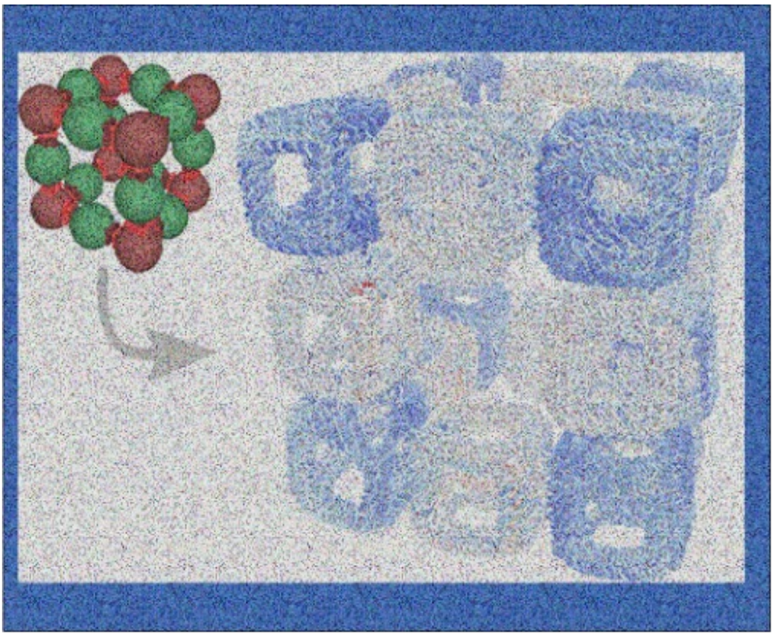
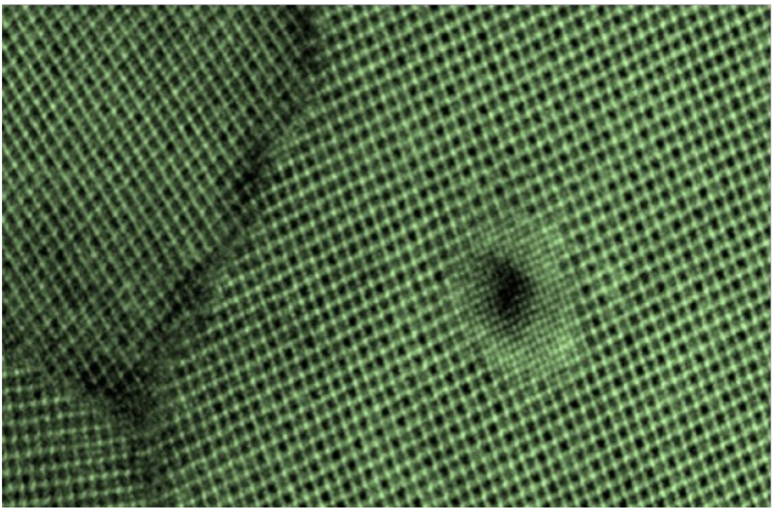
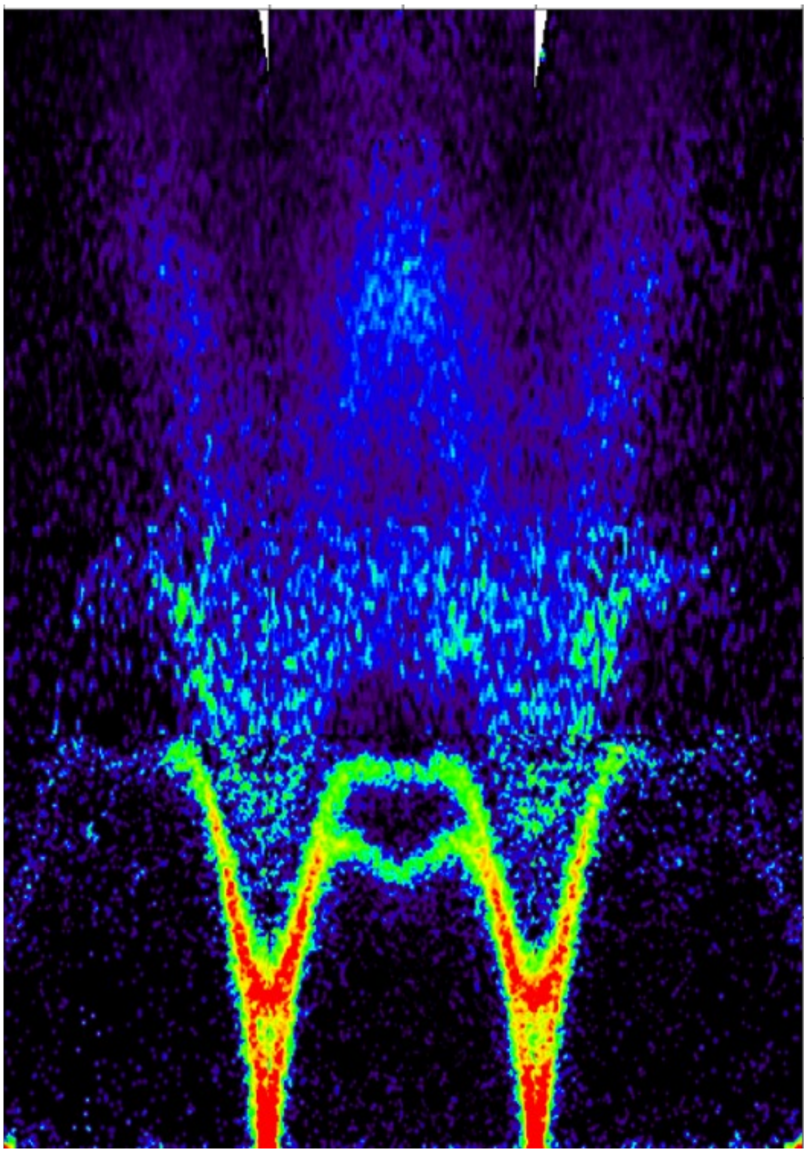
Department of Physics

UNIVERSITY OF OXFORD







DPhil in Condensed Matter Physics
Graduate prospectus

Admissions for academic year 2024-25

Content

About the course

General information

The DPhil[1] in Condensed Matter Physics (CMP) is a research-based three- to four-year course, with a taught element in the first year. You will be supervised throughout the entire duration of the programme and join the research group of your supervisor. There will usually be opportunities to attend conferences and conduct experiments, both in the extensive research facilities of the Clarendon Laboratory and at other institutions inside or outside the UK, such as the Diamond Light Source, the ISIS Facility, the Institut Laue Langevin (Grenoble) and many others. The course is hosted by the Condensed Matter Physics sub-department, one of six sub-departments of the Department of Physics, with most facilities and offices located in the Clarendon Laboratory.

You will be assigned to a research group: work on your original research project will start immediately and continue for the duration of your DPhil.

During the first year, you will be required to attend a number of lectures and courses – see section 'The taught element of the DPhil course' on page 5. In the following years, you will concentrate on your research work.

In exceptional cases, applicants may apply for an MSc by Research degree (MSc by Research in Condensed Matter Physics), which requires a shorter enrolment period. Please contact the CMP graduate administrator for further information and advice about admission to this course.

Further information about this course can be found on the course page on the department website.

The taught element of the DPhil Course

During the first year, you will be required to attend a number of lectures and courses to increase your basic and specialist physics knowledge and in preparation for the research you will carry out. This taught element is tailor-made for the individual student, and will be agreed between you and your supervisor, with the approval of

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[1] DPhil (*Doctor Philosophiae* or Doctor of Philosophy) is the Oxford abbreviation for the PhD degree (*Philosophiae Doctor*).

the Director of Graduate Studies. A system of credits is used to ensure students have received sufficient training.

The following list provides examples of courses/seminars offered over the past 3 years[2].

Course / Seminar	Lecturers	Credits	Term
Symmetry in Condensed Matter Physics	Paolo G. Radaelli & Radu Coldea	3	MT
Organic Electronics and Semiconductor Devices	Henry Snaith and Nakita Noel	3	MT
Lectures/problems from the 4th year MPhys and MMathPhys course	Depends on course	Varies	MT, HT, TT
Journal Club	Alexy Karenowska & David Keen	1	HT
Probability, Statistics & Data analysis	Steve Biller (Particle Physics)	3	MT
Leading Edge Experimental Techniques	Different lecturer each week	-	HT
Condensed Matter Physics Seminars	Varies	-	MT, HT, TT
Biophysics Seminars	Varies	-	MT, HT, TT
Perovskite Day	Academics from the Perovskite Groups.	1	Varies

[2] The department cannot guarantee that a particular course will be offered in a given year.

In the following years, DPhil students will focus mainly on their research, but are strongly encouraged to take part in further courses, including a rich palette of transferable skills courses offered by the University, and attend seminars and colloquia in the Department of Physics and elsewhere. Some research themes organise workshops and away days, specifically designed to give DPhil students the opportunity to present their research to a broader audience[3]. Poster and oral presentations are also part of the ongoing student assessment (see below).

Students are encouraged to present their work at national and international conferences (see page 33 for information about travel costs and funding) and take part in national events, such as the STEM for Britain conferences, hosted in the UK Houses of Parliament, which give students the opportunity to speak to MPs about their research.

Research and projects

You will be assigned a specific research project, which can evolve during the course of your DPhil. A list of research projects on offer in the three research themes of the Condensed Matter Physics sub-department (Quantum Materials, Biological Physics and Photovoltaics and Nanoscience) can be found on the course pages on the department website[4]. Please note that not all projects may be available at the time of your application.

Supervision

The allocation of graduate supervision for this course is the responsibility of the Department of Physics and it is not always possible to accommodate the preferences of incoming graduate students to work with a particular member of staff. Under exceptional circumstances a supervisor may be found outside the Department of Physics.

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[3] These are usually announced on the relevant Research Theme web site and, in some cases, are open to students from other universities.

[4] Projects are updated frequently – please check the web site for the latest updates.

Many DPhil students are co-supervised by a University member of staff, usually from Physics or another Department within the University. Some schemes, such as the Joint Max Planck Training Programme in Quantum Materials (see full description of this programme on page 39) or the Large-Scale Facility studentships (e.g., the Diamond Doctoral Studentship Programme[5]) require a co-supervisor from outside the University (see course page on the department website for details). In all these cases, your main University supervisor will at all times be responsible for your progress and for ensuring that the Project is of suitable content and level to satisfy the normal expectations of a DPhil at the University.

The frequency of student-supervisor meetings varies depending on the nature of the project; students should expect to interact with supervisors regularly, e.g. weekly or, in some cases, monthly. Most supervisors run an extended research group, including several DPhil students and post-docs, who interact very frequently (often on a daily basis). New students will also be welcome in the wider Oxford Physics community, currently hosting over 500 DPhil students, with multiple opportunities for mutual support and social interactions.

You are *strongly encouraged* to contact potential supervisors for further information.

Assessment

At the end of the first year, you are expected to submit a report on your research and to defend it in an interview with a member of the Graduate Studies Panel and a specialist reader. These assessors will determine whether you can transfer status from Probationer Research Student (PRS) to DPhil student.

Towards the end of the second year, you will present a poster in an open session, attended by the Graduate Studies Panel and many members of the Condensed Matter Physics sub-department.

During the third year, you are expected to give a 20 minute talk about your research, attended by the Graduate Studies Panel and many members of the Condensed

[5] https://www.diamond.ac.uk/Careers/Students/Studentships.html and https://www.isis.stfc.ac.uk/Pages/ISIS-Facility-Development-Studentships.aspx

Matter Physics sub-department, and to answer questions following your presentation.

Both the poster session and third year talks will provide an opportunity to practice presenting your work in a conference-like setting.

In your third year you will be expected to confirm your status as DPhil student. This will involve an interview with the Graduate Studies Panel, focussing on your current results and your thesis completion plans.

You will be expected to submit a substantial original thesis after three or, at most, four years from the date of admission. To be awarded a DPhil, you will need to defend your thesis orally (*viva voce*) in front of two appointed examiners (one internal and one external). Most students will have published one or more original research papers by the time they are awarded a DPhil.

Graduate destinations

Candidates for a DPhil in Condensed Matter Physics will have demonstrated a strong grounding in the relevant physics foundations, combined with experimental and analytical skills (e.g., the ability to design their own experiments to test hypotheses), strong motivation and resilience and the ability to manage their workload independently, often under time pressure – all qualities that are much sought after by potential employers. Therefore, a DPhil in Condensed Matter Physics serves as a broad high-level qualification, providing a springboard for a variety of careers in research and beyond. Past students have found careers in academic and industrial research organisations, the financial sector, information technology, consultancy, media etc. Some go on to further training in, for example, medicine and law.

Changes to this course and your supervision

The University will seek to deliver this course in accordance with the description set out in this prospectus. However, there may be situations in which it is desirable or necessary for the University to make changes in course provision, either before or after registration. The safety of students, staff and visitors is paramount and major changes to delivery or services may have to be made in circumstances of a pandemic (including Covid-19), epidemic or local health emergency. In addition, in certain circumstances, for example due to visa difficulties or because the health needs of students cannot be met, it may be necessary to make adjustments to course requirements for international study.

Where possible, your academic supervisor will not change for the duration of your course. However, it may be necessary to assign a new academic supervisor during the course of study or before registration if there are unforeseen circumstances.

For further information please see our page on changes to courses and the provisions of the student contract regarding changes to courses.

Our scientific themes

Biological Physics

Biologically inspired physics is an extraordinarily wide field, covering the behaviour of systems from single-molecule machines to organisms, ecosystems and evolution. We use the tools of physics to address biological problems and we use biology to create new tools of physics. Our work at the interface between disciplines impacts medicine and healthcare as well as the biological and physical sciences and industry.

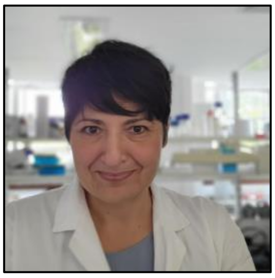
Most of our experimental biophysics research is based in the Kavli Institute for Nanoscience Research in a state-of-the-art new building dedicated to high-risk, high-reward research ‘to catalyse discovery by bringing the physical sciences into the cell’. The institute provides shared infrastructure and brings together collaborating groups from across physical and life sciences in Oxford.

For more information, please visit the Biological Physics web pages and the project list (frequently updated – please visit us often).

Biological Physics Topics

- Biomolecular motors and machines
- Ion channels
- Biomechanics
- Statistical physics and simulation of biological systems
- Development of novel single-molecule biophysical methods

Biological Physics Supervisors



Sonia Antoranz Contera

My research is in physics at the interface of biology, nanotechnology, and information processing. I am an expert in atomic force microscopy of biological systems and I have a special interest in the role of mechanics in biology. My interest in matter at the nanometre scale, particularly in understanding the profound physical meaning of “biological shape and in the study of the physics of “biological growth” in diverse systems such as plants, and tumours.

Richard Berry

My research group works on the physics of the Large Molecular Machines that perform most of the essential processes of life. We currently focus on Rotary Molecular Motors, in particular the Bacterial Flagellar Motor and F1FO ATP-synthase. The aim is to try and understand how these living machines work. We use a range of techniques, including novel forms of light microscopy to follow visible "handles" such as sub-micron gold or polystyrene spheres and rods, and single fluorescent molecules. Optical tweezers (3-D laser traps) and magnetic tweezers are used to push single motors around. Single-molecule fluorescence microscopy is used to detect separate components of the motors and assess how they interact with each other. We also develop new techniques in fields including medical diagnostics, digital holographic microscopy, lipid bilayer systems for single-molecule microscopy and synthetic biology.

Dominika Gruszka

In eukaryotic cells, DNA is packaged into chromatin and partitioned into structurally- and functionally-distinct regions that define cellular identity. My research group seeks to understand how these discrete chromatin structures are maintained during genome duplication. For DNA replication to occur, all chromatin structures must be transiently disrupted and reorganised. We combine single-molecule imaging with chemical and physical approaches to uncover the molecular mechanisms underpinning chromatin restructuring during DNA replication. On this mechanistic basis, we can better understand how genome replication operates in heathy cells and when it malfunctions in diseases, such as cancer.

Achillefs Kapanidis

Our research group studies **"Gene Machines"**, fascinating proteins that work on DNA and RNA to convert genetic information into functional proteins and nanoscale sensors. We are especially interested in deciphering the mechanisms of RNA polymerases of pathogenic bacteria and viruses. We study how these machines work by visualising molecular motions from the sub-nanometre to multi-microns scale in real-time. We are passionate about capturing such motions at the level of single molecules, even when our favourite machines function inside a living cell. This quest requires sophisticated fluorescence microscopes that find different ways to break the diffraction limit (e.g., using high precision localisation of individual fluorescent molecules). Equally, our work relies on a team effort, a "can-do" attitude, and an interdisciplinary approach that involves physics, (bio)chemistry, microbiology, modelling, and signal/image analysis (with emphasis on machine learning). Finally, we develop new tools that can improve biomedicine and healthcare; our recent efforts focus on rapid detection of viruses (influenza, coronavirus) and antimicrobial resistance in the clinic.

Stephen Tucker

Every cell in the body is electrically active - this behaviour is controlled by protein nanopores within the cell membrane that control the flow of charged ion into an out of the cell. Our research is focused on understanding the relationship between the 3D structure of different ion channels and their function. We aim to understand how ion channels open and close in response to different signals, and how their pore properties allows them to control the permeation of different ions. In particular, we are interested in how these various properties become defective in the disease state. Such questions require an interdisciplinary approach and so we employ a variety of computational, biochemical and biophysical tools to study these processes.

Quantum Materials

In many of today's most interesting materials strong interactions prevail upon the magnetic moments, the electrons and the underlying crystal structure, often forming strong links between these different aspects of the system. Such materials can exhibit exciting physical phenomena whose description requires new quantum mechanical models to be developed. Examples include superconductors, magnets, topological insulators, and multiferroics. Several research groups within the Department of Physics are actively studying quantum matter, exposing a variety of materials to different experimental techniques in order to gain a better understanding of quantum theories of matter and to exploit the findings for the next generation of functional materials and devices. We work collaboratively with groups in theoretical physics, chemistry, materials science and experimental physics both within Oxford and beyond.

The Quantum Materials theme is a partner in the Joint Oxford-Max Planck graduate training programme in quantum materials (see full description on page 39).

For more information, please visit the Quantum Materials web pages and the project list (frequently updated – please visit us often).

Quantum Materials Topics

- Magnetism
- Materials Development
- Multiferroics
- Spin systems
- Superconductivity
- Topological materials
- Experimental techniques
  - Electron spin resonance
  - High magnetic fields
  - Muon spin rotation
  - X-ray scattering
  - Neutron scattering
- Materials of interest
  - Complex oxides
  - Iron-based superconductors
  - Organic and molecular systems

Quantum Materials Supervisors

Arzhang Ardavan

My research is concerned with quantum phenomena in condensed matter ranging from strongly-correlated electron systems to molecular magnets, using techniques including electronic and thermal transport and spin resonance. I am currently working on fluctuating superconducting states, surface states of Kondo insulators with non-trivial topology, spin-electric couplings in molecular systems, and molecular quantum electronic devices assembled using DNA.

Mustafa Bakr

My research focuses on addressing the challenges of developing a Noisy Intermediate Scale Quantum (NISQ) machine. In particular, my current interest focuses on developing theoretical tools, design techniques and experimental prototypes of high coherent superconducting quantum circuits at scale. This includes the utilisation of advanced electrical circuit synthesis and filtering techniques to suppress unwanted interactions in many-qubit couplings, improve the speed and fidelity of two-qubit entangling gates, and develop frequency multiplexing methods to enable control and readout of large qubit arrays. I am also interested in research projects in numerical methods in electromagnetics and in understanding how lightning strikes are started and other physical science phenomena.

Stephen Blundell

My research is concerned with using muon-spin rotation and other magnetic techniques to study a range of organic and inorganic materials, particularly those showing interesting magnetic, superconducting, or dynamical properties. Recently I have been developing a technique called DFT+μ for understanding muon sites and also working on a project to upgrade Oxford's Pulsed Field system to generate high magnetic fields. My home page can be found on http://users.ox.ac.uk/~sjb

Andrew Boothroyd

My research exploits neutron and x-ray scattering methods to study quantum materials, including superconductors and various types of magnetic materials. Recently we have been focussing on magnetic topological insulators and semimetals. The experiments aim to probe the atomic-scale structural and magnetic correlations which are responsible for the observed physical characteristics of the materials. We compare the results with appropriate theoretical models in order to interpret the data. Underpinning the experimental programme is the growth of single crystals by a variety of methods, including the floating-zone technique in image furnaces, flux growth, and chemical vapour transport.

Yulin Chen

My research interest lies in experimental condensed matter physics, including understanding the behaviour of electrons in unconventional materials such as topological quantum matter and strongly correlated systems. I'm also interested in developing advanced instrumentation that will drive the exploration of critical information on condensed matter systems with new degrees of freedom.

Amalia Coldea

My research aims to probe experimentally the physics emerging in novel materials as result of the strong correlations between electrons. In particular, my current interest focuses to understand the electronic structure of iron superconductors, metallic systems on magnetically frustrated lattices and topological superconductors by using quantum oscillations, which probe directly the Fermi surface of metallic systems or novel superconductors and provide the basis for developing novel materials and theories. I use a variety of sensitive experimental techniques in high magnetic fields and low temperatures to probe new phases of matter in micron size crystalline materials. My research benefits from access to the highest magnetic fields available in the world and strong international collaboration with material scientists, chemists and theoreticians.

Radu Coldea

My research explores the experimental manifestation of cooperative quantum effects in strongly-interacting electron materials in novel regimes of “strong frustration” and “quantum criticality”, when electrons are “on the verge” of order. We probe the microscopic electronic states directly using neutron and synchrotron x-ray scattering on single crystals, combined with magnetometry and in-house heat capacity at mK temperatures and high magnetic field to drive quantum phase transitions. Of recent interest are quantum materials with strong correlations and spin-orbit coupling, where we have discovered unconventional forms of magnetic order and/or spin dynamics, and magnetic quasiparticles with topological properties.

Dharmalingam Prabhakaran

My research interests encompass the synthesis of novel quantum materials, ranging from wet chemistry to advanced crystal growth techniques. These techniques include flux, hydrothermal, Bridgman, top-seeded solution growth, chemical vapor transport, and optical floating zone methods. Currently, my primary focus is on the bulk growth of frustrated magnetic oxides, multiferroics, topological insulators, and superconducting materials. I also study their structural, magnetic and electrical transport properties using both in-house and central facilities.

Seamus Davis

My research concentrates upon the fundamental physics of exotic states of electronic, magnetic, atomic and space-time quantum matter. A specialty is development of innovative instrumentation to allow direct atomic-scale visualization or perception of the quantum many-body phenomena that are characteristic of these states. Present projects include studies of: the electron-pair density wave state in superconductors, orbital ordering in correlated metals, the microscopic mechanism of CuO_2 superconductivity, order parameters in spin-triplet (topological) superconductivity, the mechanism of metallicity in Kondo insulators, the transport mechanism in magnetic monopole fluids, and dissipation in quantum spin liquids. (see full description of this programme on page 39).

John Gregg

My research group works with Magnonics (the study and application of spin waves in magnetic materials), with a specific emphasis on developing microwave devices to form the basis of replacement hardware for present-day silicon electronics. Magnonic-based electronics offers 3 orders of magnitude less heat dissipation than silicon for the same task and potential device speeds are into the TeraHertz. In parallel, we work on novel computing paradigms for next-generation information technology that exploit the unusual properties and versatility of Magnonics. We collaborate with two European centres of excellence (Université de Lorraine á Nancy and Technische Universität Kaiserslautern) on Antiferromagnetic Magnonics and Magnonic Neuromorphic Computing. As a separate endeavour, we hold a patent on a novel, low-cost renewable energy generator and work in collaboration with NetHope, Save the Children, EireComposites and Oxford University Innovation to bring low-cost energy to some of the poorer regions of Somalia.

Thorsten Hesjedal

My research focuses on the growth of topological and magnetic materials in the form of thin films and of nanostructures using molecular beam epitaxy, sputtering, and chemical vapor deposition, and their structural, magnetic, and electrical exploration. Further, I am interested in developing tools for the advanced characterization of topological magnetic systems at synchrotron light sources and neutron facilities.

Moon-Sun Nam

I study the properties of fluctuating superconductors near the Mott limit and modified surface states of topological insulators using thermal and electrical transport experiments. Also, I am interested in device fabrication and gating surface states using ionic liquid electrolyte gels.

Paolo G. Radaelli

My research focusses on the study of novel quantum materials with the potential for integration in a new generation of fast, non-volatile memories and other electronic devices. The current emphasis is on magnetic oxides which can be controlled by electric fields and on system harbouring topological textures (‘magnetic vortices’). Another key component of my programme involves manipulating matter with light pulses. Projects in this field are carried out in collaboration with the Max Planck - MPSD in Hamburg, and are offered in the context of the Joint Oxford-Max Planck graduate training programme in quantum materials (see full description of this programme on page 39).

Photovoltaics and Nanoscience

We are working on next-generation technology that has the potential to change the way we live our lives. Our work with photovoltaics focuses on establishing renewable energy sources to meet the pressing needs of the expanding world population while our work with nano-sized and nano-structured semiconducting materials will be central to the development of novel electronic and photonic devices.

Photovoltaics

The expanding world population has made the supply of renewable energy sources a pressing area of current research. We are working on the development of next-generation solar cells, with particular emphasis on:

- metal halide perovskite semiconductors
- carbon-based semiconductors
- high-efficiency multi-junction solar cells
- new approaches to harnessing the Sun's energy
- generation of new active materials for PV through synthesis, characterisation and implementation into devices.

Nanoscience

Semiconducting materials often change their properties dramatically when the material dimensions are reduced to the nanometre length range. We are interested in the optical, electronic and morphological properties of nano-sized and nano-structured semiconducting materials, such as:

- carbon nanotubes, graphene and van der Waals 2D materials
- inorganic semiconductor nanowires and quantum dots
- molecular nanowires
- nanoporous metal-oxide materials

We also work on the development of these nanostructures into novel electronic and photonic devices.

For more information, please visit the Photovoltaics and Nanoscience web pages and the project list (frequently updated – please visit us often).

Photovoltaics and Nanoscience Supervisors

Marina Filip

My field of research is in First Principles Computational Modelling of Materials. My research expertise extends across various first principles methods, including density functional theory, density functional perturbation theory and many-body perturbation theory. I use state-of-the-art computational modelling techniques and high-performance computing architectures to understand structural, electronic, and optical excitations in complex semiconductors, design strategies to engineer properties and discover new materials for optoelectronic applications. I am also interested in the development of new first principles methods to better understand light-matter interactions in complex optoelectronic materials. My research is highly collaborative, and interdisciplinary, branching across Condensed Matter Physics, Materials Science and Chemistry.

Laura Herz

My research explores the fundamental science and applications of semiconducting materials and nanostructures ranging from hybrid systems such as sensitized metal oxides and organic-inorganic perovskites to organic molecules and solids, III-V inorganic semiconductors and nanostructures. Current work focuses on common themes such as photophysical and nano-scale effects, biomimetics and self-assembly, charge-carrier dynamics, energy-transfer and light-harvesting for solar energy conversion. The group has leading expertise in a large range of spectroscopic and analytical techniques, and collaborates with device physicists, theoretical researchers, synthetic chemists and materials scientists in order to advance the development of these novel materials for energy harvesting, with a particular current focus on next-generation photovoltaic cells.

Michael Johnston

My research group specialises on semiconductor physics, photovoltaics and terahertz photonics. We develop THz methods to study the electronic properties of nanomaterials, create new high efficiency vapour-deposited solar cells and invented novel THz emitters, modulators and receivers. Our current research may be divided into three themes (i) Semiconductor nanowires (ii) Terahertz photonic technologies and (iii) Vapour deposited Perovskite materials for photovoltaic applications.

Nakita Noel

My research sits at the intersection of chemistry, solid-state physics and materials science, and is geared towards developing insight into the fundamental processes governing thin-film crystallisation and defect formation in solution-processable semiconductors. In this vein, my current focus is understanding the solution chemistry and colloid physics of halide perovskite precursor inks, and how the nature of these inks affect the crystallisation kinetics and optoelectronic properties of the resultant thin-films. Generating these insights will allow the field to further improve the quality of the existing materials, as well as provide important guidelines for developing new solvent systems and deposition modalities for of this exciting class of materials. The overarching goal is to leverage the fundamental chemical insights gained into practical applications, namely the development of high-performance perovskite solar cells and LEDs.

Moritz Riede

My research interests are renewable energies and energy policy in general and organic solar cells in particular (although there are admittedly sunnier places than the UK...). Emerging solar cell technologies create only a fraction of the greenhouse gas emissions compared with current silicon solar cells, and have the potential to become the cheapest form for providing electricity globally. Our solar cells are based on abundant non-toxic raw materials, can be made light like cardboard, come in different colours (green, blue, red etc.), are flexible such they can be rolled up like a newspaper and, at the end of their lifetime, pose no waste issues. We focus on the research that is needed to make this technology successful in a real-world commercial, environment.

Henry Snaith

My research focuses on developing and understanding new materials and device concepts for photovoltaic solar energy conversion. His research group work with organic, metal oxide and metal halide perovskite semiconductors, processed via solution or vapour phase deposition methods. This inter-disciplinary work ranges from new material synthesis and discovery, device fabrication and development, advanced characterisation methodologies and theoretical modelling. I am also a co-founder and CSO of two spin-out companies, Oxford PV Ltd and Helio Display Materials Ltd., which commercialise metal halide perovskites for PV and light emitting applications respectively.

Robert Taylor

My main research interests are in making optical measurements on wide-bandgap semiconductors and low-dimensional systems such as quantum dots, wires and wells. Topics currently being investigated include the generation of single photons in the blue, coupling of quantum dot emission at telecom wavelengths to photonic crystals, coupling of various quantum emitters to discrete cavities. Past work focussed on coherent electron-hole dynamics, excitonic dynamics in wide band gap materials such as GaN and InGaN, and gain mechanisms in bulk and quantum well lasers.

Entry requirements for entry in 2024-25

Before you apply

The Condensed Matter Physics Sub-department plans to hold a virtual Graduate Information Day. Prospective candidates are invited to attend, and will have the opportunity to meet potential supervisors and ask questions. Prospective applicants are also strongly encouraged to read the projects on offer and look at the research portfolio of potential supervisors – both can be found on the on the course page on the department website.

When to apply

Although DPhil applications are assessed throughout the year, most funding decisions are made between January and March. If you are seeking funding for your DPhil, you are *strongly encouraged* to apply before the early January deadline. Please note that the Joint Oxford-Max Planck graduate training programme in quantum materials has separate deadlines (see full description of this programme on page 39).

How to apply

Applications are handled centrally by the University, and are made by filling out an online application form and providing the requested supporting material. A complete guide on how to apply can be found here. As part of your application, you will also indicate a preference for a college, though you may not get your first choice. The following page provides guidance on choosing a college.

Your application: providing evidence of academic excellence and potential

Degree-level qualifications

As a minimum, applicants should hold or be predicted to achieve the following UK qualifications or their equivalent:

- a first-class or strong upper second-class undergraduate degree with honours in physics or another relevant science.

- The equivalent of a UK four-year integrated MPhys or MSci degree is typically required. Bachelor's degrees with a minimum four years' standard duration may satisfy the entry requirements.

Entrance is very competitive and most successful applicants have a first-class degree or the equivalent. In exceptional cases, the requirement for a first-class or strong upper-second class undergraduate degree with honours can be alternatively satisfied by a graduate master's degree or substantial directly-related professional or research experience.

For applicants with a degree from the USA, the typical minimum GPA sought is 3.3 out of 4.0. However, selection of candidates also depends on other factors in your application and most successful applicants have achieved higher GPA scores.

If your degree is not from the UK or another country specified above, visit our International Qualifications page for guidance on the qualifications and grades that would usually be considered to meet the University's minimum entry requirements.

GRE General Test scores:
No Graduate Record Examination (GRE) or GMAT scores are sought.

Other qualifications, evidence of excellence and relevant experience

Although none of the following is a strict requirement, it is helpful to include details that may strengthen your application, such as:

- *Details of any publications (if any)*. Note that many candidates with no peer-reviewed publications receive offers each year.
- *Research or professional experience* especially but not exclusively in areas aligned with the proposed supervisors' research interests.
- *Depending on the project, evidence of training in scientific computer programming* or related numerical techniques.
- *Previous experience in a scientific or technical research environment.*

English language proficiency

This course requires proficiency in English at the University's **standard level**. If your first language is not English, you may need to provide evidence that you meet this requirement. The minimum scores required to meet the University's standard level are detailed in the table below.

Test	Minimum overall score	Minimum score per component
IELTS Academic (Institution code: 0713)	7.0	6.5
TOEFL iBT, including the 'Home Edition' (Institution code: 0490)	100	Listening: 22 Reading: 24 Speaking: 25 Writing: 24
C1 Advanced*	185	176
C2 Proficiency†	185	176

* Previously known as the Cambridge Certificate of Advanced English or Cambridge English: Advanced (CAE)

† Previously known as the Cambridge Certificate of Proficiency in English or Cambridge English: Proficiency (CPE)

Your test must have been taken no more than two years before the start date of your course. Our Application Guide provides further information about the English language test requirement.

Declaring extenuating circumstances

If your ability to meet the entry requirements has been affected by the Covid-19 pandemic (eg you were awarded an unclassified/ungraded degree) or any other exceptional personal circumstance (eg other illness or bereavement), please refer to the guidance on extenuating circumstances in the Application Guide for information about how to declare this so that your application can be considered appropriately.

Supporting documents

You will be required to supply supporting documents with your application, including references and an official transcript. See 'How to apply' for instructions on the documents you will need and how these will be assessed.

Indicating your preference for projects and supervisors

Although a final decision on your preferences for supervisors and projects is not required until after your interview, in your application you should indicate your areas of interest in the wider field of Condensed Matter Physics and any supervisor/project you are particularly interested in working with.

Admissions panels and assessors

All recommendations to admit a student involve the judgement of at least two members of the academic staff with relevant experience and expertise, and must also be approved by the Director of Graduate Studies or Admissions Committee (or equivalent within the department).

Admissions panels or committees will always include at least one member of academic staff who has undertaken appropriate training.

Please note that the Joint Oxford-Max Planck graduate training programme in quantum materials operates a different admission policy (see full description of this programme on page 39).

How your application is assessed

Your application will be assessed purely on academic merit and potential, according to the published entry requirements for the course. The *After you apply* section of the Oxford Admission website provides further information about the academic assessment of your application, including the potential outcomes. Please note that any offer of a place may be subject to academic conditions, such as achieving a specific final grade in your current degree course. These conditions may vary depending upon your individual academic circumstances.

Students are considered for shortlisting and selected for admission without regard to age, disability, gender reassignment, marital or civil partnership status, pregnancy and maternity, race (including colour, nationality and ethnic or national origins), religion or belief (including lack of belief), sex, sexual orientation, as well as other relevant circumstances including parental or caring responsibilities or social background. However, please note the following:

Socio-economic information may be taken into account in the selection of applicants and award of scholarships for courses that are part of the University's pilot on selection procedures and for scholarships aimed at under-represented groups:

- Country of ordinary residence may be taken into account in the awarding of certain scholarships; and
- Protected characteristics may be taken into account during shortlisting for interview or the award of scholarships where the University has approved a positive action case under the Equality Act 2010.

Further information about processing special category data for the purposes of positive action and information about using your data to assess your eligibility for funding, can be found in our Postgraduate Applicant Privacy Policy.

Panel interview

Interviews are normally held as part of the admissions process and following a pre-selection based on the application.

If you are a UK or EU candidate, you will be invited to attend a personal interview in Oxford, though acceptance is not mandatory. If you are a candidate from outside the EU or if you prefer the virtual format, the interview will be conducted via video conference. Information about the planned interview dates can be found on the Condensed Matter Physics webpages for prospective students.

Matching applicants to funding and supervision

Any offer of a place is dependent on the University's ability to provide the appropriate supervision for your chosen area of work – please refer to the 'About' section of this page for more information about the provision of supervision for this course. Fully or partially funded offers will also be contingent upon the University's ability to match available sources of funding with eligible students. For this reason, you may initially receive an unfunded offer, with confirmation of funding being provided later if funding becomes available.

After an offer is made

If you receive an offer of a place at Oxford, your offer letter will give full details of your offer and any academic conditions, such as achieving a specific final grade in your current degree course. The offer letter will state whether you are offered any funding. If the University is still trying to secure funding, you will be told when you can expect to hear the outcome of this process. Once funding is confirmed, you will receive a separate letter detailing the specific conditions attached to it.

Financial Declaration

If you are offered a place, you will be required to complete a Financial Declaration in order to meet your financial condition of admission.

Disclosure of criminal convictions

In accordance with the University's obligations towards students and staff, we will ask you to declare any relevant, unspent criminal convictions before you can take up a place at Oxford.

Academic Technology Approval Scheme (ATAS)

Some postgraduate research students in science, engineering and technology subjects will need an Academic Technology Approval Scheme (ATAS) certificate prior to applying for a Tier 4 visa. Further information can be found on our Tier 4 (General) Student visa page. For some courses, the requirement to apply for an ATAS certificate may depend on your research area.

Resources

Academic resources

The Clarendon Laboratory has extensive experimental facilities for research in Condensed Matter Physics, and most DPhil will have the opportunity to access the appropriate facilities for research in their field. These include

- The nanofabrication facility
- The crystal growth laboratory
- The Centre for Applied Superconductivity laboratory
- The magnetic characterisation suite
- The MBE facility for epitaxial thin films and multilayers
- The X-ray diffraction laboratory
- The Nicholas Kurti High Magnetic Field Laboratory
- The Atomic Force Microscopy Laboratory
- facilities for protein expression, cell culture and biophysical measurements

More details and a full description of these facilities can be found on the Condensed Matter Physics webpages for prospective students and the facilities webpages on the departmental web site.

DPhil students have access to the Radcliffe Science Library, which also provides extensive on-line services, including access to most relevant journals in the field of Condensed Matter Physics.

Non-Academic resources

There is a range of welfare and academic support available in the Department. Your supervisor, the Director of Graduate Studies, and Graduate Administrator are all available to offer support. There are also several support networks in Physics, all of which are available to our graduate students.

- Oxford Physics Gender Equity Network (OPGEN), which is run by a committee drawn from across the students, academics and staff in the Department of Physics and organises events and campaigns to promote gender equity in the department.
- The Graduate Liaison Committee (GLC). The GLC's purpose is to discuss issues that may concern graduate students in the department such as the quality of

graduate courses, availability of skills training, accessibility to library and IT services, and general student welfare
- Physics Thrive, which provides informal advice and mentorship from academic and staff members.
- The Graduate Peer Support Network, which provides support from other DPhil students on a variety of issues.

The Physics Department and Oxford University are striving to tackle a range of issues affecting minorities and other underrepresented groups and to promote and sustain an inclusive culture where diversity is valued and equity prevails. For example, the Physics Department has a Race action plan and the Mathematical, Physical and Life Science Division (MPLS, of which Physics is a member) has a Race Equality Task force. We support Lesbian, Gay, Bisexual, Transgender and Queer (LGBTQ+) staff and students. We strongly encourage applications from students with disabilities (including neurodivergence) and provide support for them at divisional and University level.

Mental health and wellbeing

Mental health first aiders are an initial point of contact for students experiencing a mental health issue or emotional distress. They are members of staff of our department, and have completed a two-day mental health first-aid training course, accredited by Mental Health England. They are trained to recognise the symptoms of mental ill health, provide initial help and guide a person towards appropriate professional help. Mental Health First Aiders are not trained to be therapists, but they are taught how to respond in a crisis.

In addition to the resources available within the Department, there is additional support available via the Oxford University Student Union (OUSU) and your college.

OUSU's Student Advice Service also provides a confidential and impartial listening and advice service, and the University has a professionally staffed confidential Student Counselling Service for assistance with personal, emotional, social and academic problems.

Additional support in your College

There is an extensive framework of support for graduates within each college. Your college will allocate to you a College Advisor from among its Senior Members, usually in a cognate subject, who will arrange to see you from time to time and whom you may contact for additional advice and support on academic and other matters. In college you may also approach the Tutor for Graduates and/or the Senior Tutor for advice. The Tutor for Graduates is a fellow of the college with particular responsibility for the interests and welfare of graduate students. In some colleges, the Senior Tutor will also have the role of Tutor for Graduates. Each college will also have other named individuals who can offer individual advice.

Funding and Costs

University and College scholarships

The University expects to be able to offer around 1,000 full or partial graduate scholarships across the collegiate University in 2024-25. Funding is also available from Research Councils (UKRI) and other sources. The current level of Research Councils support for graduate students can be found on the UKRI web site. Information about the cost of living in Oxford can be found below.

You will be **automatically considered for the majority of Oxford and Research Council scholarships**, if you fulfil the eligibility criteria and submit your graduate application by the relevant January deadline. Most scholarships are awarded on the basis of academic merit and/or potential.

For further details about searching for funding as a graduate student visit our dedicated Funding pages, which contain information about how to apply for Oxford scholarships requiring an additional application, details of external funding, loan schemes and other funding sources.

Some colleges also offer full or partial funding for graduate scholarship. Most college scholarships are centrally coordinated and you will be **automatically considered for the majority of Oxford and Research Council scholarships**, if you fulfil the eligibility criteria and submit your graduate application by the relevant January deadline. Most scholarships are awarded on the basis of academic merit and/or potential.

You will be automatically considered if you are eligible, but please ensure that you visit individual college websites for details of any college-specific funding opportunities using the links provided on our college pages (please note that not all the colleges listed above may accept students on this course.)

Further information about funding opportunities for this course can be found on the department's website.

Costs

Some prospective applicants have access to scholarships from outside the University or are in the position to fund their own studies. Although all applications are evaluated with the same rigorous academic conditions, having your own funds may allow you to choose a supervisor or project of your choice. The sections here below details the expected costs for different categories of students, which includes fees and living costs.

Annual fees for entry in 2024-25

Fee status	*Annual Course fees*
Home	£9,500
Overseas	£31,480

Further details about fee status eligibility can be found on the fee status webpage.

Course fees are payable each year, for the duration of your fee liability (your fee liability is the length of time for which you are required to pay course fees). For courses lasting longer than one year, please be aware that fees will usually increase annually. For details, please see our guidance on changes to fees and charges.

Course fees cover your teaching as well as other academic services and facilities provided to support your studies. Unless specified in the additional information section below, course fees do not cover your accommodation, residential costs or other living costs. They also don't cover any additional costs and charges that are outlined in the additional information below.

Following the period of fee liability, you may also be required to pay a University continuation charge and a college continuation charge. The University and college continuation charges are shown on the Continuation charges page.

For more information about course fees and fee liability, please see the fees section of the Oxford Admission website. EU applicants should refer to our detailed fee status information and the Oxford and the EU webpage for details of the implications of the UK's exit from the EU.

Additional information

There are no compulsory elements of this course that entail additional costs beyond fees (or, after fee liability ends, continuation charges) and living costs. However, please note that, depending on your choice of research topic and the research required to complete it, you may incur additional expenses, such as travel expenses, research expenses, and field trips. You may need meet some of these additional costs, though many supervisors and some colleges offer small grants to help you cover part of these expenses.

Living costs

In addition to your course fees, you will need to ensure that you have adequate funds to support your living costs for the duration of your course.

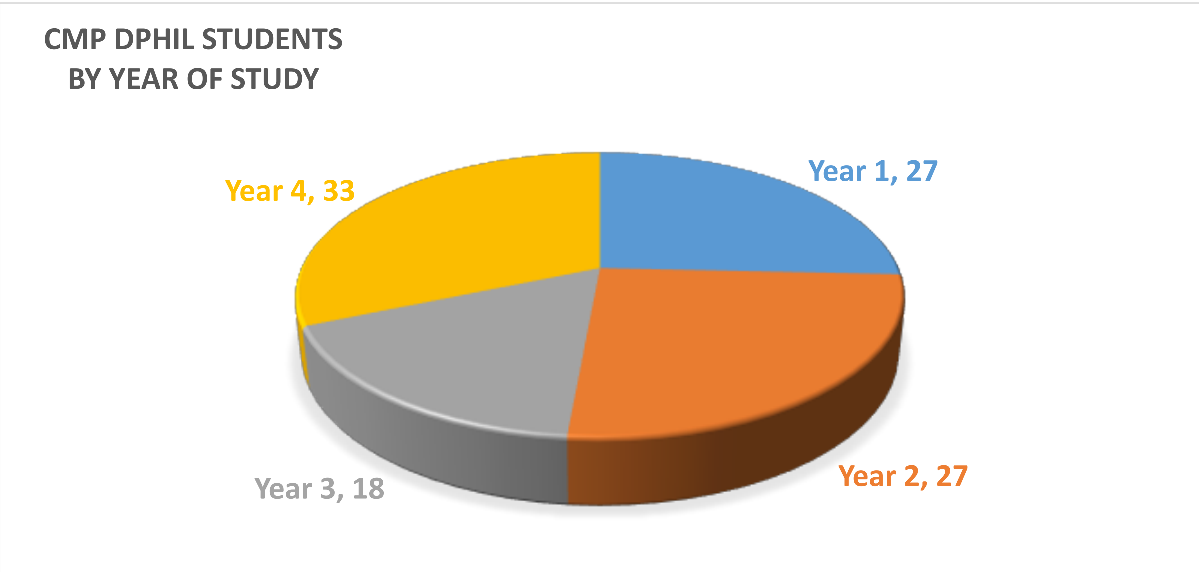
For the 2024-25 academic year, the range of likely living costs for full-time study is between c. £1,345 and £1,955 for each month spent in Oxford. Full information, including a breakdown of likely living costs in Oxford for items such as food, accommodation and study costs, is available on our living costs page. The current economic climate and high national rate of inflation make it very hard to estimate potential changes to the cost of living over the next few years. When planning your finances for any future years of study in Oxford beyond 2024-25, it is suggested that you allow for potential increases in living expenses of around 5% each year – although this rate may vary depending on the national economic situation. UK inflationary increases will be kept under review and this page updated.

The Clarendon environment

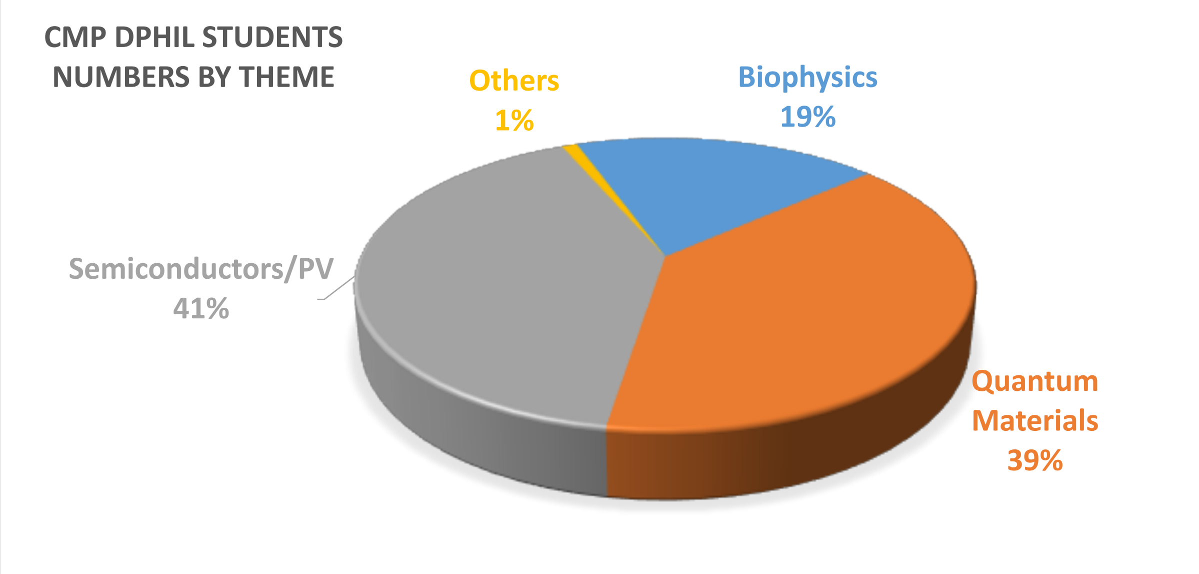
The Oxford Condensed Matter Physics Graduate Community

If you are accepted for an Oxford DPhil in Condensed Matter Physics, you will join a large and vibrant community of students, embedded in an even larger community of ~500 Oxford Physics DPhil Students. We firmly believe that interacting with your peers working in different subfield of physics will be one of the most valuable aspects of your Oxford experience.

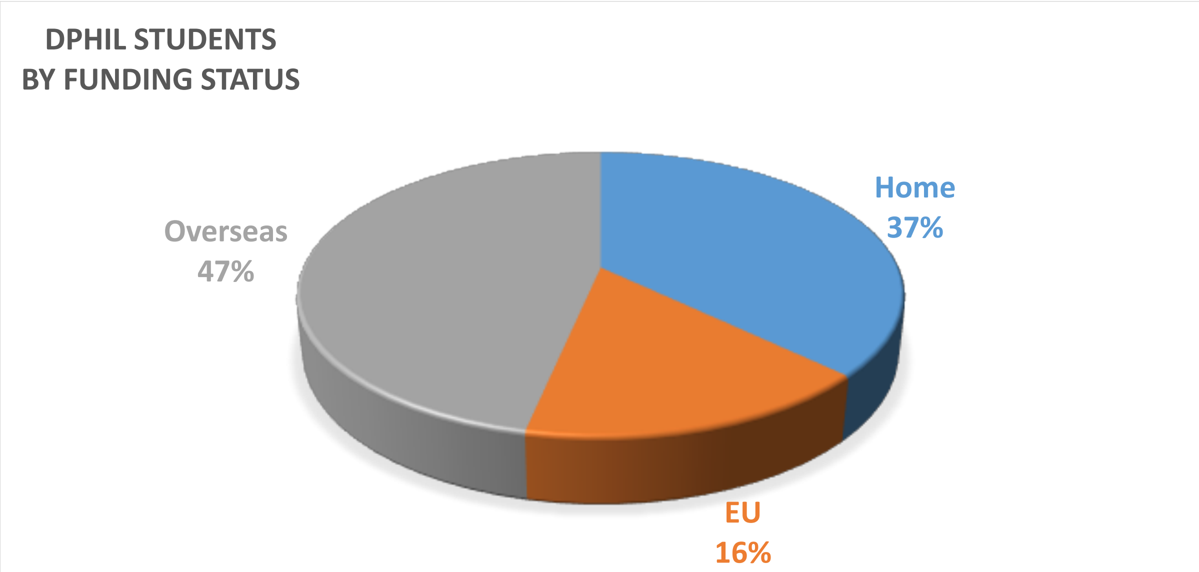
Currently, 105 students are enrolled in the Condensed Matter Physics DPhil programme. Most students complete their degree within 4 years, though a few take a bit longer (these are still included in the "Year 4" tally in the chart here below).



The Semiconductors/PV theme is the largest in terms of student numbers (41%), followed by Quantum Materials and Biological Physics.



Our community is very international, with large contingents of EU and Overseas students.



Laboratory infrastructure

Condensed Matter Physics operates extensive laboratory infrastructures, distributed between the historic Clarendon Laboratory, and two new state-of-the art buildings: the award-winning Beecroft Building (hosting Quantum Materials and Biological Physics research) and the Kavli Institute for Nanoscience Research (hosting Biological Physics research). We also host the newly-commissioned National Thin-Film Cluster Facility for Advanced Functional Materials (mainly for Photovoltaics and Nanoscience) and state-of-the-art laboratories for research in photovoltaics. Many of these laboratories (e.g., the X-rays, the Materials Characterisation, High Magnetic fields, Nanofabrication Suite, Scanning Probe Microscopy) are run as Small Research Facilities, and are accessible to all DPhil students who require them, with full training being provided. Other laboratories are more specific to individual groups

An external view of the Clarendon Quad, with the Beecroft Building (centre) and Martin Wood Lecture Theatre (right)

(e.g., laser labs, Scanning Tunnelling Microscopy).

Common spaces

The Department has ample common spaces both indoor and outdoor, including two Common Rooms (one of which located in the Clarendon Laboratory). More information on the accessibility of these spaces and other areas in the Clarendon Laboratory, the Beecroft Building and can be found at the linked web pages.

> "My experience of being a DPhil student in the Condensed Matter Physics Department has been very rewarding and enriching. In addition to conducting research, I enjoyed being able to teach and contribute to the culture and community of the Department as a Graduate Representative and Departmental Peer Supporter."
>
> Dr Anna Jungbluth, CMP Graduate

Clubs and societies

The University and colleges have extensive provisions to support Graduate Students in their studies, wellbeing and social interactions (for more detail, please consult the Oxford Students pages). Graduate students can join numerous clubs and societies and there is a University club specifically for graduate students, staff and alumni.

External and internal views of the view of the University club.

Appendix I: the Joint Oxford-Max Planck graduate training programme in quantum materials

Description of the programme

The joint Oxford-Max Planck graduate training programme in quantum materials provides candidates with the opportunity to pursue an Oxford Doctorate in Philosophy (DPhil) in Condensed Matter Physics (CMP) in the field of quantum materials, whist working on a joint research programme with Oxford and Max Planck supervisors. By joining this highly-competitive programme, students will have access to cutting-edge instrumentation and facilities available in Oxford and at the relevant Max Planck Institute, and will pursue some of the most exciting research projects available in this field worldwide – see list of projects on offer CMP and Max Planck web pages. Students will be jointly admitted to the Programme by the CMP sub-department of Oxford Physics and by the Max Planck Graduate Centre for Quantum Materials (MPGC-QM).

Programmes of study will usually be four years. Students will spend approximately two years of their Project at the Clarendon Laboratory, Oxford University and two years at a Max Planck Research Institute. Specific dates and time periods for individual students will be set out in offer letter, but please note that *this programme has residency requirements both in Oxford and in Germany*. Each student shall be supervised by a University Supervisor and a Max Planck Supervisor as set out in the offer letter – potential supervisors can be found on the CMP and MPGC-QM pages. The following Max Planck Research Institutes currently admit students on this programme:

(i) Max Planck Institute for Chemical Physics of Solids in Dresden;
(ii) Max Planck Institute for the Physics of Complex Systems in Dresden;
(iii) Max Planck Institute for Solid State Research in Stuttgart;
(iv) Max Planck Institute for the Structure and Dynamics of Matter in Hamburg;
(v) Max Planck Institute of Microstructure Physics in Halle (Saale);
(vi) Fritz Haber Institute of the Max -Planck - Gesellschaft in Berlin.

In Oxford, students will have the initial status of Probationer Research Student (PRS). All University rules and regulations concerning academic support, progress monitoring and examinations will apply. In particular, academic progress through the Transfer to DPhil Status (usually at the end of their first year) and Confirmation of Status (usually at the end of their third year) is the same as for any DPhil student in CMP. Students will also benefit from the monitoring and support structures of the

MPGC-QM and continuation of their status and funding will be contingent upon remaining in good academic standing with Max Planck.

Upon successful completion of the Programme, students will receive a (DPhil) award from the University. The award will be documented in a certificate issued by the University which contains details of the Programme under which the student had enrolled and the Max Planck logo to evidence the collaboration.

Applications and selection process

Candidates *must apply separately* to the Oxford DPhil Programme in Condensed Matter Physics and to the MPGC-QM programme by the relevant deadlines (for students starting in October 2024, the Max Planck deadline is 9th December 2023). Students must meet the highly competitive entry requirements to be admitted separately at Oxford for a DPhil as well as at Max Planck. Should a student be selected by one party but not by the other, their application will continue to be considered alongside those of other applicants to the same programme. A joint University-Max Planck committee will select a small number of students (up to 5 per year), pre-selected by both parties, for admission to the Joint Programme. Most decisions are usually made by the beginning of February each year and offer letters are sent shortly thereafter. Once the offer is accepted, students will enter into separate contractual arrangements with each of the parties (see below).

Contractual status

Students will be registered for their DPhil degree at the University and will be employed as PhD Students by Max Planck through a Max Planck funding contract for PhD students ("Max Planck Fördervertrag") according to the Max Planck rules. Each Student will be enrolled in a DPhil at Oxford for up to four years.

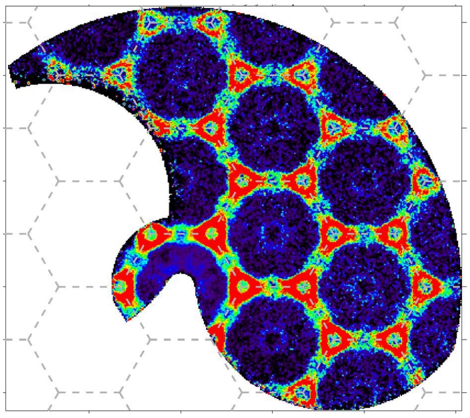
Funding

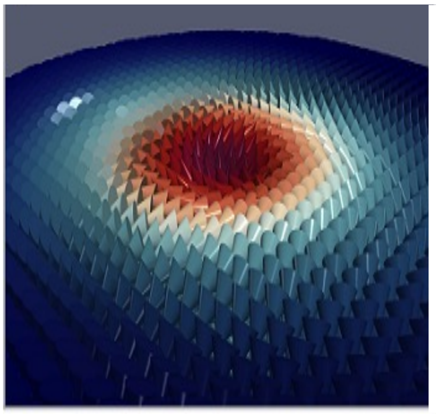
Max Planck shall pay the student a salary in accordance with the terms of their employment contract with Max Planck. Before an offer is made, appropriate funding must be sourced for Oxford tuition fees and the maintenance bursary while they are in Oxford. *Oxford and Max Planck will only make an offer when a full funding package has been secured. Students may be required to write separate applications, depending on eligibility criteria for different funding sources.* All students will be automatically considered for a range of Oxford scholarships.

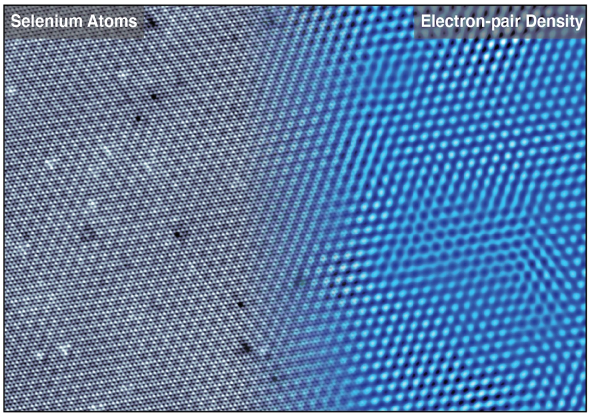
Students should indicate in their application to Oxford whether they are in the position to part-fund their own studies or to make their own applications for any relevant scholarship or bursary outside the University.

Further information

Before you consider applying to this programme, you should consult the CMP and MPGC-QM web pages. You are highly encouraged to get in touch with potential supervisors and get acquainted with the research projects on offer. It may be possible to arrange visits to the Clarendon Laboratory in Oxford and to the relevant Max Planck institutes, though students are usually expected to fund their own travel.



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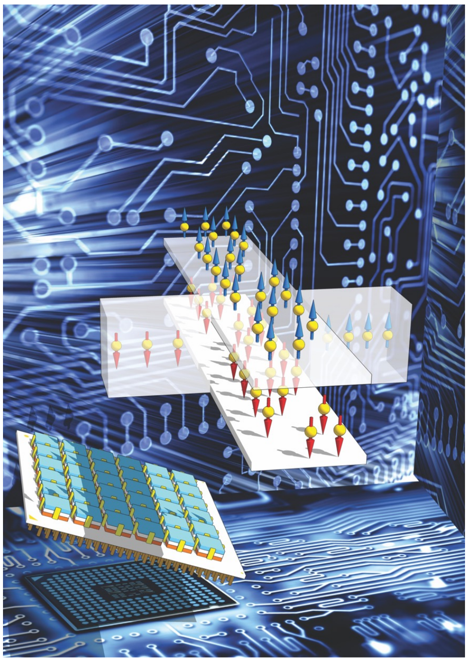

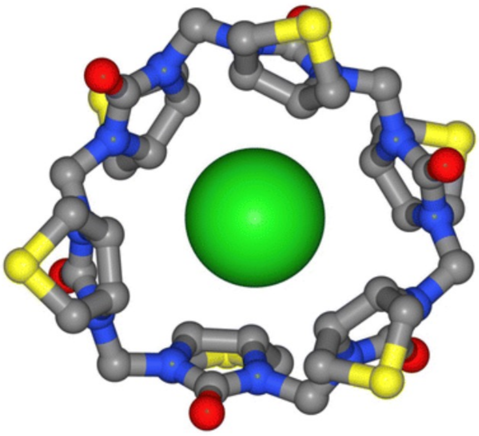

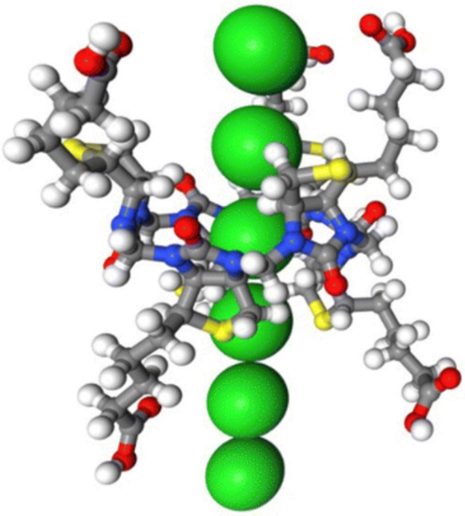

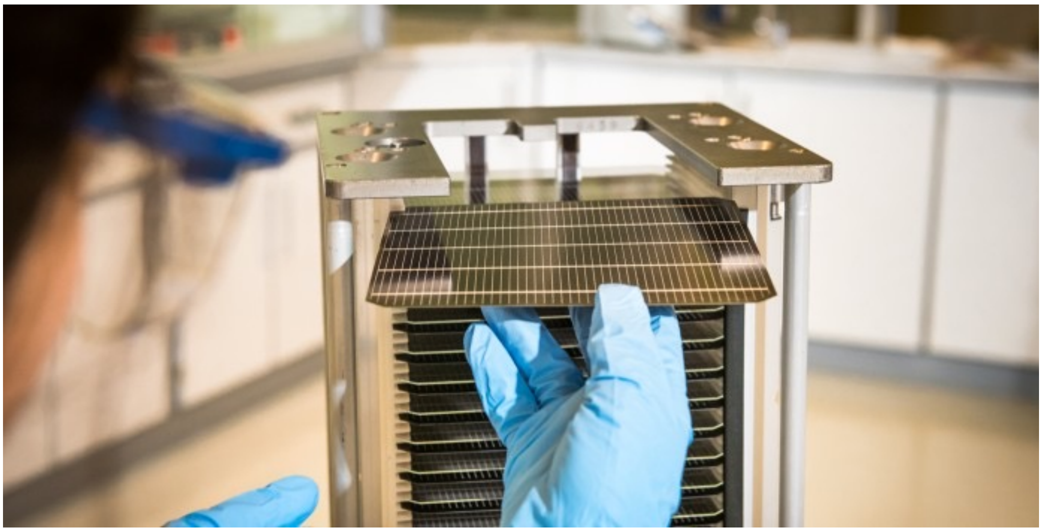

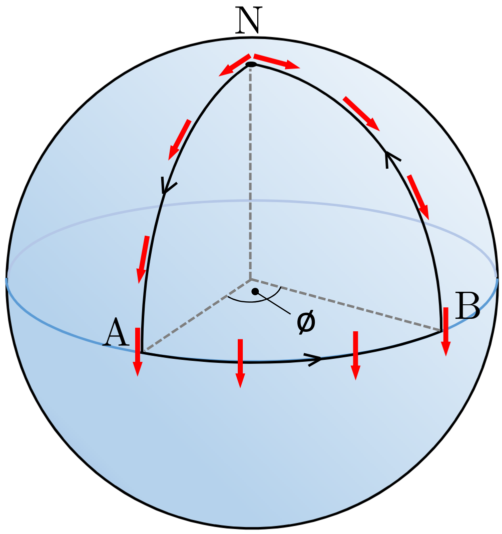
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