basic physics in situations that are often extreme compared with those available on Earth. Our astrophysics course units provide you with a broad knowledge of many parts of physics.

Most staff members teaching astrophysics course units are members of the Jodrell Bank Centre for Astrophysics (JBCA), the University's major international research centre for astrophysics within our School, which also encompasses the world-famous Jodrell Bank Observatory. Our expertise in radio astronomy has led to a series of astronomical experiments that are particularly well suited for student work.

Students can perform observations at Jodrell Bank Observatory, where a dedicated undergraduate radio observatory based on a seven-metre telescope enables you to make your own observations.

You may also observe the night sky at visible wavelengths. Some examples are: using a solar telescope to observe the sun in the first year; imaging the moon in the second year; and using optical telescopes (both in Manchester and at Jodrell Bank) to analyse the light from stars in your third and fourth years.

Course structure

You take the same core physics course units as Honours Physics students (see the description on Page 17) and follow the Astrophysics option stream.

Astrophysics content (including laboratory work) in your first year is 15-20%, and this increases in your second year. In your third and fourth years, you begin to specialise and significantly more of the course is directly related to astrophysics. You have flexibility in the later years and you may choose to pursue those aspects that interest you most. In total, about 30% of the course is astrophysics-related.

In addition to the laboratory experiments that are available to all physics students, you have dedicated astrophysics experiments, plus a series of astronomy experiments based at Jodrell Bank. You analyse data taken with the 76-metre Lovell telescope, personally use a 13-metre radio telescope to take measurements on pulsars, and run a number of experiments on the seven-metre telescope of the dedicated undergraduate radio observatory.

Astrophysics lecture courses

- Introduction to Astrophysics and Cosmology: A concise introduction to the Universe, starting with the solar system and ending with cosmology
- Physics of the Solar System: Includes topics such as the physics of energy generation in the sun, orbits of planets, planetary atmospheres and the greenhouse effect, origin of the solar system
- Galaxies: Introduces the observed properties of galaxies, covering topics such as galaxy morphology, dynamics and the evidence for dark matter
- Astrophysical Processes: Discusses astrophysical processes fundamental to a wide range of modern astrophysics topics from the interstellar medium to black holes and active galactic nuclei
- Stars and Stellar Evolution: The physics of nuclear reactions, energy transport in stars, stellar types and stellar evolution, end products such as supernovae and neutron stars
- Nuclear Fusion and Astrophysical Plasmas: Introduces the physics of plasmas and their role in nuclear fusion and astrophysics
- Cosmology: Introduces the Big Bang model, dynamics of the universe, measuring the universe, cosmic microwave background
- Radio Astronomy: The radio universe and emission mechanisms, radio telescopes and receivers, applications of radio astronomy techniques
- Gravitation: Introduces Einstein's theory of gravity and the geometry of the universe
- Galaxy Formation: Introduces modern galaxy formation theory, covering topics such as growth of large-scale structure, dark matter haloes, disk formation and super-massive black holes
- The Early Universe: Covers advanced topics in cosmology such as inflation, cosmic strings, linear structure formation, the cosmic microwave background and dark energy
- Exoplanets: Study the discovery and properties of planets orbiting around distant stars.

Examples of astrophysics experiments

First year

- Orbits, stars and asteroids
- Quasars
- Globular star clusters
- Solar flares and sunspots.

Second year

- Hydrogen gas in the galaxy
- Gravitational lenses
- Cepheid variables
- The orbit of the moon.

Third year

- Dark matter and exoplanet detection using microlensing
- The hydrogen content and the mass of M33
- Radio telescopes and pulsar astronomy
- Radio telescopes and spectral line astronomy.

Astrophysics projects

For MPhys students, your fourth year involves two projects, each running for a full semester. Projects in recent years have included:

- A study of supernova remnants in Messier 82
- Neutral hydrogen study in the spiral galaxy NGC5033
- Simulations of galaxy clusters
- Observing with the undergraduate optical telescope
- Cosmic ray extensive air showers
- Experiments with a microwave radiometer
- Separating the cosmic microwave background from our galaxy
- Shepherd moons
- Finding new clusters of young stars
- Circumstellar nebula of nova GK Persei
- Lunar occultation of the Crab Nebula and Pulsar.
- Machine Learning to Predict Space Weather.

Career opportunities

There is no danger of employers finding a Physics with Astrophysics degree too esoteric. Since this course covers the core of basic physics, our students pursue a wide range of careers after taking their degrees (see also Page 16).

Some go on to do research in astrophysics, or other branches of physics; others go into teaching, science-related careers in industry, or the civil service. Some use the analytical and numerical skills they have acquired in areas such as accounting and other financial services.

Career options therefore remain wide open. Even for those students who do not subsequently pursue astrophysics-related careers, there remains the great pleasure of having pursued a fascinating subject and of having approached the frontiers of knowledge about the Universe.

Physics with Philosophy

Like the Honours School of Physics, this BSc or MPhys course provides a solid grounding in all aspects of physics, both theoretical and experimental. However, a substantial amount of laboratory work is replaced by lecture courses and project work in philosophy.

We offer this course in conjunction with the University's Philosophy Department which is committed to on-going research and teaching in the tradition of analytic philosophy.

What you study

Throughout this course, the areas of philosophy you will explore in most detail are those relevant to the overlap with the subject of physics; namely, the nature of scientific knowledge and the status of science as a means of achieving understanding. This 'analytic core' of philosophy is an area in which many members of the philosophy department in the School of Social Sciences have their major research interest; indeed, a course unit in Philosophy of Science is currently part of their core syllabus.

Physics with Philosophy students take similar core physics course units to the Honours Physics students, and follow the philosophy option stream. It is therefore easy to transfer to Honours Physics at the beginning of any academic year. Physics with Philosophy students have the same level of tutorial support in physics and mathematics as Honours Physics students and, in addition, participate in seminar groups together with a staff member of the Centre for Philosophy for each philosophy unit.

The course also promotes areas of physics that complement the option stream in philosophy. For example, the physics course unit, Physics and Reality, discusses issues such as the nature of space and time and the implications of quantum mechanics for determinism and the nature of cause and effect. This is a core course unit for Physics with Philosophy students.

Course structure

During your first three years, you take the similar core physics course units to Honours Physics (see the description on Page 17), but only half the amount of experimental work in the laboratory. Philosophy-based course units make up approximately 30% of your total study time. Typical course units from the Philosophy option stream include:

- Moral Philosophy and Philosophical Values
- Theory of Knowledge
- Philosophy of Science
- Propositional Logic
- The Information Age
- Science and the Modern World
- Metaphysics
- Philosophy of Mathematics
- Philosophy of Language
- Philosophy of Music.

You can also choose a set of course units on mathematical logic, including nonstandard logics, set and model theory.

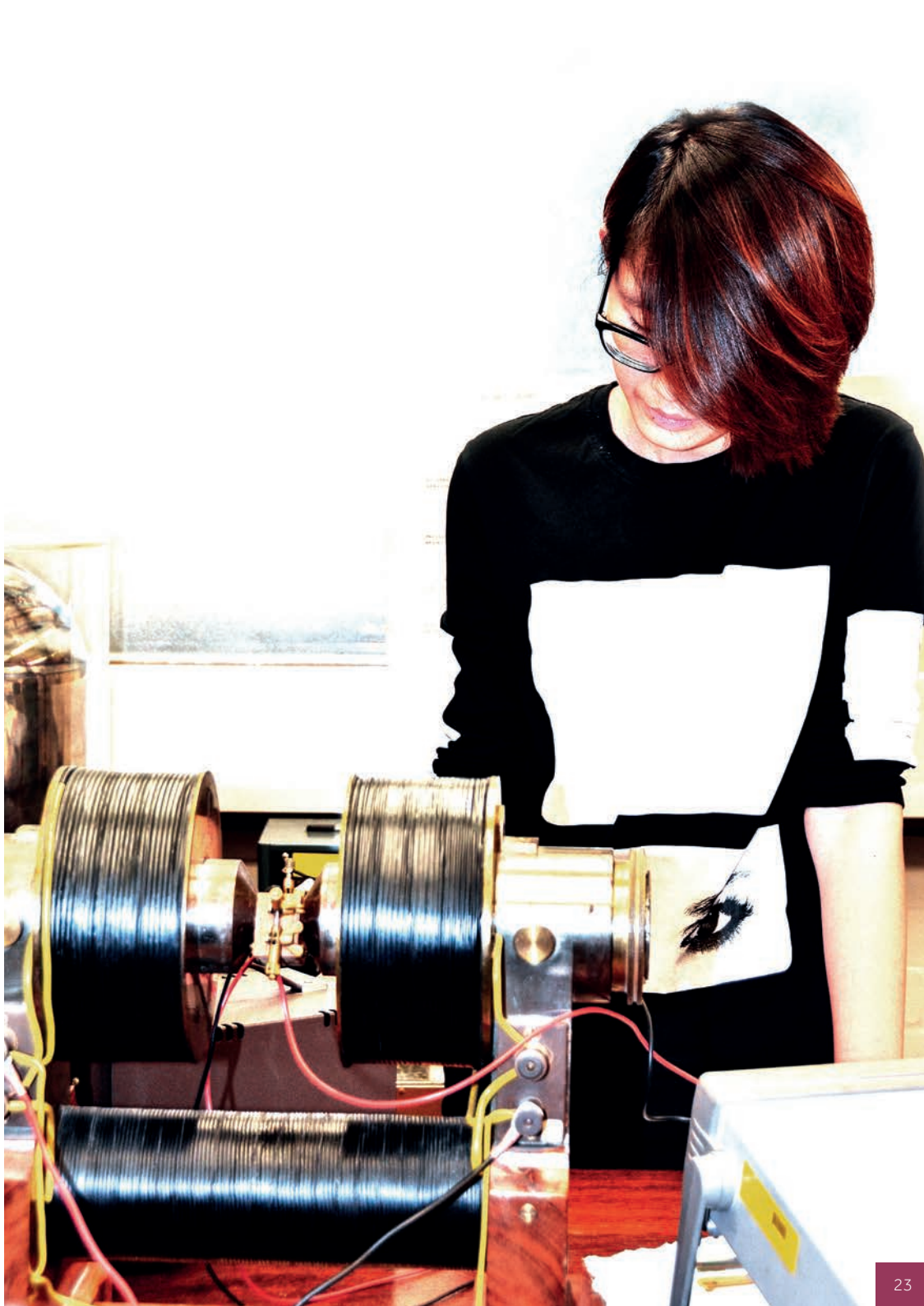
If you wish to take this degree to masters level, you will have a substantial amount of project work in both subjects. In one semester, you carry out a MPhys project in an area of physics, and in the other, you undertake an extended essay in philosophy in collaboration with a supervisor from the Centre for Philosophy. This project will typically involve the study of some area of analytic philosophy, or one that overlaps with issues relevant to physics.

Your fourth year also includes specialist course units on topics such as the philosophy of emotions and intentionality, logical properties and consciousness, as well as more advanced course units in physics.

Career opportunities

Graduates from this course have a diverse range of desirable skills and are very well placed to take up employment in many areas, from academic research to work in industry. Employers very often want people who are adaptable, rather than those who are already trained along very specific lines.

Physics with Philosophy graduates learn to identify, analyse and solve problems, and to present their solution in clear, precise and concise arguments. These are valuable skills in the workplace and provide a good intellectual basis for vocational training.



Physics with Study in Europe

The degree of MPhys with Honours in Physics with Study in Europe is based on the core of the Honours Physics course, but includes a year studying at a university on the Continent.

This course combines a comprehensive study of physics with an opportunity to study physics abroad for one year, gaining a working knowledge of a European language and experience of a different culture.

You could attend universities in France, Germany, Spain and Italy. Our School has well established links with the universities involved in the Physics with Study in Europe exchange programme. The Manchester European Study tutor is in close touch with tutors at the host universities, to ensure well-integrated course structures.

Since the student exchange scheme is largely reciprocal, many students from overseas also study at Manchester for one year or more. We normally have 10 to 15 exchange students every year in our School. Their presence enriches our School culture – and allows you to learn more about your prospective host universities. For Physics with Study In Europe, a formal language qualification such an AS- or A-level is desirable. Further language tuition is available at Manchester and normally forms part of the degree course.

Because of the general challenges of living and studying in a foreign country, you must show good language skills by the end of your first year, and obtain a good pass in your second-year examinations. If you fail to meet these criteria, you may transfer into the Honours School of Physics. Transfer to the Honours School of Physics is possible for any student who wishes to do so, at the start of any academic year up to third year.

Accommodation for the year abroad is normally arranged with the help of the host university. The International Programmes Office and the course coordinator in Manchester can provide additional assistance.

What you study

In your **first year,** you mainly follow the core physics course units (see the description on Page 17). In addition, a language unit is normally taken at a level appropriate to your initial competence in your chosen language. This includes two lectures per week throughout the teaching year and is supplemented with language laboratories and tutorials as needed. If you have already reached the appropriate level, you may omit some of the language course and replace it with additional option course units in physics or another subject.

In your **second year**, you again follow the core course units of the Honours School of Physics. You replace one option unit with a language module designed to continue your general language development. In addition, you take the more mathematical second- year options, in order to be prepared for the curriculum on the Continent which often involves more mathematics. Specially designed linear algebra tutorials will aid this process. You will also receive additional physics tutorials in the foreign language. These are not assessed, but help you to develop the technical vocabulary.

In your **third year**, you study physics at your host university in the native language— in most universities some further language study is required. The course units taken vary strongly from student to student and from university to university, and it is not possible to go into detail here. You consult with the European Study tutor in Manchester who, with an eye to your particular strengths and weaknesses, selects course units normally available at the particular European institute. These are normally at the same level as third-year course units at Manchester. As at Manchester, laboratory work is usually a significant component of the third year.

In your **fourth year**, you return to Manchester to complete your MPhys degree. You study a range of course units from the large list of options, including a number from other schools in the University. Practical work usually involves a semester of laboratory classes, followed by an extended project in the final semester. Again, the European Study tutor plays an important role in ensuring continuity in your studies.

Assessment

In your first, second and fourth year, assessment follows the same pattern as for other students in Physics and Joint Honours courses. You take examinations for all of the lecture course units; laboratory work is subject to continual assessment. Third-year assessment follows the normal practice at the institute that you visit and is converted to the mark scheme at Manchester on your return. Your final degree classification takes account of fourth-year examination and laboratory performance, as well as contributions from the earlier years.

Where you study

The School of Physics and Astronomy at Manchester has agreed undergraduate exchange programmes with the following European institutes:

- Germany: Freie Universität, Berlin; Ruprecht-Karls Universität, Heidelberg; Technische Universität München, Munich
- France: Université Pierre et Marie Curie, Paris; Université de Paris-Sud, Paris; Université Claude Bernard, Lyon; Université Grenoble Alpes, Grenoble
- Italy: Universitá Degli Studi, Trieste
- Spain: Universidad de Cantabria, Santander; Universidad Autónoma de Madrid, Madrid.

Career opportunities

Choose to pursue Physics with Study in Europe and you will place yourself at a great advantage when you are considering your career opportunities (see Page 16). The combination of the numerical and analytical skills of the physicist, together with the language skills and cultural experience gained from a year studying abroad, provide very good prospects in a market that is increasingly dominated by the European perspective.

Physics with Study in Europe will equip you with strong bilingual communication skills, so that you will be able to work effectively as scientists in Europe, in multinational companies, and in companies with European connections.

Graduates with good Honours MPhys degrees in Physics courses are eligible to proceed to a PhD degree involving further study and research in a specialised branch of modern physics. Graduates from this particular course are in a good position to seek a research position at an overseas university.

Physics with Theoretical Physics

This degree is for you if you have a particular interest in the more mathematical and theoretical aspects of physics. Like the Honours Physics course, this course provides you with a solid grounding in all aspects of physics, both theoretical and experimental, although a significant amount of practical work is replaced by lecture courses and project work in theoretical physics.

What you study

You concentrate on the option streams of theoretical physics and mathematics, although you may also choose some of the wide range of options open to students on the Physics course. Since you take the core physics lecture course units, it is easy to transfer to Honours Physics at the start of any academic year.

We have internationally renowned theoretical physicists working in many different areas in the School. Theoretical studies are currently underway in: astronomy and cosmology (the modelling of intergalactic collisions, the early universe, the cosmic microwave background and gravitational lensing); biological physics (biophysically detailed, mathematical models of the heart); high energy particle physics (quantum chromodynamics, supersymmetry and Higgs physics); condensed matter (high temperature superconductors, phase transitions, disordered systems, fractals and chaos, quantum many-body systems); complex systems (from the stock market to the evolution of languages); and nuclear physics (from the structure of light and medium-sized nuclei through to quark- gluon plasmas).

Course structure

The course is based on the core of the Honours School of Physics (see the description on Page 17), together with the Theoretical Physics option stream. Half of the core laboratory work is replaced by lecture course units and project work on theoretical physics and mathematics.

In your first two years, you study such subjects as advanced mechanics, mathematical methods and computing. In your third and fourth years, you begin to specialise, and more of the course can be directly related to theory; the core material of your earlier years now forms the foundation for advanced subjects such as quantum theory, electrodynamics and general relativity. You have a great deal of flexibility in the later years and you may choose to pursue those aspects of the course that interest you most.

Typical course units from Theoretical Physics include:

- **Random Processes in Physics**: Introduces the mathematics of random events – a subject of direct relevance to many areas in physics, including quantum physics and statistical mechanics
- **Advanced Dynamics**: Builds directly on the core course units in Dynamics and Relativity, considering the physics of the apparent forces experienced by observers who are being accelerated, the properties of rotating bodies, the dynamics of relativistic particles and gravitation
- **Lagrangian Mechanics**: The classical mechanics of particles can be described by using Newton's Laws, or by Lagrange's Equations; the second approach is more elegant and more powerful —for example Lagrangian Mechanics is not restricted to particles, but can also be used to describe fields such as the electromagnetic field, and is the starting point for Quantum Field Theory
- **Advanced Statistical Physics**: Applies advanced ideas in statistical physics to study topics such as Brownian Motion and Population Genetics
- **Complex Variables and Integral Transforms**: Deals with the properties of functions of a complex variable, an elegant subject in mathematics with many useful applications in theoretical physics
- **Advanced Quantum Mechanics**: Examines the quantum behaviour of particles moving close to the speed of light
- **Quantum Field Theory**: First introduced to describe the quantum physics of electromagnetic fields, the methods of quantum field theory unify much of modern theoretical physics, having many applications in elementary particle physics, condensed matter physics and statistical physics. Feynman diagrams are derived and used to study the interactions of elementary particles
- **Gravitation**: Explains the details of Einstein's General Theory of Relativity and the necessary warping of space and time
- **Early Universe**: Discusses the development of the cosmological model in the framework of relativistic gravity and particle physics
- **Gauge Theories**: Discusses in detail the origins and nature of the fundamental interactions.

Career opportunities

Because this course covers a wide range of physics and mathematics topics, and helps you develop many skills, graduates are well placed to pursue many different career paths after taking their degrees (see also Page 16).

Some go on to do research in theoretical or experimental physics; others go into teaching, science-related jobs in industry, or the civil service. Computing-related activities are particularly suited to students who are well versed in the mathematical and analytical techniques acquired in our Physics with Theoretical Physics course. Career options therefore remain wide open.

Mathematics and Physics

The Honours degree of Mathematics and Physics, run jointly by our School and the School of Mathematics, is designed for students who wish to study both mathematics and physics in depth. You attend lectures, tutorials, examples classes and laboratory sessions covering a broad range of topics in mathematics and physics.

What you study

Course content is closely linked with the contents of the Honours degree in Mathematics and the Honours degree in Physics, and transfer to either of these courses is possible at the start of your second year, provided that a sufficient standard has been achieved in the relevant subject. Transfer to the Honours Physics course can also be made at the start of your third year. The course may be taken for three years, leading to the BSc degree, or for four years leading to the masters degree, MMath&Phys.

Teaching in both Schools is greatly strengthened by the wide variety of research fields that are pursued by the staff. Large and lively groups are active in both applied mathematics and theoretical physics. These subjects frequently overlap and research on theoretical astronomy, chaos, fractals and fluids is carried out in both Schools. Other research topics in applied mathematics include hydrodynamics, waves, elasticity, boundary layer theory and modelling of industrial processes.

Theoretical research undertaken in the School of Physics and Astronomy includes high-energy particle physics, nuclear physics and quark matter, condensed matter physics, high temperature superconductivity, phase transitions and disordered systems, and several areas of astrophysics.

Course structure

The first two years of this course provide you with a firm foundation in the most fundamental aspects of degree-level mathematics and physics. This permits you to choose from a wide range of high-level options in your third and, where appropriate, fourth years. In your first two years, you undertake half as much physics laboratory work as Honours Physics students. In your third and fourth years, laboratory work is optional and project work in mathematics, physics and computing is available. The course workload is comparable with that of Honours Physics and Honours Mathematics students throughout, and is divided approximately equally between the two subjects.

In your first year, you take core mathematics and core physics lecture course units. Mathematics core course units include:

- Calculus and Applications
- Calculus and Vectors
- Linear Algebra
- Sets, Numbers and Functions.

Your **second year** is divided approximately 80:20 between core course units and options. Physics and Maths core course units include:

- Partial Differential Equations and Vector Calculus
- Introduction to Quantum Mechanics
- Electromagnetism
- Real Analysis
- Complex Analysis
- Thermal and Statistical Physics
- Fundamentals of Solid State Physics
- Wave Optics.

The list of option course units normally includes, among others:

- Algebraic Structures
- Metric Spaces
- Fluid Mechanics.

In your **third year**, the core course units are:

- Bosons and Fermions
- Nuclear and Particle Physics
- Electrodynamics
- Computer Programming
- Quantum Mechanics.

Physics option course units can be chosen from the list available to third-year physics students. Maths option course units are available from the main areas of research carried out by the School of Mathematics.

These areas include:

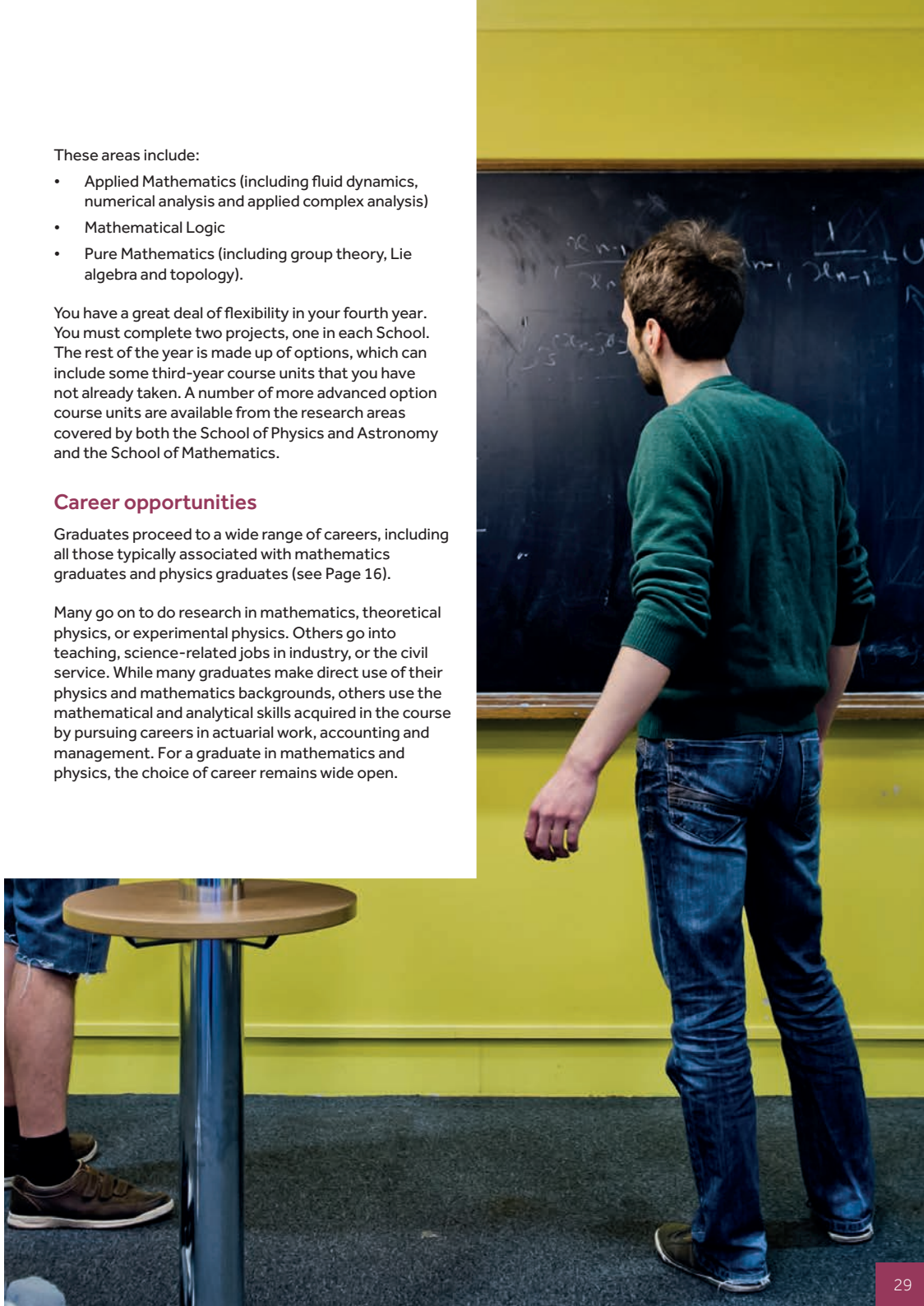
- Applied Mathematics (including fluid dynamics, numerical analysis and applied complex analysis)
- Mathematical Logic
- Pure Mathematics (including group theory, Lie algebra and topology).

You have a great deal of flexibility in your fourth year. You must complete two projects, one in each School. The rest of the year is made up of options, which can include some third-year course units that you have not already taken. A number of more advanced option course units are available from the research areas covered by both the School of Physics and Astronomy and the School of Mathematics.

Career opportunities

Graduates proceed to a wide range of careers, including all those typically associated with mathematics graduates and physics graduates (see Page 16).

Many go on to do research in mathematics, theoretical physics, or experimental physics. Others go into teaching, science-related jobs in industry, or the civil service. While many graduates make direct use of their physics and mathematics backgrounds, others use the mathematical and analytical skills acquired in the course by pursuing careers in actuarial work, accounting and management. For a graduate in mathematics and physics, the choice of career remains wide open.



Research at Manchester

The School performs research across a wide range of different fields of physics, both in laboratories at Manchester and also using large facilities such as telescopes, accelerators, neutron and light sources, in the UK and across the world. We have strong research links with other schools within the Faculty of Science and Engineering and with the University's research centres and institutes, such as the National Graphene, the Photon Science and the Dalton Nuclear Institutes. Our research informs our undergraduate teaching and the School's wide research portfolio supports a wide-ranging and flexible undergraduate curriculum with a lot of choice.

Undergraduates experience research via their laboratory and project work, but also have the opportunity for a research placement with one of our research groups in the summer before their final academic year. Many of our graduating students choose to stay in our School to do PhD research and there are opportunities across all of our research areas.

Research at Manchester

Astronomy, Astrophysics and Cosmology

The Jodrell Bank Centre for Astrophysics (JBCA) is one of the UK's largest astronomy research groups and constitutes around a third of the research in the School. Our research programme includes observational and theoretical studies covering the whole of modern astrophysics, from the discovery of planets orbiting other stars, to the origin of the universe in the Big Bang. The group is also a world leader in radio astronomy-related technology development for ground and space-based instruments.

Members of the group use telescopes working across the electromagnetic spectrum, including those in Hawaii, Chile, the USA, the Canary Islands and Australia, together with space telescopes such as Planck, Spitzer, Chandra and Hubble. A long heritage in astrophysical research includes playing a leading role in the discovery of quasars and gravitational lenses and finding the first double pulsar, the most stringent test of Einstein's general theory of relativity.

The School operates the world famous Jodrell Bank Observatory, where the radio telescopes include the iconic Lovell Telescope. The UK national radio astronomy facility, eMERLIN, is run from Jodrell Bank. This is a network of seven optical fibre-linked telescopes, including the Lovell dish, stretching 217 km across England from Jodrell Bank to Cambridge and is often linked to other radio telescopes across Europe, USA and Asia. JBCA hosts the UK regional centre for ALMA, the Atacama Large Millimeter/submillimeter Array. Jodrell Bank also hosts the international headquarters of the Square Kilometre Array which, when built, will be the world's largest telescope.

Biological Physics

Our biological physics research is focussed on molecular biophysics and physiology. Biological molecules (DNA, proteins, surfactants etc) are studied at the single molecule level with newly developed optical and magnetic techniques. More traditional X-ray and neutron methods allow the study of individual molecular bonds and their structuring. Electrical waves are modelled from the level of single ion channels in cells all the way up to the sophisticated orchestration of muscle contractions in the heart, and their subsequent relationship to cardiac disease. Similar ideas are being used to explore issues of cognition and brain activity.

Condensed Matter Physics

Manchester leads the world in studying the properties and uses of graphene, a single layer of carbon atoms. New results concerning the structure of two-dimensional solids, the strange electronic properties and the potential for applications in electronics, devices and the simulation of highly relativistic particles, have all come to light here.

The 2010 Nobel Prize in Physics was awarded to Professors Sir Andre Geim and Sir Kostya Novoselov in recognition of the pioneering work that they carried out in our School. The National Graphene Institute based at Manchester will assist and encourage research and development of commercial applications of graphene and related materials. Also within condensed matter, there are experimental programmes specialising in ultralow temperature physics, especially super fluid 3He and 4He, including the study of quantum turbulence and so-called "super solids". There is also a strong interest in metamaterials, or materials with a negative refractive index, which have been developed using advanced methods of mesoscopic physics.

Nonlinear Physics

Research in non-linear phenomena is focused on the transition to turbulence and chaos in fluid flows, pattern formation in granular motion and instabilities in elastic materials. A significant part of the research in fluid dynamics is concerned with the transition to turbulence in a pipe, which is regarded as the outstanding problem in classical Physics.

Photon Physics

We carry out research across a wide range of fields using light as the fundamental probe. Research in photon physics takes advantage of the facilities of the £30 million Photon Science Institute which provides state-of-the-art lasers, optical diagnostic systems and high sensitivity spectroscopic equipment.

Work covers such diverse fields as laser probing of electron collisions with atoms and molecules, cold atoms, the physics of nanoparticles, laser tweezering of microscopic samples, the development of novel solar cells and materials for LEDs that emit in the green/blue/UV parts of the spectrum. The group is also active in the field of laser photo-medicine and biomaterials, in laser development and THz generation, and collaborates with experimentalists and theoreticians from around the world.

Nuclear Physics

Our research programmes address key open questions in nuclear physics, such as how the ordering of quantum states changes in increasingly neutron-rich matter and whether new symmetries and new forms of nuclear matter appear in nuclei far from stability. The measurements have an impact on wider scientific issues, helping to explain, for example, how the elements and isotopes found in the universe were formed. Experimental research investigates the structure and reactions of atomic nuclei using a variety of techniques to study the properties of rare unstable isotopes, usually produced at international accelerator facilities. Our work includes studies of electromagnetic moments and nuclear radii, transfer reactions, rare isotopes produced in fission and nuclear lifetimes. More applied research projects are also underway to address technological problems in nuclear-power generation and medical imaging.

Theoretical colleagues are interested in the effect of the symmetries of quantum chromodynamics on the behaviour of nucleons and nuclei. Studies are made of the fundamental questions of how a nucleus is bound together and how the properties of nuclei arise. This links closely to their interest in atomic Bose-Einstein condensates formed in atomic gases at extremely low temperatures, where many of the same theoretical tools can be employed.

Accelerator Physics

Our research in several areas of charged-particle beam acceleration is undertaken within the Cockcroft Institute of Accelerator Science and Technology, which is equipped with cutting-edge energy recovery linear accelerators and unique circular accelerators, together with comprehensive diagnostic facilities.

We have expertise in anti-hydrogen trapping studies, novel medical accelerators, Large Hadron Collider (LHC) beam instability analysis, high accelerating field gradient compact linear accelerators (CLIC), through to extremely high gradient proton-excited plasma wakefield accelerators. Our research has demonstrated a new accelerator, EMMA (Electron Machine with Many Applications), which has the potential for proton acceleration with medical applications. We have international leadership in beam dynamics research on wakefields in the CLIC machine and on plasma acceleration. Many of our accelerator physicists collaborate on a daily basis with major laboratories in Europe (CERN and DESY in particular) and further afield (with KEK in Japan and SLAC in the USA). Our expertise extends from room temperature high gradient accelerators through to highly efficient superconducting accelerators based on niobium technology.

Particle Physics

We have a large and vibrant research activity that covers the whole spectrum from particle theory and phenomenology, through experiment to detector design and development. Our theorists work on a wide range of particle physics phenomena, from supersymmetry and extra dimensions, through to strong interactions and the early Universe.

A major experimental focus is CERN with leading roles in the ATLAS and LHCb experiments at the LHC. Our researchers are heavily involved in the study of the Higgs boson, as well as searching for supersymmetric particles that are predicted by grand unified theories. Manchester researchers are leading studies of the top quark, and were involved in the discovery of pentaquarks: bound states of five quarks. The group is also involved in the study of the neutrino, in particular working on experiments at the Fermilab accelerator complex in Chicago. The group is developing new detectors that will use liquid argon to study neutrinos. These will allow searches for new types of invisible 'sterile' neutrino, as well as enabling researchers to send neutrinos hundreds of miles through the Earth to observe how they change as the travel, possibly providing evidence to explain the disappearance of all antimatter that was created at the Big Bang. Using a detector deep underground in the south of France, Manchester researchers are investigating a process called double beta decay, which could revolutionise our understanding of the relationship between matter and antimatter.

Complex Systems and Statistical Physics

Manchester theoreticians work on a wide variety of problems in which assemblies of many interacting particles produce complex structures or patterns, using both theoretical and computational tools.

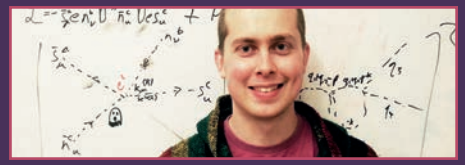
These ideas can also be applied to areas outside physics, where the interacting constituents may not be particles, but agents (individuals, companies, species, etc). The ideas and techniques of non-equilibrium statistical physics can in this way be applied to many areas in biology, language evolution, the economy and social systems.

What our students say

“The one thing that made Manchester really stand out to me was how modern and innovative the school of Physics was. Not only are they on the forefront of new discoveries, such as Graphene, but also, they are always trying to improve facilities, with the recently built Schuster Annex providing even more study spaces.

Being the largest student community in the UK means that Manchester is a great city to study in. The city is fully equipped with everything you need and there’s always something to do, with the university alone having over 300 societies. If that wasn’t enough then there are other opportunities, such as part-time paid work for the university as a student ambassador, or working in a position of responsibility as part of the student rep and student exec teams. Something for everyone!

Amy Smith



“After a year in Manchester, leaving wasn’t really on my radar. I appreciated the friendly environment within the department, and the approachability of the professors. Although I already spoke Spanish, studying abroad hadn’t crossed my mind, until one of my professors took the time to suggest the European Study programme. Going abroad ended up being the best decision of my degree. Life in Madrid was obviously great, and my first two years in Manchester had left me prepared for whatever the Spanish university system could throw at me. Moreover, a friend had learned all her Spanish during two years of Manchester language courses, and had no problems studying entirely in Spanish.

The Study Abroad destinations are chosen to offer courses that line up with the Manchester syllabus. This left me feeling confident to take demanding theoretical courses during my MPhys year. It’s during this year, while working on a project in Particle Cosmology, that I’ve come to appreciate that Manchester is a centre for world-renowned research. The department is full of field-leading professors, who are enthusiastic about passing on their knowledge.

Chris Shepard

“I originally applied to study physics with astrophysics, but realised that there was a whole world of other fields that I had not even touched at A-level and decided that I wanted a chance to try them before settling on a specialism. The School of Physics and Astronomy at Manchester stood out as the place that would allow me to get a taste of the wide variety that is available within physics as they have a huge department with experts in fields ranging from astronomy and particle physics to biophysics and liquid crystals.

The department is one of the friendliest places on earth, with everyone from peers to senior professors always happy to help you out with a problem. The students are well respected by the school, and have a very active representation system where we can give feedback on teaching and suggestions on things ranging from a new kettle to thoughts on entirely new buildings! There are also plenty of active societies, both within the school and in the uni as a whole. Staying in physics there are opportunities to go stargazing on the roof, visit Jodrell Bank or CERN, or go out to schools in the local area and inspire a new generation of physicists!

Coming to Manchester was one of the best decisions I ever made, and I have enjoyed it so much that I am staying here to study for a PhD in astrophysics.

Josh Hayes

“My experience at the University of Manchester started when I was invited for interview. I met enthusiastic and inspired lecturers and staff, and their passion for their research areas was addictive. Coming from abroad, I was very encouraged to find a diversity of backgrounds and interests. I found many openings to indulge my curiosity as researchers were ready to share their excitement and fascination for physics. I feel privileged to be part of such a dynamic environment. Initially attracted to industry, I now am sure I would regret ending my academic experience at Masters level. The department has infrastructures in place for students to pursue their studies, get inspired, ask questions and develop as part of a greater, international physics community. My personal growth has been uniquely impacted by individuals who took an interest in me personally, something I did not expect from such a large department, especially as an undergraduate. I have been in turn privileged to give back as one of the Peer Support Coordinators through which second-year students mentor the first year undergraduates.

Stephanie Baines

The University of Manchester

The School of Physics and Astronomy
Student Recruitment and Admissions
Oxford Road
Manchester
M13 9PL

t +44 (0)161 275 4100
e ug.physics@manchester.ac.uk
w manchester.ac.uk/physics

This leaflet was printed on June 2017 for the purposes of the 2018 intake. It has therefore been printed in advance of course starting dates. For this reason, information contained within this publication for example about campus life, may be amended prior to you applying for a place on a course of study. Course entry requirements are listed for the purposes of the 2018 intake only

Prospective students are reminded that they are responsible for ensuring, prior to applying for a course of study at The University of Manchester, that they review up-to-date course information, including checking entry requirements. Visit: **www.manchester.ac.uk/study/undergraduate/courses** and searching for the relevant course

Further information describing the teaching, examination, assessment and other educational services offered by The University of Manchester is available from: **www.manchester.ac.uk/study/undergraduate**