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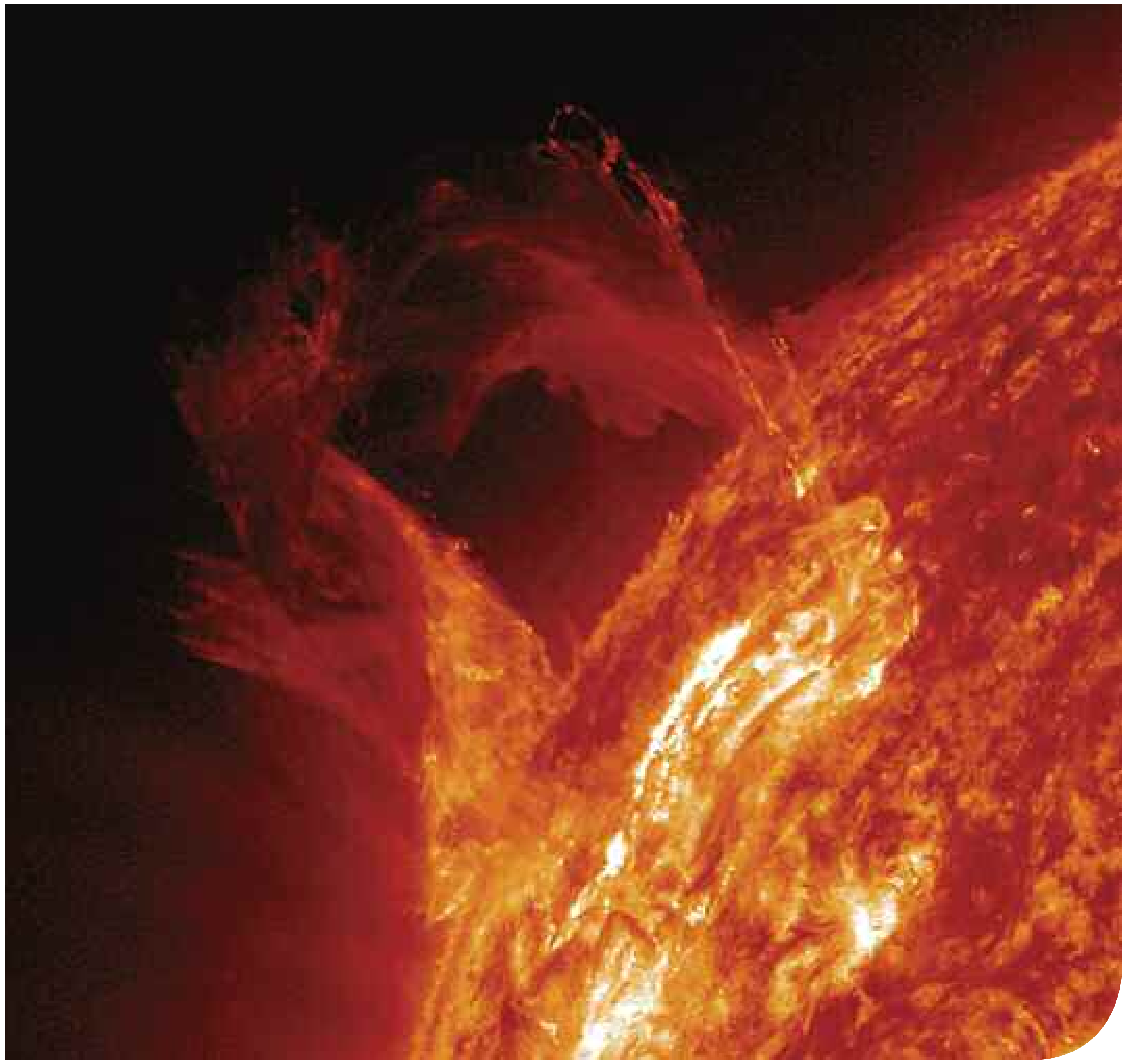
Cover image: A solar prominence eruption observed in extreme ultraviolet light by NASA's Solar Dynamics Observatory. The light recorded in this image is emitted by singly ionised Helium confined by the Sun's magnetic field and corresponds to a temperature of approximately 50,000 degrees Celsius. Credit: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

Physics | LANCASTER UNIVERSITY

Physics at Lancaster

Undergraduate 2014



www.lancaster.ac.uk/physics

Contents

Lancaster University's Department of Physics strives to play a significant positive role in which our students have many opportunities to be involved

Welcome to Lancaster

I'm proud to be head of one of the top physics departments in the UK, recognised in successive league tables and surveys both for the high quality of its teaching and the originality and excellence of its research.

Obtaining a degree in physics is a rewarding goal. By requiring us to put aside preconceptions and analyse the world from a scientific viewpoint, physics furthers our understanding and can bring immense intellectual satisfaction. It is important to the department that we provide a rigorous but engaging degree that allows our students to experience both the fascination and the challenges ahead.

Whether carrying out research with colleagues at international facilities such as CERN or providing outreach events for the local community, Lancaster University's Department of Physics strives to play a significant positive role in which our students have many opportunities to be involved. Through project work, extra-curricular activities and an open-door policy, we offer a unique and inclusive study experience within a degree programme that is constantly evolving in response to developments at the frontiers of the discipline, as well as student feedback, innovations from staff and new ideas in physics education.

I hope you will find something in this prospectus to interest you.

Professor Peter Ratoff
Head of Department

Lancaster University Physics students can pride themselves on a sense of community that is rarely matched elsewhere.

When I first arrived at Lancaster University, I was very impressed with how welcoming and helpful everyone was, especially in a totally new environment where I didn't know anyone. Lancaster University Physics and Astronomy Society (LUPAS), which is run by students, works hard to involve everyone in the student community, and to help create a good working relationship between students and lecturers. A social will be run in Freshers' Week which brings both new and old physics students together and is a great opportunity to make new friends. Additionally, we run regular socials and academic talks throughout the year. Everyone soon finds themselves surrounded by new friends, which is important in making your time at Lancaster University the best experience possible.

We look forward to welcoming you in 2014!

Matt Roscoe
LUPAS President

Studying Physics at Lancaster

Our degree programmes are recognised for providing an outstanding physics education underpinned by internationally leading research.

The quality of our teaching is reflected by high positions in all league tables and top scores in successive National Student Surveys, while our research is ranked top in the UK in the most recent government-commissioned Research Assessment Exercise (RAE2008). As a friendly, medium-sized department we take great care to provide an enjoyable, inspiring and supportive learning environment that benefits all our students.

AN OUTSTANDING EDUCATION

All of our degree programmes provide a comprehensive state-of-the-art physics education at the frontiers of the discipline. We constantly update our syllabus in response to recent scientific developments, skills required by employers, and feedback from our students.

Besides the strong research component this includes career advice and training in essential transferrable skills embedded in our programmes, the introduction of industrial projects in 2013 (see page 8), and the provision of summer internships. We also employ a Teaching Fellow, who helps us to keep up to date with the needs of our incoming students and new ideas in physics education.

Throughout your course, you receive lectures in modern theatres and have access to well-equipped teaching laboratories, an astronomical observatory and extensive computing facilities, all of which play an important role in learning. We regularly review our teaching resources, and in 2013 we invested a further £70K into our undergraduate labs. Furthermore, we are centrally located on the campus, with all facilities, including living accommodation and the University Library, within easy reach.

Our programmes are fully accredited by the IOP and are recurrently validated through external teaching audits. Our graduates have excellent employment prospects and regularly win competitive awards (see pages 22-24). We value these achievements, and offer financial bursaries and scholarships that recognise the academic talents of our students (see page 36).

The reputation of our courses is reflected in consistently high league table positions. Presently, we are ranked joint second in the Guardian University Guide and seventh in the Complete University Guide.

Furthermore, our students are extremely satisfied with their course - we receive excellent scores in the National Student Survey. This includes a consistently high score for overall satisfaction with the quality of the course (an average of 96% over the past 5 years).

AIMEE HOPPER
Graduated MPhys (Hons) in 2013

During my degree I had the privilege of being taught by many world class researchers, as well as learning a huge amount about the universe around us. From 2nd year, I was able to decide my own degree path by choosing modules I believed most suited me, making my very own custom-made Masters Degree. This made it possible for me to focus on areas of physics that I found particularly interesting, and encouraged me to continue my academic career to PhD. As a department, I couldn't have asked for a better environment! The staff and students were always very helpful, and always willing to give you a minute (or 10!) of their time! In my opinion, my time as part of the Physics Department was challenging, thought-provoking, and definitely the best years of my life!

WORLD-LEADING RESEARCH

The teaching on our courses combines fundamental concepts with cutting-edge topics and is directly informed by our world-leading experimental and theoretical research ranging from pure to applied topics (an overview of our present research activities is given on pages 26-31).

In the latest Research Assessment Exercise (RAE2008), we were ranked as the top physics department in the country, with 70% of our research rated at the world-leading (4*) or internationally excellent (3*) level. We are a very dynamic department, and since then have further widened our research activities by incorporating one of the leading space-science groups, and strengthened many sections by attracting new staff. The department continues to receive substantial support of funding agencies and industry, as well as direct investment by the University. This includes the creation of the unique Lancaster Quantum Technology Centre with brand-new clean room facilities, in which we now manufacture and characterise qubits and other quantum nanodevices.

Our courses are designed to link strongly to our research - we find that this not only provides the correct context of a contemporary physics education, but also engages and inspires our students and contributes to excellent student-staff relations. This means that our students benefit from

- a wide choice of advanced options and extensive research projects, taught and supervised by leading experts in their field,
- experimental labs culminating in the handling of highly-specialised equipment,
- access to world-leading facilities, including our unique low-temperature and quantum technology centres,
- the department's major involvement in particle physics collaborations at CERN, Fermilab, and T2K in Japan, space science experiments inside the Arctic and Antarctic circles, access to data from ESA and NASA satellite missions, and the EU flagship on graphene.

Our excellent links and reputation also further the employment prospects of our graduates.

A HIGHLY SUPPORTIVE LEARNING ENVIRONMENT

Our philosophy

While we enjoy the merits of high league table positions and excellent research assessments, we draw most of our satisfaction by witnessing the enthusiasm, engagement and achievements of our students.

The Department of Physics is a friendly, medium-sized department with about 40 permanent teaching staff and 350 students. We welcome around 100 new students each year across the range of physics courses.

As one of our students, 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.

Our department is committed to fostering a diverse, supportive community as a source of academic excellence, cultural enrichment, and social strength. We welcome applications from those who would further our aim to create a positive atmosphere in which all students and staff are able to pursue the development of their understanding of physics and the world around us.

Contact time

Our students benefit from a favourable staff-to-student ratio (1:10), which enables us to offer an open-door policy, small-group tutorials, and individually supervised projects. Per year, you have about 375 contact hours with staff. We also provide material for homework and revision, with a guideline number of 825 hours of self-study, for which you can always rely on our staff for guidance and assistance.

Supporting your study

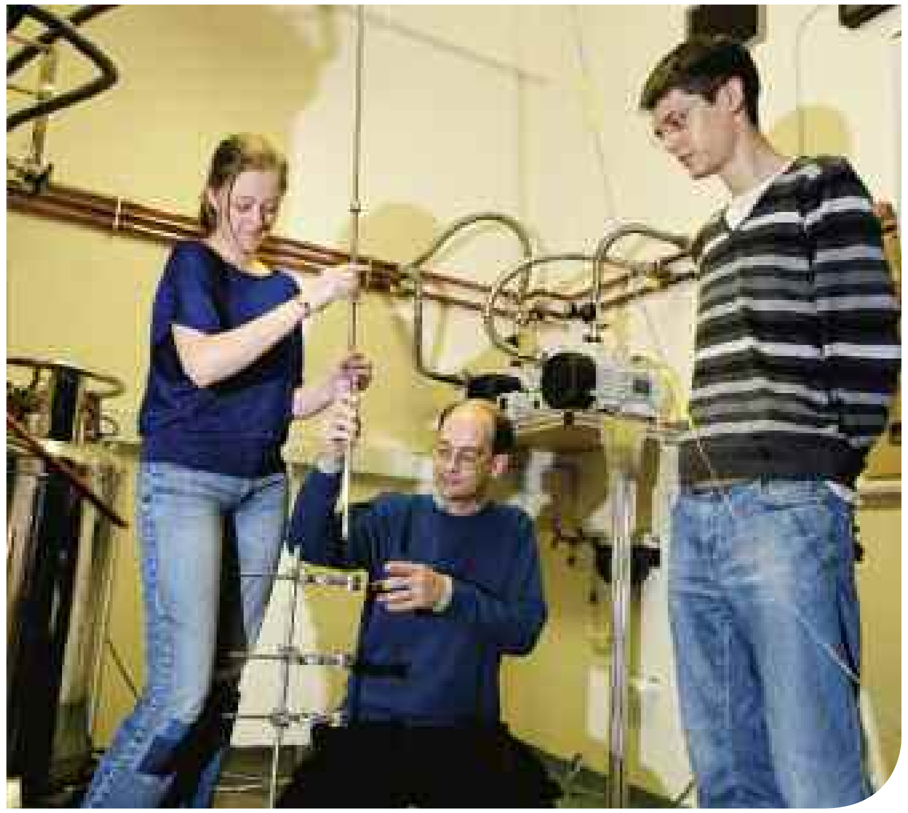
In addition to contact with physics lecturers through seminars and weekly office hours, you will have a departmental academic advisor responsible for your academic well-being. You will also be assigned a college tutor responsible for providing advice and assisting with any personal difficulties you may 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 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 coursework. 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 year groups, to discuss academic issues. We also ask you to complete questionnaires about each lecture unit as well as an end-of-year questionnaire.



RAPHAEL OYELADE
Graduated MPhys (Hons) in 2013

Four years in a degree does seem like a long time but they have undoubtedly been the most interesting, diverse and eventful four years I can recall. I began not knowing if I would be cut-out for the world of physics but with every lecture, tutorial and seminar, I have been rewarded with the challenges and the encouragement of a fantastic physics department and astoundingly knowledgeable lecturers. I have understood concepts I'd never imagined and have built up an arsenal of tools to take me forward, not only in the fields of maths and physics but indeed, to anywhere I choose to go from here.

A guide to our teaching methods

Lectures and seminars

The university year is divided into 3 terms of 10 weeks. In a typical week you will have 12 lectures, each lasting 50 minutes, in classes of varying size.

Weekly assignments set by the lecturer, perhaps from textbooks or past examination papers, will be chosen to reinforce the ideas introduced during 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 our 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

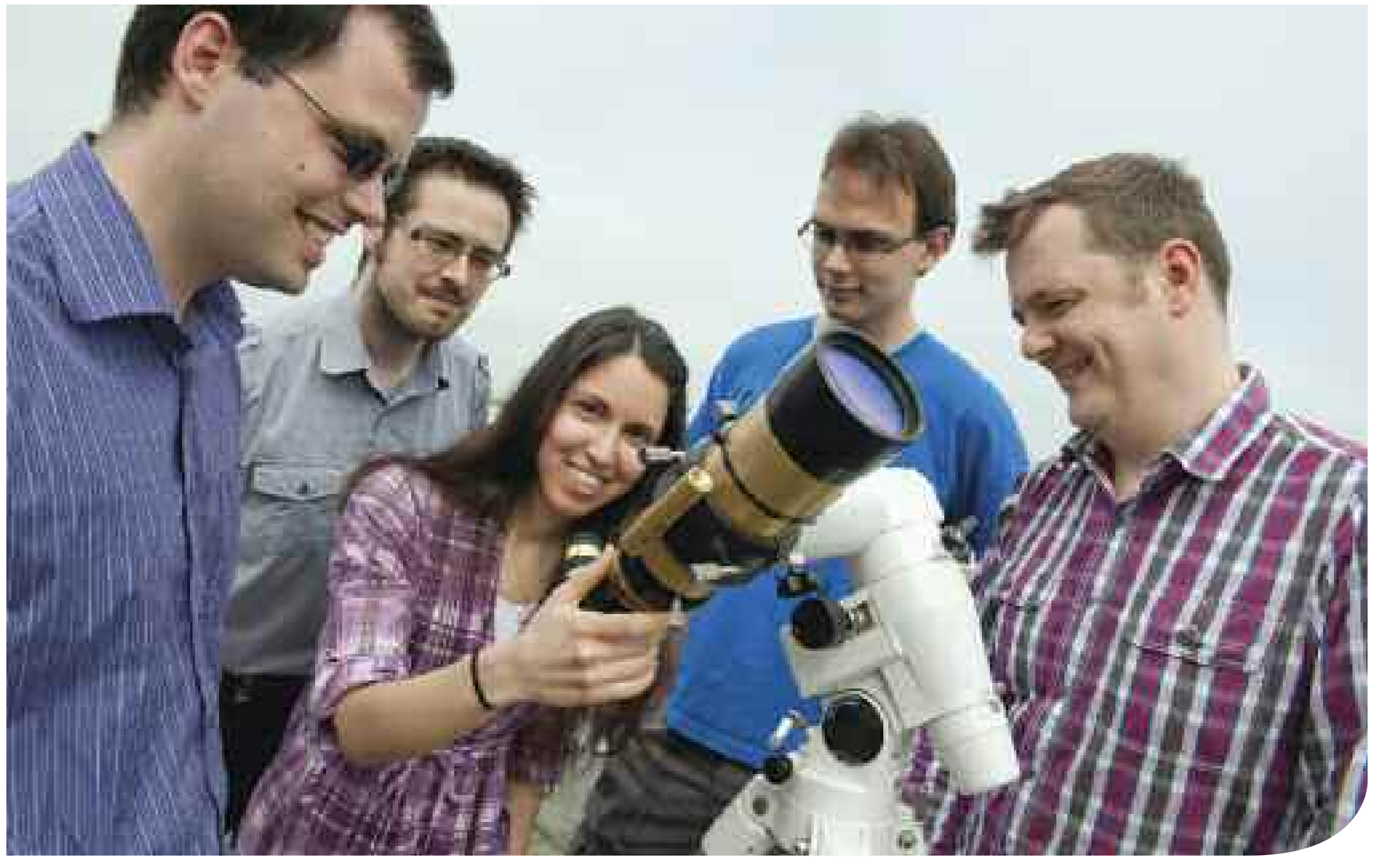
Physics is an empirical science and laboratory work is an important element of the course. You will spend approximately 6 hours per week in the laboratory, working in pairs and interacting closely with staff and other students. Demonstrators will be on hand to guide you and discuss your work. You will 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.

Projects

A major goal of university-level degree programmes is to develop your skills and understanding to the level where you can address the exciting open problems that abound in contemporary physics. Throughout your course, you build up the necessary skills by a succession of projects, commencing with a small computer project in year two and progressing to open-ended research projects of increasing complexity in the following years. You have a wide choice of projects of a pure or applied, experimental or theoretical nature. The topics are closely connected to our research interests, allowing us to provide expert guidance and supervision, and often afford students opportunities to make an active contribution to actual research. These projects are further described on page 8, and current topics are listed throughout the description of the various degree schemes.

Computer programming and other transferrable skills

Physics makes extensive use of computation in both experimental and theoretical work. All students are taught modern programming techniques, and computational methods feature in a number of the advanced research projects. Throughout your project work, we also familiarise you with report writing and presentation skills, which culminate in talks at our mini-conferences.



CALLUM KILBY
Fourth Year MPhys Physics with Particle Physics and Cosmology

What makes Lancaster a really excellent physics department for Undergraduates is the helpfulness and teaching ability of the lecturers and staff. A good lecturer can make the difference between an incomprehensible wall of equations, and a clearly and patiently explained topic, even for the hardest subjects. The lecturers at Lancaster definitely make this difference. Quantum mechanics in second year ended up being a favourite module, the lecturer was so good! More than this, they are always patient and understanding if you don't get something, no matter how basic, and are always willing to take time out of their day to talk to you one on one if it would help.

GARETH DAVIES
graduated MPhys Physics in 2011. Gareth is undertaking a PhD in gravitational waves at the Institute of Gravitational Research, University of Glasgow.

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.

Lecturers are active in their research and have a real passion for what they teach.

Impressions from our labs and lectures.

Projects

In the 3rd year, Physics students have the choice of taking the Practical Research Skills module or doing an Industrial Group Project.

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

Practical Research Skills includes a series of short experiments in the Semiconductor Physics and Low Temperature Physics Laboratories, and a more extended investigation in a Particle Physics Group Project. Practical Research Skills gives students hands-on experience of the topics that drive much of the experimental research in the Physics Department.

Alternatively, students can choose to do an extended industrially-oriented project, occupying 15 weeks in the lab. A team of 4 to 6 students work together on a 'real life' problem in collaboration with a company or other external organisation. Students are expected to research, plan and execute their project themselves, including obtaining or building any apparatus. Recent examples include developing an automated, reproducible method for assessing the efficacy of surface cleaning products, reducing false alarms generated by commercial smoke detectors and investigating the properties of advanced materials incorporating nano-graphene. External partners for Industrial Group Projects range from multi-nationals with turnover of ~£50bn to small, locally-based companies.

Practical Research Skills and Industrial Group Projects involve open-ended investigation, and help to develop a range of transferrable skills such as team working, time and project management and communication skills, all of which are highly valued by employers. Report-writing is a key form of assessment for projects, and all 3rd and 4th year students present their project work at our annual mini-conference at the end of the summer term.

Team Tyco assembles their optical fire detector.

MATT ROSCOE
graduated BSc Physics in 2013

Team Tyco was set the task of investigating possible methods of accurate smoke detection using optical methods for non-domestic settings such as schools, hospitals and hotels. Essentially, we looked at the way light scatters from smoke and false alarms (such as steam) to distinguish between them. The project was very open ended and as a group we had to research, plan and budget everything ourselves. The fact that there is no set lab script for the module was daunting at first, but in hindsight it is a very good way of finding out first hand what it's like to solve a real world problem in an industrial setting.

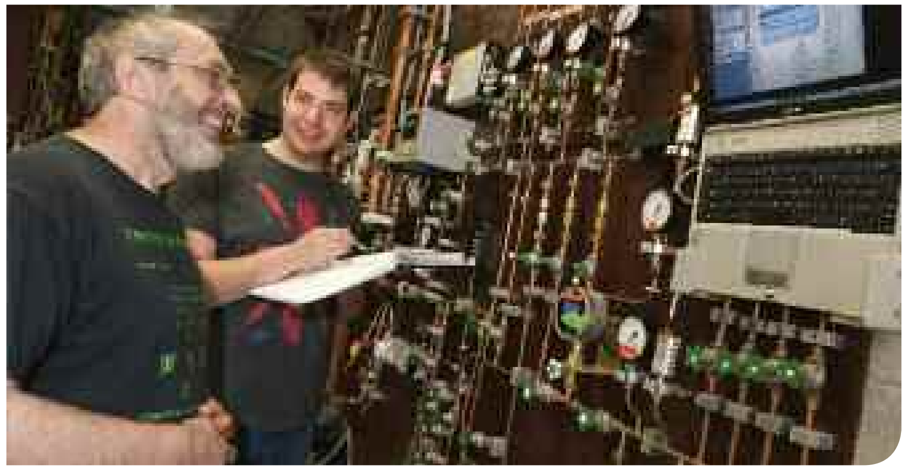
STEPHEN PENNEY, EUR ING
Principal Engineer, Tyco Fire Protection Products

Whilst we were hopeful that the students would find something to challenge them in this project, we were pleasantly surprised at the calibre of the work. They showed initiative in both structuring their work efficiently, and selecting aspects of the study to ensure that their work complemented our own, resulting in some useful research.

WAYNE DILLON
Third Year MPhys Physics

The industrial project was a brilliant opportunity to experience how research is undertaken in a company, which was very different to any of the lab work we had done before. We were given a great deal of freedom in deciding how to approach the problem and in conducting the research, which gave us an immense sense of achievement when things started to come together.

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



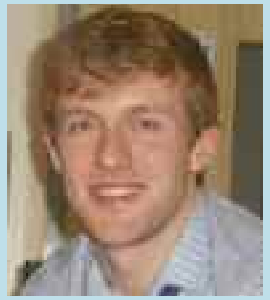
Receiving instructions in the ultra low temperature lab.

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 in the descriptions of the degree schemes. 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.

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.



NICHOLAS KAY
graduated MPhys Physics in 2012 and is currently undertaking a PhD in Nanoscience at Lancaster. Based on his MPhys project on "The behaviour of graphene nanotrampolines", he won the 2012 Best Physics Student of the Year SET (Science, Engineering and Technology) Award

I studied for an MPhys at Lancaster and enjoyed every minute of it. First of all there was an extensive selection of modules on offer which really allows you to pick topics that genuinely interest you. These modules were taught by world experts in the field and were portrayed with real enthusiasm. My favourite part of the MPhys scheme involved a year-long project; this allows students to work within one of the research groups and study currently unsolved physics problems. The topic of my project was in investigating a series of recently discovered materials. The support given to me as well as the enthusiasm shown by my supervisors helped me to win an award for the best Physics student within the UK that year. The staff at Lancaster are very friendly and they operate an open door policy which makes it easy to approach lecturers about any problems you may have.

NATHAN DAVIES
graduated MPhys Physics with Theoretical Physics and stayed on to complete his PhD in the Lancaster Condensed Matter Theory Group in 2013. He is shown here being brought up to speed with quantum electronic transport.

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.

Choosing your degree

We offer a choice of physics degrees at the master's (MPhys, MSci) or bachelor's (BSc) degree level. The BSc degrees take 3 years to complete whereas the MPhys and MSci degrees comprise 4 years of study.

The content of the first 3 years of our master's degrees is identical to the corresponding bachelor's 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 extended research project.

MPhys and MSci degrees are ideal if you are planning a career as a professional physicist, and are the recommended route into higher research degrees (MSc or PhD). However, a good result from a BSc course can also allow you to continue your studies at the postgraduate level, or to enter a teacher-training programme. Furthermore, all of our degrees seek to provide you with general and specialist skills valued by employers in both the private and public sectors. (More details on graduate destinations can be found on page 22).

In addition to our physics degree we offer a range of degree specialisations. These courses share common physics content in the first year, where our students undertake lectures in core physics, experimental labs, and mathematics courses that equip them with tools for tackling problems in physics. After the first year you will continue to attend core physics lectures with all of your fellow physics students, but this will then be supplemented by advanced lecture courses that are specific to your degree schemes. Typically 25%-30% of your second year courses will be related to your choice of speciality. In the third and fourth year you have further choices of advanced courses and projects that let you tailor the degree to your interests. This includes a wide range of options which you can use to explore other specialisations in physics. An overview of the degree scheme structure is given on page 11. The common core syllabus is described on page 12, and the details for each scheme are described on pages 13-16.

We also offer an MSci in Theoretical Physics with Mathematics, which is a good option for students with a keen interest in the mathematical aspects of physics. Here you also attend lectures in pure mathematics given in the Department of Mathematics and Statistics, beginning already in year one (see page 17 for further details).

Finally, we run one of the best developed North American exchange programmes. This can be combined with any of the four-year degrees (MPhys and MSci) and allows students to spend their third year studying in the USA or Canada (see pages 18-19).

Transferring between courses

You have the flexibility to transfer between all MPhys and BSc courses at any time up until the end of the first term of the second year.

It is also possible to change from a 3 year to a 4 year degree course, if marks are sufficiently high. A change from a 4 to a 3 year course is possible provided that this takes place well before the end of your third year.

Courses and entry requirements

CODE	DEGREE	SCHEME	INDICATIVE A-LEVEL
MPHYS AND MSCI COURSES (4 YEARS)			
F303	MPhys (Hons)	Physics	A*AA
F3F5	MPhys (Hons)	Physics, Astrophysics and Cosmology	
F373	MPhys (Hons)	Physics with Particle Physics and Cosmology	
F321	MPhys (Hons)	Theoretical Physics	
F305	MPhys (Hons)	Physics (North America) Year 3 spent in the USA or Canada	A*AA
F3G1	MSci (Hons)	Theoretical Physics with Mathematics	A*AA
F3G5	MSci (Hons)	Theoretical Physics with Mathematics (North America) Year 3 spent in the USA or Canada	
BSC COURSES (3 YEARS)			
F300	BSc (Hons)	Physics	AAA
F3FM	BSc (Hons)	Physics, Astrophysics and Cosmology	
F372	BSc (Hons)	Physics with Particle Physics and Cosmology	
F340	BSc (Hons)	Theoretical Physics	
F3GC	BSc (Hons)	Theoretical Physics with Mathematics	AAA

All degrees require physics and mathematics at A-level or equivalent. Please note that all applications are considered on an individual basis. Applicants may be invited for interview.

International Baccalaureate: 38pts (=A*AA) or 36pts (=AAA) overall with 17pts from three HL subjects including physics and mathematics with typically 6pts or 7pts in each.

Alternative Qualifications: We welcome enquiries from applicants with alternative qualifications and strongly recommend our OpenPlus degree operated in partnership with the Open University as a flexible route to joining us (see page 20).

International students: Please note that the requirements presented here are aimed mainly at UK students. We do accept a range of overseas qualifications. The Lancaster experience of international students is described on page 21.

For further information, please refer to our web-site or contact the Admissions Tutor (see page 38).

Degree scheme structure

	YEAR 1	YEAR 2	YEAR 3		YEAR 4	
COMMON CORE	**Physics Core I** Mechanics Electric & Magnetic Fields Thermodynamics Quantum Physics Laboratory **Maths Core** Vectors Calculus Series Methods Complex Methods Vector Calculus	**Physics Core II** Quantum Mechanics Electromagnetism Waves and 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 Particle Physics Statistical Physics Solid State Physics Project Skills	GRADUATE BSC OR CONTINUE TO MPHYS	**Physics Core IV** Extended Project	GRADUATE MPHYS
SCHEME-SPECIFIC COURSES	**Physics**	Laboratory	Research Skills: Advanced Laboratories Particle Physics Project OR: Industrial Project 3 Optional Courses		6 Optional Courses	
	Astrophysics & Cosmology	Astronomy Introductory Astrophysics Introductory Cosmology	Stellar Astrophysics Big Bang Cosmology Research Skills: Astrophysics Lab Cosmology Project 2 Optional Courses		Advanced Relativity and Gravitation Current Cosmology 4 Optional Courses	
	Particle Physics & Cosmology	Astronomy Particle Physics Lab Introductory Cosmology	Flavour Physics Big Bang Cosmology Groups and Symmetries Particle Physics Lab Cosmology Project 1 Optional Courses		Advanced Relativity and Gravitation Current Cosmology Further Particle Physics Gauge Theory 2 Optional Courses	
	Theoretical Physics	Analytical Mechanics Field Theory Introductory Cosmology	Research Skills: Complex Analysis Advanced Quantum Methods Theory Project 3 Optional Courses		Advanced Magnetism & Quantum Nanophysics Quantum Transport 4 Optional Courses	

Optional courses in Year 3&4 include courses from other degree schemes and additional advanced topics, e.g. Astronomy, Cosmology I&II, Space Physics, Groups & Symmetries, Flavour Physics, Gauge Theories, Experimental Particle Physics, Quantum Information, Quantum Transport, Advanced Relativity & Gravitation, Advanced Electromagnetism, Advanced Magnetism, Matter at Low Temperatures, Fluids, Lasers, Semiconductors, Global Warming, Energy, Computer Modelling

The physics syllabus

Our MPhys and BSc degree schemes combine a common core, which covers essential topics of fundamental and modern physics, with advanced subjects at the forefront of their discipline.

First year

In your first year, the physics element of your studies will consolidate your pre-university knowledge, 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, optics 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. You will measure a range of fundamental constants, often based on quantum effects. 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 problems can be solved by the application of mathematical methods. You will be introduced to new mathematical techniques during lectures, and you will develop your skills by tackling exercises in weekly workshops.

Second year

The courses in the second year introduce you to the fundamental theories on which most of modern physics is built: electromagnetism, thermodynamics, quantum mechanics, and special relativity. You will also learn about the properties of elementary particles.

The computing module not only aims to develop your programming techniques, but is also the setting of your first project, in which you take your first steps in planning, execution, and reporting of your own independent work.

In this year, the content of the optional element is fixed by the degree scheme.

Third and Fourth year

In year three, you learn more about the main areas of modern physics in which these fundamental theories are applied—atomic physics, particle physics, statistical physics, and condensed-matter (solid state) physics.

In each scheme, you will learn about specialised applications, in the form of advanced lectures and labs with specialist equipment, such as cryostats, particle detectors, and our telescopes.

You also have a choice of options from a range of topics reflecting the most recent areas of interest in modern-day physics. Studying topics 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.

JESS WERRELL
Third Year MPhys Physics, Astrophysics and Cosmology

My first two years at Lancaster have been very enjoyable. I like the way the Physics course is structured, covering a broad range during the common first year before choosing options for the remaining years.

A major element of this year is the open-ended project, in which you tackle a research problem of your specialisation under the dedicated guidance of an experienced academic.

If you carry on into year four you have the chance to further deepen your knowledge in advanced lectures, and to contribute actively to the research of our leading groups. This is a highly rewarding experience, which is thoroughly enjoyed by our students. For details on these projects see page 8.

Physics

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

Our Physics degree provides a broad conceptual and working knowledge of physics along with key transferrable skills which will enable you to embark on a wide variety of career paths.

The basic structure is outlined on page 11. In addition to the core curricula, students are taught the key skills required to perform state-of-the-art experiments. Skills include measurement techniques, project planning, report writing and presentation delivery. Students will use and become familiar with a wide range of sophisticated equipment and associated software. Laboratory work will complement the core physics modules, giving greater insights into how modern physics is performed.

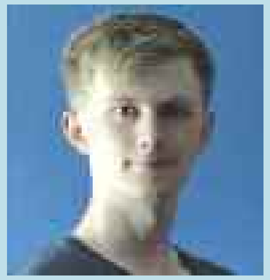
Experiments will recreate some of the key discoveries in physics, such as the quantisation of light, the existence of nuclei and electrons, the quantum nature of particles and wave-particle duality. Students will be able to co-ordinate their own investigations using:

- 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
- X-ray crystallography to investigate atomic structure.

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:

- Self-assembled quantum dots
- Scanning force microscopy
- Nanomechanical resonators
- Thermophotovoltaic cells
- Ultra-miniaturised sensors
- Nano-scale imaging microscopy
- Quantum turbulence
- Superfluid helium-4 in aerogel
- Nonlinear dynamics in biological ion channels
- Microelasticity of biological and biomimetic materials
- Wind electricity generation
- Solar wind: origin and evolution
- Creation of artificial aurora
- Pressure-induced electrical signals in granite
- Ultrasonic measurements
- Infrared avalanche photodiodes
- Light analogues of matter waves

Students can also choose from a multitude of options related to the research specialisations in the other degree schemes.



JAMES HOWARTH
Second Year MPhys Physics

I was first drawn to Lancaster due to its impressive research standards and the fascinating areas in which that research was being done. Whilst studying at Lancaster you are taught by a variety of lecturers, all of whom are experts in their field and leading researchers in various areas of physics. This is really demonstrated by the outstanding quality of teaching and the enthusiasm with which they teach the course. In addition the department operates an office hour policy ensuring every week at least one hour is set aside for students to ask any questions they may have. You also conduct a wide variety of experiments from various areas of physics, allowing you to get a first-hand experience of all the things you've covered in lectures. Though lab sessions are hard work, the benefits to your understanding and the fascinating topics of experimentation easily make up for this.

Astrophysics and Cosmology

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

Our degrees in Physics, Astrophysics and Cosmology develop your understanding of the relationship between the physical laws of the Universe and the astrophysical and cosmological domains.

A Star Party in our observatory.

Star V838 Monocerotis. Credits: NASA, ESA and H.E. Bond (STScI).

In addition to a thorough grounding in Quantum Physics and Electromagnetism in your first year, this degree scheme includes lectures on Astronomy, Introductory Astrophysics and Introductory Cosmology in your second year.

Our teaching of astrophysics and cosmology at Lancaster is 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.

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)

Some of the recent and current project topics are:

- Variable stars
- Stellar spectra
- Lunar topography
- Radio fluctuations of the sun
- Exo-planet transits
- The impact of solar flares on cosmic radio noise
- Relic particles in the Universe (dark matter)
- A model of inflationary cosmology
- Origin of large-scale structure of the Universe

SARAH SMEDLEY
graduated MPhys Physics, Astrophysics and Cosmology in 2011. Sarah is currently carrying out a PhD in astrophysics at the University of Cambridge

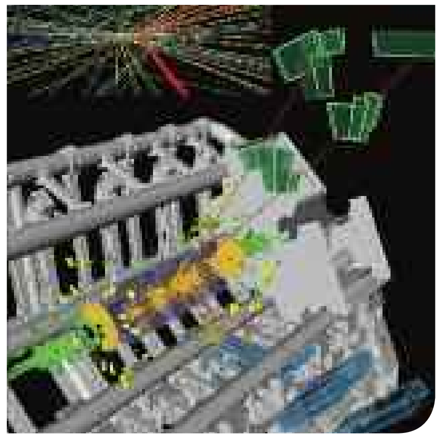
I completed many interesting modules during my degree. I enjoyed my MPhys project the most because I was able to use the departmental telescope to take new data and attempt to interpret what I found. My fourth year was challenging, but it was also incredibly rewarding. The range of modules offered by 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.

Particle Physics and Cosmology

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

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?

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



Candidate for a Higgs-boson decaying to 4 leptons, discovered at CERN with direct involvement of the Lancaster Particle Physics Group.

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?

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 its recent shut-down, at Fermilab's Tevatron) to investigate and identify the nature of space and time via new particles such as the Higgs, 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 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.

BELLA BOULDERSTONE
Third Year MPhys Physics with Particle Physics and Cosmology

I decided to study particle physics and cosmology because I find the differences between the quantum world and the Newtonian world fascinating – especially how all of that corresponds to the birth of the Universe and how we got here today. I am very glad that I came to Lancaster University, the course is great, the people are as enthusiastic as I first found them and I wouldn't want to be anywhere else.

Project topics include:

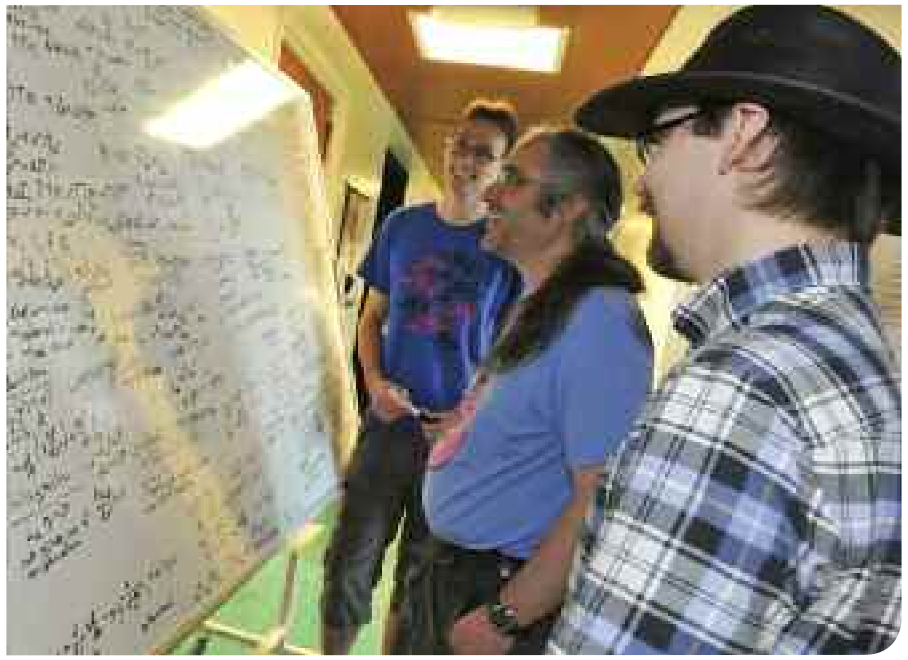
- Search for the Higgs particle at the LHC
- T2K – neutrino oscillations
- The physics of B-quark particles at ATLAS
- Dark matter and galaxy formation
- W bosons for polarimetry at electron-positron colliders
- Characterisation of silicon sensors for ATLAS
- Designing intense positron beams
- Dimuon charge asymmetry at Tevatron
- Quarkonium physics with ATLAS

lancasteruniversity
particle physics package
http://lppp.lancs.ac.uk/

Theoretical Physics

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

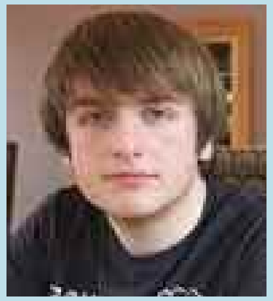
Which mathematical laws govern the natural world? How can we best make accurate predictions or deduce macroscopic properties of matter from microscopic descriptions? Which model describes a system or phenomenon most accurately and efficiently?



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 focuses 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 elementary particle physics.



DOM ROSE
Third Year MPhys Theoretical Physics

I visited a number of universities before selecting Lancaster to do my physics degree. I was impressed with the Physics Department and its commitment to supporting students and research. Now at the end of my third year I have found my Theoretical Physics degree both challenging and rewarding. Through the support of the university I have received funding for a research project in the summer of 2013, and am looking forward to the challenges of my MPhys in my final year.

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 areas of recent projects include:

- Gravitational waves
- Quantum computation
- Physics of graphene
- Topological superconductors
- Photonic crystals
- Geometry and electrodynamics

Our MPhys students are often afforded the opportunity to study towards a PhD in the Theoretical Physics Group.

Theoretical Physics with Mathematics

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

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 specialised theoretical physics courses taught by the Physics Department with classes in pure and applied mathematics provided by the Mathematics Department. For instance, this allows you to learn how quantum mechanics is underpinned by the powerful mathematical concept of a Hilbert space.

The final-year MSci TPM programme includes advanced courses in nanoscience, quantum fluids, general relativity, elementary 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 special blend of physics and mathematics included in our MSci TPM course opens up unique career opportunities in industry, education, and for PhD studies.

HANNAH ROBERTS
Third Year MSci Theoretical Physics with Mathematics

The physics department is very welcoming and supportive and the staff go out of their way to help you; any problems you have are dealt with in a timely manner by very accommodating people. The wide range of interesting course and module options available mean I can tailor my degree to suit me and find the perfect balance of theoretical physics and maths. The small class sizes mean we are on good terms with the lecturers and there is a sense of camaraderie between all the students on the course, making my time here thoroughly enjoyable.

MSci/BSc Theoretical Physics with Maths Degree Scheme Structure

YEAR 1	YEAR 2	YEAR 3		YEAR 4	
Physics Core I Mechanics Electric & Magnetic Fields Thermodynamics Quantum Physics Laboratory	**Physics Core II** Quantum Mechanics Electromagnetism Waves and Optics Special Relativity Particles and Nuclei Physics Skills Analytical Mechanics	**Physics Core III** Atomic Physics Particle Physics Statistical Physics Solid State Physics Adv Quantum Methods Theory Project Computational Methods 1 Optional Course	GRADUATE BSC OR CONTINUE TO MSCI	**Physics Core IV** Extended Project 3 Optional Courses, eg Advanced Relativity and Gravitation Adv Electromagnetism Quantum Information (see page 11 for more)	GRADUATE MSCI
Mathematics I Calculus Geometry Matrices Probability Numbers Differential Equations	**Mathematics II** Real and Complex Analysis Linear Algebra Group Theory	**Mathematics III** 2 Optional Course from: Hilbert Spaces Differential Equations Groups & Symmetries Representation Theory		**Mathematics IV** Topology and Fractals One Advanced Option: Hilbert Spaces Differential Equations Groups and Symmetry Operator Theory	

Physics (North America) **Theoretical Physics with Mathematics** (North America)

UCAS code: F305 (MPhys), F3G5 (MSci)

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 as the 3rd year of a 4-year MPhys or MSci degree. Whilst in Lancaster, you will study on one of the standard degree schemes outlined on the preceding pages. 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:

In USA

- Iowa State
- Michigan State
- Purdue
- Georgia
- Kentucky
- Maryland
- North Carolina, Charlotte
- Illinois

In Canada

- McMaster
- Trent
- Western

This list is constantly reviewed and arrangements with other universities may be possible on request.

Prior to the year abroad you will be given every assistance with both academic and administrative aspects of the exchange. The North America 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.

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 enhance and maximise your cultural experience during your study abroad.

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 F305 or F3G5, we will as an alternative consider you for one of our other degree schemes. 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.

TIM PATRICK
graduated MPhys Physics (North America) in 2012. As part of his degree he spent a year at Michigan State University.

My year in America has been the most exciting year of my life so far, full of new experiences. My time at MSU has broadened my horizons and given me mountains of confidence. A year studying abroad is an experience everyone should try!

Overleaf: Physics department at MSU (Credits: David Wilson) and some other impressions by our Physics (North America) students during their year studying (and playing) abroad.

OpenPlus with the Open University

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).

Typically two or three years are spent studying part time with the Open University, allowing you to combine study with other responsibilities or full time employment. Successful completion of this component allows direct transfer into 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. Based on academic performance, students 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?

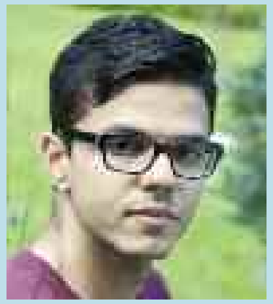
In your first two years of part time study with the OU (your foundation year and year one) you will get a thorough grounding in basic physics and mathematics via distance-learning courses.

Experimental work is included to 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 student to complete your degree. At Lancaster, you will study the required core courses and the courses associated with your degree specialism.

The standard Physics scheme is shown below, but all of the options described in pages 13-18 of this booklet are available.

In your first year at 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 object-oriented computer programming, 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 a number of 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 scheme 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.



CALAN APPADU
graduated MPhys Theoretical Physics on our OpenPlus scheme in 2013

I've just completed my Theoretical Physics MPhys and it was very rewarding. In the final year, you have to balance studying for your classes and working on your research project. It wasn't easy, but having studied with the OU meant that I was accustomed to managing my own time and working independently. Overall I had a great experience at Lancaster University, it was definitely worth continuing my degree here through the OpenPlus scheme. The transition from the OU isn't seamless: you have to adapt to different lecturing styles and course materials. However, the lecturers are very approachable so don't hesitate to ask for help if you have any issue whatsoever

OpenPlus Degree Scheme structure

OPEN UNIVERSITY	YEAR 2	YEAR 3		YEAR 4	
Physics Practicing Science The Physical World Practical Physics **Mathematics** Using Mathematics Exploring Mathematics	**Physics Core II** Quantum Mechanics Electromagnetism Waves and Optics Properties of Matter Special Relativity Particles and Nuclei Computer Programming	**Physics Core III** Atomic Physics Particle Physics Statistical Physics Solid State Physics Project Skills	GRADUATE BSC	**Physics Core IV** Extended Project	GRADUATE MPHYS
Physics	Laboratory	Advanced Laboratories Particle Physics Project 3 Optional Course		6 Optional Courses (see page 11)	

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, including Europe, Asia, Australasia and America.

In the Department of Physics, our undergraduate students are mainly from the UK, so our international students are given ample opportunity to mix, work and socialise with UK physics students.

Support for international students at Lancaster is second to none. Lancaster University's International Student Advisory Service **http://www.lancs.ac.uk/sbs/international/** provides dedicated support for both prospective and current international students. Throughout the application process you will be able to access comprehensive advice on how to prepare for studying at Lancaster, including guidance about obtaining visas, travelling to Lancaster, planning your costs and accessing medical care in the UK.

Once you are here we aim to help you settle in as quickly as possible. The International Student Advisory Service runs a number of events during Introductory Week designed to help you embrace life in a new country. These events continue throughout term-time and include a number of excursions to interesting and historic locations such as York, Chester and the Lake District, providing you with the opportunity to explore your new home in a friendly, supportive environment. A termly newsletter will keep you informed of exciting social events such as our International Student Evening, where you are guaranteed a fun night of great food and entertainment!

Throughout your time as an international student at Lancaster, the International Student Advisory Service will provide support and advice on a wide range of issues. Important topics are covered by a comprehensive range of leaflets, available both in hard-copy and on the web. You may prefer to make an appointment for an informal, confidential chat with one of our International Student Advisors. Whether helping you deal with culture shock or providing practical help as you become familiar with a new academic system, our advisors have a wealth of experience to help you make the most of your time studying at Lancaster.

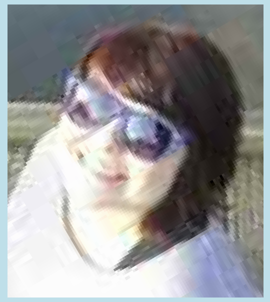
We greatly value the diversity of our international students and encourage applications from students with a wide range of academic qualifications. Please contact us directly for further information on how your qualifications relate to our entry requirements:

physics-ugadmissions@lancaster.ac.uk

Please note that Lancaster Physics Department Scholarships are available to overseas students (see page 36).

RAHUL DASS
graduated MPhys Theoretical Physics in 2013

The past four years at Lancaster has truly been a life changing experience for me. I came to the UK, with aspirations of being taught by leading researchers in different areas in physics, especially with regard to particle physics and relativity. The lecturers were not only most helpful when I faced problems during my modules but what helped me gain tremendous self-confidence was the fact that they were very encouraging when we discussed current research topics using all the knowledge I gained since starting this degree. The most enjoyable aspect was when I worked on my MPhys project, as I had the opportunity to study what excited me the most in physics in great detail and upon completion it motivated me to pursue a career in fundamental research. Ultimately, with happiness, incredible friendship and such an intense education, I leave Lancaster much the richer thanks to this whole experience.



IDA LARSEN
Third Year MPhys Physics with Space Science

The reason why I chose Physics at Lancaster University was because of the high student ratings and the Physics Department being one of the best in England. As an international student, I was worried it was going to be difficult settling down, but the lecturers have an open door policy and are happy to help if you have any sort of problem, or even if you just want to talk. The atmosphere in the department is amazing; everyone is friendly, welcoming and encouraging. It is also a very international community with many lecturers being from all over the world, and if needed they will help you with the transition to a new culture. My stay at Lancaster University has been fantastic so far, and I look forward to spending the next couple of years at this wonderful university.

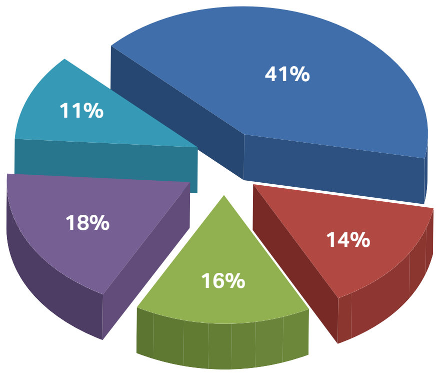
After your degree

Physics is an exciting subject that is fundamental to the developments in modern society.

Applications of the subject range from the very pure to the very applied, and a physics degree opens up a wide range of rewarding careers in scientific research and technological development, as well as in a wide variety of other professions.

Many of our graduates carry on with a research degree or enter employment that directly relies on their specialist skills. Physics graduates are in high demand across many industries, including semiconductor industries, medical and telecommunication businesses, 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. Our students also find employment in a wide range of other careers where they are valued because of general skills gained during the course such as logical thinking, problem solving, communication skills, teamwork, numeracy and computer literacy. Examples include consulting, finance, computer programming, and accountancy, as well as managerial and administrative positions.

The early careers of our students



- PhD (research degree)
- PGCE (teacher training)
- Other physics-related employment (hi-tech industries etc)
- Other employment (finance, marketing, consulting...)
- MSc and similar full-time study

From HESA data, six months after graduation.

A few of our graduates

ANT ROSS
graduated from Lancaster in September 2012 with a PhD in Physics

As an undergraduate I chose to specialise in astrophysics and cosmology; I had always been interested in space-related subjects thanks to a particular computer game I enjoyed in childhood. After completion of my Masters project I decided to continue studying how the Universe ended up as it did by working towards a PhD in particle physics. This allowed me to spend time living and working in an international laboratory in the US, surrounded by leaders in the field. It was an intensive and enjoyable educational experience, giving me a lot of experience in large scale computing, along with physics techniques and presentation skills. After a follow-up Post Doctoral term I decided to move away from physics research and use my programming skills to help create the sequel to the computer game which inspired me to take up physics in the first place.

Career Highlights:

MPhys in Physics with Astrophysics and Cosmology at Lancaster University

PhD in Experimental Particle Physics at Lancaster University

PostDoc at Lancaster University working on matter-antimatter asymmetry with the DZero experiment at Fermilab, Illinois.

Software Developer at Frontier Developments, working on the sequel to the game which inspired his interest in physics as a child.

ERICA RICHARDS (pictured right)
graduated MSci Theoretical Physics with Mathematics in 2011.

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. 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.

JAMES CORNISH (pictured left)
Consultant, BAE Systems Detica. Graduated from Lancaster in 2011 with MPhys Physics. Above he is seen visiting us at our annual employers exhibition.

Working for BAE Systems Detica, I routinely apply the knowledge and skills I developed studying Physics at Lancaster. The course is ideal preparation for anyone seeking to develop a career in the computing and defence industries, providing a solid foundation in programming and complex problem solving IT. I have been able to apply specialist knowledge from my degree to enhance business capability, particularly in the field of quantum communication. Physics at Lancaster offers you so many opportunities throughout your degree and beyond.

CHRIS POOLE
Software Engineer at IBM. Graduated MPhys Theoretical Physics in 2007 and stayed on to complete a PhD with our Condensed Matter Theory Group in 2012.

Working for IBM, I often draw on the skills and experience I gained while studying Theoretical Physics at Lancaster. As well as gaining presentation and other soft skills, the course helped me improve my problem solving abilities. In my fourth year I studied the very latest developments in theoretical condensed matter physics, which led me to decide to stay on for a PhD. At IBM, I'm required to balance several business commitments at once, including software engineering, running outreach events, driving ideas through to implementation, and writing technical documentation. Physics at Lancaster has helped me succeed in all of these areas, and is a great starting point for a career in any technical sector.

DR PETER CARRINGTON
obtained both his MPhys and PhD degrees from Lancaster Physics Department, winning the Chancellor's Medal in 2005 and receiving his PhD in 2009. He has won an award for his research from the British Vacuum Council, and in 2012 he was awarded a five year Fellowship from the Royal Academy of Engineering.

My time at Lancaster has certainly prepared me well for a career in physics research. The most rewarding part of my undergraduate degree was the 4th year project which enabled me to pursue my interests in infrared lasers. This subsequently inspired me to continue my research as a PhD student. The high level of support in the department from staff and colleagues combined with the excellent research facilities enabled me to make a number of breakthroughs in this field, from which I was able to secure my own funding which will help me build my own research group and develop a long term career in academia.

Enhancing your prospects

Studying physics at Lancaster will not only give you opportunities to explore research in an academic environment. If you are interested, you can also explore the significance of physics in industry, or take up extracurricular activities with our Teaching Fellow in a school environment. Industry and outside agencies contribute to the range of our third and fourth year projects and fund some departmental research in a number of areas, including optoelectronics and lasers, scanning probe microscopy, applications of graphene, and mathematical physics. These links with outside organisations are of benefit to all our students when they seek employment. We also run sessions with career advice, organise an employers exhibition, and arrange internships on and off campus, while the University offers the Lancaster Award to round off and enhance your education.

IDA LARSEN
(in front in blue clothes) – Third Year MPhys student, on her 2013 summer internship arranged by our Space Science Group

During my internship at ALOMAR at Andøya Rocket Range, I am learning to use and analyse the riometer and its data in addition to operating different types of Lidars. What we are doing is studying different parts of the atmosphere through performing continuous measurements, producing data which we then can analyse. I am producing absorption spectra, keograms and Quiet Day Curves from the raw data produced by the riometer. At ARR they also launch rockets, and I am also taking part in the rocket campaigns - they are launching a total of 13 rockets during my stay at ARR!

Awards for academic scholarship

The academic achievements of our graduates receive wide recognition.

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.

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 is now studying for a PhD with Lancaster's Low Temperature Physics group.

2012 Kirsty Dunnett, MPhys Theoretical Physics. Kirsty is now studying for a PhD in superfluids at Warwick University.

2013 Thomas Banaszek, MPhys Theoretical Physics. Thomas is now studying for a PhD with Lancaster's Mathematical Physics Group.

External recognition

Some our recent graduates have carried on to gain further recognition through competitive and prestigious awards and nominations.

Nick Kay: winner of the 2012 Best UK Physics Student of the Year SET (Science, Engineering and Technology) Award. For a description of Nick's study experience see page 9.

Cherry Canovan: won the 2011 IOP Very Early Career Woman Physicist of the Year.

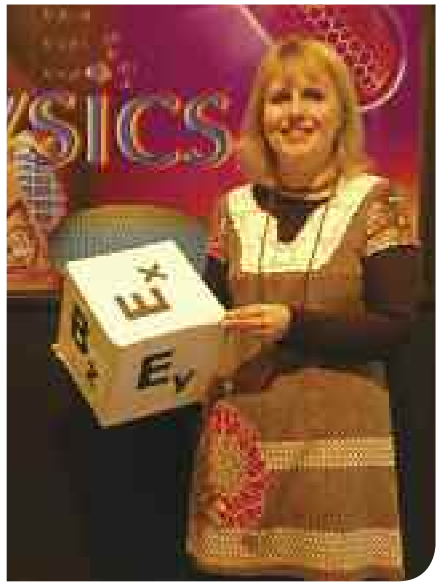
Also won in the Returner category at the annual Red Hot Women Awards 2011.

Katie Turnbull: won a Royal Astronomical Society Rishbeth Prize at the UK National Astronomy Meeting 2010.

Philip Clemson: invited to present his research to a panel of judges on during the 2013 National Science and Engineering Week as part of the competition SET for Britain .

Andrew Hoyle: runner-up in the 2010 Best Physics Student of the Year SET (Science, Engineering and Technology) Award.

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



Cherry Canovan, 2011 IoP Very-Early Career Woman Physicist of the Year.

Graduation day!

Near the pond on the Lancaster University campus - a perfect spot to relax.

Research at Lancaster

Lancaster's Physics Department is renowned for carrying out cutting-edge research at an internationally leading level. The department was ranked number 1 in the UK in the most recent government-commissioned research assessment (RAE 2008), confirming the excellence of our research.

Our staff are very research active and publish regularly in high impact, peer-reviewed scientific 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. Furthermore, our teaching benefits from the access to unique and world-leading facilities, and the department's active involvement in major national and international collaborations.

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

The following provides a flavour of our current research, 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 cosmological experiments in liquid helium; non-linear dynamics and chaos; and the development of gallium-arsenide particle detectors. We are also involved in many interdisciplinary areas including the biological, chemical and medical interfaces.

Low Temperature Physics

Low Temperature research at Lancaster includes experiments on superfluids and other materials with wide applications in areas such as cosmology and turbulence. The group has a strong international reputation for performing pioneering 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.

NATHAN CASE
currently undertaking a PhD in Physics

Lancaster University stood out for me as soon as I started looking into which university I was going to attend after my A-Levels. Lancaster is a world top-100 institution with a leading UK physics department and it has the friendly campus atmosphere I was looking for. After four enjoyable years studying for my undergraduate degree, I started a PhD in Space Physics at Lancaster. The department is welcoming, lecturers are approachable and the research is world-class - there was no reason for me not to continue for another three years!

Opposite: PhD student Chris Lawson working at one of our dilution refrigerators

Quantum Technology

Quantum technology is a rapidly developing research field encompassing physics, chemistry, biology and engineering, aimed at harnessing unusual effects not encountered in classical systems, and using them for practical purposes. Potential applications which are being developed include: quantum computing, quantum cryptography and metrology, novel types of lasers, memories and sensing instrumentation, solar cells and batteries.

Fundamental research in the Quantum Technology Centre is focused on creation, manipulation and measurement of quantum states in engineered solid-state systems, investigation of charge transport and optical properties at the nanoscale and studying mechanical systems in the quantum regime. This requires control at the level of a single charge, single flux quantum, single photon and single phonon. Such fundamental control is enabled by combining striking effects such as Coulomb blockade, magnetic flux quantisation, and superconductivity.

These are found in self-assembled and lithographically constructed nanoscale structures such as Josephson tunnel junctions and quantum dots. Complementary research is carried out on quantum optics and photonic devices based on a variety of nanostructures, exploring and exploiting quantum confinement effects across a wide spectral range in collaboration with industry and end-users.

The Quantum Technology Centre contains state-of-the-art cleanroom fabrication facilities capable of producing structures with a lateral dimension of about 10 nm and aligning multiple layers with an accuracy of about 20 nm. This is supported by molecular beam epitaxy reactors for atomic layer-by-layer growth of semiconductor nanostructures and devices.

The nanofabrication techniques include electron-beam lithography using a dedicated electron-beam writer, plasma processing and thin-film deposition. Electronic nanostructures are measured at temperatures down to about 10 mK by means of DC, microwave and pulse techniques. Photonic structures are characterised using a variety of specialist (0-17 Tesla) magneto-optics and (4-300 K) spectroscopy techniques, x-ray diffraction, electron microscopy and atomic force microscopy methods.

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 understanding of the oscillatory processes involved in energy and information transfer within the body, and then to apply this 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.

Particle Cosmology

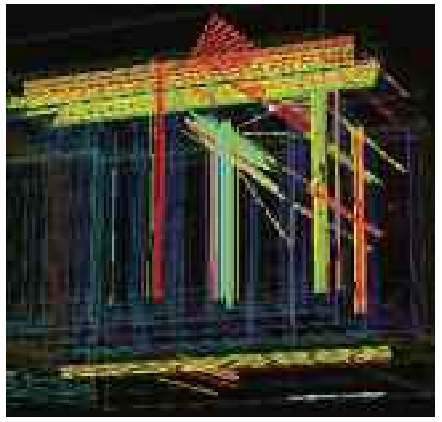
Cosmology is the study of the entire Universe as a system. Particle cosmology uses what is known or conjectured about fundamental particle theory to model and trace the history and evolution of the early Universe, when the energy density was so immense that high energy physics is necessary to describe 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 on 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 antimatter 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.

PL lab, Class 100 and 1000 clean rooms. Credits; Michael Thompson

Construction of the DSECal calorimeter for T2K's neutrino near-detector.



A reconstruction of a neutrino event inside the T2K near detector in Japan.

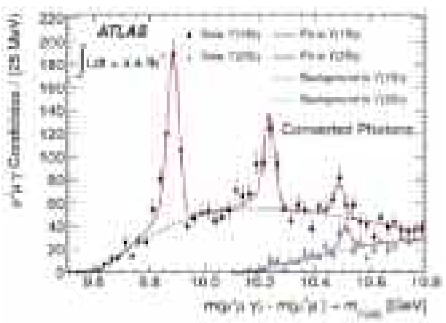
William Dearnaley and the ATLAS detector. William is a PhD student with the Lancaster Particle Physics Group studying CP violation at CERN.

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 dark matter and also into the development of the early Universe following the initial Big Bang.

Experiments in Particle Physics are carried out by large international teams of physicists based at accelerator laboratories such as CERN (Geneva), JPARC (Japan) and Fermilab (Chicago). We are involved in the ATLAS experiment at the most powerful accelerator ever constructed, the Large Hadron Collider (LHC) at CERN. There, we have used proton-proton collisions to investigate many open questions and directly contributed to the discovery of the Higgs-like boson, the particle associated with the mechanism giving fundamental particles their mass. We are also investigating the matter-antimatter asymmetry and searching for dark matter and new physics using particles containing beauty quarks, and studying the most massive quark, the top.

The Lancaster team also assembled a calorimeter for use in the T2K experiment (near Tokyo, Japan), which they are now using to study the nature of the elusive neutrinos and their ability to transform from one sort of neutrino to another. In part, the T2K experiment, like the ATLAS 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.



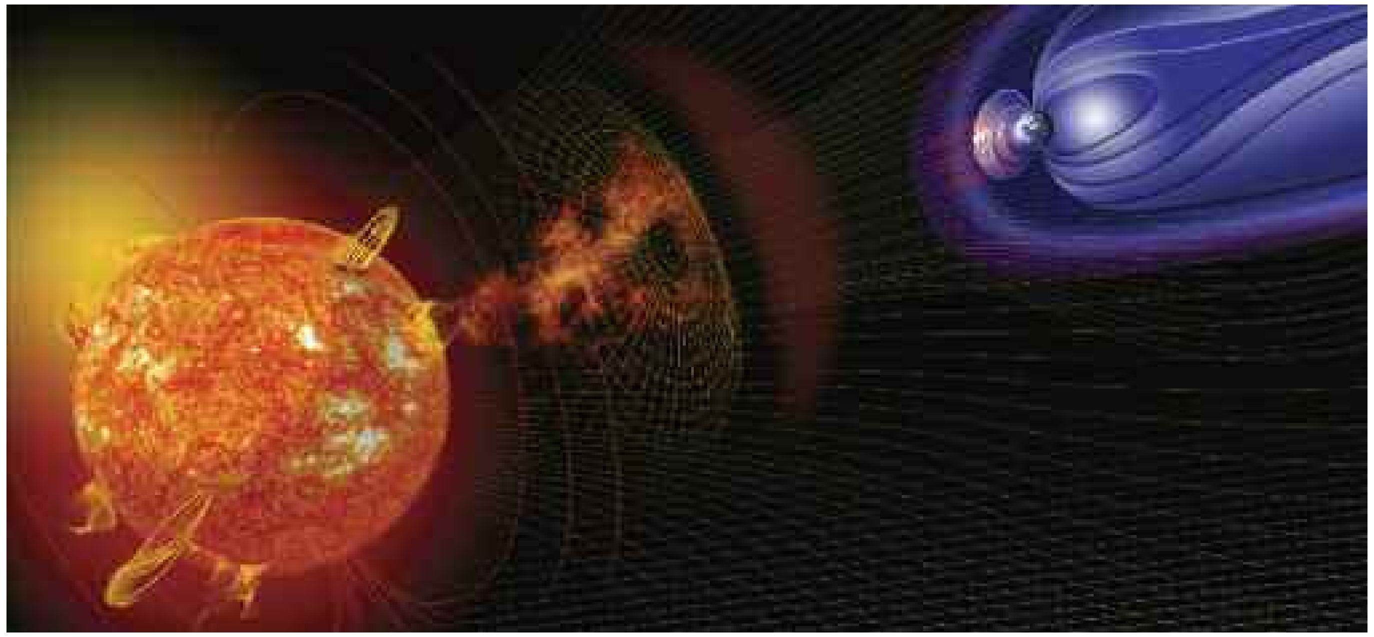
Lancaster discovery of the chi_(3p) particle with ATLAS at the LHC.

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. Research at Lancaster spans all of these applications. Our theorists are developing new effective classical and quantum theories for analysing matter in extreme conditions, with implications for cosmic particle acceleration as well as for experiments in the laboratory. Our experimentalists are currently developing experiments using accelerator cavities to search directly for the existence of exotic, hypothesised particles such as hidden-sector photons. 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 future proposed 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 (http://www.cockcroft.ac.uk), a centre of excellence for accelerator science in the UK.

Mathematical Physics

When investigating physical phenomena, considerable insight can often be gained using modern mathematical techniques commonly associated with general relativity and string theory. We make extensive use of analytical techniques and effective theories, rather than large-scale computation, to explore the world around us, and interdisciplinarity pervades our work. Our broad research programme reflects our extensive range of interests; for example, it connects the theoretical investigation of matter in extreme conditions (such as the ultra-powerful laser fields of the Extreme Light Infrastructure (ELI), or the strong electromagnetic and gravitational fields i n the environment of a magnetar) with ubiquitous fluid-structure interactions of utmost importance to the oil industry (such as the vortex-induced vibration of marine risers). Some of the most mathematical aspects of our recent work include novel regularization-free techniques for analysing quantum (Casimir) stresses and the development of new methods for investigating electromagnetic transport in spatially dispersive media such as metamaterials.



Solar wind and the magnetosphere. Credit: NASA/ESA/J Clarke.

Theoretical Condensed Matter Physics

Condensed matter comprises a diverse range of complex systems where atoms and electrons interact strongly by the laws of quantum mechanics. Because of the intricate and varied nature of the interactions, such systems are an ideal playground to discover novel physical effects of fundamental and practical significance. Our research focuses on carefully designed and controlled artificial systems such as electronic nanostructures, graphene, molecular conductors, photonic crystals and ultra-cold atomic gases, which exhibit striking effects such the quantum Hall effect, unconventional superconductivity or spin-dependent transport, which find applications from photonics to quantum information technologies.

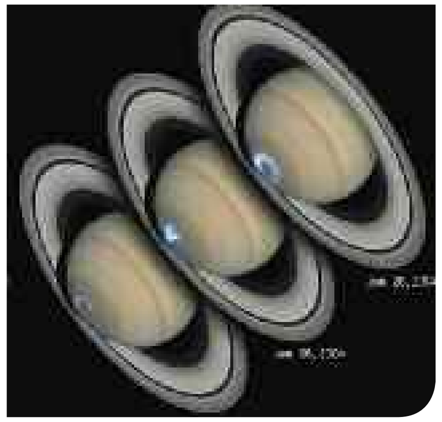
Our theoretical investigations provide an accurate mathematical and conceptual understanding of phenomena which otherwise defy understanding. This requires the advance and application of analytical and numerical methods from quantum mechanics, statistical mechanics, and electrodynamics. In recent years, we have contributed significantly 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, the quantum statistics of photons generated in optically amplifying microstructures, and the intriguing characteristics of topological superconductors.

Our research is generating interest from high-tech industries and has allowed us to take leadership in a number of international collaborations, including the EU Future Emerging Technology flagship on graphene.

Space Science

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 shields delicate planetary atmospheres (like the Earth's) from the onslaught of the solar wind, powers a complex system of electrical currents throughout the solar system, and drives breathtaking natural phenomena such as the aurora borealis (for real-time aurora alerts visit aurorawatch.lancs.ac.uk).

To explore this strange and exciting environment we employ measurements from the latest international space missions, as well as ground-based experiments in the UK and inside the Arctic and Antarctic circles. We also develop detailed computer simulations that allow us to make reliable predictions for the space weather - the impact of solar activity on conditions on Earth. Our research finds applications in the design of high technology infrastructure both on and above the surface of the Earth, such as for the protection of the power grid and communication satellites.



Auroras on Earth and on Saturn. Credits: Pete Lawrence; NASA.

Making you feel at home

LUPAS Executive 2013.

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 organised 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 you can find LUPAS on Facebook at **http://www.facebook.com/groups/LUPAS/** or on YouTube at **http://www.youtube.com/user/lancasterphysics** or email them at lupas@lancaster.ac.uk.

Women in Physics Group

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 women studying and working in our Physics Department. The group meets about once a term and aims to provide a forum for the women in the department to meet and 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 was awarded Juno Champion status—the highest level attainable in this initiative—in 2013.

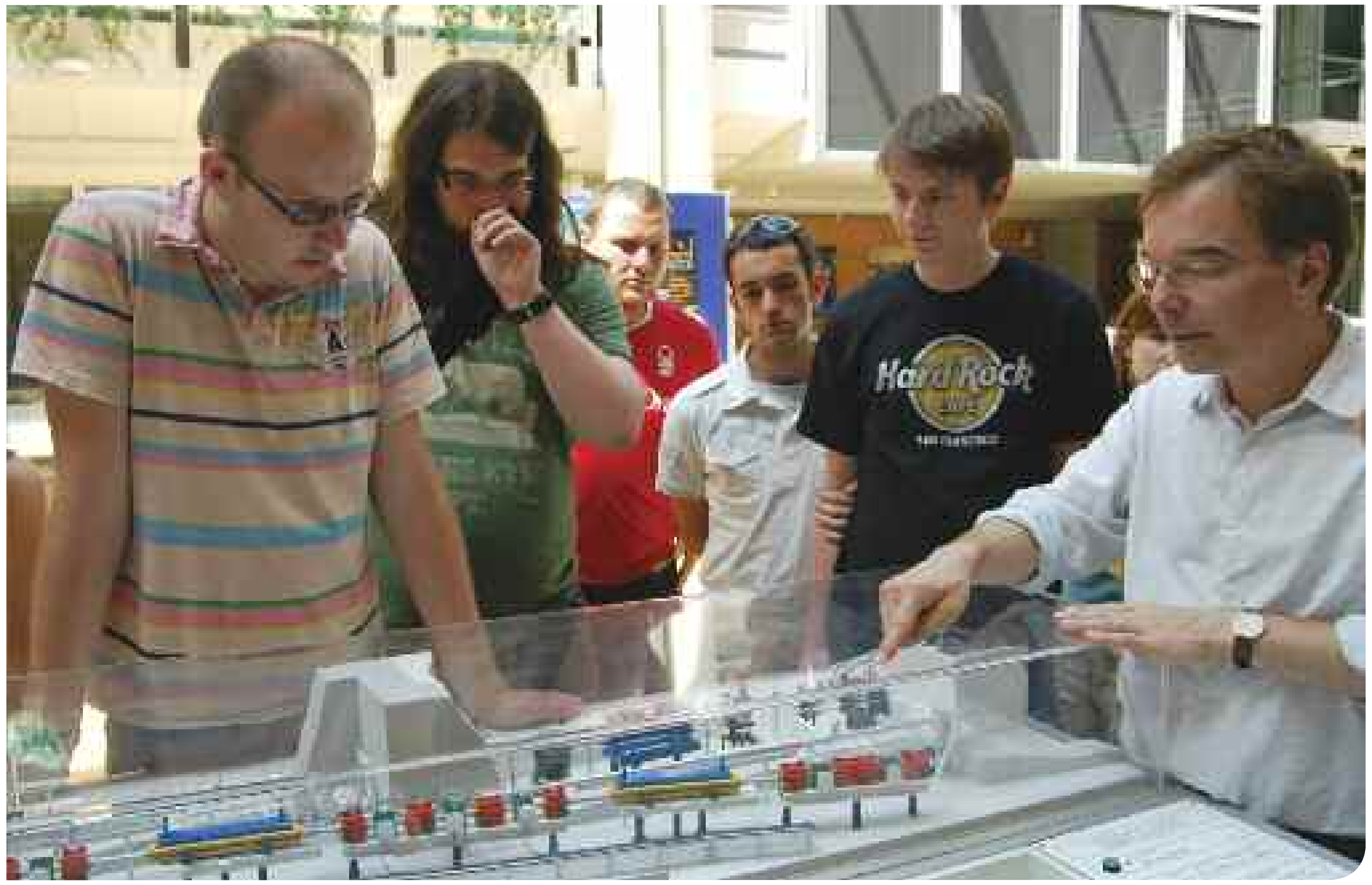
PROFESSOR PETER RATOFF
Head of the Lancaster Physics Department

The department fully supports the Juno initiative and is proud to have attained Juno Champion status. We see our Women in Physics group as a welcome development in the department and a key component in our aspirations to enhance inclusiveness and diversity in physics.

JORDEN SENIOR
Second Year MPhys Physics

One of the greatest things about Lancaster's Department of Physics is the fact that you are part of a community from the moment you join. You get to know and become friends with your lecturers, whilst automatically becoming a member of LUPAS, the student society which arranges anything from interesting guest seminars to nights out (some of which you will catch your lecturers joining in with!)

IOP | Institute of Physics
Juno Champion



Regular social activities include the Physics relay, Student-Staff football game and BBQ (sponsored by IOP Lancashire and Cumbria Branch) and excursions to CERN.

Is Lancaster the place for me?

If you are looking for a well-regarded university that is friendly, flexible and offers a great social life without the problems associated with large cities, then Lancaster is the place for you!

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. You will find the cost-of-living in Lancaster 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, an art gallery, cinema, concert hall, theatre and a brand new £20m sports centre with a swimming pool.

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 building on its experience as a cycling demonstration city and has 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.

NICKIE WAREING
Third Year MPhys Physics

I'm very glad that I chose Lancaster; the town is a brilliant, friendly place with a very active local community!

A guaranteed room in our multi-award winning student accommodation

We retained the title of Best University Halls in the 2013 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.

On-campus room prices are amongst the lowest in the country (rates for 2012/13 were £79-£102 per week or £102-£120 per week for an en-suite room where the exact cost depends on the college and the size of the 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.

For more information on our campus accommodation please visit:

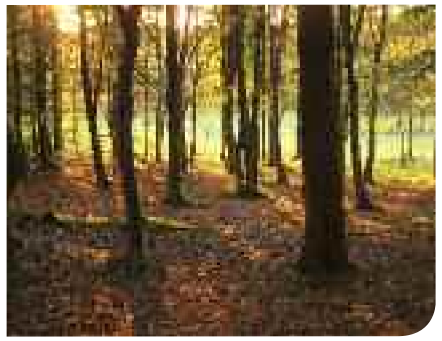
http://www.lancs.ac.uk/study/accommodation/undergraduate-accommodation/

Easy travel

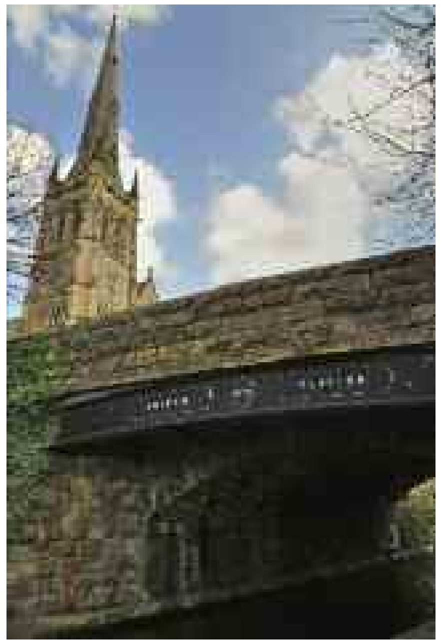
The University is just off the M6 so there are good road links to many parts of the country. National Express coaches stop at the campus. The city is on the West Coast Inter-city rail line (London is about two and a half to three hours away and Manchester one hour).

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.



Student finance



Lancaster University financial support

Lancaster University has committed £3.7m in scholarships and bursaries to help with your fees and living costs. Our financial support depends on your circumstances and how well you do in your A-levels (or equivalent academic qualifications) before starting to study with us.

Lancaster University's priority is to support every student to make the most of their life and education. For students starting their study with us, over 600 each year will be entitled to bursaries and/or scholarships to help them with the cost of fees and/or living expenses. For UK students we will have the following financial support available:

- An **Academic Scholarship of £2,000** for the first year of study to any student from the UK entering with A*, A*, A or equivalent academic qualifications
- An **Access Scholarship of £1,000** per year for all UK students from households with an income of less than £42,600 who achieve grades of A*, A, A or the equivalent academic qualifications
- A **Lancaster Bursary of £1,000** per annum for all students from England with a household income of more than £25,000 but less than £42,600
- As part of the National Scholarship Programme, a **£1,000 Bursary, a £1,000 Fee Waiver** and a **£1,000 on campus Accommodation Discount** or **Catering Card** in the first year of study, for students from England with a household income of less than £25,000. Plus: a **Lancaster Bursary** of **£1,000** in subsequent years.

Once you have applied for your financial support from the government and you have received an offer from Lancaster, your application for a scholarship or bursary will proceed automatically; there are no further forms to fill in.

For the latest information please see the Lancaster University student funding web pages at **http://www.lancs.ac.uk/study/undergraduate/fees-and-funding/**

Additional departmental support (open to Overseas and UK/EU students):

The Department of Physics is rewarding excellence by providing additional scholarships of £1,000 in the first year of study to those students who choose a Lancaster University Physics course as their firm choice and achieve A*A* in A-level mathematics and physics, or equivalent grades for those with alternative qualifications including overseas/EU students and OpenPlus students.

Physics staff with final year students 2013.

Scenic Ullswater in the Lake District.

Interested? What next?

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.**

Entry requirements

These are given with the course information on page 10.

Scholarships and bursaries

These are described on page 36.

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**

Further information

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

Prof Henning Schomerus
Admissions Tutor
Physics Department
Lancaster University
Lancaster LA1 4YB
Tel: 01524 592261
Email: 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.

You can also follow us on Twitter and Facebook: @LancUniPhysics facebook.com/LancasterPhysics

To find out more about Lancaster University in general, see **http://www.lancs.ac.uk** The 2014 University prospectus can be requested from **http://www.lancs.ac.uk/study/undergraduate/**

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. For Sat Nav use: LA1 4YW.

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**