

Physics

Lancaster
University



Physics at Lancaster

Undergraduate 2016



RESEARCH-LED
TEACHING AND
PROJECTS

A HIGHLY
SUPPORTIVE
ENVIRONMENT

RANKED NUMBER 2
BY THE GUARDIAN
FOR PHYSICS

98% OF STUDENTS
SATISFIED WITH
THEIR COURSE

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Welcome to Lancaster

I am proud to be head of one of the top physics departments both for physics outputs and for teaching in the UK, as recognised in repeated assessments and league tables.

By putting aside preconceptions and analysing the world from a scientific viewpoint, physics furthers our understanding and can bring immense intellectual satisfaction. We provide rigorous but engaging degrees that allow our students to experience both the fascination and the challenges ahead; the BSc establishes the foundations to the physicist's approach while the MPhys develops that further as the basis for postgraduate study. We also ensure that our students gain transferable skills, leading to a wide range of careers requiring acute and critical thinking or a rigorous approach to analysis and problem solving.

Whether carrying out research with colleagues at international facilities such as CERN, presenting our work to the world through digital applications like AuroraWatch and our media interactions, or by providing outreach events for the community, Lancaster University's Department of Physics strives to play a

significant positive role, and 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 along with the frontiers of the discipline. I hope that this prospectus will be the beginning of a rewarding journey leading to a deeper understanding of our world.



Professor Roger Jones
Head of Department

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

A remarkable feature of Lancaster University is how everyone, staff or student, are very approachable and happy to help. Lancaster University Physics and Astronomy Society (LUPAS) is the student run organisation for all Physics students and others who enjoy the subject. We host many activities, ranging from fun and games straight through to organising student-held lectures where you can practise your skills. The most important thing we do, though, is to bring people together and make it easy to find friends with common interests, so that your time at the University becomes a much more enjoyable social experience.



Connor Rothwell
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 league tables as well as top scores in successive National Student Surveys and external teaching audits, while our research excels in the recent government-commissioned Research Assessments. 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 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 – for instance, we are ranked 2nd in the Guardian University Guide 2016 (also 2013 and 2014),

and equal 4th in the Times and Sunday Times University Guide 2015. Our students are extremely satisfied with their courses – we receive excellent scores in the National Student Survey, where we were ranked top in the country twice in the past four years. This includes a consistently high score for overall satisfaction with the quality of the course (98%).

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 Research Assessment Exercises (2001 and 2008), we were ranked as the top physics department in the country, while in the 2014 Research Excellence Framework we were ranked second for world-leading (4*) research outputs. 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 from 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 (see page 27/28), and the creation of a new observational astrophysics group (see page 31).

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 (see page 22).



Stuart McDonald
Graduated MPhys Theoretical Physics in 2014

"Before selecting which university to do my degree at, I had visited lots of different departments but I found Lancaster to be the most friendly and welcoming. After starting my degree, this first impression lasted with the staff and students being very friendly and supportive. There are a wide range of modules that the department offer, which are both interesting and challenging. These, along with working on the final year research project, make a degree in physics from Lancaster University a very rewarding experience."

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 45 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 encourage everyone to create a positive atmosphere in which all students and staff enjoy developing 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 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.

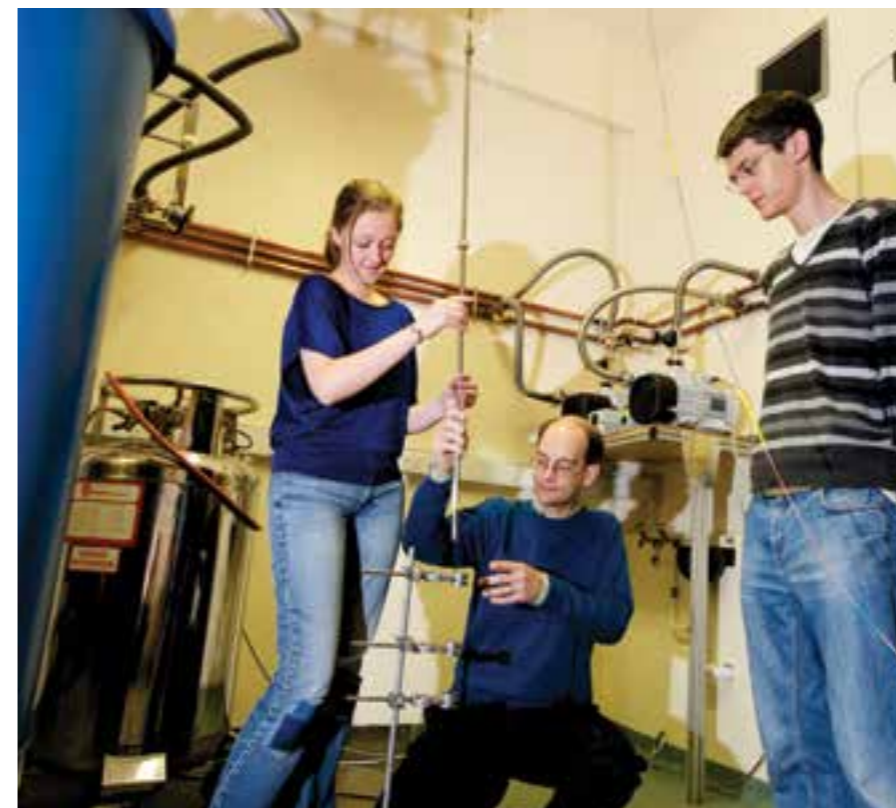
We value your feedback

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.

DID YOU KNOW?

WE ARE RANKED SECOND IN THE GUARDIAN UNIVERSITY GUIDE 2016.

98% OF OUR STUDENTS ARE SATISFIED WITH THEIR COURSE. (NSS 2014).



Sophie Burley
First Year MPhys Physics, (Study Abroad)

"Of all the physics departments I visited, Lancaster really had the greatest sense of community. The department has a warm atmosphere and all members of it feel easy to approach. The lecturers here put their all into teaching and ensure no one gets left behind. As a first year, the open door policy offered by all lecturers is really helpful in keeping you on track and feeling looked after. I absolutely love the course and am certain that my future years here will be just as enjoyable!"

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 12-15 lectures, each lasting 50 minutes, in classes of varying size.

Weekly assignments reinforce the ideas introduced during lectures. You will take part in 3-4 hours of seminars per week where the lecturer will explain solutions and help with any difficulties.

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 undergraduate 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 8/9, and current topics are listed throughout the description of the various degree schemes.

Computer programming and other transferrable skills

Physics makes 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 in year 3 and 4.

DID YOU KNOW?

IN 2014 WE ATTRACTED £400K FOR LAB REFURBISHMENT IN A COMPETITIVE HEFCE BID, TO BE SPENT FROM 2015.



Callum Kilby
Graduated MPhys Physics with Particle Physics and Cosmology in 2014

"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."



Theo Noble
Final Year MPhys Physics

"My time at Lancaster has been the best years of my life. The Physics Department has a fantastic course that I have found to be challenging and rewarding. My course has options that have allowed me to pursue topics that I have found interesting such as my favourite module about quantum information processing, where I have really enjoyed learning about a field that is at the forefront of current research. The lecturers and staff throughout my degree have all been friendly, and it is very easy to get help with any problems. The drive, friendliness and outstanding research found at Lancaster has convinced me to continue my studies here as a PhD research student, and I am very much looking forward to what the coming years will bring."



Impressions from our labs and lectures.

Projects

In the 3rd year, all students develop their research skills in open-ended group projects and skills modules.



Team Tyco assembles their optical fire detector.

The research skills modules give students hands-on experience of the topics that drive the wide-ranging experimental and theoretical research in the Physics Department, while students on the straight Physics degree can also choose to complete an industrial group project.

All 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.



Shaun May
First Year BSc Physics, Astrophysics and Cosmology

"Lancaster University first caught my attention for being so highly ranked for physics in the University league tables, but it wasn't until I visited the department on an open day that my decision was made. The staff and students were very welcoming and unmistakably passionate, combine that with the department is dedicated to so many projects, and I was sold!"

Ben Percy
Third Year MPhys Physics

"Tyco Fire Protection Services charged our team with the task of discovering a method of detecting when a mesh found inside non-domestic fire alarms becomes blocked from dirt or grease. From this point on there was no further instruction of what to do next. This lack of guidance was challenging, as it meant that we had to manage our time and our budgets by ourselves. Through research and many experiments, we designed a set up that could check if the mesh was blocked through measuring the attenuation of infrared light as it passed through the mesh. Though the project was a challenge, I would recommend it to anyone who wants to develop their practical, problem solving and research skills as well as their personal skills such as communication and team work."

Dr Christopher Anderson
Director / Consultant at DefineX

"Industrial group projects are invaluable to the students; providing them with the opportunity to apply theory to industrial problems, whilst collaborating with others to achieve a common objective. The projects also benefit the industrial partner, allowing it to experience the quality of students in the Physics Department. This has been a very positive experience from DefineX's perspective."

Jorden Senior
Final Year MPhys Physics

"The industrial project is a great alternative to the traditional physics lab. With its open ended approach, you gain the skills required to take a problem and research a solution. Through the weekly review presentations, you can also gain a great amount of experience in presenting your work to your peers. Where the industrial project excels, in my opinion, is the freedom that it allows you, as a team, to have. You decide on how you will allocate your time, you pick how you will spend your budget and crucially, you pick how you will proceed with your project."

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.



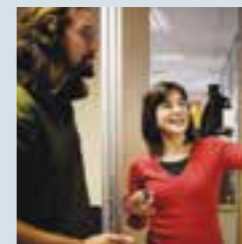
Nicholas Kay
graduated MPhys Physics in 2012 and is currently undertaking a PhD in Nanoscience at Lancaster. Based on his MPhys project on "The behaviour of graphene nanotrampolines", he won the 2012 Best Physics Student of the Year SET (Science, Engineering and Technology) Award

"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."



RECENT PROJECTS

FOR LISTS OF RECENT PROJECTS SEE THE COURSE DESCRIPTIONS ON PAGE 12-17.



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, where you also attend lectures in pure mathematics given in the Department of Mathematics and Statistics from your first year onwards (see page 17 for further details).

Finally, we run one of the best developed Study Abroad 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, Canada, Australia, New Zealand or Europe (see pages 18-19).

Courses and entry requirements

CODE	DEGREE	SCHEME	INDICATIVE A-LEVEL
MPHYS AND MSCIENCE 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 (Study Abroad). Year 3 spent in the USA, Canada, Europe or Australasia	A*AA
F3G1	MSci (Hons)	Theoretical Physics with Mathematics	A*AA
F3G5	MSci (Hons)	Theoretical Physics with Mathematics (Study Abroad). Year 3 spent in the USA, Canada, Europe or Australasia	
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: 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	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	Physics Core IV Extended Project	GRADUATE BSC OR CONTINUE TO MPHYS	GRADUATE MPHYS
	Maths Core Vectors Calculus Series Methods Complex Methods Vector Calculus	Further Mathematics Further Linear Algebra Partial Differential Equations Fourier Methods				
SCHEME-SPECIFIC COURSES	Physics	Laboratory	Advanced Laboratories Particle Physics Project OR: Industrial Project 2 Optional Courses	6 Optional Courses		
	Astrophysics & Cosmology	Astronomy Introductory Astrophysics Introductory Cosmology	Stellar Astrophysics Big Bang Cosmology Astrophysics Lab Cosmology Project 1 Optional Course	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 Project or Cosmology Project 1 Optional Course	Advanced Relativity and Gravitation Current Cosmology Further Particle Physics Gauge Theory 2 Optional Courses		
	Theoretical Physics	Analytical Mechanics Field Theory Introductory Cosmology	Complex Analysis Group Theory Advanced Quantum Methods Theory Project 1 Optional Course	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, Energy, Computer Modelling, Physics of Living Systems.

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 AS WELL.

The common physics core

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, including 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, executing, and reporting 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 to 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 telescope.

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.

A major element of these years are the open-ended projects (see page 8/9), in which you tackle research problems of your specialisation under the dedicated guidance of an experienced academic and contribute actively to the research of our leading groups. This is a highly rewarding experience, which is thoroughly enjoyed by our students.



PHYSICS CORE

FOR THE DEGREE-SPECIFIC ELEMENTS COMPLEMENTING THIS CORE, SEE THE DIAGRAM ON PAGE 11 AND THE COURSE DESCRIPTIONS ON THE FOLLOWING PAGES.



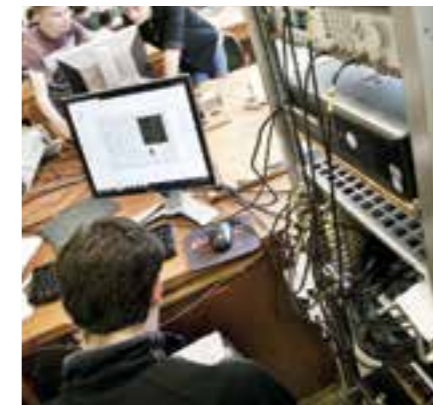
James Fong
Second Year MPhys Physics, Astrophysics and Cosmology

"Lancaster was the obvious choice for me when applying to university. I was most impressed by the flexibility of the course structure. Everyone studies the same first year, which enabled me to study a broad range of topics, and I didn't have to choose which degree scheme I wanted to study until the end of the year. This gave me the time to decide which area in physics I really wanted to pursue. The academic staff are really best in their field, and their enthusiasm for their subject comes across in the quality of their teaching."

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

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
- Nanomechanical resonators
- Nano-scale imaging microscopy
- Quantum turbulence
- Superfluid helium-4 in aerogel
- Nonlinear dynamics in biological ion channels
- Solar wind: origin and evolution
- Creation of artificial aurora
- Light analogues of matter waves

In year three, students can choose to do an extended industrially-oriented group project in collaboration with a company or other external organisation, where they research, plan and execute the 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 carbon-based sheets for use in fuel cells.



Joshua Chawner
Third Year MPhys Physics

"Studying Physics at Lancaster University is an extremely rewarding experience. The course is challenging, but the staff and lecturers are incredibly friendly and will offer help on pretty much anything. The course also promotes discussions between yourself and your fellow Physicists, giving you plenty of opportunity to meet new people who like Physics as much as you do! I chose to do straight Physics, which has allowed me to study theoretical modules as well as taking part in practical lab and project work, both of which have had a positive impact on my skills as a Physicist. I look forward to my 4th year project!"

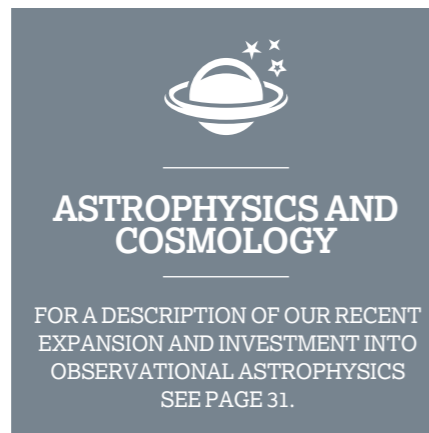
Astrophysics and Cosmology

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.



Taking measurements 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 coursework 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)
- Models of inflationary cosmology
- Origin of large-scale structure of the Universe



Katherine Cogman

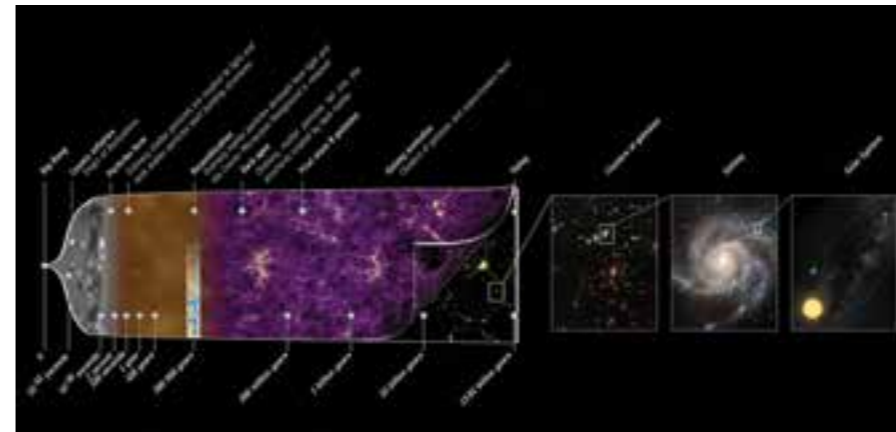
First Year MPhys Physics, Astrophysics and Cosmology

"Lancaster's physics department first caught my eye when I saw its ranking in the league tables, and after visiting the department and researching the different courses available I knew it was for me. I chose to study Astrophysics and Cosmology both because of my interest in that area, and because of the great choice of modules that are included in that degree. The course is well structured and enjoyable, and the different options available mean everyone can tailor their course to their interests. Every lecturer I've had has been engaging and interested in what they're teaching, and their enthusiasm makes the lectures really enjoyable. I can't see myself anywhere else and I know that I made the right choice in coming to Lancaster"

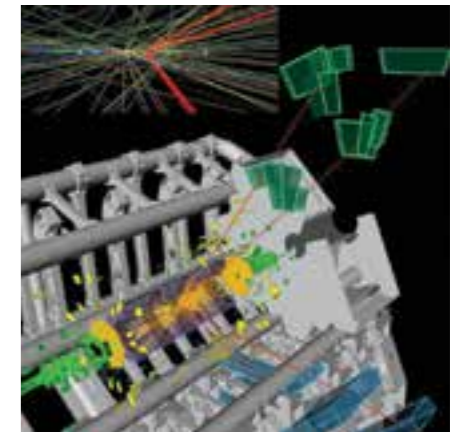
Particle Physics and Cosmology

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?



History of the Universe (credit: NASA)



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 the Fermilab neutrino beam) 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.

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
- Neutrino physics with liquid argon
- Quarkonium physics with ATLAS



Sam Jenkins

Second Year MPhys Particle Physics and Cosmology

"As well as the campus, my main reason for choosing Lancaster was how highly rated the physics department is, both in terms of courses and research. Each module is taught by a lecturer actively researching the subject and their passion makes it so much more interesting and engaging. The lecturers are very friendly, approachable, and always happy to answer questions, whether it's about the course, worksheets or beyond the scope of the module. With the variety of different courses available, and a range of optional modules in later years, you can really tailor the course to suit your interests. After two years studying here I know Lancaster was the right choice, and am looking forward to specialising further in particle physics and cosmology over the next two years."

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.



Ben McKeever
Graduated MPhys Theoretical Physics in 2014, now postgraduate student at Utrecht University in the Netherlands

"I have found my degree to be both demanding and fulfilling, curiously often with peaks in both of these at the same time. The specialised theory modules in particular have been a recurring highlight, with interactive styled classes offering many opportunities for collaborative problem solving and developing presentation skills. Also, I have really enjoyed my masters project, and this experience as well as a funded summer research project before my 3rd year to study Graphene has led me to apply for further graduate study abroad."

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

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 research interests of the centre span:

- 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.



Josh Thompson
Final Year MSci Theoretical Physics with Mathematics

"The course is set up in a way that ensures that I am able to learn as much theoretical physics as those on the Theoretical Physics course, whilst also learning pure mathematics with the maths department. This course is ideal for people who enjoy physics and maths, with short courses in labs and programming. I use the pure mathematics and physics I have learned to undertake my 4th year research project in graphene."

MSci/BSc Theoretical Physics with Maths Degree Scheme Structure

YEAR 1	YEAR 2	YEAR 3	GRADUATE BSC OR CONTINUE TO MSCI	YEAR 4	GRADUATE MSCI
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		Physics Core IV Extended Project 3 Optional Courses, eg Advanced Relativity and Gravitation Adv Electromagnetism Quantum Information (see page 11 for more)	
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 (Study Abroad) Theoretical Physics with Mathematics (Study Abroad)

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

A physics degree with a year in the USA, Canada, Australia, New Zealand or Europe

A year studying in a university abroad provides a unique opportunity to extend your higher educational experience to the challenging environment of a select partner 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 abroad 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 at the partner university is assessed and counts towards your final degree. Lancaster has the most experience of any UK institution in organising exchange programmes, with more than 50 co-operating institutions including Michigan State University, University of Illinois, University of Georgia, Purdue University, University of Iowa (USA), University of British Columbia, McMaster University (Canada), Australian Nation University (Australia), Victoria University Wellington (New Zealand), Adam Mickiewicz University of Poznan (Poland), and Universitat Leipzig (Germany).

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 Study Abroad tutor in the Physics Department will guide you in selecting 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 Study Abroad 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 Study Abroad exchange programme, it may be possible for you to transfer into the programme at the end of first year.



Alexander Booth

Currently in his final year MPhys Physics, Alexander spent a year at University of Illinois as part of his degree.

"The years I have spent as an undergraduate with the physics department have been some of the most rewarding of my life. The flexibility in the degree scheme also applies to Study Abroad, and has enabled me to tailor my studies toward the theoretical side of the subject, allowing me to focus on what I enjoy learning about the most, the mathematics. I have particularly enjoyed my final year project, where you can apply everything that has been learnt during the first three years and make a genuine contribution to your field. My third year was spent at the University of Illinois, where I was lucky enough to experience a very different way of life and learning. Thanks to my time spent in the USA, I was able to secure a work placement with Fermilab National Accelerator Laboratory near Chicago. I will begin this next chapter in my studies following graduation from Lancaster."



DID YOU KNOW?

LANCASTER HAS THE MOST EXPERIENCE OF ANY UK INSTITUTION IN ORGANISING EXCHANGE PROGRAMMES



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.

Typically two or three years are spent studying part time with the Open University (OU), allowing you to combine study with other responsibilities or full time employment. Successful completion of the required Open University modules with appropriate grades allows you to directly enter into the second year of any of our BSc or MPhys physics degree schemes at Lancaster. You then have the opportunity to study full-time for a further two years with the aim of graduating with a Lancaster University BSc degree in physics, or for three years with the aim of graduating with a Lancaster University MPhys degree.

How does it work?

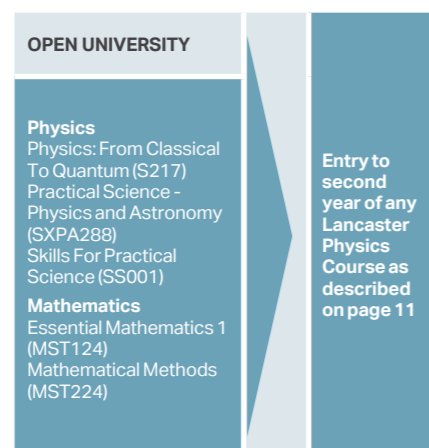
In your time with the OU you will get a thorough grounding in basic physics and mathematics via distance-learning courses. Experimental work is included to give you the experience and background knowledge necessary to undertake laboratory work in physics at degree level. On successful completion of all 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. All of the options described in pages 13-18 of this prospectus are accessible through this scheme.

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.

To apply to the OpenPlus scheme you should contact the Physics admissions office directly; you do not need to contact UCAS. Further details can be found at www.physics.lancs.ac.uk/study_here/undergraduate/openplus. If you would like to spend a year abroad, would like to study for the MSci degree in theoretical physics with mathematics or would like to study with us part-time then please ensure that we are made aware of this when you make your application so that we can contact you to discuss these options.

OpenPlus Degree Entry Route



Lucas Mogg
Third year MPhys Phys who joined via Open Plus

"The OpenPlus scheme is a viable entry route into second year undergraduate level. The OU gives you a broad breadth of maths and physics to build upon, and I complemented this with a summer school at Observatorio Astronómico de Mallorca and a weeklong residential to the University of Sussex. Once at Lancaster you build on what was learnt with the OU and study a range of subjects in physics in much more detail, which is both challenging and rewarding. There are opportunities for the experimentally or theoretically inclined student at Lancaster, and it's a fantastic environment to study in."

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 www.lancaster.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.



Rahul Dass
Graduated MPhys Theoretical Physics in 2013

"The four years at Lancaster have 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."

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).



Ingrid Tengs
First Year MPhys Physics (Study Abroad) student who relocated from Norway to study at Lancaster

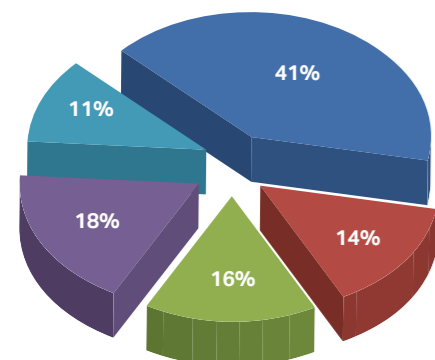
"Before coming to Lancaster, I was very anxious about settling in and adapting to a whole new culture. As Lancaster is very highly rated, both in academic performances and student experiences, I was worried I wouldn't fit in. But already in the first week all my concerns were proven unfounded. Everyone I've met in the department has been nothing but helpful, encouraging and accommodating. They all want the best for their students and as the lecturers have an open door policy, there is no need to be nervous about knocking on their doors if there is anything you're wondering or want to chat about. Moving to a new country can be daunting, but as everyone, from the members of staff to fellow students, are so friendly and welcoming, the transition to life at Lancaster seemed like the most natural thing in the world."

After your degree

Physics is an exciting subject that is fundamental to many 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 sectors, 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

A few of our graduates:



Ant Ross

Software developer working with Frontier Developments on the sequel to the game which inspired his interest in physics. Graduated MPhys Physics with Astrophysics and Cosmology followed by a PhD in 2012.

"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."



Dr Tim J. Walton

Graduated MSci Theoretical Physics with Applied Mathematics followed by a PhD in 2008, Research Associate until 2014. Now Lecturer in the Department of Mathematics at the University of Bolton.

"My reasons for remaining in the department after my undergraduate degree were identical to those which made me choose Lancaster in the first place: the very warm, approachable staff which made the process of learning and discussing ideas with them interesting and rewarding, without any apprehension that your questions weren't relevant; high quality research-led teaching by staff at the forefront of their respective fields; the ability and freedom to tailor my work to my interests and specialities; and the resources on offer to the students, both from an academic point-of-view - such as the Physics library, computer suite and access to whiteboards - and for more personal reasons, such as my enjoyment of campus life and its close proximity to Lancaster and the Lake District. I am still in active collaboration with staff at the department, hope this remains true for long into the future."



Razak Elmaslmane

Final Year MPhys Theoretical Physics.

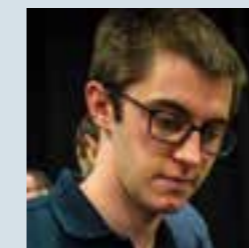
"The Physics department at Lancaster is extremely helpful when dealing with future career guidance, which becomes more of a concern in later years of the Physics course."



Hannah Laurens

Graduated MPhys in 2013 and now pursuing a PhD in our Space Science group, here pictured in front of the ESA Centre in Madrid during her 2013 summer internship.

"At the end of my Master's degree in 2013 I was able to gain a year's traineeship with the European Space Agency to work at both the Astronomy Centre in Spain and the Operations Centre in Germany. I worked with the Space Weather team and my role involved analysing, by comparing observation to forecast, numerous space weather models that are used to predict conditions from the upper atmosphere to the near Earth space environment. In my time there I was able to gain insight into what goes into planning missions, launching satellites and maintaining them. A real highlight was sending the space weather report that gave the all clear, just before the launch of the GAIA spacecraft!"



Jacob Home

BSc Physics graduate (2011), now working as a Nuclear Engineer at Horizon Nuclear Power.

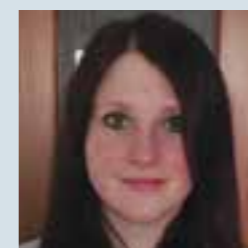
"Studying at Lancaster was a fantastic experience and has been fundamental in preparing me for my next big challenge; helping to build the next generation of nuclear reactors in the UK. The skills and knowledge I gained while studying Physics at Lancaster have proved important in my role as part of the Operations team here at Horizon, especially the practical experience I gained from laboratory modules. It was fantastic to be taught by staff who are not only experts in their respective fields, but are so incredibly enthusiastic and passionate about your learning and development. Lancaster has helped me get to where I am today. Anyone who is up for a challenge that will shape the rest of your life should come and study Physics at Lancaster."



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."



Becky Ridgley

2011 MPhys graduate now working as a vascular sonographer for Sheffield Teaching Hospitals.

"I left college with an interest in both human biology and physics. Having the opportunity to cover both modules appealed to me when I was researching university degrees. Looking back I'm still happy with the decision I made. The course was interesting and there was always a great deal of support on offer. Although it was slightly daunting starting a medical career with very basic anatomy and physiology knowledge I quickly discovered that my background gave me a significant advantage when it came to ultrasound physics and haemodynamics. My four years at Lancaster University were not only enjoyable, but the variety of subjects and skills I have learnt continue to provide a solid foundation for my work today."

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. 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.



Karl Ramwell

Graduated from Lancaster in 2012 with MPhys Physics, Astrophysics and Cosmology.

"My current role with Public Health England revolves around modelling radioactive discharges. Day-to-day work can vary significantly, from data analysis to participating in nuclear emergency exercises with organisations such as the MoD and Environment Agency. I frequently apply knowledge and skills developed at Lancaster to my professional life, whether problem solving or giving presentations to stakeholders. I am currently leading an investigation into using supercomputers for accident simulation, and have co-authored a peer-reviewed paper related to the economics of a nuclear accident to be presented to a conference in April 2015.

I have previously worked in a graduate role within technology transfer for the Science and Technology Facilities Council. My role was to identify promising intellectual property being developed by scientists with potentially ground-breaking real world applications. My work within the organisation resulted in the identification of many pieces of novel IP that had applications in sectors such as space, defence and nuclear. I also supported the ESA Technology Transfer Programme run out of ESA Noordwijk.

Lancaster provides not only good scientific education; it also prepares you for many aspects of professional life. The wide range of modules offered here provides a solid foundation for many career paths, whether science or business based.

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.



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

Recent physics winners of the Chancellor's Medal

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.

2014 Dominic Rose, MPhys Theoretical Physics. Dominic is now undertaking a MAsT in Applied Mathematics at University of Cambridge.



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

External recognition

Some of 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 (an annual event showcasing the work of Britain's top early-stage research scientists, engineers and technologists). 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 (2010) and Carl Bryers (2012): won a Royal Astronomical Society Rishbeth Prize at the UK National Astronomy Meeting.

Philip Clemson (2013) and Edward Guise (2014): invited to present their research to a panel of judges during the National Science and Engineering Week as part of the competition SET for Britain.



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 research assessments RAE 2008 and 2001, and second for world-class outputs in REF2014, confirming the excellence of our research.

Our lecturing and research staff include several world authorities, and the department has achieved a number of world firsts in key research areas. For example, our particle physicists have played a key role in discovering the Higgs boson, our cosmology group has pioneered the theory of cosmic inflation, our astrophysicists and space scientists participate in satellite missions such as Hubble and Cassini, our low T lab produces the lowest temperatures on earth, our quantum metrologists and biomedical physicists are developing novel methods of medical diagnosis, our condensed matter theorists and experimentalists have made groundbreaking discoveries on graphene, and researchers in our Quantum Technology Centre are renowned for their superconducting qubits. 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.



Chris Woodhead

Currently in his second year of his PhD (Physics)

"As an undergraduate at Lancaster for 4 years, I found that the physics department's excellent teaching, and friendly atmosphere, combined with its world class research facilities, made choosing to do PhD in Quantum Technology at Lancaster one of the easiest decisions I have ever made.

Now as a postgraduate, my research involves creating and testing prototypes for the next generation of quantum devices, most of which were grown and built right here in Lancaster."



Taking data in the biomedical physics lab.

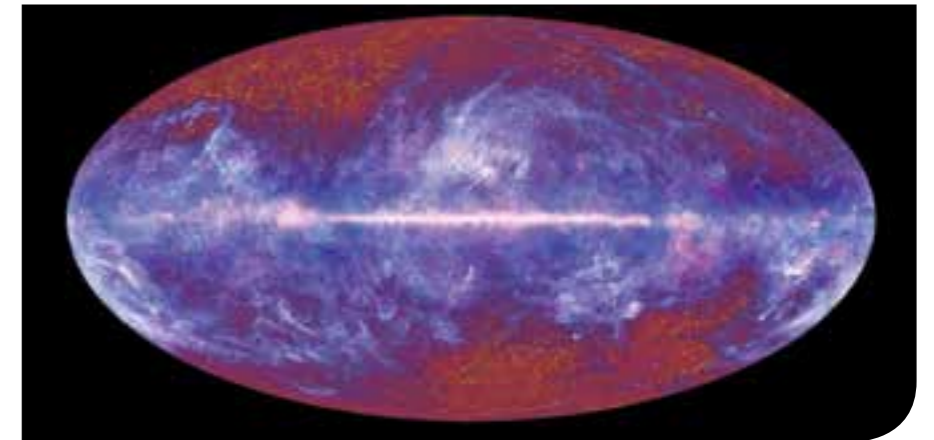
Quantum Technology

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.



Cosmic microwave radiation allows our cosmologists to test their theories of inflation (Credit: NASA).

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 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, anaesthesia, 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 at 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 make up 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, as well as the generation of gravity waves in the early Universe.



Credits: Artzai Jauregui.



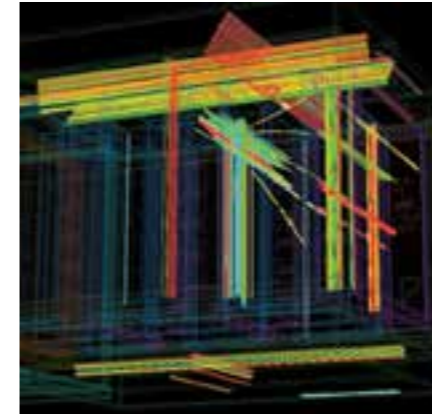
Credits: Michael Thompson.



Credits: Artzai Jauregui - MBE suite, PL lab, Class 1000 clean room.



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 dark matter and 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 group also plays a major role in the T2K experiment (near Tokyo, Japan) which studies nature's most enigmatic particle, the neutrino. Neutrinos have the ability to transform from one sort to another, and may be the key to understanding the existence of the universe. Lancaster built a substantial part of the T2K near-detector and continues to maintain it. We also lead several aspects of the data analysis aimed at improving our tenuous understanding of how neutrinos interact in matter. Building on the success of the T2K experiment, Lancaster is involved with the design and construction of two future neutrino experiments, DUNE and Hyper-Kamiokande, which aim to provide a better fundamental understanding of why matter predominates over antimatter. Lancaster is also involved with the SNO+ experiment, which will try to determine whether the neutrino is its own anti-particle, and also the short-baseline programme at Fermilab, which will search for sterile neutrinos. It is hoped that both the neutrino and ATLAS experiments will shed new light on the origin of mass, the beginnings of the universe and new symmetries in nature.

Accelerator Physics

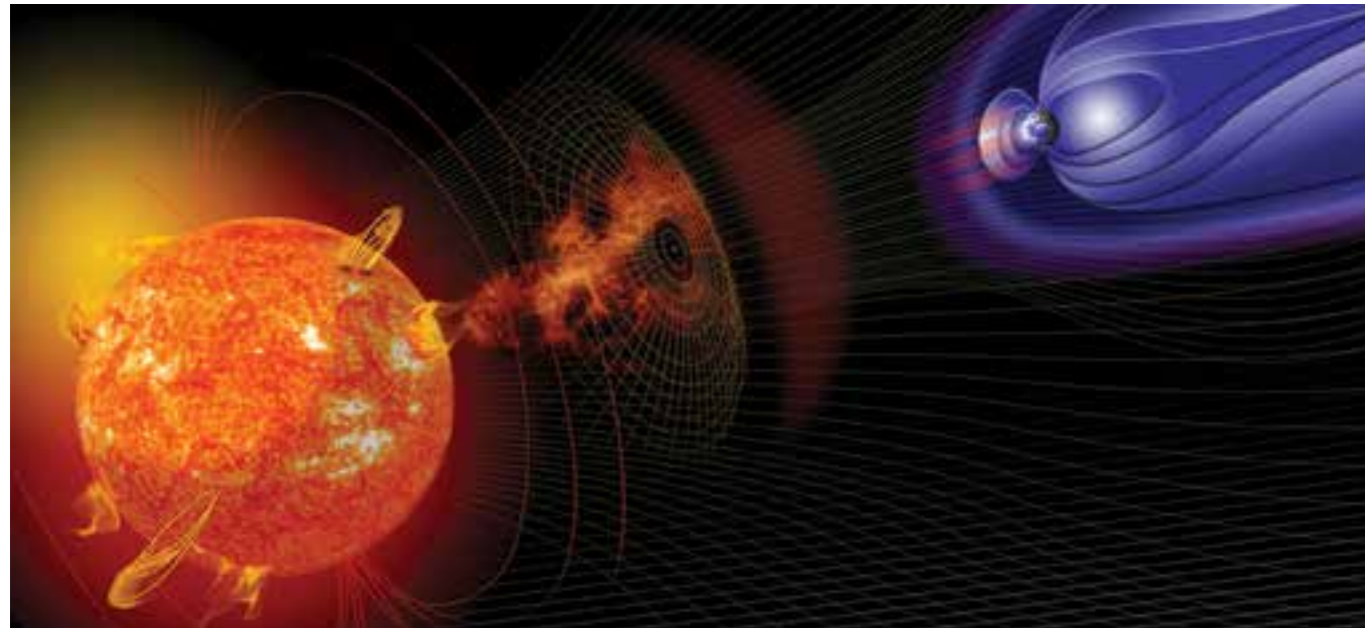
Particle accelerators are used for pushing the boundaries of elementary particle physics and also for a wide range of applications in nuclear physics, medicine and material science. Research at Lancaster spans all of these areas. Our theorists are developing new effective classical and quantum theories 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 techniques using accelerator cavities to search directly for the existence of exotic, hypothetical particles such as axions. In addition, experimental work is being undertaken on the design, simulation and prototyping of sources of intense polarised positron beams and gamma ray beams. We are founder members of the Cockcroft Institute (www.cockcroft.ac.uk), a centre of excellence for accelerator science in the UK.

Mathematical Physics

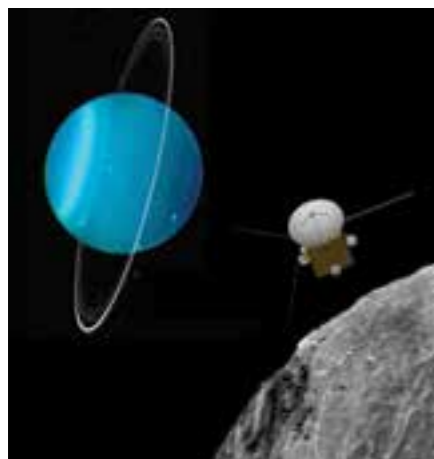
When investigating physical phenomena, considerable insight can often be gained using modern mathematical techniques commonly associated with general relativity and string theory. We make extensive use of analytical techniques and effective theories, rather than large-scale computation, to explore the 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 in 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.



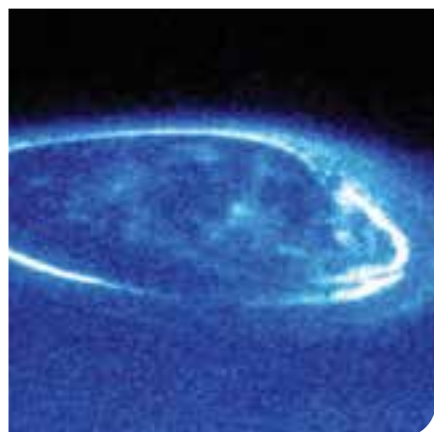
Some of our researchers discussing their newest findings.



Solar wind and the magnetosphere. Credit: NASA.



Lancaster's space physicists are working on the next generation of missions to the outer planets such as Uranus. Credits: NASA/JPL/USGS, Lawrence Sromovsky (UW-Madison Space Science and Engineering Center), Chris Arridge (Lancaster University).



Jupiter's auroral emissions observed in ultraviolet light by the Hubble Space Telescope. Image: Sarah Badman (Lancaster University), NASA, ESA.

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 as 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 space environment from the Sun to the edge of our Solar System. We study how planets and moons are electromagnetically coupled to the rest of their planetary systems and to the Sun; investigate how radio waves are affected as they propagate through the atmosphere of a planet; and are at the forefront of studying how the Sun affects life on Earth through the emerging field of Space Weather.

Recent highlights of our research include understanding the effect of moon dust on spacecraft, determining how Saturn's aurora is driven by the Sun, observing the merging of magnetic fields at Saturn, and detecting clouds of plasma being drawn out of the ionosphere of Mars by the Sun. An important part of our research is studying powerful systems of electrical currents in the Solar System which drive breathtaking natural phenomena such as the aurora (for real-time aurora alerts visit aurorawatch.lancs.ac.uk).

To explore these strange and exciting environments we work with international research organisations, including NASA and the European Space Agency, and use measurements from the latest international space missions orbiting Earth, Mars, Saturn and Jupiter, and the Hubble Space Telescope.



Artist's impression of the European Extremely Large Telescope, a 39-metre aperture optical and infrared telescope sited on Cerro Armazones in the Chilean Atacama Desert. It will be the world's largest "eye on the sky". Credit: ESO/L. Calçada.

Our scientists are also actively involved in the development of new missions to Jupiter, Earth and Uranus. We also use measurements from ground-based experiments in the UK and inside the Arctic and Antarctic circles and develop detailed computer simulations that allow us to make reliable Space Weather predictions, understand the giant planets, and study how spacecraft and spacecraft instruments operate in space. 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.

Observational Astrophysics

The Observational Astrophysics group, which complements the existing Astroparticle Cosmology and Space Science groups, is the most recent addition to our research activities. The group is led by Prof. Isobel Hook, who previously held a joint position at the University of Oxford and the Observatory of Rome in Italy, and will consist of four staff members with associated PhD studentships and postdoctoral researchers.

The group's initial research focus is observational cosmology. This includes measuring fundamental parameters of the Universe, such as its expansion rate and geometry, and the relative fractions and properties of its constituents (including ordinary matter and the mysterious dark matter and dark energy). These measurements can be made by observing distant supernovae, or by other techniques such as observations of galaxy clustering or the effects of gravitational lensing by matter (including dark matter) on the shapes of background galaxies.

The group's research will also work towards a better understanding of the formation and evolution of galaxies, one of the biggest open areas in astrophysics, and towards understanding the physical processes behind extreme objects in the Universe such as black holes and transient objects.

This research involves making state-of-the-art observations using the world's most powerful telescopes. At the same time we will prepare for the arrival of new telescopes coming online in the next 5-10 years. These new facilities include the Large Synoptic Survey Telescope (an 8m diameter survey telescope being built in Chile), the European Extremely Large Telescope (with a primary mirror 40m across) and in space ESA's Euclid mission (a wide-field survey telescope for cosmology) and the 6m diameter James Webb Space Telescope (the successor to the Hubble Space Telescope). These new telescopes will revolutionise research in astrophysics - this is an extremely exciting time to be an astrophysicist!



Isobel Hook
Newly appointed Chair in Observational Astrophysics

"Astronomy has always fascinated me because of the extremes involved - extreme distances, speeds, temperatures, densities - many of which are only encountered by observing the strange phenomena in our Universe. I am particularly interested in the properties of the Universe as a whole, and by the unknown process that is causing the expansion of the Universe to accelerate. I look forward to conveying some of these concepts as part of the undergraduate course and exploring them further in student projects."



Supernova 1994D in Galaxy NGC 4526. Credit: NASA, ESA, The Hubble Key Project Team, and The High-Z Supernova Search Team.

Making you feel at home



LUPAS Executive 2015.


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 www.facebook.com/groups/LUPAS 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 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. Furthermore, in 2014, the department has been awarded the Athena SWAN Silver award, recognising its commitment to encouraging women in science and technology careers.



Professor Roger Jones
Head of Lancaster Physics Department

"We see our Women and Physics group as a key component in our aspirations to enhance inclusivity and diversity in physics, and are proud to have attained the prestigious JUNO champion and Athena SWAN Silver awards."



Prof Farideh Honary and Dr Laura Kormos receiving the Athena SWAN Silver award for the Department



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?

Ranked in the UK Top 10 and global top 1%, Lancaster University is recognised as outstanding in teaching, research and the student experience.

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.

A guaranteed room in our multi-award winning student accommodation

Lancaster University accommodation was voted 'Best Value for Money' in the National Student Housing Survey 2014, and won the title of Best University Halls in 2010-13. 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 2015/16 start at £89 per week or £115 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:

www.lancaster.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.



Nickie Wareing

Graduated MPhys Physics in 2014, now pursuing a PhD in Environmental Science

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



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 400 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 and who place Lancaster as their firm choice
- 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 and who place Lancaster as their firm choice. In addition, students from household incomes of less than £42,600 who achieve higher entry grades of A*, A*, A (or equivalent academic qualifications), will also be awarded our £2,000 Academic Scholarship in their first year of study.
- A **Lancaster Bursary of £1,000** per annum for all students from England with a household income of less than £42,600

Please note that all financial support is subject to approval by OFFA.

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 www.lancaster.ac.uk/study/undergraduate/fees-and-funding/scholarships-and-bursaries

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.



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 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 a University Open Day or Campus Tour (booking is required). See www.lancaster.ac.uk/study/visit-days-and-campus-tours

Further information

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

Professor Henning Schomerus
Admissions Tutor
Department of Physics
Lancaster University
Lancaster LA1 4YB
Tel: 01524 592261

Email: physics-ugadmissions@lancaster.ac.uk

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

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](https://www.facebook.com/LancasterPhysics)

To find out more about Lancaster University in general, see www.lancaster.ac.uk

The 2016 University prospectus can be requested from www.lancaster.ac.uk/prospectus



Professor Henning Schomerus.

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 1 3/4 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.

Buses 3 and X4 stop outside the train station and run to the University every 30 minutes on weekdays. 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 2, 2A, 3, 4, X4, 42) from Lancaster bus station run to the University every 5 minutes on weekdays.

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



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

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You can also follow us on Twitter and Facebook:

[@LancUniPhysics](https://twitter.com/LancUniPhysics)

facebook.com/LancasterPhysics

Cover image: Saturn eclipsing the Sun as viewed by Cassini, a spacecraft used by our space scientists to study Saturn and its moons.

Credit: Cassini Imaging Team/SSI/JPL/ESA/NASA