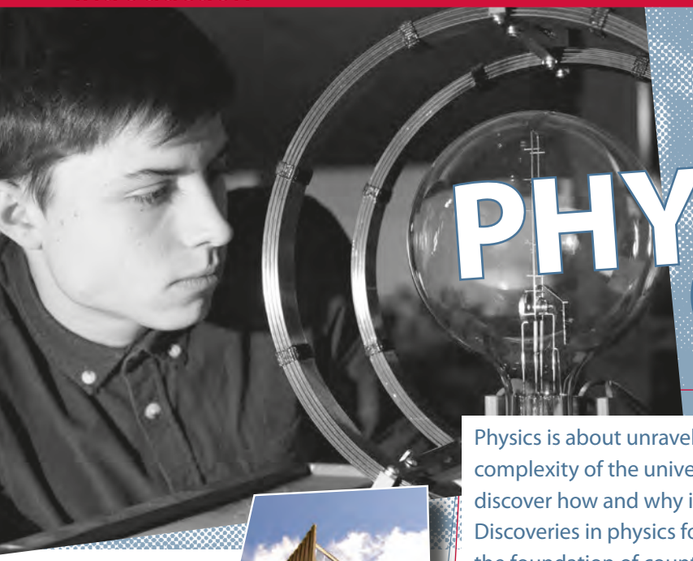
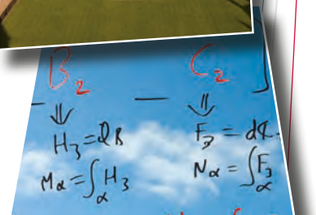
Physics at Oxford

UNDERGRADUATE DEGREE COURSES AT THE UNIVERSITY OF OXFORD FOR ENTRY IN 2018

UNIVERSITY OF OXFORD



PHYSICS@ OXFORD



Physics is about unravelling the complexity of the universe to discover how and why it works. Discoveries in physics form the foundation of countless technological advances and play an important role in many scientific areas. The contributions of physics to solving global problems such as energy production, environmental protection, global warming and public health are essential and have an enormous impact on our society.

It is an exciting and challenging field to study, requiring an adventurous and inquiring mind, and good mathematical abilities. The rewards include a deeper understanding of the world around us and the development of skills that are highly sought after by many employers.

TEACHING

Oxford has a unique approach to undergraduate physics teaching, drawing upon the breadth and quality of the Department's research programme and a wealth of expertise.

Teaching involves both the Physics Department and the Colleges. The Physics Department determines subject matter, arranges lectures and practicals, and sets and marks examinations. The Colleges organise tutorials, where work is submitted and discussed, and also provide pastoral support and advice.

Tutorials

Tutorials give students direct and regular access to physicists actively involved in research and provide an opportunity to explore scientific ideas face-to-face with experts in the field. Tutors take a personal interest in the academic progress of their students and offer help and advice. Students normally have two tutorials or classes a week. Classes are typically with their College year group (approximately six students), while tutorials are with one or two other students.

WHAT IS THE BEST THING ABOUT STUDYING PHYSICS AT OXFORD?

"One of the best things is that the physics course is very broad. On the MPhys course you take all six third-year options, which means you get an insight into a variety of topics, ranging from chaotic systems to the hyperfine structure of atomic energy levels. It helps you to make a well-informed decision on what to specialise in." — Nora

THE COURSE

There are two undergraduate physics degrees, a three-year BA and a four-year MPhys. All applicants apply for the four year MPhys in the first instance. We also offer a four-year joint degree in Physics and Philosophy.

BA Physics

The three-year course provides a general education in the basic principles of physics and includes a group industrial project.

MPhys

Most students study the four-year course, in which they pursue two fields up to the research frontier and complete a longer project. The MPhys should be of interest to those who seek a possible career in research.

MPhysPhil

Physics and philosophy are studied in parallel for the first three years and then students may specialise in one subject or continue with both.

FIRST YEAR

During the first year about half of the lectures are about physics and half about mathematical methods. Physics topics include: **Mechanics, Special Relativity, Circuit Theory, Electromagnetism** and **Optics**.

Mathematics topics include: **Differential Equations, Complex Numbers, Vectors and Matrices and Waves**.

SECOND YEAR

The second year provides a common core for both the BA Physics and MPhys courses. It has three main subject areas:

Electromagnetism and Optics: The topics started in the first year are developed and covered in more depth.

Quantum Physics: Introducing the mathematically beautiful and conceptually puzzling world of quantum mechanics.

Thermal Physics: Exploring the nature and properties of heat, kinetic theory of gases, classical thermodynamics and statistical mechanics – the 'why' of thermodynamics.

THIRD YEAR

In the third year the BA Physics and MPhys courses diverge. Six subjects are offered: MPhys students take all six and BA Physics students choose four alongside project work. The subjects offered are:

Condensed Matter Physics: Focusing on the properties of solids, including thermal and magnetic properties and why they form insulators, metals and semiconductors.

Flows, Fluctuations and Complexity: The dynamics of complex systems such as fluid mechanics, energy flows and stochastic processes are covered along with an introduction to biological systems.

General Relativity and Cosmology: The effect of gravity on light, Einstein's field equations and our understanding of the expansion of the universe are among the topics studied.

Quantum, Atomic and Molecular Physics: The topics covered include multi-electron atoms and lasers.

Sub-Atomic Physics: Ideas such as the theory of beta decay and the standard model of particle physics are explored.

Symmetry and Relativity: The complex worlds of symmetry and relativity, including Lorentz transformations and classical fields are studied.

WHERE CAN I FIND MORE INFO?

WWW.PHYSICS.OX.AC.UK/STUDY-HERE

MPhys students spend their fourth year working on two major options and a substantial project.

ASTROPHYSICS
Astrophysics is concerned with the application of the laws of physics to phenomena throughout the observable universe. Some of these phenomena present conditions so extreme as to challenge current physical knowledge. The course combines important basic astrophysics with an introduction to topics at the forefront of current research.

BIOLOGICAL PHYSICS
The study of the physical processes of life is a rapidly growing interdisciplinary field, with links to biochemistry, bioinformatics, medicine and nanotechnology. The course covers the biological structures and physical mechanisms responsible for fundamental biological processes such as motion, energy generation, signal transmission and molecular transport.

CONDENSED MATTER PHYSICS
The study of the fundamental properties of solids at a microscopic level. Interactions in novel materials give rise to many new phenomena, from high temperature superconductivity to low-dimensional electron behaviour in semiconductor nanostructures.

LASER SCIENCE AND QUANTUM INFORMATION PROCESSING
Coherent optical phenomena play a central role in research into the quantum nature of matter and radiation. This course covers the basic properties of lasers and laser-matter interactions, including nonlinear optics and beam propagation, as well as applications to several important technologies and the emerging area of quantum information processing.

PARTICLE PHYSICS
The study of the fundamental nature of matter and forces. The course covers electrons and neutrinos, and quarks that make up the proton and neutron, as well as the heavier versions of these basic particles. The course considers our theoretical understanding of the strong and electroweak interactions of these particles and looks at recent discoveries, such as the very massive top quark, neutrino masses and the Higgs-like boson at the LHC.

PHYSICS OF ATMOSPHERES AND OCEANS
Physics helps us understand and interpret a wide range of atmospheric and oceanic phenomena. This course starts with simple applications of thermodynamics and fluid dynamics to atmospheric behaviour. It then goes on to explore the greenhouse effect, atmospheric ozone depletion and details of modern space instruments, as well as our current understanding of climate and climate variability.

THEORETICAL PHYSICS
Modern physics has revealed how fundamental laws are often encoded in beautiful mathematical structures. This course provides an introduction to three areas: classical field theory, including Einstein's theory of gravitation; advanced quantum mechanics, including Dirac's relativistic wave equation for the electron; and statistical physics, including the theory of phase transitions.

MPhys projects
Projects give students valuable experience of open-ended work and solving real problems, and are the equivalent of about one full term's work.

MMathPhys Fourth Year
The Physics and Mathematics Departments in Oxford jointly offer an integrated masters level course in Mathematical and Theoretical Physics. Physics students will be able to apply for transfer to a fourth year studying entirely mathematical and theoretical physics, completing the degree with an MMathPhys. The course offers research-level training in: Particle Physics, Condensed Matter Physics, Astrophysics, Plasma Physics and Continuous Media. For full details see **www-thphys.physics.ox.ac.uk/MMathPhys**

Oxford also offers a joint Physics and Philosophy Masters degree (MPhysPhil), which aims to bridge the arts/science divide. Physics and philosophy complement each other as they both seek to reach a fundamental understanding of the nature of reality.

In this degree students will learn how to write, reason and argue with precision, as well as how to use physical principles and mathematical equations to solve problems. Graduates are equipped with the ability to think in abstract and general terms as well as to evaluate scientific claims that arise in areas such as social sciences, policy making, media and business. In addition, depending on students' choices in the fourth year, the course provides an ideal springboard to graduate work in either physics or philosophy. Graduates regularly go on to the very best research programmes worldwide in physics, and likewise in philosophy.

The course covers topics in physics, philosophy and the philosophy of physics.

PHYSICS AND PHILOSOPHY
Physics and philosophy are studied in parallel for the first three years. Philosophy covers topics such as the theory of knowledge, metaphysics, philosophy of science and logic. There is flexibility in the fourth year to specialise in either physics or philosophy, or to continue with both.

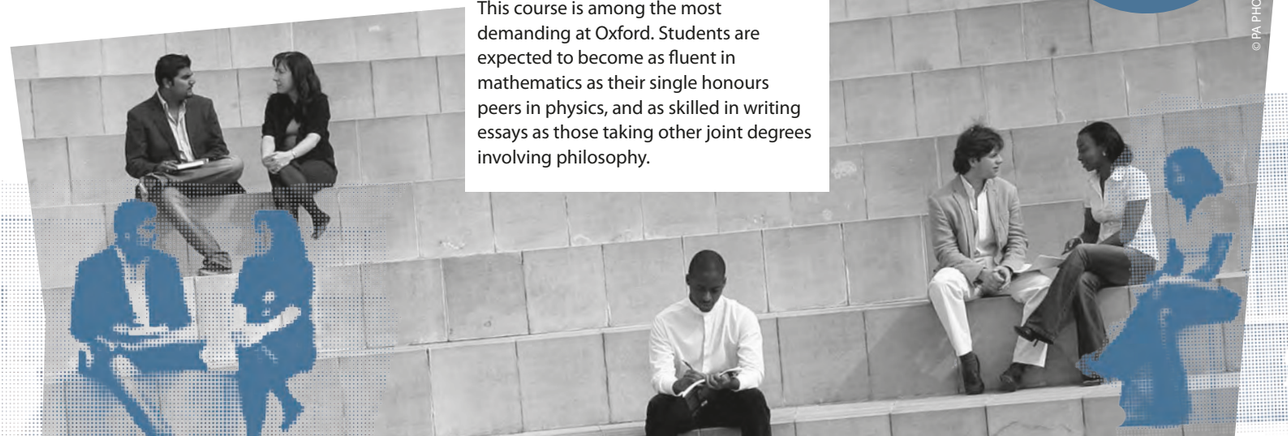
PHILOSOPHY OF PHYSICS
Linking physics and philosophy throughout the course is the subject area of Philosophy of Physics. Topics covered include classical space-time concepts, foundations of special relativity, conceptual problems in quantum mechanics, concepts of symmetry and foundations of general relativity and statistical mechanics.

This course is among the most demanding at Oxford. Students are expected to become as fluent in mathematics as their single honours peers in physics, and as skilled in writing essays as those taking other joint degrees involving philosophy.

College choice
Applications for Physics and Philosophy are accepted by the majority of Colleges. Of these Colleges, some will take Physics and Philosophy students only on occasion (typically one in every year or two years); others have declared a policy of attempting to take at least 2 students per year in the course if possible. As of 2014-15, these Colleges have such a policy: Balliol, Brasenose, Merton, Oriel, St. Edmund Hall, St. Hilda's, Somerville, University.

SHOULD I APPLY FOR PHYSICS, OR P&P?

WWW.PHYSICS.OX.AC.UK/STUDY-HERE/UNDERGRADUATES/THE-COURSES/4-YEAR-MPHYSPHIL



Experimental work forms an important part of any physics degree, providing training in transferable skills such as teamwork and problem solving, in addition to learning about measurements and instrumentation.

Practical work is compulsory for the first three years; students spend on average one day a week in the laboratories.

Oxford's practical course is unusual in offering a wide range of experiments, which allows students plenty of choice. In the second and third years it is possible for students to identify their own "mini-specialism", or gain extra laboratory credit for developing their own ideas and project work. The experiments are designed to both reinforce and complement the physics taught in lectures and tutorials. Some useful skills (computing and electronics) are taught almost entirely through practical work.

The first year of the practical course provides basic training in experimental physics and computing.

In the second year the only compulsory laboratory topic is electronics, and students can choose between several optional subjects including computing, thermal physics and optics.

By the third year the experiments are fairly specialised and usually take two days to complete, including:

- microscopy of DNA, or even students' own blood cells, in the state of the art biophysics laboratory
- analysis of real astrophysical data
- identifying crystals with X-ray diffraction
- running a real Nuclear Magnetic Resonance spectrometer (MRI scanner)
- measuring the radioactivity of Brazil nuts.

Training in communication skills is provided through talks and write-ups. A student's final project often involves experimental work in the teaching laboratories or in a research group.

The course descriptions provided are correct at time of publication, but details are subject to change.

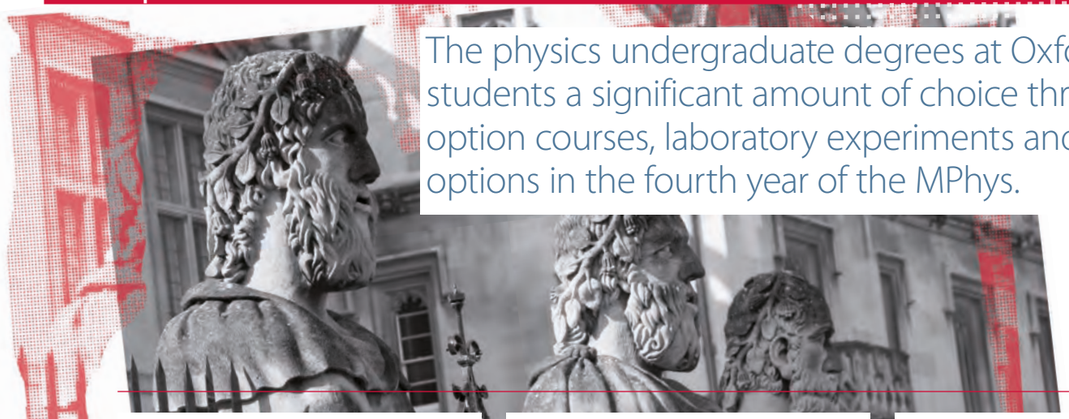
WHAT WILL A TYPICAL DAY BE LIKE?

SEE TOBY'S STORY ON PAGE 8

HOW DO YOU FEEL ABOUT THE PRACTICAL LABS AT OXFORD?

"The Oxford practical course provides a wide range of beautiful experiments which are always connected to theoretical coursework. Practicals provide opportunity to think through historically important experiments such as measurement of the spin of electron or determining electronic charge by measurement of emitted spectra." — Marco

The physics undergraduate degrees at Oxford offer students a significant amount of choice through short option courses, laboratory experiments and two major options in the fourth year of the MPhys.



Short option courses allow students to experiment with new material. All students have the opportunity to either acquire expertise in a more specialised area of physics or to broaden their education by studying subjects outside the mainstream course, offered by another department or faculty.

A sample of short optional courses is presented here. For more information about major option choices see page four, and for laboratory choices see page six.

HOW DO YOU FEEL ABOUT THE TUTORIALS AT OXFORD?

"Tutorials were initially quite scary, because you are sat across from someone who is an expert in their field. But once you realise that they don't mind if you get things wrong, the environment is incredible. A tutor will never hesitate to ask you difficult questions, and will push you to fully understand. I've walked away from tutorials with a much clearer knowledge, feeling so pleased that I'm here because it is the best teaching I've ever had." — Alice

COURSE TITLE

- Astrophysics: from Planets to the Cosmos
- Introduction to Biological Physics
- Classical Mechanics
- Climate Physics
- Energy Studies
- Exploring Solar Systems
- Functions of a Complex Variable
- Exoplanets
- Plasma Physics
- Quantum Ideas
- Advanced Quantum Mechanics
- Stars and Galaxies

From other departments or faculties

- History of Science
- Language Option (French, Spanish or German)
- Philosophy of Quantum Mechanics
- Philosophy of Science
- Philosophy of Space-Time
- Teaching and Learning Physics in Schools

EXAMINATIONS

Students take a set of written examinations at the end of each year and must show a satisfactory record of practical work. The BA Physics degree classification is made from the combined results of the second and third years as well as project work. The MPhys degree classification is made from the combined results of the second, third and fourth year examinations and the project report. There is a minimum required standard of a 2:1 in the second year exams for continuation onto the MPhys degree.

MEET OXFORD PHYSICS STUDENTS!

WWW.PHYSICS.OX.AC.UK/STUDY-HERE/UNDERGRADUATES/MEET-OUR-STUDENTS

A day in the life of Toby

WHO? Toby is in his second year of the four year MPhys course. He enjoys coxing for his College, as well as cycling training when he can fit it in. He is finding the second year course really interesting, and is enjoying the insights into new areas of Physics that it is giving him; more things to talk about over a pint at the pub.

LEFT: A QUANTUM MECHANICS LECTURE
BELOW: SUMMER BBQ

05:45 An early start with coxing on the river. Dragging myself out of bed is difficult, but definitely worth it

08:30 Shower, breakfast, and get out the door to lectures

10:00 Electromagnetism lecture

11:00 Quantum Mechanics lecture

12:00 Kinetic Theory lecture

13:00 Grab a quick bite to eat at home with my flatmates, or in Hall if I am feeling particularly hungry

14:00 A class on Quantum Mechanics with the rest of my year in college, followed by a one-on-one tutorial. These both really help tie up any loose ends that I might have with a problem sheet

17:00 Back to my room, and check emails before getting started on the next problem sheet. I will generally work in my room for a couple of hours; I'm not a library person! I might fit in a bike ride or a run if I am feeling like it

19:00 Dinner at home, but sometimes in Hall to have a nice social evening; plus the food is great!

20:00 Usually spent in the College Bar or a pub relaxing with friends. Occasionally, we will go and see a speaker at the Oxford Union, or see a student production in town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WHAT SPORTS/ SOCIETIES CAN I JOIN?

WWW.PHYSICS.OX.AC.UK/STUDY-HERE/UNDERGRADUATES/OUTSIDE-OF-THE-COURSE

"In my free time I teach lessons about the environment in schools, train for lifesaving competitions, sing in a choir and keep the website for the Oxford Physics Society up to date. At Oxford, the possibilities are endless." — Nora

"I am secretary of the Oxford Space Society (we have an observatory!) and enjoy writing, I have written a science fiction novel." — Ryan

"I practise yoga and enjoy baking." — Natalie

WILL I FIT IN AT OXFORD?

WWW.OX.AC.UK/VIDEOWALL

"I am the treasurer of the Jiu Jitsu Club, am a member of the Warewolves Society, run Dungeons and Dragons games as a Dungeon Master, love cooking and enjoy discussing physics and its philosophical implications with non-physicists over lunch (which I have usually cooked)." — Aniq


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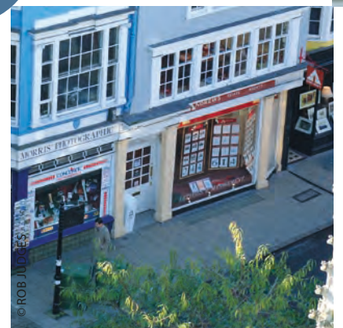
"Acting is a huge passion of mine, and I try and fit in at least one play a term (there's a wide variety of different types of shows to be in here). I also row for my College team and am in the University's cheerleading squad, the Oxford Sirens, which is fantastic fun!" — James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"I'm not particularly amazing at any sport or hobby, but I'm involved in College football and rowing, and I'm regularly in the College games room after tutorials and classes, playing pool and table tennis with friends." — Matthew

A degree in physics is a valued qualification and provides a pathway into a wide variety of rewarding careers. This is reflected in the diversity of employers, such as energy companies, research laboratories, banks, government agencies and engineering firms, who actively target trained physicists.

A CAREER IN RESEARCH

Careers in research are rewarding, with opportunities to travel and collaborate with other researchers across the globe. A large proportion (40%) of graduates at Oxford take higher scientific degrees such as DPhil / PhD qualifications; the first steps in an academic career in research.

Fundamental research in physics can help us understand the nature of our universe. Physicists specialise in topics ranging from galaxies to quarks, and clouds to crystals. Physics also plays an important role in the development of technology. At Oxford, for example, quantum computing is an exciting area of research, as is work in medicine to develop techniques such as proton therapy. Physics research can also help to solve global problems, such as improving the efficiency of solar cells to meet the increasing demand for energy in developing countries.

USING YOUR KNOWLEDGE

Physics graduates often use their knowledge and skills in areas other than academic research. For example, many physics graduates also work in industry; working for companies that specialise in areas such as energy, instrumentation, audio and visual technology, defence and telecommunications. They also go on to work as engineers, medical physicists, teachers, TV science advisors, environmental scientists, science journalists, writers, editors for scientific journals and in many other fields, e.g. specialising in law involving intellectual property and patents.

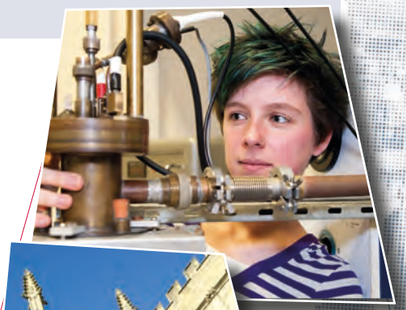
USING YOUR SKILLS

You may decide you don't want to work in a physics-related job; however the broad skills acquired by physics students are in high demand, especially in professions requiring analytical, IT and numerate problem solving abilities such as computing, finance and technical consultancy. Physicists have an ability to grasp concepts quickly, along with a determination to find coherent answers. Their ability to understand and model complex systems, for example, lends itself to a variety of different careers such as computer games design and financial forecasting.

Studying physics is not only very enjoyable but is an excellent preparation for the world of work.

WHAT PHYSICS TOPIC DO YOU FIND THE MOST INTERESTING?

"Medical physics, because it applies the fundamental concepts of physics to something that is so incredibly useful. The human body is a very interesting subject in its own right, so the physics of fMRI of the brain, for example, is really fascinating, both in terms of principles and applications." — Naomi



We seek to recruit highly-motivated students who have exceptional ability in physics and mathematics. Successful applicants need to be able to analyse and solve problems using a logical approach and see how one part of a physical system connects with another. They also need to have an ability to give precise explanations both orally and numerically.

ENTRANCE REQUIREMENTS

Candidates are expected to have Physics and Mathematics to A-level, Advanced Higher, IB Higher Level or other equivalent. The standard offer is A*AA at A-level or the equivalent, specific details can be found at **www.ox.ac.uk/admissions/undergraduate_courses**

An A-level or an AS-level in Further Mathematics may be helpful for students taking this course, however it is not an admissions requirement.

OPEN DAYS

Potential applicants are invited to join us at an Open Day on Wednesday 28 or Thursday 29 June 2017, or the smaller Information Day on Friday 15 September 2017. Booking for a Physics Open Day is not required. Many Colleges also hold events on these days and you should contact the Colleges to confirm booking requirements. For more information see **www.ox.ac.uk/admissions**

HOW TO APPLY

For a five-step process on how to apply see **www.ox.ac.uk/admissions/undergraduate_courses/applying_to_oxford**

For more information about the course and how to apply, visit **www.physics.ox.ac.uk/study-here**

STUDENT FINANCE

The cost of studying is an increasingly important consideration when applying to university. The funding arrangements for students entering higher education are available on the University website: **www.ox.ac.uk/fundingupdate**

This page also includes information about the University's generous support package for students from lower income households in the form of tuition fee waivers and bursaries.

VISITING OXFORD? DOWNLOAD THE OXFORD PHYSICS MAP: WWW.PHYSICS.OX.AC.UK/CONTACTS/HOW-TO-FIND-US

APPLICATION CALENDAR

1 September 2017
First day for submitting UCAS applications:
www.ucas.com

15 October 2017
Final deadline for registering for the Physics Aptitude Test. Your school will need to have submitted your details via the Cambridge Assessment Admissions Testing's secure Entries Extranet. More information can be found here:
www.admissionstestingservice.org/pat

15 October 2017
Closing date for all UCAS applications

2 November 2017
All applicants must sit the Physics Aptitude Test

December 2017
Interviews take place in Oxford, more information is available on the Physics website:
www.physics.ox.ac.uk/study-here/undergraduates/applications/interviews

By mid January 2018
You will be notified of the outcome of your application

August 2018
If you have been made a conditional offer and you meet the conditions of the offer, your College will confirm your place after the publication of examination results

WATCH OUR VIDEO! CURRENT STUDENTS AND A TUTOR TALK ABOUT STUDYING PHYSICS AT OXFORD:

WWW.PHYSICS.OX.AC.UK/STUDY-HERE

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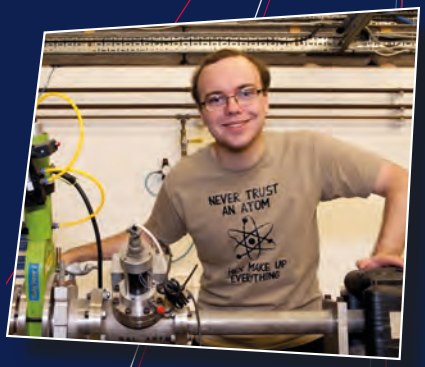
"A knowledge of physics lets you do things that could only otherwise be considered magic. Levitating frogs, making objects appear and disappear, even looking back at the beginning of the universe! At Oxford you are taught by world leaders, the very best and brightest minds in their fields. If you don't understand a textbook, there's a good chance the author is here in Oxford to answer your questions." — Ryan



"Physics at Oxford is better than I could ever have imagined it to be. There is so much variety – from thermodynamics lecturers who make the topic hilarious, to learning about the seemingly mad effects caused by special and general relativity. The course is both challenging and exciting, and the opportunities available to students are mindblowing." — Lauren

"Studying Physics at Oxford is brilliant: not only does it equip you with the tools to understand and pick apart this fascinating subject, but it trains your brain to attack all manner of problems in an efficient and intelligent way. There is an expansive amount of resources available to support your learning, ranging from your college library, to getting insights from some of the leading world experts in their field." — Toby

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