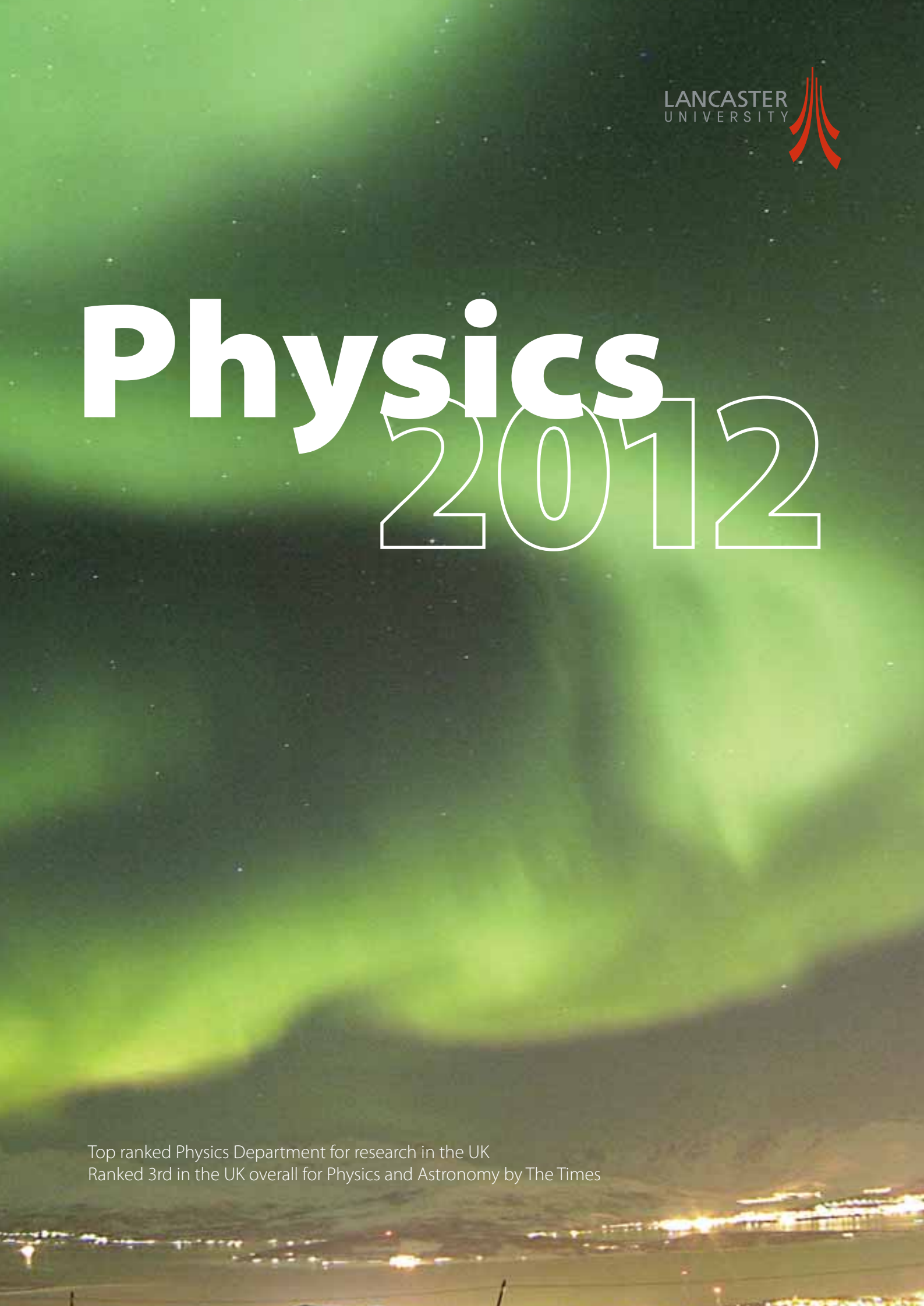

LANCASTER
UNIVERSITY
Physics
2012
Top ranked Physics Department for research in the UK
Ranked 3rd in the UK overall for Physics and Astronomy by The Times

Contents

"Academic standards at the university are high - the physics department in particular."

Guardian University Guide 2008

Cover image: Based on a photograph of an auroral display taken in Tromso. Credit: Pete Lawrence.

Image: A beautiful solar prominence eruption observed in extreme ultraviolet light by NASA's Solar Dynamics Observatory on March 30, 2010. The light recorded in this image is emitted by singly ionised Helium confined by the Sun's magnetic field and corresponds to a temperature of approximately 50,000 degrees Celsius.
Credit: NASA.

The information given in this booklet was accurate at the time of writing. Lancaster University reserves the right to make changes at any time.

In brief

- Lancaster : One of the top physics departments in the UK with a reputation for high quality teaching driven by outstanding research; the ideal university for studying physics.
- Our overall UK ranking is 3rd in The Times, 4th in The Guardian and 6th in The Complete University Guide.
- High quality teaching : our staff-to-student ratio is the highest of the top research-driven physics departments, and we are proud of the supportive learning environment that our students enjoy.
- We operate an Open Door policy, giving access to all of our academic staff when you need them.
- Our students expressed 100% satisfaction with the quality of their degree course in a recent National Student Survey.
- Our graduates have excellent career prospects (see pages 24-25).
- Outstanding research : we are ranked as the top physics department in the UK in the most recent Research Assessment Exercise (RAE2008) and rated equal with Cambridge, Imperial College London and Oxford in the previous Research Assessment Exercise (RAE2001).
- Projects in the third and fourth year give our students the opportunity to investigate an area of interest in depth in a research environment, working alongside our research staff and sometimes in collaboration with industry.
- Well-equipped departmental observatory for use by our students in their astronomy projects.
- Possibility of spending a year abroad in the USA or Canada. We have the best developed North American exchange programme of any UK university with numerous co-operating US and Canadian institutions.
- All of our degrees schemes are fully accredited by the Institute of Physics in recognition of their high quality and success in producing professionally qualified physicists.
- Guaranteed on-campus accommodation in your first year.
- Lancaster's multi-award winning student accommodation retained the title of Best University Halls in the 2011 National Student Housing Survey.
- A brand new £20m Sports Centre housed on campus, boasting a multitude of state-of-the-art exercise and recreational facilities, was opened in 2011.
- We offer a broad spectrum of student societies and clubs covering a diverse range of pastimes.
- We offer financial bursaries and scholarships that recognize the academic talents of our students. See page 37.

We offer a range of degree specialisms:

- Physics
- Physics, Astrophysics and Cosmology
- Physics with Particle Physics and Cosmology
- Physics, Astrophysics and Space Science
- Theoretical Physics
- Theoretical Physics with Mathematics
- Physics North America

Studying physics at Lancaster

About the Department

The Department of Physics is a medium-sized friendly department with about 40 permanent teaching staff. We welcome around 65-75 new students each year across the range of physics courses.

We are centrally located on the campus, with all facilities, including living accommodation and the University library, within easy reach. We have well-equipped teaching laboratories, an astronomical observatory and computing facilities, all of which play an important role in learning.

You will be part of a working community - your lecture rooms and laboratories are alongside our offices and research areas; therefore, you will have regular informal contact with staff and researchers.

We have implemented initiatives supporting all of the females studying and working in our Physics Department. We also provide an active student society for physics that organises a varied programme of social and science-based events each year. See page 27.

Lectures and seminars

The university year is divided into 3 terms of 10 weeks. In a typical week you will have 12 lectures, each 50 minutes, in classes of varying size.
Weekly assignments will be set by the lecturer, perhaps from textbooks or past examination papers, chosen to reinforce the ideas introduced during the lectures. After attempting these you will take part in 3-4 hours of seminars per week where the lecturer will run through the solutions and help with any difficulties.

In addition to the lecture material, you will be expected to read from recommended texts. The University library has multiple copies of the recommended course books and research periodicals. In addition, there is a Physics Library in the Physics Building where our students can find a copy of many of the texts that are used in their lecture courses.

Laboratory work

Physics is an experimental subject and laboratory work is an important element of the course. You will spend approximately 6 hours per week in the laboratory, working in pairs and interacting closely with staff and other students. Demonstrators will be on hand to guide you and discuss your work. You will participate in demonstrations of the physical phenomena described in lectures, learn to use scientific equipment and develop skills in taking measurements, drawing conclusions and writing reports. You will use computers to control experiments and to input, manipulate and analyse data.

Computer programming

Physics makes extensive use of computation in both experimental and theoretical work. To prepare for this, and to teach valuable transferable skills, all students are taught modern programming techniques using the JAVA computer language.

Coming to Lancaster University and studying physics was such an amazing experience. I knew Lancaster was right for me from the warm welcome I received right from the start. The friendliness of the staff and all the support I had helped me to overcome my dyslexia, push myself and get my degree. If it wasn't for my degree and all the extra curricular opportunities in the department I wouldn't have got my wonderful job at the Museum of Science and Industry in Manchester communicating science.

Ruth is a Science Communicator working for Science Made Simple, Chemistry with Cabbage and the Museum of Science and Industry in Manchester.

I chose Lancaster University because it is one of the best UK universities, while its Physics department is top for research in the country. It is the perfect place for someone to study physics as the teachers are leaders in their research areas but will always help with any problems you have, spending time with you or even chatting with you if they see you around. The community in the department is international, with many of the teachers, researchers and students being from many different countries, which is something that makes an international student more welcome inside the department. All these contribute so that the students feel like home in a lovely and friendly atmosphere on a beautiful campus.

George Korpas, international student currently studying MPhys Theoretical Physics.

Supporting your study

In addition to the contact with physics lecturers through seminars and weekly office hours, you will have a departmental academic advisor responsible for your academic well-being. You will also be assigned a college tutor responsible for monitoring your progress, providing advice and assisting with any personal difficulties you may encounter. They will remain a point of contact for you throughout your time at Lancaster.

How we assess your progress

There is a considerable amount of continuous assessment as well as formal examinations. All the experiments, seminar set work and projects will count towards your final degree mark. As a rough guide, your degree will be based 60% on examinations and 40% on course work. We will keep you fully informed of your results and progress at all stages of the course.

We value your feedback

We value your comments on our courses and our teaching. We have a joint student-staff committee, which includes elected student representatives from all years, to discuss academic issues. We also ask you to complete questionnaires about each lecture unit as well as an end-of-year questionnaire.

International students

Lancaster is an international university and our campus community is friendly, vibrant and cosmopolitan. Our staff and research students originate from many different continents from around the world, including Europe, Asia, Australasia and America. However, our undergraduate students are mainly from the UK so, as well as being immersed in fascinating topics in physics, our international students are given ample opportunity to mix and work with UK physics students.

There are a number of on-campus services dedicated to supporting international students (for further details see the university prospectus at http://www.lancs.ac.uk/admissions/undergrad.htm).

Please note that Lancaster Physics Department Scholarships are available to overseas students (see page 37 of this booklet).

Choice of course

Listed on the opposite page are the degree courses we offer at Lancaster; the subsequent pages provide more detailed information. You have the flexibility to change your degree course by the beginning of the second year.

We offer MPhys, MSci, and BSc degree courses. The BSc degree takes 3 years to complete whereas the MPhys and MSci degrees require 4 years of study. The content of the first 3 years of our master's (MPhys and MSci) degrees is identical to the corresponding bachelor's (BSc) degree but, in addition, the 4th year of our master's degrees provides the opportunity to study physics in greater depth and to undertake an extensive research project.

MPhys and MSci degrees are ideal if you are planning a career as a professional physicist, and are the recommended route into research degrees. However, a good result from a BSc course will allow you to continue your studies at the MSc or PhD level or to enter a teacher-training programme.

It is possible to change from a 3 year to a 4 year degree course. Any change must take place well before the end of your third year. A change from a 4 to a 3 year course is also possible.

We offer a range of degree specialisations at either the MPhys or BSc level. Typically after the first year, 25-30% of your subjects will be related to your choice of speciality.

You may wish to take advantage of the opportunity to spend a year in the USA or Canada as part of your course (see pages 20-21).

The MSci Theoretical Physics with Mathematics is for students with a keen interest in the mathematical aspects of physics (see page 19).

A common first year

Most of our courses have common physics content in the first year. This allows you to change your initial choice of course as your interests develop during the first year.

Our students undertake lectures in core physics and mathematics courses that equip them with tools for tackling problems in physics. Students following one of our Theoretical Physics with Mathematics degrees attend lectures in pure mathematics given in the Department of Mathematics and Statistics.

Choices at the end of the first year

After you have completed the first year you specialise in your chosen field of study. You will attend core physics lectures with other students but each of the degree schemes has their own specialist additional lecture courses (see the diagram on page 9). You will also specialise further through your choice of options and projects in the third and fourth years.

The first year of the Undergraduate Physics Degree schemes is very interesting as everyone is doing exactly the same thing. It starts off with things you are used to through M1 and C1-C4 of the A Level Maths you took but quickly moves on to looking at something new in Rigid Bodies. You are also rewarded with familiar topics from A Level Physics such as Electromagnetism, Circuits and Waves but these quickly surpass A Level standard and finally move to the world of strange and utterly bizarre phenomena called Quantum Physics. One of the most enjoyable parts of first year is going through a worksheet or a past exam paper and realising you can actually do the problems. This is second only to the feeling of utter relief and joy when your final exam is over!

Raphael Oyelade, currently studying MPhys Physics, Astrophysics & Cosmology.

Course list & entry requirements

International students : Please note that the requirements presented here are aimed mainly at UK students. We do accept a range of overseas qualifications; please contact the Physics Admissions Tutor for further information (see page 38 for contact details).

Code	Degree	Scheme	Indicative A-level requirements
MPhys and MSci Courses (4 years)			
F303	MPhys (Hons)	Physics	
F3F5	MPhys (Hons)	Physics, Astrophysics and Cosmology	
F373	MPhys (Hons)	Physics with Particle Physics and Cosmology	AAA
F3FA	MPhys (Hons)	Physics, Astrophysics and Space Science	
F321	MPhys (Hons)	Theoretical Physics	
F305	MPhys (Hons)	Physics North America Year 3 spent in the USA or Canada	AAA
F3G1	MSci (Hons)	Theoretical Physics with Mathematics	AAA
BSc Courses (3 years)			
F300	BSc (Hons)	Physics	
F3FM	BSc (Hons)	Physics, Astrophysics and Cosmology	
F372	BSc (Hons)	Physics with Particle Physics and Cosmology	AAB
F3FN	BSc (Hons)	Physics, Astrophysics and Space Science	
F340	BSc (Hons)	Theoretical Physics	
F302	BSc (Hons)	Physics North America Year 2 spent in the USA or Canada	AAA
F3GC	BSc (Hons)	Theoretical Physics with Mathematics	AAA
OpenPlus Courses in conjunction with the Open University			
	BSc (Hons) & MPhys(Hons)		Contact Admissions Tutor

Please note that all applications are considered on an individual basis. Applicants may be invited for interview.

All degrees require physics and mathematics at A-level.

A-levels: AAA = 360 points, AAB=340 points.

2 AS-levels are considered in place of the third A-level.

International Baccalaureate: 36 pts (=AAA) or 34 pts (=AAB) overall with 16 pts from three HL subjects including Maths and Physics.

Alternative qualifications: we welcome applicants with alternative qualifications such as Open University, Open College, PPLATO etc.

Mature applicants: we welcome your application - you may not need to meet the requirements above, please contact the Admissions Tutor.

For further information, please refer to our web-site **www.physics.lancs.ac.uk** or contact the Admissions tutor (see page 38).

We welcome applications from everyone, independent of gender, race, ethnic or national origin, religious or political beliefs, disability, age, sexuality or any other distinction irrelevant to academic study. Everyone is treated equally throughout their time in the Department.

The core physics syllabus

Our MPhys, and most of our BSc, degrees are based on a common structure (see page 9). However, the mathematics content of MSci and BSc Theoretical Physics with Mathematics differs from what is shown on page 9; see page 19 for details.

Degree structure

The common structure of the degree schemes is indicated in the diagram on the opposite page. The specialism dependent optional components are indicated. As a rough guide, 25 to 30% of your degree content is fixed by your choice of specialism.

First year course

In your first year, the **Physics** element of study will consolidate your A-level learning, building upon basic physical concepts and providing the understanding necessary for the second year. The course will also develop your mathematical skills and equip you with useful techniques for making quantitative physical predictions.

Topics discussed include Newtonian kinematics, Newton's Laws, force, energy, momentum and angular momentum. We introduce you to the applications of fundamental mechanics to real many-body systems including gravitation, planetary motion, simple harmonic motion, pendulums and elementary fluid mechanics.

You will learn about the thermal properties of matter, kinetic theory, phase changes and the first law of thermodynamics. Waves and oscillations and many connected phenomena are discussed. You will also study electric and magnetic fields. After gaining this quantitative understanding of classical physics, you will be introduced to the problems that require the introduction of a modern quantum understanding of the world.

Laboratory classes are an integral part of the first year course. You will learn essential experimental techniques and computer skills necessary to enable you to make measurements, account for any uncertainties, and then interpret your results accurately. Our module in Communication Skills is an integral part of this course and will help train you to present your findings clearly and concisely to others.

The **Mathematical** element of the first year course demonstrates how a wide variety of physical and engineering problems can be solved by the application of mathematical techniques. We introduce our students to new mathematical techniques in lectures, and they develop their skills by tackling exercises in mathematics workshops.

Second year course

In the second year, all physics students study the core topics listed in the diagram opposite. The content of the optional element is fixed by the degree scheme.

Courses for year 3 and year 4

In year 3, all physics students take the core topics indicated in the diagram. You also choose options from a range of topics reflecting the most recent areas of interest in physics. Studying areas such as cosmology, matter at low temperatures or lasers and their applications, not only brings you right up to date with the latest scientific theories and techniques but also allows you to explore and enjoy the range and depth of the field of physics.

The lecturers are fantastic and will always make the time to assist when asked, as well as providing well-constructed lectures and notes. I've loved the challenge of the first year; getting out of parrot fashion learning and actually being able to research things for myself. Some of the most rewarding aspects of the second year so far have definitely got to be the derivations of the speed of light and studying Maxwell's equations - so much physics summed up in just a few lines! Now if THAT isn't rewarding, I don't know what is!!! Having the freedom to question the learning material, and being kept up to date with cutting edge physics is phenomenal.

Aimee Hopper, currently studying MPhys Physics, Astrophysics & Cosmology.

Degree scheme structure

	Year 1	Year 2	Year 3	Year 4
	Physics Core I *Mechanics* *Thermodynamics* *Electromagnetism* *Waves and optics* *Quantum physics* *Laboratory* **Maths Core** *Vectors* *Calculus* *Series Methods* *Complex numbers* *Vector calculus*	**Physics Core II** *Quantum mechanics* *Electromagnetism* *Waves & optics* *Properties of matter* *Special relativity* *Particles and nuclei* *Computer programming* **Further Mathematics** *Further linear algebra* *Partial differential equations* *Fourier methods*	**Physics Core III** *Atomic physics* *Physics of fluids* *Statistical physics* *Particle physics* *Solid state physics* *Project skills*	**Physics Core IV** *Extended project*
Physics		*Laboratory*	*Project/dissertation* *3 optional courses*	*7 optional courses*
Astrophysics & Cosmology		*Astronomy* *Introductory astrophysics* *Introductory cosmology*	*Stellar astrophysics* *Big Bang cosmology* *Astrophysics and Cosmology labs* *2 optional courses*	*Advanced relativity and gravitation* *Current cosmology* *5 optional courses*
Particle Physics & Cosmology		*Astronomy* *Detection and acceleration of particles* *Introductory cosmology*	*Particle physics lab* *Big Bang cosmology* *Flavour physics* *Groups & symmetries* *1 optional course*	*Advanced relativity and gravitation* *Current cosmology* *Further particle physics* *Gauge theory* *3 optional courses*
Astrophysics & Space Science		*Astronomy* *Introductory astrophysics* *Space physics*	*Stellar astrophysics* *Solar wind* *Aurora/atmosphere* *2 optional courses*	*Solar-planetary physics* *6 optional courses*
Theoretical Physics		*Further classical mechanics* *Classical field theory* *Further quantum mechanics*	*Project/dissertation* *3 optional courses*	*Advanced magnetism and nanophysics* *Quantum transport in nanostructures* *5 optional courses*

Scheme specific courses

Graduate BSc

Graduate MPhys

Projects

All MPhys students undertake a major project in their final year with expert guidance from a member of staff (the project supervisor).

Project topics can be experimental or theoretical and should be relevant to the student's chosen degree theme, if any (so Theoretical Physics students will do a theoretical project etc). The aim of project work is to provide an opportunity to study a particular subject in depth and to further develop transferrable skills that are highly sought after by prospective employers, such as independent study and thinking, planning, time management, communication skills (written and oral) and experimental or theoretical research techniques. Projects give our students an insight into physics research and provide excellent training for those who want to pursue a research career in academia or industry.

The world-class research undertaken in our department is reflected in the broad range of project topics we offer, some examples of which are listed opposite. Students usually choose their project topic from a similar list, which is renewed annually, but can also suggest their own, subject to there being a suitable project supervisor specialised in the field. For this reason projects are usually related to the current research interests of the project supervisor and often uncover new results, occasionally leading to a publication in a scientific journal. Some projects are conducted in collaboration with industry or other external agencies.

An undergraduate student presents her project work to some of her peers at our physics mini-conference.

Students may work singly or in pairs on a project, but each student writes up the results of their project in an individual final report, and presents their work to fellow students and staff members at a mini-conference at the end of the summer term. Since it comes after the final exams the mini-conference has a relaxed and fun atmosphere, offering a chance to develop vital presentation and communication skills amongst friends. Research communication skills, including professional poster design, are taught in a course given to MPhys and MSci students.

It is not surprising that graduates often describe project work as the most useful, enjoyable and rewarding part of their degree course, and that many stay on to study for a doctorate in the same field as their project.

I can't imagine not having done the 4th year project, while it was some of the hardest work I did in my degree, it was also by far the most stimulating and rewarding. While working on your project you are doing real research alongside approachable and genuinely interested staff, research that could get published. I most definitely learned a lot working on my project, including how physical principles can be used to study a new real life system. I also, and more importantly, discovered what kind of physics I liked doing and what kind of work I really wanted to do following my degree. Without a doubt this was what prompted me to study for my PhD.

Nathan Davies graduated in 2007 (MPhys Physics with Theoretical Physics) and is now a PhD student in the Lancaster Condensed Matter Theory Group.

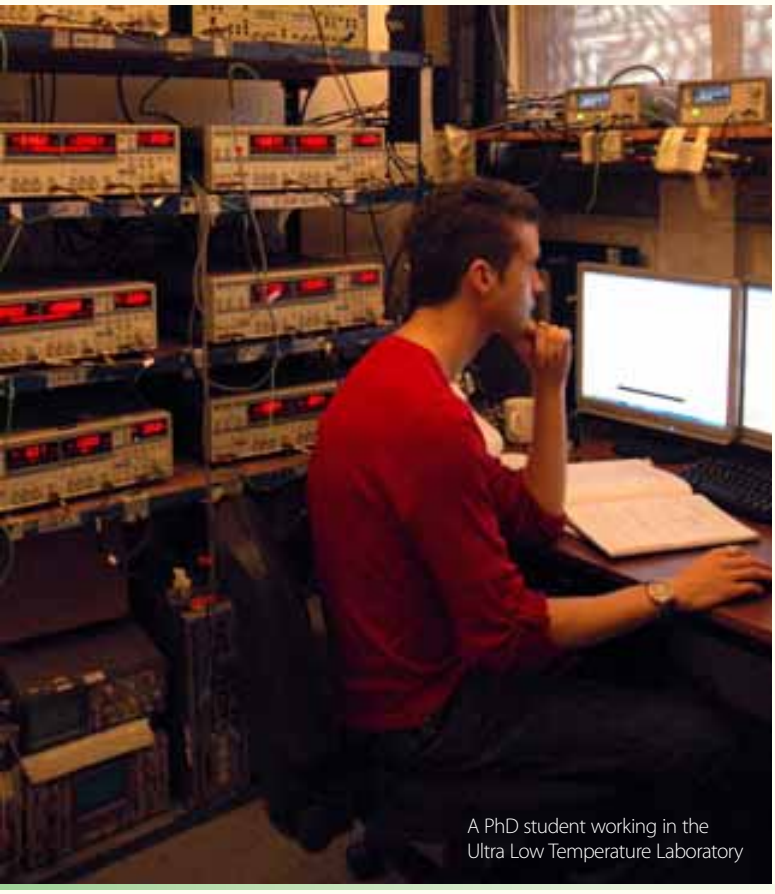
My fourth year project was the most enjoyable aspect of my whole course. I was able to work with fellow students without a pre-written instruction guide, allowing us a certain level of freedom to investigate low temperature phenomena whilst under supervision by academic staff. This was the closest I came in an undergraduate context to experiencing a research environment, which in conjunction with the excellent supervision I received made me decide to stay on at Lancaster to do a PhD in the same area as my fourth year project.

Matthew Fear graduated 2007 (MPhys Physics) and is now a PhD student in the Ultra Low Temperature Group at Lancaster

The following list of final year projects offered to our final year students in 2011 shows the breadth of the research interests of our staff:

Low Temperature, Solid State, Biomedical and General Physics

- Pressure-induced electrical signals in granite
- Superfluid helium-4 in aerogel
- Self-assembled quantum dots
- Microelasticity of biological and biomimetic materials
- Nanoscale probe microscopy of low-dimensional nanostructures
- Thermophotovoltaic cells
- Infrared avalanche photodiodes
- Light analogues of matter waves
- Nonlinear dynamics of selectivity, conductivity and gating in biological ion channels
- Physics of non-autonomous systems: a new perspective on the time variability of complex systems
- Quantum turbulence in superfluid helium-4
- Novel InAsN dilute nitride quantum structures



A PhD student working in the Ultra Low Temperature Laboratory

Particle Physics

- Depolarisation at the interaction points of future particle colliders
- W bosons for polarimetry at electron-positron colliders
- Designing a source to produce very intense positron beams
- CP violation of B mesons using data from the Tevatron
- Study of the like-sign dimuon charge asymmetry at Tevatron
- Higgs searches at the LHC
- Characterisation of silicon sensors for ATLAS
- B-hadron lifetime measurements with first ATLAS data
- Quarkonium physics with ATLAS
- T2K – neutrino oscillation physics

Astronomy/Space Science

- Spectrographic measurements using the telescope
- The solar wind: origin and evolution
- The impact of Solar Flares on Cosmic Radio Noise (CNA) absorption
- Investigating the source mechanism for energetic particle precipitation into the Earth's atmosphere
- Black aurora
- Atmospheric contraction and satellite lifetime
- Amateur radio telescope
- In-situ measurements of magnetosphere-ionosphere coupling
- Multi-wavelength solar observations

Cosmology

- Gravitational waves
- Chaotic inflation : theory and observations
- The largest temperature of the Universe
- Matter-antimatter asymmetry
- Galaxies and Dark Matter
- The cosmology of neutrinos and nucleosynthesis

Theoretical Physics

- Physics of graphene
- Quantum states of matter
- Analytic approximations to many-particle wave functions
- Radiation-reaction of electrons and the Abraham-Lorentz-Dirac term

Physics staff/student annual football game

Annual Physics relay race

A student, who undertook MPhys Physics North America, skydiving during her year abroad in the USA (see page 20)

Physics

UCAS code: F303 (MPhys), F300 (BSc)

Our Physics Degree provides a broad conceptual and working knowledge of Physics along with key transferrable skills to enable graduates to embark on a very wide variety of careers paths.

The basic structure is outlined on pages 8 - 9. In additional to the core curricula, students are taught the key skills required to perform modern state-of-the-art experiments. Skills include test and measurement, project planning, report writing and presentation. Students will use and become familiar with a wide range of sophisticated equipment and associated software. Experiments will complement the core physics modules, giving greater insights into how modern physics is performed.

Experiments will recreate some of the key discoveries in physics, such as the quantization of light, the existence of nuclei and electrons, the quantum nature of particles and wave-particle duality. Students will be able to co-ordinate their own investigations using:

- X-ray crystallography to investigate atomic structure
- Cryostats to cool materials down to 1 degree above absolute zero in order to observe exotic phenomena such as superfluid Helium and superconductors
- Computer controlled state-of-the-art particle detectors to investigate cosmic rays reaching the Earth's surface.

Physics students are also able to undertake extended projects, researching a topic of their choice. Our strong research activity allows us to provide a wide range of high level projects. Some recent examples are:

- Scanning force microscopy
- Ultrasonic measurements
- Solar PV cells and haze monitoring
- Ultra-miniaturised sensors
- Nano-scale imaging microscopy
- Superfluid helium-4
- Control of cardiovascular systems
- Lasers
- Wind electricity generation
- Quantum turbulence

I came to Lancaster University as a quiet and shy young girl and left as a confident graduate.

I chose Lancaster because of how small the department is, in the hope that this would give me a chance to be noticed and not blend into a background of hundreds of students. I was right to do so. In the department everyone knows everyone and not a single member of the group is an anonymous member. Staff and students become a family unit, so much so that even now when I call in to visit the physics department everyone says hello and knows who I am. In choosing Lancaster I didn't have to leave my family, instead it was extended. The open door policy really is just that and not only with staff but with postgrads and fellow undergrads of all years. Lancaster killed the stereotype of the nerdy, unsociable physicist and replaced it with one where they are fun and friendly. Now that I am training to be a teacher, this is the image I can pass on to my students as I strive to inspire the next generation of physicists, in the same way I was inspired.

Nikki Lammin, graduated 2008

Astrophysics and Cosmology

UCAS code: F3F5 (MPhys), F3FM (BSc)

You may choose from either our MPhys or BSc degree schemes in Physics, Astrophysics and Cosmology. Our teaching of astrophysics and cosmology at Lancaster has been enhanced by our observatory, the Dame Kathleen Ollerenshaw Observatory, named after a former pro-Chancellor of the University. You will have the opportunity to use the telescope either through course work or as part of a full year research project.

The main instrument is a 356 mm Schmidt-Cassegrain reflecting telescope, with imaging carried out either visually or via a CCD camera. The CCD camera can be used to take black and white or colour images. The telescope can also be fitted with a high-resolution spectrometer. The astrophysics laboratory attached to the observatory supports associated experimental course work for optical and radio astronomy using a number of smaller instruments.

A Star Party in our observatory

We believe that these degree schemes provide a balanced combination of general core physics with a specialised study of an area of great current interest and relevance. See pages 8 - 9 for an overview of the degree scheme. Approximately 25-30% of your time will be spent on topics related to Astrophysics and Cosmology.

Course topics include:

- Measurement and astronomy
- Structure of the Universe
- Special relativity
- The observable Universe
- Advanced relativity and gravity
- Physics of stars
- The early Universe
- The hot Big Bang
- Stellar and particle astrophysics
- Recent advances in astrophysics and cosmology
- Laboratory in observational astrophysics
- Cosmological modelling (computer project)
- A full year observational or theoretical project

Some of the recent and current project topics are:

- Variable stars
- Stellar spectra
- Lunar topography
- Radio fluctuations of the Sun
- Relic particles in the Universe (dark matter)
- A model of inflationary cosmology
- Origin of large-scale structure of the Universe

I completed many interesting modules during my degree. I enjoyed my MPhys project the most because I was able to use the departmental telescope to take new data and attempt to interpret what I found. My fourth year was challenging, but it was also incredibly rewarding. The range of modules offered by the department is wide so I was able to tailor my degree to my interests, thus making it very enjoyable. The support of the staff in the department, mixed with a lot of hard work, helped me to secure a PhD place at the University of Cambridge to continue my quest to become a researcher/lecturer.

Sarah Smedley, graduated MPhys Physics, Astrophysics and Cosmology in 2011. Sarah will undertake a PhD in astrophysics at the University of Cambridge.

Astrophysics and Space Science

UCAS code: F3FA (MPhys), F3FN (BSc)

Both the MPhys and BSc Physics with Astrophysics and Space Science degree schemes are designed to teach you about the physics underpinning processes in the space environment that stretches from the surface of the Sun to the limits of our solar system. The electromagnetic coupling between the Sun and the various bodies in the solar system varies hugely from planet to planet, depending upon whether or not the planet is strongly magnetised (like the Earth), weakly magnetised (like Mars) or unmagnetised (like Venus). Meanwhile, Jupiter and Saturn, the massively magnetised and rapidly rotating gas giants of the solar system, both have complex interactions with their systems of moons. Nevertheless, the universal laws of physics allow us to compare the similarities and differences between the family of planets orbiting our Sun and translate our knowledge and understanding of the Earth to distant alien worlds.

A series of Hubble photos show Saturn's amazing aurorae changing under the influence of the Sun's magnetic field and the solar wind.
Credit: NASA/ESA/J. Clarke.

Spacecraft such as NASA's THEMIS probes (shown in this artist's impression) are required to explore the physics that controls the near-Earth space environment.
Credit: NASA

Image credit: Pete Lawrence. http://aurorawatch.lancs.ac.uk/

Lancaster space scientists develop and deploy state-of-the-art experiments in the Earth's arctic circle and exploit measurements from the latest NASA and ESA space missions, including Earth-orbiting satellites, spacecraft that constantly sample the solar wind streaming from the Sun and space probes orbiting our neighbouring planets.

Specialised subjects include: the solar-terrestrial environment, atmospheric and aurora physics, the solar wind, and planetary magnetospheric systems.

Project topics may include:

- Creation of artificial aurorae
- Effect of space weather on ground-based technologies
- Mapping plasma temperature in the Earth's magnetic tail
- Studying the dynamics of the Earth's space environment
- The impact of solar wind particles on spacecraft lifetime
- Energy transfer in the Sun-Earth system
- The causes of magnetic storms

Particle Physics and Cosmology

UCAS code: F373 (MPhys), F372 (BSc)

Final year students visiting CERN

lancasteruniversity

particle physics package

http://lppp.lancs.ac.uk/

The universe is a mysterious place! How did it form? Where does mass come from? What is the nature of the "dark matter" or "dark energy" which we cannot see and which accounts for almost all of the mass of the Universe? Where did all the anti-matter go? What are the properties of the elusive neutrino? How can we truly understand the universe in which we live when there are still so many unanswered questions?

Final year students visiting CERN

All of these questions are addressed by research into particle physics and cosmology. Lancaster particle physicists work at state-of-the-art particle accelerators (CERN's LHC, JPARC's neutrino beam and, until recently, Fermilab's Tevatron) to investigate and identify the nature of space and time, while the resident cosmologists employ all of their creative and mathematical abilities to explain the early history of the Universe in a way that complements and supports observational and experimental data.

This expertise is translated into an exciting, modern physics course based on the foundation of our core physics program.

Subjects include:

- Big Bang cosmology
- The origin of large scale structure of the Universe
- Dark matter
- Fundamental particle theory
- Gauge theories and grand unification
- Particle acceleration and detection
- Flavour physics

In addition to learning about the Universe on its largest and its smallest scales during the first 3 years, MPhys students will also have an opportunity to collaborate with one of the active researchers in the department on a final-year project. This allows our students to explore some of the key questions more fully, and contribute towards finding the answers.

Project topics include:

- Search for the Higgs particle
- Neutrino oscillations
- The physics of B-quark particles
- Dark matter and galaxy formation

Constructing an electromagnetic calorimeter at Lancaster for the T2K neutrino experiment in Japan.

Engineers checking the electronics on a LHC dipole magnet. [© CERN]

Theoretical Physics

UCAS code: F321(MPhys), F340 (BSc)

Which mathematical laws govern the natural world? How can we best make accurate predictions or deduce macroscopic properties of matter from microscopic descriptions? Which model describes a system or phenomenon most accurately and efficiently?

Quite possibly the most astonishing aspect of the world around us is that so much of it can be understood using a relatively small number of physical laws; a few well-chosen mathematical equations can describe a vast range of physical phenomena. Theoretical physicists devote themselves to uncovering the simplest possible set of principles that describe experimental observation. Their work focusses on developing and investigating the most appropriate mathematical laws and deducing the essence of physical phenomena. The resulting microscopic and higher-level descriptions provide the foundation of many branches of modern science and are a vital component of technological innovation.

Lancaster theoretical physics is dedicated to the study of Nature on all scales, from the quantum world of microscopic matter and nanomaterials to geometry of curved spacetime and the large-scale structure of the cosmos. Our broad range of internationally recognised research activities makes use of the two main pillars of modern theoretical physics: quantum mechanics and relativity, which also underpin the specialist teaching in this degree scheme.

A degree in theoretical physics equips you with analytical skills that are in high demand in academic and industrial research. Our theoretical physics degree exposes you to advanced topics in quantum theory, electromagnetism, condensed matter, gravitation and cosmology, and fundamental particle physics. These topics are embedded into the general degree scheme structure shown on page 9.

Research project: MPhys students on this degree scheme undertake an individual research project in theoretical physics in their final year, carried out under the guidance of a member of the theoretical physics group. Some recent project topics include:

- Geometry and electrodynamics
- Gravitational waves
- Quantum computation
- Physics of graphene

MPhys students who perform well may be afforded the opportunity to study towards a PhD in the theoretical physics group.

Studying MPhys Theoretical Physics gave me the opportunity to attend great lectures on material that I'd previously read about in popular science books, but didn't fully understand. In my 4th year I studied the latest developments in theoretical condensed matter and tackled very interesting quantum systems using techniques I'd learned in my courses.

Chris Poole graduated in 2007 and is now a PhD student in the Lancaster Condensed Matter Theory Group

Theoretical Physics with Mathematics

UCAS code: F3G1 (MSci), F3GC (BSc)

When I applied to university I wanted to study both maths and physics, but wasn't sure how to do it; the MSci course sounded like an ideal way to learn about physics and still learn pure maths. The scheme was challenging but it was very rewarding and a lot of fun came out of it. Both departments were very friendly and supportive, and the small class sizes meant that we were on good terms with most lecturers. Being taught by the maths department made the course unusually varied and gives me a unique perspective on many of the physics problems I encounter in my PhD.

Stephen Flood graduated MSci Theoretical Physics with Mathematics in 2010 and is now a PhD student in the Lancaster Mathematical Physics Group.

Physics and mathematics enjoy a symbiotic relationship. While mathematics provides physicists with the most appropriate language to formulate laws of nature, physics often motivates the development of new mathematical tools, thus, giving birth to new branches of pure and applied mathematics. Examples of fundamental mathematical concepts that produced powerful tools of modern theoretical physics include:

- symmetry groups and operator algebras, with numerous applications in quantum mechanics;
- functional analysis, in application to field theories;
- Riemannian geometry, in relation to special and general relativity.

Our Theoretical Physics with Mathematics (TPM) degree combines core physics and specialized theoretical physics courses taught by the Physics Department with classes in pure and applied mathematics provided by the Mathematics Department.

The final-year MSci TPM programme includes advanced courses in nanoscience, quantum fluids, general relativity, fundamental particle physics, and an individual research project carried out under the guidance of a member of the Centre for Nanoscale Dynamics and Mathematical Physics. The centre's research was ranked among the strongest in the UK by the RAE2008. The research interests of the Centre span over

- low-dimensional materials and nanostructures, such as graphene;
- quantum many-body theory of ultra-cold atomic condensates and quantum Hall effect;
- quantum information and optics;
- space-time geometry of ultra-relativistic plasmas;
- continuum mechanics for industrial applications.

The blend of physics and mathematics included in our MSci TPM degree course is very positive for our graduates' careers in industry, education, and for PhD studies.

MSci/BSc Physics and Maths Joint Degree Scheme

Year 1	Year 2	Year 3		Year 4	
Physics I *Mechanics* *Thermodynamics* *Electromagnetism* *Waves and Optics* *Quantum physics*	**Physics II** *Quantum mechanics* *Electromagnetism* *Waves and optics* *Properties of matter* *Special Relativity* *Computer programming*	**Physics III** *Atomic Physics* *Physics of fluids* *Statistical physics* *Particle physics* *Solid state physics* *Theory mini projects*	*Graduate BSc*	**Physics IV*** *Extended project* *Advanced relativity and gravitation* *Advanced electrodynamics* *Advanced magnetism and nanophysics* *Quantum transport in nanostructures* *1 additional course*	*Graduate MSci*
Mathematics I *Calculus* *Logic* *Matrices* *Probability* *Numbers* *Differential Equations*	**Mathematics II** *Real and Complex Analysis* *Linear Algebra* *Group Theory*	**Mathematics III**** *Hilbert Spaces* *Differential Equations* *Groups and Symmetry* *Representation Theory*		**Mathematics IV***** *Topology and Fractals* *Hilbert Space* *Differential Equations* *Groups and Symmetry* *Operator Theory*	

*in addition to the compulsory extended project, students currently follow 3 courses from this list
**students currently choose 2 courses from this list
*** in addition to Topology and Fractals, students currently follow 2 courses from this list

Physics North America

UCAS code: F305 (MPhys), F302 (BSc)

A physics degree with a year in the USA or Canada

A year studying in North America provides a unique opportunity to extend your higher educational experience to the challenging environment of a select US or Canadian university. You will be able to broaden your study of physics within a totally different academic and cultural context. Many former Lancaster students attest to the value of their year abroad for their personal development and the enhancement of their long-term career prospects.

You take the year abroad either as the 3rd year of a 4-year MPhys (strongly recommended) or the 2nd year of a 3-year BSc degree. Whilst in Lancaster, you will study on one of the standard degree schemes outlined on page 9. The courses taken in North America are chosen to be similar to those you would have studied in Lancaster so that you will smoothly fit back in on your return. All the work that you do whilst in North America is assessed and counts towards your final degree. Lancaster has the greatest experience of any UK institution in organising North American exchange programmes, with more than 50 co-operating US and Canadian institutions. At present, physics students can choose between the following universities:

USA

- North Carolina State University
- University of North Carolina (Charlotte)
- University of Florida
- Michigan State University
- University of Illinois
- Iowa State University

Canada

- Trent University (Peterborough, Ontario)
- University of Waterloo

Prior to the year abroad you will be given every assistance with both academic and administrative aspects of the exchange. The North American tutor in the Physics Department will guide you in choosing a study programme best suited to your interests, and will ensure that you are well prepared both for the year abroad and for your subsequent return to Lancaster.

I spent my year abroad at the University of California San Diego. It was a truly unforgettable experience. I learnt many things, made friends, had fun and was able to travel during the vacations – all in plenteous amounts! Don't miss the opportunity to study abroad; it will be the best thing you've ever done!

Gemma Anderson, graduated MPhys Physics North America in 2008. Gemma is currently undertaking a PhD in theoretical early universe cosmology at the University of Sussex.

Gemma Anderson in San Diego, California 2006/2007

You will also be given advice on matters of general concern: insurance, obtaining a visa, travel, banking and other financial aspects. A number of bursaries are available on a competitive basis for assistance towards the costs of travel. During the year abroad you will be in regular contact with a 'study abroad' tutor at the host university and (by e-mail) with the Lancaster tutor. Every effort is made to minimize the cultural shock – both socially and academically – of spreading your study between two continents!

Entry requirements

Our North American courses are both more competitive and more demanding than many of our other degree schemes. If, after interviewing you, we are unable to make you an offer for F302 or F305, we will as an alternative consider you for the equivalent Physics degrees, F300 or F303. Depending on progress in your first year and the availability of places on the North American exchange programme, it may be possible for you to transfer into the programme at the end of first year (MPhys only).

Trent Bridge which separates the two halves of Trent University campus in Peterborough, Ontario

It has been a most rewarding and enjoyable experience. I must point out the value particularly of being able to carry out undergraduate research in the USA.

David Evans (MPhys North America) spent the year abroad at Iowa State University, now working as a physicist/programmer at the Fermi National Accelerator Laboratory, Chicago.

OpenPlus with the Open University

The university's open door policy means that someone is always available to talk to about any problems I'm having with the courses. Inevitably there will be some topics taught differently in the OU courses, but everyone has been extremely helpful in making the transition to Lancaster as easy as possible.

Colin Henderson
studying physics on our OpenPlus scheme.

Lancaster University in partnership with the Open University offers a flexible route to a degree in physics for prospective students without A-level maths and physics (or their equivalent).

Two years are spent studying in your own time with the Open University, allowing you to combine study with full time employment. Successful completion of this component allows direct transfer onto the second year of our full time Physics BSc at Lancaster. You study for a further two years as a full time student and graduate with a Lancaster University BSc degree in Physics. Students performing very well can also qualify to study at Lancaster for a third year and graduate with an MPhys degree - the usual qualification for a professional physicist.

How does it work?

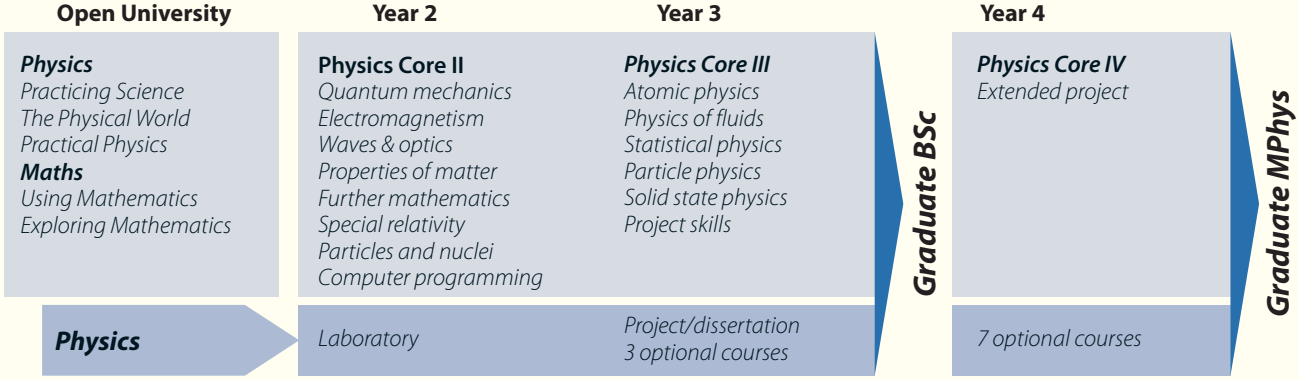
In your first two years of part-time study with the OU (your foundation year and year one) you will get a thorough grounding in basic physics and mathematics via distance-learning courses. Experimental work is included in residential courses that give you the experience and background knowledge necessary to undertake laboratory work in physics at degree level. On successful completion of all the OU courses you will be equipped to transfer to Lancaster University as a full time year two student to complete your degree. At Lancaster, you will study the required core courses, and choose one of our special flavours for your other courses. The standard Physics scheme is shown below, but all of our other schemes (excluding Theoretical Physics with Mathematics) are available, as described on pages 9 to 21 of this booklet.

In the Lancaster year 2 fundamental topics are explained further and you will be given training in advanced mathematical techniques. Also you will be introduced to more advanced physics topics in such areas as relativity and nuclei & particles. A useful transferable skill learnt in year 2 is the object oriented computer programming language Java, an essential tool for later projects and a useful ability for future employment. In year 3, you will see further applications of quantum mechanics in core courses, as well as taking 3 optional modules from a selection covering many of the most recent areas of discovery in physics, allowing you to explore and enjoy the range and depth of physics knowledge and graduate with a BSc. If you stay with us for a further year for an MPhys, you will hear more about the frontier topics in physics and undertake a significant research-based project.

Students apply for entry to the OpenPlus directly to the Physics admissions office, NOT to UCAS.

If you would like to spend a year in Canada or USA, please ensure that we are made aware of this when you make your application.

OpenPlus Degree Scheme Structure



Awards for academic scholarship

Rewarding excellence

Each year we reward our most successful undergraduates with financial prizes and certificates for academic achievement. Awards are given to 1st, 2nd, 3rd and 4th year students, and our very best students have won prizes at the end of every year of their studies. In addition to awards for excellent overall performance in exams and coursework, we also offer the Dame Kathleen Ollerenshaw Prize for the very best performance in an astronomy project and the Azzedine Hammiche Prize for exceptional project work (see page 10 for more details about projects).
In addition to the prizes awarded by our department, every year Lancaster University awards the Chancellor's Medal to its very best undergraduates. The competition for this prize is extremely fierce because it is open to all of the best final-year undergraduates students across all departments, and only up to six are awarded each year. We are very proud of our physics students who have won this prestigious prize, and the fact that our department has produced winners in consecutive years is testament to the quality of our physics graduates.

Recent physics winners of the Chancellor's Medal

- 2008 Cherry Canovan, MPhys Physics. Cherry is now a PhD student studying accelerator physics in the Mathematical Physics Group, Department of Physics, Lancaster University.
- 2009 Laura Nuttall, MPhys Physics, Astrophysics and Cosmology. Laura is now a PhD student studying gravitational waves in the Gravitational Physics Group, School of Physics and Astronomy, Cardiff University.
- 2010 Jon Emery, MPhys Physics, Astrophysics and Cosmology. Jon is now a PhD student studying cosmology at the University of Portsmouth.
- 2011 Andrew Woods, MPhys Physics.

Andrew Woods, winner of the 2011 Chancellor's Medal, being congratulated by Sir Chris Bonington, Chancellor of Lancaster University.

Developing skills for business

If you enjoy physics at school it is probably because you are interested in discovering how things work in the world around us. Physics is an exciting subject that is fundamental to the developments in modern society. The subject has a broad range of specialisms, from the very pure to the very applied, reflected in our research interests at Lancaster.

Our research interests include : Accelerator physics, biomedical physics, condensed matter physics, cosmology and astroparticle physics, mathematical physics, microstructural physics of materials, nanoelectronics, optoelectronics and lasers, particle physics, polymers, quantum fluids, semiconductor physics and nanostructures, space plasma physics, theoretical physics, ultra low temperature physics.

Graduates of physics are in demand in many career areas:

- The electronics and semiconductor industries employ a large number of new graduates in research and development in the fields of device design, manufacturing techniques and materials research.
- Physicists are needed to exploit recent advances in telecommunications and medical physics.
- There are opportunities in local government in civil and defence research, public health programmes and teaching.
- Many scientists originally trained in physics are working in areas such as electronic engineering, metallurgy, geology, information technology and molecular biology.

However, many of our former students find employment in a wide range of other careers where the skills gained during the course such as logical thinking, problem solving, communication skills, teamwork, numeracy and computer literacy are valued. Examples include computer programming, accountancy, managerial and administrative positions.

An insight into physics careers

In choosing to study physics, you may or may not have an idea about your future career options. We help you to understand the significance of physics in industry and to give you an insight into real applications of the subject. Industry and outside agencies contribute to the range of our third and fourth year projects as well as funding departmental research in a number of areas including optoelectronics and lasers, scanning probe microscopy and mathematical physics. These links with employer organisations are of benefit to our students in seeking employment.

The University also has a highly regarded careers service that will help you with every aspect of seeking employment or further study opportunities. The departmental careers tutor also arranges careers courses as part of the physics degree.

I loved studying physics at Lancaster; the lecturers were really friendly and were always prepared to make time for you. As a campus university Lancaster is naturally a very friendly place, but even more so within the Physics Department where everyone knows each other and your fellow students quickly become your best friends. Since leaving Lancaster I have gone on to study for a PhD in Astrophysics at Manchester and have just started work in nuclear risk assessment. Although I have gone on to do some very interesting things, I will always have a soft spot for Lancaster.

Holly Thomas, Lancaster physics graduate

Our graduates

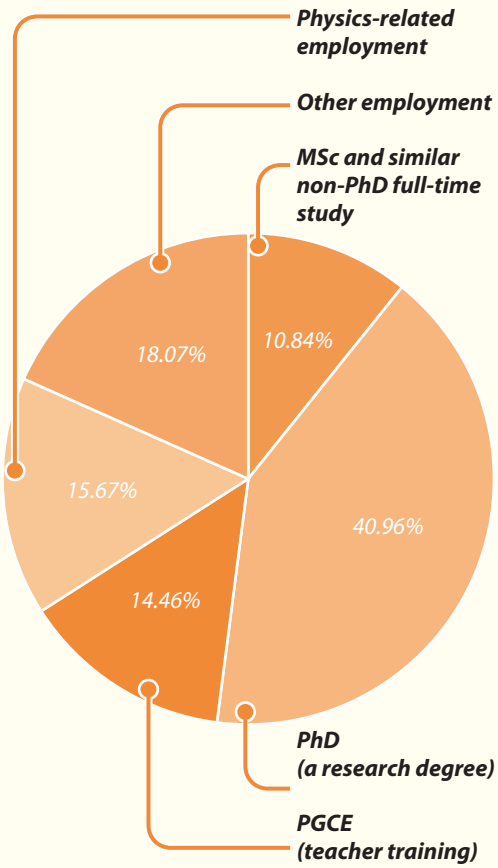
Since finishing my degree in Physics, Astrophysics and Cosmology, I went into a temporary job in Higher Education and quickly excelled using the skills that I had learnt while I was on my course. Now that I have decided what I would like to do, I am training to become a teacher to promote Physics to students and I am looking forward to teaching students of all ages. I am going to even have the opportunity to use my degree by teaching GCSE Astronomy in the future. Lancaster's Physics Department has helped me on my path and given me an incredible range of transferable skills that have and will aid me greatly in the future. I would highly recommend the Physics department at Lancaster as they are extremely supportive and friendly. Physics at Lancaster would be one of the best decisions of your life!

Mark Hetherington, Lancaster physics graduate

Our recent records of where our graduates obtain employment show that about half enter physics related careers i.e. in scientific or engineering research and development, or undertake research degrees at Lancaster or elsewhere. Others make use of the numeracy and problem solving skills that they have learned during their degree studies to find employment in finance and management. Media and IT-related employment, often based around physics computing skills, account for most of the remaining graduates together with some entering careers in medical physics.

Physics graduates pondering the mysteries of the Universe…

The early careers of our students



The above chart was derived from HESA data from 2007-2010, obtained six months after graduation. 'Physics-related employment' includes, for example, hi-tech engineering, defence and energy companies. 'Other employment' includes jobs in marketing and administration.

Physics at Lancaster introduced me to Cosmology, where I discovered great pleasure in trying to understand the Universe on the largest scales. Regardless of my future career, I'm hugely grateful to have learnt the techniques to understand nature. Developing these techniques, instead of memorising facts, made the degree much more interactive and ultimately rewarding.

Jon Emery graduated MPhys Physics, Astrophysics and Cosmology in 2010. Jon is currently undertaking a PhD in cosmology at the Institute of Cosmology and Gravitation at the University of Portsmouth.

Is Lancaster the place for me?

When I first visited Lancaster I was immediately taken with the atmosphere of warmth and friendliness. This was important to me because it's important for students to feel that they can approach their tutors and lecturers. Now that I'm a student, one of the best things about Physics at Lancaster is the people on my course. I really enjoy spending time with them, even when it means getting up for a 9am lecture!

Natasha Vracas, currently studying MPhys Physics, Astrophysics and Cosmology.

Going to university is not just about choosing the right course, you also need to consider the place itself – after all you will be making it your home, or at least spending a considerable proportion of your time there, for 3 or 4 years. If you are looking for a well-regarded university that is friendly, flexible and has a great social life without the problems associated with large cities, then Lancaster could be the place for you. You will find the cost-of-living here relatively inexpensive and the campus well placed for travelling and for enjoying some of the most beautiful scenery in the world.

A campus community…

With around 12,000 students and staff on campus every day, the University is like a small town. It has everything you will need within 10 minutes walk including banks, shops, eating places, art gallery, cinema, concert hall, theatre and a brand new £20m sports centre with a swimming pool.

…in easy reach of the city

Lancaster has a good reputation for student-friendly off-campus activities. The Students' Union has its own nightclub (The Sugar House) in the city and there are other nightclubs in Lancaster and in Morecambe. Lots of pubs have live music and a student atmosphere. There are eating places to suit all tastes and budgets, theatres, cinemas, concert venues, a bowling alley and a range of sports facilities. Frequent bus services link the city and campus and there is a cycle route avoiding busy roads. Lancaster is a cycling demonstration city with a constantly-expanding system of on- and off-road cycling routes.

Make friends quickly in college

Lancaster is one of only a handful of collegiate universities in Britain. The residential college system is great for meeting people from outside your own subject area. Each college has its own social facilities and sporting programmes.

A guaranteed room in our multi-award winning student accommodation

We retained the title of Best University Halls in the 2011 National Student Housing Survey and if you choose Lancaster as your first choice, you are guaranteed a place in our on-campus accommodation in the first year. Most final-year students who want to live on campus can normally do so. Some rooms have en-suite facilities and there are purpose-built rooms for students with disabilities. All rooms have a telephone and points to connect computers to the campus network and the internet.

Competitive prices

On-campus room prices are amongst the lowest in the country (depending on the college, currently £69-£88 per week or £90-£105 per week for an en-suite room). Catered options are also available. You will also benefit from cheaper insurance than in many major cities around the country as Lancaster (LA1 postcode) is in the lowest insurance group.

Easy travel

The University is just off the M6 so there are good road links to many parts of the country. National Express coaches stop at the campus. The city is on the West Coast Inter-city rail line (London is about two and a half to three hours away and Manchester one hour).

Outdoor pursuits

Lancaster is an ideal location if you are interested in the outdoor life. The Lake District and the Yorkshire Dales are within easy reach for sailing, hiking, climbing, pot-holing, hang-gliding and other adventure sports.

Women in Physics

Approximately 1 in 5 undergraduates undertaking physics degrees in the UK are female and our Women in Physics group was formed to support all of the females studying and working in our Physics Department. The group meets about once a month and aims to provide a forum for the women in the department to get together to get to know one another better, discuss physics and make new contacts. They run an innovative partnership scheme between undergraduates, postgraduates and postdoctoral research staff, aiming to improve relations between women at different stages of their careers and to provide undergraduates with a first port of call for advice on physics-related matters such as careers and research options. Our Physics Department takes part in the Institute of Physics' Juno project, which addresses the problem of the very low proportion of women in physics, especially in higher academic posts. Our Physics Department attained Juno Practitioner status and is now seeking to become a Juno Champion.

Lancaster University Physics and Astronomy Society (LUPAS)

LUPAS is a physics society run by our students for our students, and is one of the most active and largest student societies on campus. Whether they are off having paintball battles, taking on their lecturers at football or giving talks on the latest developments in physics, there is always something entertaining going on! LUPAS has a very busy calendar throughout the year with at least one event every fortnight, including numerous social gatherings and guest lectures on a multitude of different physics themes organized in conjunction with the Institute of Physics. In addition, LUPAS gives our students the opportunity to undertake student-run extended practical physics projects that range from observing variable stars to studying muon decays with a weather balloon. For more information please search LUPAS on Facebook or contact them at lupas@lancaster.ac.uk.

The department fully supports the Juno initiative and sees it as a priority for us to attain Juno Champion status. We see our Women in Physics group as a welcome development in the department and a key component in our attempt to attain Champion status.

Professor Peter Ratoff, Head of the Lancaster Physics Department.

Research at Lancaster

The fact that the lecturers are active in their research means that they have a real passion for what they are teaching, and can explain how it fits into what they do. The laboratory work is a great example of this, where world-leading researchers teach you the methods they use every day.

Gareth Davies graduated MPhys Physics in 2011. Gareth will undertake a PhD in gravitational waves at the Institute of Gravitational Research, University of Glasgow.

We carry out cutting edge research at the international level across a variety of different areas of interest. The Department was ranked number 1 in the country in the last national research assessment (RAE 2008), confirming the international excellence of our research. Our staff are very research active and publish regularly in high impact, peer-reviewed scientific and specialist journals. They regularly give invited talks and present the results of their work at international conferences and symposia all over the world. In addition our lecturing and research staff include several world authorities and the Department has achieved a number of world firsts in key research areas. As a Lancaster student you will benefit from this not only through the range of optional courses and research projects which we provide in the 3rd and 4th years, but also from well-informed and enthusiastic staff.

You may decide that you would like to become a research student yourself after you graduate from your degree. Research in physics is essential to gain new insights and understanding of matter and the Universe, in order to make technological advancements and improve the quality of life in society. We have a range of opportunities available and encourage promising students to stay on in the Department and undertake PhD (research) degrees.

The following provides a flavour of our current research, most of which has strong international links. In addition to the work done within our main research groups, there is also much cross-group activity.
This brings together the leading complementary expertise from widely differing areas of physics in order to address important problems. Examples of such topics include non-linear dynamics and chaos; cosmological experiments in liquid helium; and the development of gallium arsenide particle detectors. We are also involved in many interdisciplinary areas including the biological, chemical and medical interfaces.

Space Plasma Physics

Research in this area investigates the physics of our local space environment - the region from the surface of the Sun to the edge of the solar system. We collaborate with international research organisations, including ESA and NASA, to study the role that plasma processes have in electromagnetically coupling the planets (and other bodies) in our solar system. This work offers insights into the physics that drives breath-taking natural phenomena such as the aurora borealis, shields delicate planetary atmospheres like the Earth's from the onslaught of the solar wind and powers a complex system of electrical currents throughout the solar system. We employ space- and ground-based experiments, as well as computer simulations, to explore this strange and exciting environment.

The most rewarding experiences during my time at Lancaster took place in the lab. I entered into my physics degree with the hope of a more practical orientation. I wasn't disappointed. Lancaster's outstanding reputation for research does not go unfounded. Low temperature physics, an area Lancaster is particularly famous for, has captured my interest in and out of the lab. From the Meissner effect through to quantum turbulence, every area has been extremely enjoyable. My passion for this subject has resulted finally in a PhD at Lancaster.

Above all the most enjoyable part of being at Lancaster must be working with a world leading set of academics. The inspiration that comes from being in such proximity to some of the leading minds in your field is unmatched.

George Foulds, MPhys Physics, graduated in 2010 and is now a PhD student in Experimental Condensed Matter Physics at Lancaster. Research work from his undergraduate project was presented at a national conference on semiconductors.

Prof. G.R. Pickett FRS preparing for an ultra-low temperature experiment

One of the dilution refrigerators we use to study the quantum properties of helium at ultra-low temperatures.

Low Temperature Physics

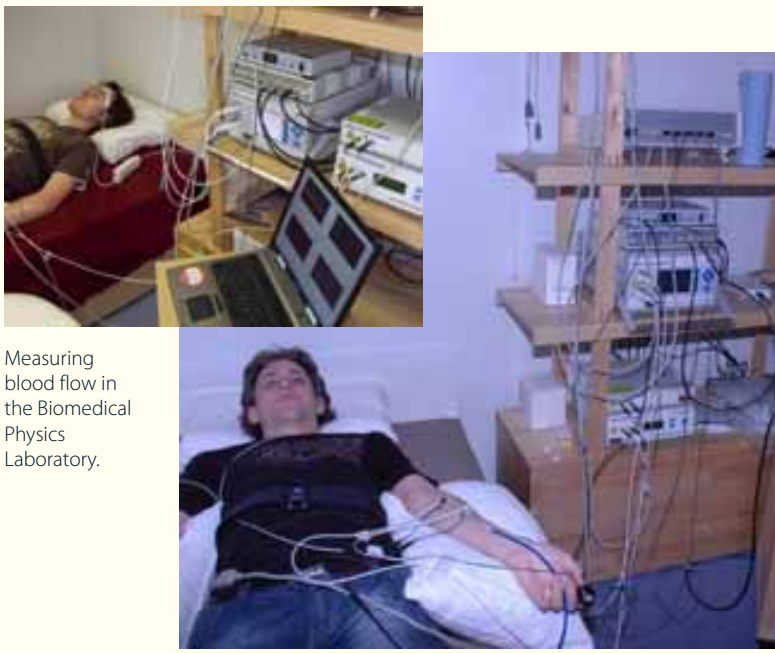
Low Temperature research at Lancaster includes experiments on superfluids and other materials with wider applications in areas such as cosmology and turbulence. The group has a strong international reputation for performing state-of-the-art experiments at the lowest achievable temperatures. Our custom made dilution refrigerators, built in-house, achieve world record low temperatures. We have pioneered several innovative approaches including: `Lancaster-style' nuclear cooling stages to cool superfluids to record low temperatures; `heat-flush' procedures to produce highly purified helium-4; ion transport measurement methods for quantum fluids; novel NMR systems; and various mechanical oscillator techniques which provide extremely sensitive thermometry and bolometry at microkelvin temperatures. Low temperature physics gives unique access to large-scale quantum phenomena, notably superconductivity in some metals and superfluidity in liquid helium-3, and we have a broad research portfolio specialising in quantum fluids and solids research. We have performed ground-breaking research on numerous topics, including: superfluid analogues of cosmological processes; ion and vortex ring dynamics; ballistic quasiparticle beams; exotic superfluid spin phenomena; superfluid phase nucleation; phase boundary dynamics; wave turbulence; and quantum turbulence. The Ultralow Temperature cluster of cryostats has been designated a European Facility, providing experimental access for visiting European scientists through the EU Framework 7 collaboration MICROKELVIN.

Solid State Physics

We study the physics of semiconductor nanostructures and devices, including the MBE growth of antimonides and dilute nitrides, with emphasis on mid-infrared (2-5µm) optoelectronics and spectroscopy of quantum structures. This is stimulated by a wide range of novel physical phenomena and practical applications, such as mid-infrared lasers; LEDs and detectors for environmental monitoring; fire detection and freespace optical communications; devices for telecommunications; and charge-based digital data storage memories. This research includes the growth, characterisation and high-magnetic-field spectroscopy of self-assembled quantum dots. These 'artificial atoms' are spontaneously formed when a few mono-layers of material are deposited on a substrate with a different lattice constant, and are an area of intense scientific activity worldwide. Work is undertaken in an atmosphere of national and international cooperation supported, for example, by the PROPHET European Network. Particularly strong links exist with TU Berlin, NTU Taiwan, the Ioffe Institute, KU Leuven and University of Antwerp. Our UK industrial partners include QinetiQ Ltd and Oclaro.

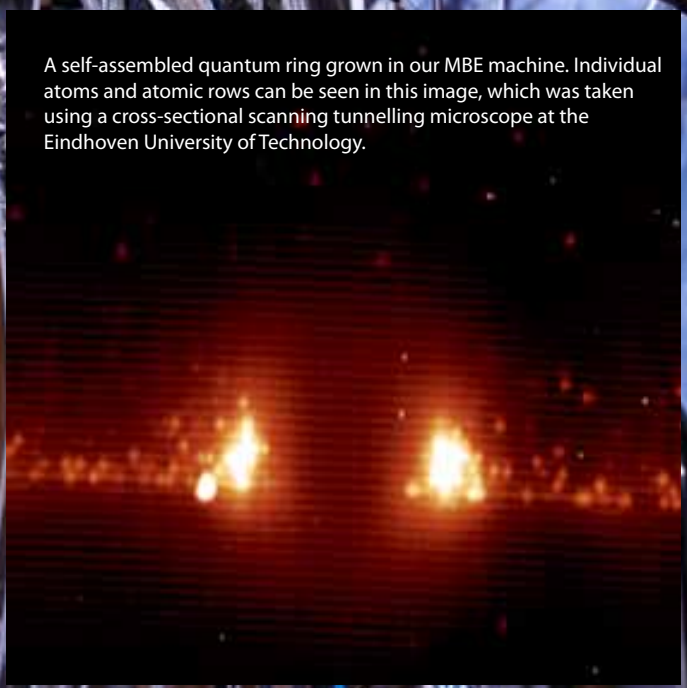
Biomedical Physics

Biomedical physics applies physics to living systems. Traditionally medical physics develops methods for imaging structures within the human body and therapeutic techniques for treatment of diseases, such as radiological treatment of cancer. At Lancaster we also develop new techniques for monitoring and imaging on all scales – from cells to the whole body. We apply nonlinear physics to study human physiological functions, on scales ranging from the opening and closing of ion channels within a cell membrane, to interactions between the heart, the lungs and the brain. Joint projects link us with the Royal Lancaster Infirmary and with partners within UK, Europe, USA, Canada, Australia, New Zealand and Japan. Our work aims to generate fundamental



Measuring blood flow in the Biomedical Physics Laboratory.

One of three Lancaster Physics MBE (Molecular Beam Epitaxy) machines used for fabricating new semiconductor nanostructures.



A self-assembled quantum ring grown in our MBE machine. Individual atoms and atomic rows can be seen in this image, which was taken using a cross-sectional scanning tunnelling microscope at the Eindhoven University of Technology.

understanding of the oscillatory processes involved in energy and information transfer within the body, and then to apply the new knowledge to hypertension, cardiac failure, diabetes, postmyocardial- infarction, anæsthesia, aging, cancer and many other human conditions. Our studies of biological oscillations are revealing fascinating new insights into systems designed by Nature and how they can function robustly despite their extraordinary complexity.

Theoretical Condensed Matter Physics

Condensed matter comprises a diverse range of systems where individual constituents (like atoms and electrons) are densely packed and interact strongly. Besides naturally occurring in solids and liquids, this also includes carefully designed and controlled artificial systems such as electronic nanostructures, graphene (the first truly two-dimensional crystal, and the subject of the 2010 Nobel Prize for Physics), molecular conductors, photonic crystals and trapped cold gases, which are at the focus of theoretical research at Lancaster. Because of the intricate and varied nature of the interactions, such systems exhibit striking effects of fundamental and practical significance, such as superconductivity, the quantum Hall effect or spin-dependent transport. Our theoretical investigations aim to provide an accurate mathematical and conceptual understanding of phenomena which presently defy understanding, and to develop and study models for conditions where new physics may arise. This requires the advance and application of analytical and numerical methods from quantum mechanics, statistical mechanics, and electrodynamics. In recent years, the group contributed in particular to the understanding of the electronic properties of graphene, the coherence of excitations in quantum dots, the conductance of molecular bridges, the dynamics of condensed Bose gases and strongly correlated one-dimensional systems, and the quantum statistics of photons generated in optically amplifying microstructures.

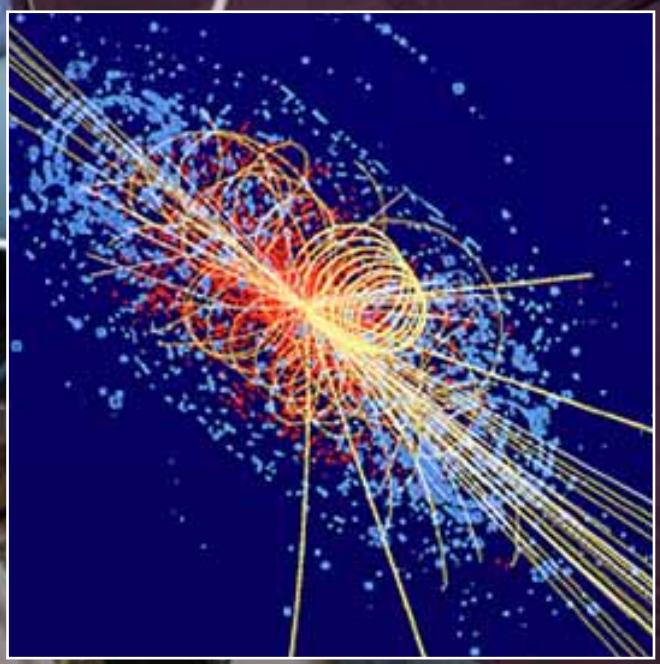
Particle Cosmology

Cosmology is the study of the entire Universe as a system. Particle cosmology uses what is known or conjectured about fundamental particle theory to model and trace the history and evolution of the Early Universe, when the energy density was so immense that high energy physics is necessary to describe the behaviour of the material filling the Universe. As such, particle cosmologists make use not only of astrophysical data, such as those from the WMAP and Planck satellites, but also of the findings of accelerator experiments such as the LHC at CERN. In turn, they use the Universe as a giant laboratory to probe physics at energies well beyond colliders on Earth. Our Cosmology group concentrates much of its research in the physics of cosmic inflation, which is a period of explosive expansion of space at the onset of the known history of the Universe, only a tiny fraction of a second after the Big Bang itself. Inflation is thought to be the reason why the Universe is so big and looks so uniform on very large distances. It also produced the original ripples in the Universe's density, which sourced the formation of the observed structures such as galaxies and galactic clusters. These ripples are revealed in the Cosmic Microwave Background radiation, providing precise information about the whereabouts of the physical processes very close to the beginning of time. Another aspect of our research focuses on the nature and origin of Dark Matter, whose presence is inferred by its gravitational effects on galaxies and galactic clusters but which has not been as yet identified in spite of constituting more than 1/5th of the Universe's content. Finding exotic particles which can be the Dark Matter is one of the aims of the LHC particle accelerator. Furthermore, we study and develop mechanisms to explain the observed imbalance between matter and anti-matter in the Universe. We also investigate the cosmological effects of string theory and alternative theories of gravity, and the possible generation of gravity waves in the Early Universe, which may be observed in the near future.

Experimental Particle Physics

Matter and the forces that act upon it are described at the fundamental level by elementary Particle Physics. These studies provide insight, not only into the composition of the ordinary matter around us, but also into the development of the early Universe following the initial Big Bang.

Testing the powerful electromagnetic modes of a Photonic Band Gap structure. Such devices hold considerable promise for reducing the size of particle accelerators.



I decided to study at Lancaster University based on, among other reasons, the opportunity to study abroad in the USA through the MPhys North America programme. This allowed me the chance to study in a different environment and experience a new culture. Nevertheless I also thoroughly enjoyed my time at Lancaster. So much so that I decided to continue for a further three years upon graduation to do a PhD in High Energy Physics. I work on the Japanese based T2K project and am heavily involved in constructing a neutrino detector in the Lancaster lab. I am able to apply all of the skills acquired throughout undergraduate life on a daily basis.

Gavin Davies graduated MPhys Physics North America in 2006 and recently obtained his PhD in Experimental Particle Physics from Lancaster

Experiments in particle physics are carried out by large international teams of physicists based at accelerator laboratories such as CERN (Geneva), Fermilab (Chicago), and JPARC (Japan). We are involved in the DZERO experiment at Fermilab's Tevatron proton-antiproton collider which, until recently, was the most powerful particle accelerator in the world. The DZERO collaboration recently achieved public fame when they uncovered significant matter-antimatter asymmetry in muon-antimuon production. Dr Guennadi Borrisov, a particle physicist in our department and co-leader of the DZERO experiment, was quoted in May 2010 in The New York Times saying 'This result may provide an important input for explaining the matter dominance in our universe'. This exciting result portends the exciting new physics awaiting discovery using the most powerful accelerator ever constructed : the Large Hadron Collider (LHC) at CERN; we are also members of the ATLAS team studying very energetic proton-proton collisions at the LHC. Furthermore, the Lancaster team assembled a calorimeter for use in the upcoming T2K experiment (near Tokyo, Japan) which will study the nature of the elusive neutrino. In part, the T2K experiment, like the DZERO experiment, aims to provide a better understanding of the fundamental reasons behind why matter predominates over antimatter in our universe.

It is hoped that these experiments will shed new light on the origin of mass and new symmetries in nature.

Testing our 'Baby Prototype' of a layer of a neutrino detector.

Accelerator Physics

Particle accelerators are not just used for pushing the boundaries of elementary Particle Physics; their lower energy cousins have numerous applications in medicine and material science. New acceleration concepts are currently under development at Lancaster; experimentalists design, build and test novel structures for future accelerators while mathematical physicists develop new tools for analysing the complex behaviour of large collections of accelerating charged particles. We aim to develop powerful compact accelerators by exploiting inhomogeneous/dispersive media, photonic crystals and metamaterials. Furthermore, our theorists are interested in astrophysical scenarios in which electromagnetic field intensities and particle accelerations are so large that new effective descriptions of accelerating charged matter deserve attention. The scope of our theoretical research includes cavity QED, magneto-electric media, plasmas and non-linear electrodynamics and we use mathematical tools more commonly reserved for general relativity and string theory. In addition, experimental work is being undertaken on the design, simulation and prototyping of positron sources that can produce intense polarised positron beams for a range of applications including planned high-energy particle colliders such as the International Linear Collider (ILC), Compact Linear Collider (CLIC) and Large Hadron Electron Collider (LHeC). We are founder members of the Cockcroft Institute (see http://www.cockcroft.ac.uk), a centre of excellence for accelerator science in the UK.

Near the pond on the Lancaster University campus. A perfect spot to relax!

This department is one of the most fun and rewarding to be included in, due largely to the remarkable amount of support offered and the facilities made available. The broad variety of courses and modules on offer allowed for me to choose my ideal degree, covering a wide range of theoretical physics and maths topics.

Moreover, on completion of my degree I have found that a wide range of careers are open to me; next year I am starting a teaching career where I hope to eventually focus on teaching A-level maths, helping to provide others with the opportunity of a university experience as fulfilling as mine has been.

Erica Richards graduated MSci Theoretical Physics with Mathematics in 2011.

Student finance

Lancaster University has set tuition fees at £9,000 per year for full-time UK undergraduate students commencing study in 2012, and has set up a £1.8 million bursary and scholarship fund to support new undergraduates. Please note that university access for UK students is free at the point of entry; the fees are not paid up-front.

Tuition Fee Loan (UK/EU nationals)

UK undergraduate students do not have to pay any tuition fees up-front while they are studying. Instead they are able to defer payment of their tuition fees by taking out a non-means tested Tuition Fee Loan to cover the fee charged. The amount borrowed is paid directly to the University by their local Student Finance company (e.g. Student Finance England). If a student chooses to borrow less than the full tuition fee amount charged they are responsible to the University for paying the difference between the amount borrowed and the tuition fee charged. If you are an EU student from outside the UK then you may also be eligible for a Tuition Fee Loan (see http://studentfinance-yourfuture.direct.gov.uk/ for further details).

Living expenses

We estimate annual living costs for a single undergraduate student to be £6,500 - £9000 per annum. For details see: **www.lancs.ac.uk/sbs/funding/costsandbudgeting.htm**

Assistance with living expenses – Living Cost Loans and Grants (UK/EU nationals)

Living cost loan:
UK undergraduate students are usually entitled to a living cost loan. The level of loan depends on annual financial assessment. If you have to study abroad as part of your course the student loan for the year spent abroad may be higher. If you are an EU student from outside the UK then you may also be eligible for help with living costs (see http://studentfinance-yourfuture.direct.gov.uk/ for further details).

Living cost grant:
A grant (non-repayable) of up to £3,250 will be payable to students where household residual income is below £25,000. The grant will be reduced on a sliding scale until income reaches approximately £42,600 where no grant will be payable.

Other grants:
There are a range of other grants for students with child or adult dependants.

Making an application and further information:
For information on the application process for UK Government Funding and details of University support see: **www.lancs.ac.uk/sbs/funding**

Government information including a guide to student finance is available at:

http://studentfinance-yourfuture.direct.gov.uk/

Lancaster University financial support

Lancaster University Bursary package:

If you are a student from England and your assessed household income is less than £25,000 per year then you will be awarded a £1,000 bursary for each year of study, a £1,000 on-campus accommodation discount in the 1st year of study and a £1,000 tuition fee waiver in the 1st year of study. This equates to £5,000 in total for those on a 3 year course and £6,000 in total for those on a 4 year course.

Bursaries will be paid directly into your bank account. You do not need to apply, they will be automatically triggered each year by the information received by the University from your assessment authority.

Lancaster Physics Department scholarships (open to Overseas and UK/EU students):

The Department of Physics is rewarding excellence by providing scholarships of £1,000 in year 1 to those students who choose a Lancaster University Physics course as their firm choice and achieve exceptional grades in A-level mathematics and physics. We have not yet set the threshold for this award, but it is expected to be A*A – A*A*.

Lancaster University academic scholarships:

All students who achieve A*AA in their A-level examinations (or equivalent academic qualifications) will be eligible to receive an annual scholarship of £1,000 for every year of their undergraduate studies.
The above awards are cumulative; our very best students may obtain a Lancaster University academic scholarship, a Physics Department scholarship, and a Lancaster University Bursary package totalling £9,000 - £11,000 during their studies.

Eliahou Dangoor Scholarship Scheme:

The Eliahou Dangoor Scholarship Scheme was created to give talented British students the opportunity to study science, and related subjects, at leading edge research universities. Each scholarship is worth £1,000. Please see **www.lancs.ac.uk/admissions/undergrad.htm** for information about eligibility and application details.

Interested? - What next?

Entry requirements

These are given with the course information.

How to apply

You must apply through the University and Colleges Admissions Service (UCAS). Details are given in their Handbook, available in schools and colleges or from UCAS, Rosehill, New Barn Lane, Cheltenham, Glos GL52 3LZ or see their web page **www.ucas.ac.uk.**

Visit our campus

We believe our campus is one of our strengths and encourage you to visit us before you make your final choice of where to study.

If you decide to apply we may invite you to spend an afternoon with us during one of our many interview days. These include talks and guided tours of the campus and the department. Parents/guardians are welcome.

You can also come and visit us on one of the University Visit days or campus tours (booking is required). See **http://www.lancs.ac.uk/undergraduate/uk/visit.htm.**

Further information

If you would like to know more about any of our courses or about entry, please contact:

Dr David A Burton
Admissions Tutor
Physics Department
Lancaster University
Lancaster LA1 4YB

Tel: 01524 594786

E-mail: **physics-ugadmissions@lancaster.ac.uk**

You may like to visit our web pages at:
www.physics.lancs.ac.uk

Here you will find more details about our teaching, news about the department and much more information on our research activities and the Lancashire and Cumbria Branch of the Institute of Physics. You can also find out more about the University in general.

The 2012 Lancaster University prospectus is available as a downloadable PDF and as a hard copy. See **www.lancs.ac.uk/admissions/undergrad.htm** for further details.

Email: **ugadmissions@lancaster.ac.uk**

We are easy to find!

...by road
From the north or south: leave the M6 motorway at junction 33 and take the A6 north towards Lancaster and continue for 1¾ miles (passing through the village of Galgate). Turn right at the third set of traffic lights into the University main drive. Take the first exit left from the roundabout at the top of the main drive, then the first avenue on your right. This brings you to the Reception Lodge where security staff will direct you to a Pay and Display car park and the Physics Department.

...by rail
There are direct rail links between Lancaster and London (Euston), Birmingham, Leeds, Manchester, Glasgow and Edinburgh. The single journey between London and Lancaster takes between 2.5 and 3 hours.

The X1 bus stops outside the train station and runs to the University every 20 minutes on weekdays and taxis are also usually available from just outside the station. Bus stops for other services to the University are a 5-10 minute walk from the train station, and are located at the Bus Station and by Lancaster market on Common Garden Street.

... by coach and bus
Lancaster city is on the national coach network; National Express coaches call at the University. Local buses (numbers X1, 2, 2A, 3 and 4) from Lancaster bus station run to the University every 5 minutes on weekdays.

Further details can be found on:
www.lancs.ac.uk/travel/travel.htm

Keswick
Windermere
Kendal
Morecambe
Lancaster
Lancaster University
Jct. 33
Fleetwood
M55
Blackpool
Preston
M6
M6
RAIL
RAIL