Oxford Master Course
in
Mathematical and Theoretical Physics

Master of Mathematics and Physics (MMathPhys) and MSc in Mathematical and Theoretical Physics

Course Handbook

2022–2023

This handbook applies to students starting the Master of Mathematics and Physics (MMathPhys) or the MSc in Mathematical and Theoretical Physics in Michaelmas term 2022. The information in this handbook may be different for students starting in other years.

The Examination Regulations relating to this course are available at **https://examregs.admin.ox.ac.uk/**.

If there is a conflict between the information in this handbook and the Examination Regulations then you should follow the Examinations Regulations.
If you have any concerns please contact mathematical.physics@maths.ox.ac.uk.

The information in this handbook is accurate as of 1 October 2022, however it may be necessary for changes to be made in certain circumstances, as explained at **www.ox.ac.uk/coursechanges**. If such changes are made the department will publish a new version of this handbook together with a list of the changes and students will be informed.

Version 1.0

Welcome

Welcome to the Oxford Master Course in Mathematical and Theoretical Physics. Our course provides a high-level education in the areas of Theoretical Particle Physics/String Theory, Condensed Matter Theory, Theoretical Astrophysics/Fluids and Mathematical Foundations of Theoretical Physics up to the level of research.

As you are probably aware, there is considerable flexibility in designing your path through the course; you can decide to focus on one of the above areas or study more widely across areas. It is important that you consider your choices carefully. Consult the syllabi and the case studies in this handbook for more information and, if in doubt, talk to your personal tutor or an academic related to the programme.

For an advanced programme of these kind written examinations are not always the best form of assessment. You will find that the way we evaluate your work often correlates with the nature of the material. Typically, there will be formal written exams for the basic, foundational courses, other forms of assessment such as take-home exams or mini-projects for intermediate courses and a home-work completion requirement for advanced courses. There are certain constraints on assessment — for example you have to sit four written exams. Be sure that your course choices are consistent with these constraints. Also note that Trinity term is devoted to advanced courses and there is no designated "revision" period.

Passing exams is a necessary and important part of learning and education but we hope you agree that there is significantly more to it. Enthusiasm, engagement with the subject, the desire for deep and profound understanding is what truly motivates us and we hope this is how you will engage with the course. We wish you a successful, productive and insightful year.

Fernando Alday and Steve Simon

Contents

1 Introduction

This handbook contains important information about the Masters course in Mathematical and Theoretical Physics. It is intended as a guide and reference for you throughout the course. There are a number of other sources of information that you will need to refer to during your course and links to these are given below, together with a list of key contacts.

1.1 Key Sources of Information

Course website: http://mmathphys.physics.ox.ac.uk/

The course schedule, course synopses, details of seminars and the online course handbook can all be found here.

Mathematical Institute website: http://www.maths.ox.ac.uk/

Department of Physics website: www.physics.ox.ac.uk

Examination Regulations: https://examregs.admin.ox.ac.uk/

The University's examination regulations govern all academic matters within the University and contain the general regulations for the conduct of University examinations, as well as specific regulations for each degree programme offered by the University.

Examination Conventions: http://mmathphys.physics.ox.ac.uk/students

The examination conventions for the course set out how each unit will be assessed and how the final degree classification will be derived from the marks obtained for the individual units.

Seminars: http://mmathphys.physics.ox.ac.uk/seminars

Oxford Student website: http://www.ox.ac.uk/students

This website provides access to information, services and resources.

Oxford Student Handbook: https://www.ox.ac.uk/students/academic/student-handbook

This contains general information and guidance about studying at the University of Oxford, and gives you formal notification and explanation of the University's codes, regulations, policies and procedures.

College Handbook: The handbook for your college will be available on the college website.

1.2 Key contacts

Director of Studies Prof. Fernando Alday (tel: (6)15327)

email: luis.alday@maths.ox.ac.uk

Chair of JSC Prof. Steve Simon (tel: (2)73954)

email: steve.simon@physics.ox.ac.uk

MTP Administrator (tel: (6)15159)

email: mathematical.physics@maths.ox.ac.uk

Undergraduate Administrator Clare Sheppard (tel: (6)15207)

email: Clare.Sheppard@maths.ox.ac.uk

Graduate Administrator Sarah Randall (tel: (6)11507)
email: sarah.randall@maths.ox.ac.uk

Head of Academic Administration Charlotte Turner-Smith (tel: (6)15203)
email:academic.administrator@maths.ox.ac.uk

Mathematical Institute Reception (tel: (2)73525)

Department of Physics Reception (tel: (2)72200)

As a graduate student you will have access to a Microsoft Teams account. During the pandemic Microsoft Teams and e-mails are the most common means of communication between students and staff. All people listed in the contacts list above can also be contacted via Microsoft Teams.

1.3 The Academic Year

The course lasts three terms, from the beginning of October to the end of the following June. Some work is carried out in the vacations.

For the academic year 2022–2023, the course begins with an induction on 4 October 2022. The dates of the University Full Terms for the Academic Year 2022–2023 are:

MT = Michaelmas Term 2022: 10 October – 2 December
HT = Hilary Term 2023: 16 January – 10 March
TT = Trinity Term 2023: 24 April – 20 June

A calendar of important dates is given in Appendix A.

1.4 Finding Your Way Around

Teaching for the course (where in-person teaching occurs) will take place in the Mathematical Institute (**http://www.maths.ox.ac.uk/about-us/travel-maps**) and in the Denys Wilkinson Building or in the Clarendon Building of the Department of Physics. To enter the Denys Wilkinson Building, go up the wide concrete steps from Keble Road; turn left at the top and the entrance is facing you:

https://www.accessguide.ox.ac.uk/denys-wilkinson-building#collapse1426661

The main entrance to the Clarendon Building in on Parks Road, next to the University Parks:

https://www.accessguide.ox.ac.uk/clarendon-laboratory#collapse2861361

At the Mathematical Institute, all lecture rooms and classrooms are located on the mezzanine level.

A searchable, interactive map of all college, department and libraries can be found at **https://maps.ox.ac.uk/bd821e30-d8ba-11eb-a363-059e537832a1**.

2 The MSc Course

2.1 Overview

The Master's Course in Mathematical and Theoretical Physics is offered in two modes, the MMathPhys for Oxford students and the MSc for students from outside Oxford. The academic content is identical for both modes. If you are an Oxford MPhys, MMath or MPhysPhil student, who transfers to the MMathPhys you will graduate as a "Master of Mathematical and Theoretical Physics" with a double classification consisting of the BA degree class in your original subject and an MMathPhys degree class. If you are a student on the MSc course, you will graduate with an "MSc in Mathematical and Theoretical Physics."

These qualifications may be compared to national standards for higher education qualifications through the Framework for Higher Education Qualifications (FHEQ). The University awards framework (UAF) maps the awards of the University against the levels of the FHEQ. The FHEQ level for both the MMathPhys course and MSc course is 7. The relevant subject benchmark statements for the course, which set out expectations about standards of degrees in a given subject area, are Physics & Astronomy (QAA 2008) and Mathematics, Statistics & Operational Research (QAA 2015).

2.2 Aims

The Oxford Master's Course in Mathematical and Theoretical Physics aims to provide students with a high-level, internationally competitive training in mathematical and theoretical physics, right up to the level of modern research in the area.

As a graduate of this programme you will be in a prime position to compete for research degree places in an area of Theoretical and Mathematical Physics at leading research universities in the UK or overseas; or to pursue a research-related career, based on the acquired high-level ability in mathematics and its applications to physical systems, outside academia.

2.3 Learning Outcomes

During the course you will develop a knowledge and understanding of:

- Theoretical and Mathematical Physics, focusing on one of the areas of Theoretical Particle Physics, Theoretical Condensed Matter Physics, Theoretical Astrophysics/Fluids, or studying across these areas.
- A broad range of physical phenomena and their description within Theoretical and Mathematical Physics.
- A wide range of advanced mathematical techniques and structures and how they are applied in Theoretical Physics.

You will also have the opportunity to develop the following skills.

Intellectual Skills

- An appreciation of the principles of Theoretical and Mathematical Physics and their application to natural phenomena.
- The ability to model physical phenomena and deploy a wide range of mathematical methods for their description.

- A working knowledge of high-level mathematical methods and their application to systems in physics and beyond.

Practical Skills

- Ability to apply mathematical methods to practical problems.
- Ability to construct, write-up and communicate logical arguments of some complexity.

Transferable Skills

- Ability solve problems effectively and to apply high-level mathematical methods to a wide range of problems.
- Ability to manage your time and to acquire a complex body of knowledge in a limited time.
- Ability to manage your own learning and study for research or other professional qualifications.

2.4 Course Structure

The programme consists of a large array of lecture courses covering the main areas of modern Theoretical/Mathematical Physics and Applied Mathematics. The courses are subdivided into the following *strands:*

- Quantum Field Theory, Particle Physics and String Theory
- Theoretical Condensed Matter Physics,
- Theoretical Astrophysics, Plasma Physics and Physics of Continuous Media.
- Mathematical Foundations of Theoretical Physics

Various areas of Theoretical and Mathematical Physics are interconnected, grounded in universal principles and thrive on ideas that cross many sub-field boundaries. A number of courses are shared between the three strands and emphasise the unity of the subject. This applies especially to the *foundational courses* offered in Michaelmas term. These are followed by increasingly specialised courses in Hilary and Trinity terms, although those too will strive to make connections between subject areas.

There are no compulsory courses and you will thus be able to choose a path reflecting your intellectual tastes or career choices; Appendix B gives examples of different pathways through the course. An overview of the courses can be found in the table accompanying this section. Detailed synopsis for each course can be found at **https://mmathphys.physics.ox.ac.uk/course-schedule** and a table providing details of the assessment method for each course can be found in Appendix A of the examination conventions.

You will be required to undertake 10 units, with 1 unit corresponding to 16 hours of lectures. This means that 16-hour lecture courses count as one unit, while, for example, 24-hour lecture courses count as 1.5 units. More specifically you are required to offer:

(a) four units that are assessed by written invigilated exams,

(b) three units that are assessed by written invigilated exams or by other formal assessments,

(c) three other units (which may be from courses with homework completion requirement only or from assessed courses).

One or two of the 10 units in (b) or (c) can be replaced by a dissertation. There are no other formal constraints on course choices and students are otherwise free to design their own pathways (although paying close attention to the guidance offered is strongly recommended). Note however that you should be careful about the number of units you undertake each term, and that taking too many units in Trinity term may be difficult as exams start on week 6. In practice it may be difficult to fit in more than 12 units in total. Please note that it is your responsibility to ensure that you fulfil the requirements for the overall number of units and the number of assessed units. The modes of assessment and details on completion requirements for all courses are provided in Appendix A of the exam conventions.

You will be offered detailed academic guidance from the Director of Studies or an Academic Adviser designated by the Director of Studies on choosing an individual path suitable for you. Course lecturers will also advise on the recommended background for their courses or possible follow-up courses you might wish to choose.

2.5 Additional Courses

In addition to the courses listed in the table, which are offered explicitly as part of the MMathPhys/MSc programme, you will also be allowed to choose a maximum of three-units worth of MMath Part C **seehttp://www.maths.ox.ac.uk/members/students/undergraduate-courses/teaching-and- learning/** or MPhys Part C **seehttp://www.physics.ox.ac.uk/lectures/** lecture courses that are not listed here, subject to approval by the Director of Studies, Prof. Fernando Alday at luis.alday@maths.ox.ac.uk, and copying in mmathphys@maths.ox.ac.uk. Once Prof Alday has granted approval, your request will then be passed on by the administration to the Director of Undergraduate Studies, Dr Richard Earl, who will provide the final approval, depending on whether there are spaces in the associated Part C Maths classes for the approved subjects you applied for. For Physics Part C approved subjects, please e-mail **mathematical.physics@maths.ox.ac.uk** and your request will be passed on to the relevant colleagues at Physics. Approval for MT additional courses should be sought by Monday week 1 of MT. Approval for HT additional courses should be sought by week 9 of MT. If you stated any preferences for approved subjects on your initial course registration form in August, these will be handled by the administration and you do not need to make the request again.

Legend for fonts, colours and superscripts in the Table:

Bold: a foundational course;

Plain: an interdisciplinary course shared between strands;

Italic: a course special to a particular strand;

Red*(P U:NN)*: a course also taught (in some cases in part) as a Part C course in Physics, NN is its number;

Blue*(MU:NNN)*: a course also taught as a Part B or C course in Mathematics, NNN is its number;

Purple*(MG)*: a course also taught as a PG course in Mathematics;

Black: an MMathPhys/MSc course, also taught as a PG course in Physics;

'M' a course where lectures and classes are taught at the Mathematical Institute;

'P' a course where lectures and classes are taught at the Department of Physics;

'Phil' a course where lectures and classes are taught at the Department of Philosophy;

(∗) a course that may not be available every year.

<table>
<tr><th colspan="4">Overview of Lecture Courses</th></tr>
<tr><td></td><td>Theoretical Particle Physics</td><td>Theoretical Condensed Matter Physics</td><td>Theor. Astrophysics, Plasma Physics & Physics of Continuous</td></tr>
<tr><td rowspan="16">MT</td><td colspan="2">Quantum Field Theory (P) (24)</td><td></td></tr>
<tr><td></td><td colspan="2">Advanced Quantum Theory (P U.C6) (P) (20)</td></tr>
<tr><td colspan="3">Topological Quantum Theory (P) (16)</td></tr>
<tr><td></td><td colspan="2">Kinetic Theory (P) (28)</td></tr>
<tr><td></td><td></td><td>Quantum Processes in Hot Plasma (P) (12)</td></tr>
<tr><td>Gen. Relativity I (MU:C7.5) (M) (16)</td><td>=</td><td>Gen. Relativity I (MU:C7.5) (M) (16)</td></tr>
<tr><td colspan="3">Perturbation Methods (MU:C5.5) (M) (16)</td></tr>
<tr><td></td><td>Networks (MU:C5.4) (M) (16)</td><td></td></tr>
<tr><td colspan="3">Numerical Linear Algebra (MU:C6.1) (M) (16)</td></tr>
<tr><td colspan="2">Groups and Representations (P) (24)</td><td></td></tr>
<tr><td>Algebraic Topology (MU:C3.1) (M) (16)</td><td></td><td></td></tr>
<tr><td>Differential Geometry (MU:C3.3) (M) (16)</td><td>=</td><td>Differential Geometry (MU:C3.3) (M) (16)</td></tr>
<tr><td colspan="3">Advanced Philosophy of Physics (Phil.) (16)</td></tr>
<tr><td>Lie Algebras (MU:C2.1) (M) (16)</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Topics in Fluid Mechanics (MU:C5.7) (M) (16)</td></tr>
<tr><td>Algebraic Geometry (MU:C3.4) (M) (16)</td><td></td><td></td></tr>
<tr><td rowspan="17">HT</td><td></td><td colspan="2">Advanced Fluid Dynamics (P) (16)</td></tr>
<tr><td></td><td></td><td>Astroparticle Physics (P) (16)</td></tr>
<tr><td></td><td colspan="2">Soft Matter Physics (P) (8)</td></tr>
<tr><td></td><td colspan="2">Nonequilibrium Statistical Physics (P) (16)</td></tr>
<tr><td>Advanced QFT (24)</td><td></td><td>High Energy Density Physics (P) (16)</td></tr>
<tr><td>String Theory I (MG) (M) (16)</td><td></td><td>Collisionless Plasma Physics (P) (18)</td></tr>
<tr><td>Supersymmetry & Sugra(M) (16)</td><td></td><td>Galactic & Planetary Dyn. (P) (16)</td></tr>
<tr><td></td><td></td><td>Quantum Matter I (P) (16)</td></tr>
<tr><td></td><td></td><td>Geophys. Fluid Dynamics (P) (16)</td></tr>
<tr><td colspan="3">Intro to Quantum Information (MU:C7.4) (M) (16)</td></tr>
<tr><td>Gen. Relativity II (MU:C7.6) (M) (16)</td><td>=</td><td>Gen. Relativity II (MU:C7.6) (M) (16)</td></tr>
<tr><td>Cosmology (P) (16)</td><td>=</td><td>Cosmology (P) (16)</td></tr>
<tr><td></td><td></td><td>Rad. Proc. & High Energy Astro. (P) (18)</td></tr>
<tr><td colspan="2">Random Matrix Theory (MU:C7.7) (M) (16)</td><td></td></tr>
<tr><td colspan="3">Applied Complex Variables (MU:C5.6) (M) (16)</td></tr>
<tr><td colspan="3">Advanced Philosophy of Physics (Phil.) (16)</td></tr>
<tr><td>Geom. Group Th. (MU:C3.2) (M) (16)</td><td></td><td></td></tr>
<tr><td rowspan="10">TT</td><td colspan="2">Conformal Field Theory (*) (M) (16)</td><td></td></tr>
<tr><td>String Theory II (MG, *) (M) (16)</td><td></td><td></td></tr>
<tr><td>The Standard Model and Beyond I (P) (16)</td><td></td><td></td></tr>
<tr><td>The Standard Model and Beyond II (P) (16)</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Topics in Soft & Active Matter Physics (P) (8)</td></tr>
<tr><td></td><td></td><td>Collisional Plasma Physics (P) (18)</td></tr>
<tr><td></td><td></td><td>Collisionless Plasma Physics (P) (18)</td></tr>
<tr><td></td><td></td><td>Quantum Matter II (P) (20)</td></tr>
<tr><td></td><td colspan="2">Renormalisation Group (P) (16)</td></tr>
<tr><td colspan="3">Symbolic, Numerical and Graphical Scientific Programming (M) (16)</td></tr>
<tr><td></td><td colspan="3">Dissertation, replacing one or two 16-hour lecture course</td></tr>
</table>

3 Teaching and Learning

3.1 Organisation of Teaching

Teaching for the course will be provided jointly by the Department of Physics and the Mathematical Institute through lectures and classes. In addition, students undertaking a dissertation will have supervision meetings with their dissertation supervisor.

3.2 Lectures

Depending on the options you take you will have between 6-8 hours of lectures per week. Where in-person lecturing occurs, a lecture timetable for each term will be made available on the course website **https://mmathphys.physics.ox.ac.uk/course-schedule**. For online teaching, you will be sent a document providing links to access recorded lectures or to access live-streamed lectures. Please do not share these links outside your cohort. If you have a friend on another Maths/Physics related degree at the University of Oxford who would like to access lecture links, please direct them to either the course lecturer or mmathphys@physics.ox.ac.uk and one of us will be able to determine if the student can be given access.

Course Material

Course material, such as lecture notes and problem sheets, will be published on the Mathematical Institute's website and the Department of Physics' website. Students should follow the links to the appropriate pages from the lecture schedule on the course website.

3.3 Class Registration

Lecture courses will normally be accompanied by problem sets and weekly or fortnightly problem classes. Classes will usually contain 8–10 students. For most courses you will need to sign-up for the set of classes you wish to attend at the start of each term, and this is usually done via an online sign-up system.

For classes held at the Mathematical Institute, you will be sent an email in week 0 from the e-mail address academic.administration@maths.ox.ac.uk alerting you that class registration is open and providing you with details of the registration process. You will not be able attend classes at Maths unless you register for them beforehand. You can will be able to enroll in classes and then view which classes you have successfully signed up to via (**https://tms.ox.ac.uk/**).

For classes held at the Department of Physics, depending on the course, you will either register for classes online via a poll to select which class you can attend, or the lecturer may advise you that you can attend the class without undertaking any registration beforehand. At the start of each term, please look out for e-mails from the mathematical.physics@maths.ox.ac.uk, where information on how to register for the different courses.

To see which courses take part in each department, please refer to the table page 6 of the course handbook, where a course followed by a (P) is a course held at the Department of Physics, and a course followed by an (M) is a course held at the Mathematical Institute.

If you are taking the Advanced Philosophy of Physics option, you will arrange tutorials directly with the course tutor and there will not be a separate class registration process.

3.4 Class Withdrawal

If you wish to withdraw from a class held at the Department of Physics, please inform your tutor or teaching assistant.

For classes held at the Mathematical Institute, please note that after being assigned to a class, you will have until Monday week 4 of each term to request a class switch or to decide that you would no longer like to attend a particular class. To do so, please contact your class tutor as well as the MTP administrator.

It is important to withdraw from a class if you no longer wish to take it. If you do not withdraw from a class, then your college will be charged for your attendance. Furthermore, when you withdraw from a class, your tutor and teaching assistant will know not to expect you to attend, and will not need to enquire any further to the reason for non-attendance or be concerned about your absence from classes.

If you have made an official exam entry for a course via student self-service (see page 12) and decide that you no longer wish to take that course, please note that in addition to withdrawing from the classes that accompany the lecture course and assessment, you must also withdraw from the assessment itself. Please contact your college office to officially withdraw from any exams, formal assessments or homework options for which you have made an official exam entry.

Online Submission Process

Whether you are taking a course which is assessed by homework completion, or are submitting problem sheets in general for an examined or formally assessed course, you will be required to submit your homework online by the time and dates which will be made available on the course pages when times and dates have been confirmed by the lecturers and teaching assistants. If you are submitting problem sheets for a Physics course, you will submit via Canvas. If you are submitting problem sheets for a Maths course, you will submit via Moodle.
https://canvas.ox.ac.uk/courses/110068
https://courses.maths.ox.ac.uk/course/index.php?categoryid=148
Ensure your name and college e-mail address is on your work, but NOT your candidate number. This is because the candidate number is meant to make you anonymous, but in the instance of homework, your teaching assistant needs to know your name so they can return your work to you. If you reveal your candidate number along with your name, you are no longer anonymous.
Include your name in the name of the PDF of homework you submit. Write the name of the lecture course and problem sheet at the top of your work e.g. Groups and Representations Problem Sheet 1.
Please note that it is your responsibility to ensure that your work has been submitted, especially if you are submitting your homework for the purpose of homework completion. If you are concerned that your internet connection may have been interrupted and your work did not submit, you should contact your Teaching Assistant as soon as possible to confirm it has been received.

3.5 Dissertations

You may opt to offer a dissertation as one, or with special permission two, of your ten units. A dissertation offers a substantial opportunity for independent study and research, and would be undertaken under the guidance of a member of the Department of Physics or the Mathematical Institute. A dissertation involves investigating and then presenting in writing a particular area of Mathematical Physics or Theoretical Physics; you would not be required to (but may) obtain original results. A list of possible dissertation topics is given in Appendix C but you are not limited to this list and may propose your own topic instead.

The exact process to apply for a dissertation can be found via the Dissertation Guidance document here. The link also includes a LaTeX template you can use for formatting your dissertation, ways to find a supervisor and names of those unable to supervise a dissertation for 2022-23.

You can view past students dissertations via the following link: **https://www.maths.ox.ac.uk/members/students/undergraduate-courses/mmathphys-msc-mtp/past-dissertations** you will need to log in via the top right corner using your Single Sign On (SSO)

You should plan on beginning work on your dissertation soon after your abstract has been approved. You are advised to bear in mind that you will need to use your time in the Easter vacation and early Trinity term wisely to balance preparing for the Trinity term exams, working on your dissertation, and completing work for other courses you may be taking.

Your supervisor will read and provide feedback on the initial draft of your dissertation (provided that it is submitted to them in good time!).

The submitted dissertation should conform to the following points.

- The dissertation must include an abstract and a bibliography.
- The dissertation must be word-processed and have a font size of 12pt.
- The text should be double spaced
- The dissertation should have a title page which includes the following:
  - the title of dissertation,
  - the candidate's examination number,
  - the title of the candidate's degree course,
  - the term and year of submission.
- Its length should not exceed 30 pages for a single unit and 60 pages for a double unit. The page count may exclude any table of contents, diagrams, tables, bibliography, dedications/acknowledgements, abstract and the texts of computer programs. However, any footnotes and appendices must be included.

3.6 Advice on Teaching and Learning Matters

There are a number of people you can consult for advice on teaching and learning matters. Academic advisors will be appointed for all students at the start of the course and will be available for consultation on any academic matter. Students can also seek guidance on academic matters from their college personal tutor. All students will receive academic guidance from the Director of Studies.

If you have any issues with teaching or supervision please raise these as soon as possible so that they can be addressed promptly. Details of who to contact are provided in Section 7.2 Complaints and Appeals.

3.7 Skills and Learning Development

Expectations of Study

You are responsible for your own academic progress. Therefore, in addition to the formal teaching you receive through lectures, classes and dissertation tutorials, you will be expected to undertake a significant amount of self-directed, independent study both during term time and in the vacations. You are advised to read the University's guidance on undertaking paid work at **http://www.ox.ac.uk/students/life/experience**.

You should seek advice from your advisor if you find it impossible to complete your academic work without spending significantly longer than 48 hours per week on a regular basis.

Your academic progress will be monitored by your academic advisor and also your college tutor. College tutors will receive reports from the class tutors for the classes you attend. In addition, academic advisors of MSc students will submit termly reports on their student's progress via the Graduate Supervision Recording (GSR). These reports are reviewed by the Director of Studies. If you are concerned about your academic progress please contact your college tutor, academic advisor or the Director of Studies.

For MSc students, it is also mandatory to complete a self-assessment report via GSR for every reporting period. You can access GSR via the following link: **https://www.ox.ac.uk/students/selfservice**. Students will be sent a GSR automated email notification with details of how to log in at the start of each reporting window, and who to contact with queries.

Completing the self-assessment will provide the opportunity to:

- Review and comment on your academic progress during the current reporting period
- Measure your progress against the timetable and requirements of your programme of study
- Identify skills developed and training undertaken or required
- List your engagement with the academic community
- Raise concerns or issues regarding your academic progress to your Academic Advisor
- Outline your plans for the next term (where applicable)

If you have any difficulty completing this you must speak to your Academic Advisor or Director of Studies. Your self-assessment report will be used by your Academic Advisor as a basis to complete a report on your performance this reporting period, for identifying areas where further work may be required, and for reviewing your progress against agreed timetables and plans for the term ahead. GSR will alert you by email when your Academic Advisor has completed your report and it is available for you to view.

University Lectures and Departmental Seminars

University lectures in all subjects are open to all students. A consolidated lecture list is available on the University website at: **http://www.ox.ac.uk/students/academic/lectures/**.

Seminars and colloquia given in the Mathematical Institute and Physics Department, often by mathematicians and physicists of international repute, are announced on the departmental notice boards (**https://www.maths.ox.ac.uk/events/list** and **http://www2.physics.ox.ac.uk/research/rudolf-peierls-centre-for-theoretical-physics**); you are encouraged to attend any which interest you.

Study Skills

Much of the advice and training in study skills will come in the regular class teaching you receive. A wide range of information and training materials are available to help you develop your academic skills – including time management, research and library skills, referencing, revision skill and academic writing – through the Oxford Student website: **http://www.ox.ac.uk/students/academic/guidance/skills**.

3.8 Key Teaching Links

Lecture Timetable: http://mmathphys.physics.ox.ac.uk/course-schedule

And: https://www.maths.ox.ac.uk/members/students/lecture-lists

Class Lists: https://tms.ox.ac.uk/

Physics Class Information: Follow links to course pages from https://mmathphys.physics.ox.ac. uk/course-schedule

And on Canvas: https://canvas.ox.ac.uk/courses/174015

Problem Sheet Submission: https://courses.maths.ox.ac.uk/course/index.php?categoryid=148 (maths) and https://canvas.ox.ac.uk/courses/174015/assignments (physics)

4 Examinations and Assessments

4.1 Assessment of the Course

All of the units you undertake will have either a component of formal assessment (written invigilated exam, take-home exam, mini-project or dissertation) or a homework completion requirement. Each unit will be assessed by the method most suited to the material being taught. The table in the examination conventions indicates which courses are assessed and by which method and it indicates which courses have a homework completion required. The examinations are governed by the University's Examination Regulations and the course examination conventions.

4.2 Examination Conventions

The examination conventions for the course are the formal record of the specific assessment standards for the course. They set out how each unit will be assessed and how the final degree classification will be derived from the marks obtained for the individual units. They include information on marking scales, marking and classification criteria, scaling of marks, formative feedback, resits and penalties for late submission. The examination conventions for 2022–23 can be found on the course website at **http://mmathphys.physics. ox.ac.uk/**.

4.3 Examination Entries

You will need to formally enter for the units you wish to be assessed on, including those courses which only have a homework completion requirement, by completing an examination entry form. This is done online through Student Self Service (**https://evision.ox.ac.uk/**) and further information on the process can be found at **http://www.ox.ac.uk/students/academic/exams/entry**. For this course there will be three examination entry dates:

4th November, week 4, Michaelmas term for courses examined by invigilated written examination in Hilary term;

27th January, week 2, Hilary term for Michaelmas Term practicals (homework) Hilary term submissions (such as mini-projects released in Hilary Term) and all courses assessed by invigilated written examination in Trinity term.

12th May, week 3, Trinity term for Hilary and Trinity term practicals (homework) and Trinity term submissions (such as the dissertation).

When completing your examination entry, you should try to ensure that the decisions you make are as final as possible. However, if you subsequently change your mind about which courses you would like to be assessed on, then it is possible to make changes to your entry. To change an option after the examination entry deadline has passed you must apply for permission in writing through your senior tutor or other college officer using the change of options form available from your college office. You will need to pay a fee for making a late change to your examination entry.

If you have entered for assessments in additional courses (beyond the required ten units) but subsequently decide not to take the additional assessments, then you should inform your college office. You must do this prior to either the examination date for written examinations or the submission date for coursework.

4.4 Examination Dates and Submission Deadlines

The calendar of important dates (Appendix A) gives the expected start dates for the invigilated written examinations and coursework submission deadlines. The examination timetable for invigilated written examinations will be set by the Examination Schools and published online at: **http://www.ox.ac.uk/students/academic/exams/timetables**.

4.5 Preparation and Submission of Coursework

4.5.1 Mini-Projects and Take-Home Examinations

Some units will be assessed wholly or partially by submitted work. This will take one of two forms: mini-project or take-home examination. The deadline for the submission of the assessment for each unit is given in the table included in the examination conventions.

The examiners will send out notices to candidates detailing where your work should be submitted and what format your submission should be in (e.g. handwritten or word-processed). Candidates will be required to submit an electronic copy and instructions on the online submission process will be included in the notice to candidates.

It is vital that you submit your work by the given deadline as any late submission will be reported to the Proctors and a late submission penalty may be applied (see section 5 in the examination conventions). Please see the examination conventions and the Oxford Student website (**http://www.ox.ac.uk/students/academic/exams/submission**) for advice on what to do if you are unable to submit your work on time due to medical emergency or other urgent cause.

4.5.2 Dissertation

The deadline for submission of the dissertation is 12 noon on Monday of week 6, Trinity term. Dissertations must be submitted electronically and instructions on the online submission process will be included in the notice to candidates. Please note the information in section 4.5.1 regarding the importance of submitting your work on time.

4.5.3 Plagiarism

Plagiarism is presenting someone else's work or ideas as your own, with or without their consent, by incorporating it into your work without full acknowledgement. All published and unpublished material, whether in manuscript, printed or electronic form, is covered under this definition. Plagiarism may be intentional or reckless, or unintentional. Under the regulations for examinations, intentional or reckless plagiarism is a disciplinary offence. Please see the University's guidance on plagiarism **http://www.ox.ac.uk/students/academic/guidance/skills/plagiarism** for further information.

4.6 Sitting Invigilated Written Examinations

Information on (a) the standards of conduct expected in examinations and (b) what to do if you would like examiners to be aware of any factors that may have affected your performance before or during an examination (such as illness, accident or bereavement) are available on the Oxford Student website (**http://www.ox.ac.uk/students/academic/exams**) and in Section 8.2 of the examination conventions.

4.7 Examination Prizes

A prize may be awarded by the Examiners for excellence in examination for the Master of Mathematics and Physics (MMathPhys) or MSc in Mathematical and Theoretical Physics. The assessors of a dissertation that, in their view, shows particular originality and/or insight may recommend to the Examiners that this dissertation be given a commendation. A prize may be awarded by the examiners for the best dissertation.

4.8 Key Assessment Links

Dissertation Guidance: http://mmathphys.physics.ox.ac.uk/students

Examination Regulations: https://examregs.admin.ox.ac.uk/

Examination Timetables: http://www.ox.ac.uk/students/academic/exams/timetables

Online Submission for Dissertations, Mini-Projects and Take-Home Exams: https://oxford.inspera.com/

Online Submission for Problem Sheets: https://courses.maths.ox.ac.uk/ and https://canvas.ox.ac.uk/courses/174015/assignments

Past examination papers: https://mmathphys.physics.ox.ac.uk/past-examination-papers

Past examiners reports: http://mmathphys.physics.ox.ac.uk/students

5 Resources and Facilities

5.1 Departmental Work and Social Spaces

You will be able to use the computers and desks in the Mezzanine Study Room to work within the Mathematical Institute. The study room has power sockets for students wishing to use their own laptops and there is wi-fi throughout the building.

The Institute's café is also located on the mezzanine level and has seating and tables for 100. The café serves drinks, snacks and meals from 08.30–16.15.

5.2 Libraries

Whitehead Library

Website: **https://www.maths.ox.ac.uk/members/library**

Radcliffe Science Library (RSL)

Website: **http://www.bodleian.ox.ac.uk/science/**
The Radcliffe Science Library is the Science Library of the Bodleian and includes mathematics books at graduate and research level.

College Libraries

You will have access to the library in your own College.

Oxford Libraries

Information about all Bodleian Libraries can be found at: **https://www.bodleian.ox.ac.uk/libraries** and non-Bodleian Libraries at **https://www.bodleian.ox.ac.uk/other-libraries-at-oxford**

5.3 Computing Facilities

Information regarding the University's IT Services can be found at **http://www.it.ox.ac.uk/**.

IT and Email accounts

MSc students will receive a University 'single-sign-on' IT account. This will have an email address associated with it which will be of the format

firstname.lastname@college.ox.ac.uk.

It is important that students either read this email regularly or set up a forward from it to an account which they do read regularly. MMathPhys students will retain the account they were issued with at the start of their degree.
For further information about Departmental IT matters, including rules and regulations surrounding the use of IT facilities, please see **http://www.maths.ox.ac.uk/members/it**

You will have access to various licenses for further details go to **http://www.maths.ox.ac.uk/members/it/software-personal-machines**.

5.3 Careers and Employability

Careers guidance is provided by the *Careers Service* (**http://www.careers.ox.ac.uk/**), which also provides training in writing applications, interview techniques and analysis of transferable skills. The Careers Service provides information about occupations and employers, and advertises work experience opportunities.

In addition to its general programme, the Careers Service runs an annual 'Jobs for Mathematicians' half-day, in collaboration with the Mathematical Institute. At this event there are talks from alumni working in various industries and a talk for those interesting in continuing on to further postgraduate study. Further information about postgraduate study opportunities at the Mathematical Institute can be found at **http://www.maths.ox.ac.uk/study- here/postgraduate- study** and at **http://www2.physics.ox.ac.uk/ study-here/postgraduates** for opportunities in the Department of Physics.

6 Student Representation and Feedback

6.1 Student Representation

Students will be able to nominate two representatives to sit on the Joint Supervisory Committee (JSC) which oversees the course. Volunteers will be sought at the Induction Session and an election held if necessary. The student representatives will be able to raise matters with the JSC on behalf of the cohort.

6.2 Consultative Committee for Graduates – Mathematics

The Consultative Committee for Graduates meets regularly once a term and discusses any matters that graduate students wish to raise. Students will be invited to nominate a representative to serve as the Mathematics and Physics rep on this committee via email in Michaelmas term.

6.3 The Physics Joint Consultative Committee

The Physics Joint Consultative Committee (PJCC) has elected undergraduate members who meet twice in MT and HT, and once in TT to discuss both academic and administrative matters with academic staff representatives. See **https://pjcc.physics.ox.ac.uk/** for more information.

6.4 Divisional and University Representatives

The MPLS Division also runs a divisional Undergraduate Joint Consultative Forum, a divisional Graduate Joint Consultative Forum, and is establishing a Joint Consultative Forum for Graduate Taught Courses. Each Forum is chaired by the senior MPLS Academic who is responsible for that area across the Division, an undergraduate or graduate representative from each department, the undergraduate or graduate representative on the Academic Committee and Divisional Board, and the Oxford Union Student Union (OUSU) Vice-President (Access and Academic Affairs) or Vice-President (Graduates).

Student representative sitting on the MPLS Divisional Board are selected through a process organised by OUSU. Details can be found on the OUSU website along with information about student representation at the University level.

6.5 Opportunities to Provide Feedback

Students will be asked to complete questionnaires evaluating the teaching received for each unit. Please take time to complete these as your feedback is valuable for future course planning.

MSc students, like all students on matriculated courses, will be surveyed on all aspects of their course (learning, living, pastoral support, college) through the annual Student Barometer. Previous results can be viewed by students, staff and the general public at: **https://www.ox.ac.uk/students/life/student-surveys**. MMathPhys students, as final year undergraduates, will be surveyed through the National Student Survey instead. Results from previous NSS can be found at **https://www.thestudentsurvey.com/**.

6.6 Key Student Representation Links

CCG: http://www.maths.ox.ac.uk/members/students/postgraduate-courses/doctor-philosophy/consultative-committee-graduates. Minutes of meetings and list of student representatives.

Oxford SU: http://oxfordsu.org/

University Surveys: https://www.ox.ac.uk/students/life/student-surveys

7 Student Support and Academic Policies

7.1 Where to Find Help

Generally speaking for graduate students, departments are the main source of academic support and colleges are the main source of pastoral support. For undergraduate students, colleges also play a key role in providing academic support.

Every college has their own systems of support for students, please refer to your college handbook or website for more information on who to contact and what support is available through your college.

Details of the wide range of sources of support available more widely in the University are available from the Oxford Student website (**http://www.ox.ac.uk/students/welfare**), including in relation to mental and physical health and disability.

7.2 Complaints and academic appeals within the Department of Physics and the Mathematical Institute

The University, the Mathematical, Physical and Life Sciences Division, the Department of Physics and the Mathematical Institute all hope that provision made for students at all stages of their course of study will result in no need for complaints (about that provision) or appeals (against the outcomes of any form of assessment).

Where such a need arises, an informal discussion with the person immediately responsible for the issue that you wish to complain about (and who may not be one of the individuals identified below) is often the simplest way to achieve a satisfactory resolution.

Many sources of advice are available from colleges, faculties/departments and bodies like the Counselling Service or the OUSU Student Advice Service, which have extensive experience in advising students. You may wish to take advice from one of those sources before pursuing your complaint.

General areas of concern about provision affecting students as a whole should be raised through Joint Consultative Committees or via student representation on the faculty/department's committees.

Complaints

If your concern or complaint relates to teaching or other provision made by the faculty/department, then you should raise it with Director of Undergraduate Studies (Dr Richard Earl (Maths), Prof Jonathan Jones (Physics)) or with the Director of Graduate Studies (Prof. Raphael Hauser (Maths)) as appropriate. If your concern relates to the course as a whole, rather than to teaching or other provision made by one of the faculties/departments, you should raise it with Prof Steve Simon, Chair of the Joint Supervisory Committee for the Master of Mathematical and Theoretical Physics/MSc in Mathematical and Theoretical Physics. Complaints about departmental facilities should be made to the Head of Administration/Head of Physical Resources (Dr Jocasta Gardner (Maths), Mrs Nicola Small (Physics)). If you feel unable to approach one of those individuals, you may contact the Head of Department Prof. James Sparks (Maths), Professor Ian Shipsey (Physics)). The officer concerned will attempt to resolve your concern/complaint informally.

If you are dissatisfied with the outcome, you may take your concern further by making a formal complaint to the Proctors under the University Student Complaints Procedure **https://www.ox.ac.uk/students/academic/complaints**.

If your concern or complaint relates to teaching or other provision made by your college, you should raise it either with your tutor or with one of the college officers, Senior Tutor, Tutor for Graduates (as appropriate). Your college will also be able to explain how to take your complaint further if you are dissatisfied with the outcome of its consideration.

Academic Appeals

An academic appeal is an appeal against the decision of an academic body (e.g. boards of examiners, transfer and confirmation decisions etc.), on grounds such as procedural error or evidence of bias. There is no right of appeal against academic judgement. If you have any concerns about your assessment process or outcome it is advisable to discuss these first informally with your subject or college tutor, Senior Tutor, course director, director of studies, supervisor or college or departmental administrator as appropriate. They will be able to explain the assessment process that was undertaken and may be able to address your concerns. Queries must not be raised directly with the examiners. If you still have concerns you can make a formal appeal to the Proctors who will consider appeals under the University Academic Appeals Procedure (**https://www.ox.ac.uk/students/academic/complaints**).

7.3 Buddy System

The Buddy System is an initiative to help our new MSc students integrate with current MMath/MPhys/ MPhysPhil students who are transferring to the MMathPhys for their final year. Once an MSc student's offer has become unconditional, they will be paired with a buddy from the same college, or a nearby college and will receive their buddy's college e-mail address. New students can seek advice from their MMathPhys buddy about aspects of student life which interest them such as exams, social events or courses.

7.4 Student Societies

There are number of Mathematics and Physics student societies which you may like to join. Details of the main societies are given below. In addition, there are also over 200 clubs and societies covering a wide range of interest which you may join or attend. A full list is available at **http://www.ox.ac.uk/students/life/ clubs/list**.

Invariants

The Oxford University's student society for Mathematics. The society promotes Maths and hosts informal lectures, often given by leading mathematicians. Website: **http://www.invariants.org.uk/**.

LGBTI∧3

LGBTI∧3 is the student group for all LGBTQ+ identifying students in Maths, Stats and Computer Science. Contact: **oxlgbtqubed@gmail.com**.

Mirzakhani Society

The Mirzakhani Society is a society aimed at supporting women and non-binary students in Oxford who are studying maths. Contact: **mirzakhanisociety@gmail.com**.

The Oxford University Physics Society

The Oxford University Physics Society (PhysSoc) is a student society that exists to promote and encourage an interest in Physics in and around Oxford University. PhysSoc hosts talks most weeks during term time in the Physics Department, often by leading experts and also holds social events which are a great opportunity to get to know others with an interest in all things Physics. Website: https://oxfordphyssoc.wordpress.com/.

7.5 Maths Outreach

The Department has an active Outreach programme https://www.maths.ox.ac.uk/outreach which runs throughout the year, with events and programmes for school students aged 5-18. You can take a look at what's currently happening on the website. Keep an eye out throughout the year for e-mails asking for volunteers for various events and other ways to get involved. Contact Mareli Grady mareli.grady@maths.ox.ac.uk or James Munro james.munro@maths.ox.ac.uk if you have any questions or ideas you would like to discuss.

7.6 University Policies

The University has a wide range of policies and regulations that apply to students. These are easily accessible through the A–Z of University regulations, codes of conduct and policies available at http://www.ox.ac.uk/students/academic/regulations/a-z. Particular attention is drawn to the following University policies.

Equal Opportunities Statement:
https://edu.admin.ox.ac.uk/equality-policy

Intellectual Property Rights: https://www.ox.ac.uk/students/academic/guidance/intellectual-property#:~:text=The%20University%20in%20its%20statutes,of%20copyright%20created%20by%20students.

Code on Harassment: https://edu.admin.ox.ac.uk/harassment-advice#:~:text=The%20University%20does%20not%20tolerate,with%20respect%2C%20courtesy%20and%20consideration.

Policy on Plagiarism: http://www.ox.ac.uk/students/academic/guidance/skills/plagiarism

Policy on Students Recording Lectures

https://www.ox.ac.uk/sites/files/oxford/field/field_document/Recording%20of%20lectures%20and%20other%20teaching%20sessions%20by%20students.pdf

7.7 Departmental Safety Policies

You are urged to act at all times responsibly, and with a proper care for your own safety and that of others. Departmental statements of safety policy are posted in all departments, and you must comply with them. Students should note that they (and others entering onto departmental premises or who are involved in departmental activities) are responsible for exercising care in relation to themselves and others who may be affected by their actions.

In the Mathematical Institute accidents should be reported immediately to reception, telephone 73525, who keep the accident book. There is a first aid room located on the ground floor of the South wing. If you require access to this room please report to reception.

Each lecture theatre has its own proper escape route and you are urged to familiarise yourself with these. Those for the Mathematical Institute lecture and seminar rooms, are set out online at **http://www.maths.ox.ac.uk/members/building-information/security-safety-and-reporting-building-issues**. In the case of evacuation of the lecture theatre give heed to the instructions of the lecturer.

7.8 Key Student Support Links and Contacts

Disability Co-ordinator (Mathematics):
Charlotte Turner-Smith (academic.administrator@maths.ox.ac.uk)

Information on Disability and Accessibility: **https://www.maths.ox.ac.uk/members/policies/disability**
https://www.maths.ox.ac.uk/members/building-information/accessibility

Disability Co-ordinator (Physics): Carrie Leonard-McIntyre (c.leonard-mcintyre@physics.ox.ac.uk)

University's Disability Advisory Service: **http://www.ox.ac.uk/students/welfare/disability**

Counselling Service: (tel: (2)70300) email: counselling@admin.ox.ac.uk

Proctors' Office: (tel: (2)70090) email: proctors.office@proctors.ox.ac.uk

Departmental Harassment Advisors: a list can be found by clicking here

Oxford University Student Union, Vice President (Welfare):
(tel: (2)88452) email: welfare@ousu.ox.ac.uk

A Course Calendar

Michaelmas Term

Tuesday 4th October, (week 0)	Induction
Monday 10th October (week 1)	Michaelmas term lectures begin
TBC November (week 4)	Examination entry for courses assessed by invigilated written examination in Hilary term
Friday 2nd December (week 8)	Michaelmas term lectures end

Hilary Term

Monday 9th January (week 0)	Provisional start date for HT invigilated examinations
Monday 16th January (week 1)	Hilary term lectures begin
TBC January (week 2)	Examination entry for Michaelmas term practicals Hilary term submissions and all courses assessed by invigilated written examination in Trinity term
Monday 6th March (week 8)	Hilary term mini-projects released
Friday 10th March (week 8)	Hilary term lectures end
Monday 27th March, 12noon (week 11)	Hilary term mini-project submission deadline

Trinity Term

Monday 17th April (week 0)	Provisional start date for first set of Trinity term week 0 invigilated examinations
Monday 24th April (week 1)	Trinity term lectures begin
TBC May (week 3)	Examination entry for Hilary and Trinity practicals Trinity term submissions (including dissertation)
Monday 29th May (week 6)	Provisional start date for second set of Trinity term invigilated examinations
Monday 29th May, 12noon (week 6)	Dissertation submission deadline
Friday 20th June (week 8)	Trinity term lectures end
Monday 22nd June – Wednesday 24th June (week 9)	Trinity term take-home examinations released between these dates.
Wednesday 24th June – Friday 26th June (week 9)	Submission deadlines for Trinity term take-home examinations between these dates.

B Case Studies

The following table details some examples of possible pathways through the Programme. These case studies are for illustrative purposes only and show the breadth and diversity of the programme. Many other paths through the course are possible — and in fact much more eclectic or more generalist selections of courses may be appropriate for students who have not settled on a specialisation they intend to pursue eventually. Indispensable courses ("core") for each given case study are indicated in bold. 1 unit=16 lectures; at least 10 units have to be taken over three terms. Note that some of the Case Studies below are sufficiently broad to allow multiple pathways within them, however you should ensure that your chosen pathway allows you to fulfil the requirements for the overall number of units and the number of assessed units. Please see the examination conventions for further details of these requirements.

Pathway	*MT*	*HT*	*TT*
Generalist Theoretical Physicist *“TEORICA UNIVERSALIS”* **Core 6.25 units** Total 10.25-12.25 units	**1. QFT 24** **2. Kinetic Theory 28** **3. GR I 16** **4. Pert. Methods 16**	1-3. *Three of* **Noneq. Stat. Phys 16** Advanced QFT 24 Advanced Quan. Th. 20 Adv. Fluid Dyn. 16 Collisionless Plasma Physics 18 Random Matrix Theory Soft Matter 8 Cosmology 16 Quantum Matter 16	1-3. *Three of* Quantum Matter II 20 Renormalisation Group 20 The SM and Beyond I 16 The SM and Beyond II 16 Dissertation
Applied Mathematician *“APPLICATA”* **Core 7.75 units** Total 11.25 units	**1. Kinetic Theory 28** **2. GR I 16** **3. Pert. Methods 16** **4. Diff. Geometry 16** **5.** Num. Lin. Algebra 16 **6.** Riemannian Geometry **7.** Networks 16	**1. Adv. Fluid Dyn. 16** ***2.*** *One of* **Noneq. Stat. Phys 16** Geophysical Fluid Dynamics 16 Collisionless Plasma Physics 18 Galactic Dyn. 16 GR II 16 Random Matrix Theory 16 **3. Complex Variables 16**	Collisional Plasma Physics 18 Symbolic, Num. and Graphical Scientific Prog. 16 Dissertation
Fluid Dynamicist *“CONTINUA”* **Core 3.75 units** Total 10.75 units	**1. Kinetic Theory 28** **2. Pert. Methods 16**	**1. Adv. Fluid Dyn. 16** **2.** Soft Matter Phys. 16 **3.** Collisionless Plasma Phys. 18 **4.** Geophysical Fluid Dyn. 16 **5.** Complex Variables 16 **6.** Noneq. Stat. Phys 16	1. Collisional Plasma Physics 16 2. Dissertation
Mathematician with a physics streak *“GEOMETRA”* **Core 5.5 units** Total 10–11 units	**1. QFT 24** **2. GR I 16** **3. Diff. Geometry 16** ***4.*** *One of* Groups & Repr. 24 Algebraic Topology 16 Algebraic Geometry 16	**1. String Theory I 16** ***2.*** *One of* Advanced QFT 24 SUSY & SUGRA 16 GR II 16 Geom. Group Theory 16 Riemannian Geometry 16 Low Dimensional Topo. 16 Random Matrix Theory 16 Astroparticle Phys. 16	**1. String Theory II 16** ***2.*** *Three of* CFT 16 The SM and Beyond I 16 The SM and Beyond II 16

Particle Phenomenologist *“PARTICULATA”* **Core 5.5 units** Total 10 units	**1. QFT 24** **2. Groups & Repr. 24** **3.** *One of* GR I 16 Pert. Methods 16	**1. Advanced QFT 24** **2. SUSY & SUGRA 16** **3.** *Two of* String Theory I 16 GR II 16 Cosmology 16	*Two of* String Theory II 16 The SM and Beyond I 16 The SM and Beyond II 16
Hard-core String Theorist *“SUPERCORDULA”* **Core 7.5 units** Total 11.5 units	**1. QFT 24** **2. Groups & Repr. 24** **3.** *One of* GR I 16 Pert. Methods 16 Diff. Geometry 16 Algebraic Geometry 16	**1. Advanced QFT 24** **2. String Theory I 16** **3.** *One of* SUSY & SUGRA 16 Riemannian Geometry 16 Low Dimensional Topo 16 GR II 16 Cosmology 16	**1. String Theory II 16** **2. CFT 16** 3. *One of* The SM and Beyond I 16 The SM and Beyond II 16
Condensed Matter Theorist *“CONDENSATA”* **Core 3.5 units** Total 11.5–12.5 units	**1. QFT 24** **2.** Advanced Quant. Th. 20 3.*One of* Kinetic Theory 28 Topological Quantum Theory 16	**1. Noneq. Stat. Phys. 16** **2.** Advanced QFT 24 **3.** Adv. Fluid Dyn. 16 **4.** Random Matrix Theory 16 **5.** Low Dimensional Topo. 16	**1. Quantum Matter 16** **2.** Quantum Matter II 20 **3.** Renormalisation Group 20 **4.** CFT 16
Hard-core Hard Condensed Matter Theorist *“DURACELLA”* **Core 4.25 units** Total 10.5–11.25 units	**1. QFT 24** **2. Advanced Quant. Th. 20** **3.** Kinetic Theory 28 **4.** Pert. Methods 16	*Three of* 1. Noneq. Stat. Phys. 16 2. Advanced QFT 24 3. String Theory I 16 4. Low Dimesional Topo 16 5. Adv. Fluid Dyn. 16 6. Random Matrix Theory	**1. Quantum Matter 16** **2.** Renormalisation Group 20 **3.** Quantum Matter II 20 **4.** CFT 16
Soft Condensed Matter Physicist/Biophysicist *“MOLLIS”* **Core 5.25 units** Total 10.25 units	1. QFT 24 **2. Kinetic Theory 28** **3.** Pert. Methods 16 4. Networks 16	**1. Adv. Fluid Dyn. 16** **2. Noneq. Stat. Phys. 16** **3. Soft Matter 16** **4.** Collisionless Plasma 18	**1. Topics Soft Matter 8** **2.** Dissertation

All-round Astrophysicist *“ASTRA-STELLA”* **Core 3.75 units** Total 10.75–11.75 units	**1. Kinetic Theory 28** **2. GR I 16** ***3.*** *Two of* QFT 24 Quantum Processes in Hot Plasma 16 Pert. Methods 16	**1.Galactic Dyn. 16** **2. Cosmology 16** ***3.*** *Three of* Adv. Fluid Dyn. 16 Collisionless Plasma Physics 18 Rad. Proc and High Energy Astro 16 Astroparticle Phys. 16 High Energy Density 16	1. Dissertation
Dedicated Cosmologist *“COSMICOSMICA”* **Core 3 units** Total 10.75 units	**1. GR I 16** 2-5. QFT 24 Kinetic Theory 28 Pert. Methods 16	**1. Cosmology 16** **2. GR II 16** **3.** Galactic Dyn. 16 **4.** Astroparticle Phys 16 **5.** Rad. Proc. and High Energy Astro 16	1. Low Dimesional Topo. 16
Geophysicist/ Climate Physicist *“GAIA”* **Core 2 units** Total 7.75 units	1. Kinetic Theory 28 2. **Pert. Methods 16** 3. Networks 16	**1. Geophysical Fluid Dynamics 16** **2.** Advanced Fluid Dynamics 16 **3.** Noneq. Stat. Phys. 16	1. Dissertation
Plasma Theorist *“PLASMA”* **Core 5.75 units** Total 10.75 units	**1. Kinetic Theory 28** **2. Pert. Methods 16** **3.** Quantum Processes in Hot Plasma 16	**1. Adv. Fluid Dyn. 16** **2. Collisionless Plasma Physics 18** **3.** Noneq. Stat. Phys. 16 ***4.*** *One of* Complex Variables 16 High Energy Density 16	1. Dissertation 2. Collisional Plasma Physics 16

C Suggested Dissertation Topics

Deep Neural Networks and Algorithmic Information Theory

Adviser: Ard Louis (**ard.louis@physics.ox.ac.uk**)

Abstract: Deep neural networks (DNNs) have revolutionised machine learning. In spite of their great success, many questions remain about why they work so well. One key issue is why they generalise so well in the overparameterised regime, where classical learning theory predicts that they should heavily overfit. We have recently used concepts from Algorithmic Information Theory (AIT) to argue that that DNNs are exponentially biased towards functions with low Kolmogorov complexity. If this inductive bias reflects patterns seen in nature, then this may explain the conundrum of good generalisation in the overparameterised regime. But many questions remain, and in this project you would use a combination of theory and simulations to peer into the DNN black box, and to hopefully understand what makes them so special.

see **http://www.physicsmeetsml.org/posts/sem 2020 06 03/** for some more background.

Deformation Quantisation

Supervisor: Christopher Beem (christopher.beem@maths.ox.ac.uk)

ABSTRACT: In the passage from classical to quantum physics, the observable quantities of a system are promoted from functions on a symplectic manifold (phase space) to (not necessarily commuting) operators on a Hilbert space. Removing the Hilbert space from the picture, one has a replacement of a (commutative) Poisson algebra with a non-commutative associative algebra that, in the limit $\hbar \to 0$, allows one to recover the classical Poisson algebra of observables. The problem of *deformation quantisation* is to find, or classify, non-commutative deformations of Poisson algebras obeying various technical conditions. This problem has been considered in diverse array of scenarios (symplectic manifolds, Poisson manifolds, smooth algebraic varieties, singular algebraic varieties; all of the above in both strict and formal cases). It remains an area of active research. In this project you will learn the basic algebraic concepts associated with the deformation quantisation problem and study some advanced topics or applications.

The aim of this dissertation will be to come to terms with the formulation of the deformation quantisation problem and to give an expository account of at least one major branch of the theory. Classic theorems include those of Groenewold-van Hove on the impossibility of achieving an overly strict version of deformation quantisation and the De Wilde-Lecomte theorem proving the existence of formal deformation quantisations of symplectic manifolds. Much more abstract is Kontsevich's famous *formality theorem*, which established the existence of deformation quantisations of general Poisson manifolds (and classified them). One can also study important concrete examples, such as the deformation quantisations of coadjoint orbits of simple Lie groups or Moyal quantisation of affine space.

Prerequisites: Intermediate courses on classical and quantum mechanics (equivalents of Oxford B7.1 and B7.3) and a first or second course on abstract algebra. Michaelmas courses Differentiable Manifolds, Groups & Representations, and Homological Algebra could all be useful.

Useful Reading

[1] A. Weinstein, *Deformation quantization*, Astérisque **227** (1995): 389-409.

[2] M. Bordemann, *Deformation quantization: A survey,* J. Phys. Conf. Ser. **103**, (2008).

[3] S. Gutt, *Variations on deformation quantization*, Math. Phys. Stud **21** (2000): 217–254.

Additional Reading

[4] F. Bayen, M. Flato, C. Fronsdal, A. Lichnerowicz and D. Sternheimer, *Deformation Theory and Quantization. 1. Deformations of Symplectic Structures*, Annals Phys. **111**, 61 (1978).

[5] M. De Wilde, Marc, P. Lecomte, *Existence of star-products and of formal deformations of the Poisson Lie algebra of arbitrary symplectic manifolds*, Letters in Mathematical Physics, **7**, (1983): 487–496.

[6] C. Frønsdal, *Deformation Quantization on the Closure of Minimal Coadjoint Orbits*, Letters in Mathematical Physsics, **88**, (2009): 271–320.

Dynamical Instabilities in Black Hole Accretion Discs

Supervisor: Steven Balbus

Abstract: It has been forty-nine years since the seminal paper of Shakura & Sunyaev (1973) laid down the foundations of turbulent accretion disc theory and twenty-five years since the establishment of the magnetorotational instability (MRI) as the fundamental physical basis for disc turbulence (Balbus & Hawley 1991). Yet, major features of disc behaviour remain poorly understood, especially transient behaviour around black holes. Discs can spontaneously change their emission profile, and perhaps their gross physical state. Depending on the black hole mass, this can occur over a wide variety of time scales. In addition, there is another major class of black hole transients, so-called tidal disruption events (TDEs), in which a star passing near a massive (in excess of $10^6 M_\odot$ black hole is pulled apart by the hole's tidal forces, with some fraction of the star's mass ultimately accreting into the hole. These objects are intrinsically time-dependent. While time-dependent disc theory following Newtonian gravity (Lynden-Bell & Pringle 1974) is by now well-established, the extension of this to Kerr black holes is very recent (Balbus 2017).

In this dissertation we shall study the theory of accretion around Kerr black holes, and apply this knowledge to better understand observations of TDEs. The behaviour of dynamical instabilities is of particular interest, as these can affect the disc's turbulent stress, accretion rate, and subsequent emission. The Lightman-Eardley instability, which afflicts regions of the TDE disc dominated by radiation pressure, will be an important focus of this work. The project can take many different directions (e.g., modelling, numerical study, analysis) depending upon the student's interest and background.

References and Background Reading:

Balbus, S. A. 2017, MNRAS, 471, 4832 Balbus, S. A., & Hawley, J. F. 1991, ApJ, 376, 214 Balbus, S. A., & Mummery, A. 2018, MNRAS, 481, 3348 Franck, J., King, A.,& Raine, D. 2002, *Accretion Power in Astrophysics* (CUP: Cambridge) Lightman, A.P. & Eardley, D,M. 1974, ApJ (Letters), 187, 1 Lynden-Bell, D., & Pringle, J. 1974, MNRAS, 168, 603 Mummery, A., & Balbus, S. A. 2019, *MNRAS* 489, 132 Page, D. N., & Thorne, K. S., 1974, ApJ, 191, 499 Shakura, N. I., & Sunyaev, R. A. 1973, A&A, 24, 337

Hydrodynamic and MHD turbulence

Adviser: Alexander Schekochihin (alex.schekochihin@physics.ox.ac.uk)

Abstract: Kolmogorov's 1941 scaling theory of developed turbulence. Structure of statistical correlations of an isotropic vector field (fluid velocity). von Karman-Howarth equations and the exact scaling law for 3rd-order moments (the 4/5 law). Theory of intermittency: Kolmogorov and She-Leveque.

If student's time and energy permit, this dissertation can also cover the theory of MHD turbulence (or, alternatively, the student can skip some of the hydro topics and skip to MHD):

Scaling theories: Goldreich-Sridhar theory, critical balance, dynamic alignment. Weak turbulence theory for Alfven waves. Intermittency models and further refinements. (These latter topics contain some potential for research-relevant contributions.)

Other optional topics that can be covered in addition or instead of MHD: Application of the critical balance principle to rotating and stratified turbulence. Kolmogorov-style theory for turbulence in kinetic (collision-less) plasma.

Relevant Courses: a course in fluid dynamics; MHD part of Advanced Fluid Dynamics (HT) or equivalent if the student wishes to cover MHD turbulence.

References:

1. Lecture notes: http://www.mathphys.physics.ox.ac.uk/people/AlexanderSchekochihin/notes/SummerSchool07/
2. L. D. Landau & E. M. Lifshitz, *Fluid Mechanics*, Butterworth-Heinemann 1995 (Sec 33, 34)
3. U. Frisch. *Turbulence*. The Legacy of A. N. Kolmogorov. CUP 1995
4. P. A. Davidson. *Turbulence — An Introduction for Scientists and Engineers*. OUP 2004.
5. http://www-thphys.physics.ox.ac.uk/research/plasma/JPP/papers17/schekochihin2a.pdf

Solvable models for passive turbulent fields

Adviser: Alexander Schekochihin (alex.schekochihin@physics.ox.ac.uk)

Abstract: Normally it is (or has so far been) impossible to obtain analytic solutions for correlation functions in turbulent systems. However, for a class of models, analytical treatment is possible: those concern the turbulent advection of scalar and vector fields in an imposed random flow most often white-in-time Gaussian random velocity field is used, as a far-fetched but solvable model of turbulent flow. Exact analytical results can be obtained for this model and it is remarkable how well they tend to work. The two main applications are the advection of a scalar, describing turbulent mixing of a temperature field in a fluid (or perhaps of the concentration of an admixture), and the advection of a vector, describing the evolution of a weak magnetic field in a turbulent conducting fluid. The latter is a model for the so-called "turbulent dynamo" amplification of mean magnetic energy via random stretching and tangling by a turbulent flow, believed to be responsible for the origin of cosmic magnetism (dynamically strong tangled magnetic fields observed in the interstellar and intergalactic medium, on the surface of the Sun and in many other places). This dissertation will help the student learn both the physics of passive advection and a suite of analytical techniques for handling stochastic systems. While most of the material is standard, there is some potential for research-level calculations, which can be attempted if the student so desires.

Relevant Courses: Nonequilibrium Statistical Physics (MT), a course in fluid dynamics, MHD part of Advanced Fluid Dynamics (HT) or equivalent.

References:

1. Lecture notes: ask supervisor.
2. Ya. B. Zeldovich, A. A. Ruzmaikin & D. D. Sokoloff, *The Almighty Chance* (World Scientific 1990)
3. N. G. van Kampen, *Stochastic Processes in Physics and Chemistry* (Elsevier 1992)
4. a selection of research articles

Langmuir turbulence and modulational instabilities

Adviser: Alexander Schekochihin (alex.schekochihin@physics.ox.ac.uk)

Abstract: This dissertation is devoted to the theory of nonlinear states that emerge in systems of interacting Langmuir waves ("plasmons") and sound waves ("phonons") in plasmas. Besides being a rich and interesting topic in itself, this is also the paradigm for many (indeed, most) other plasma turbulence systems, as it is in this context that most of the relevant toolkit was developed: weak turbulence theory, modulational instabilities, soliton solutions, Langmuir collapse, thermodynamic (Jeans) states, strong-turbulence theories, etc. A specific path through this material is negotiable and should be discussed at the start of the dissertation. There is scope for research-level contributions if the student's time and energy level allow.

Relevant Courses: Kinetic Theory (MT), Collisionless Plasma Physics (HT), Nonequilibrium Statistical Physics (MT), a course in fluid dynamics

References:

1. Zakharov, V. E. 1972 Collapse of Langmuir waves. Sov. Phys.–JETP 35, 908
2. Zakharov, V. E., Musher, S. L. & Rubenchik, A. M. 1985 Hamiltonian approach to the description of non-linear plasma phenomena. Phys. Rep. 129, 285.
3. Thornhill, S. G. & ter Haar, D. 1978 Langmuir turbulence and modulational instability. Phys. Rep. 43,
4. 4. Tsytovich, V. N. 1995 Lectures on Non-linear Plasma Kinetics. Berlin: Springer

Sloppy Systems

Adviser: Ard Louis (ard.louis@physics.ox.ac.uk)

Abstract: Many models in biology, engineering and physics have a very large number of parameters. Often many of these are only known approximately. Moreover, in John von Neuman's famous quip "with four parameters I can fit an elephant, and with five I can make him wiggle his trunk." suggests that only a small set of these parameters are actually relevant? Could there be a fundamental theory of these complex systems that allows us to work out what the key parameters are?

References:

1. Transtrum, Mark K., Machta Benjamin, Brown Kevin, Daniels Bryan C., Myers Christopher R., and Sethna James P. , *Perspective: Sloppiness and Emergent Theories in Physics, Biology, and Beyond*, J. Chem. Phys., Volume 143, Issue 1, (2015)
2. Machta, Benjamin B., Chachra Ricky, Transtrum Mark K., and Sethna James P. , *Parameter Space Compression Underlies Emergent Theories and Predictive Models*, Science, Volume 342, p.604-607, (2013)
3. Gutenkunst, R. N., Waterfall J. J., Casey F. P., Brown K. S., Myers C. R., and Sethna J. P., *Universally sloppy parameter sensitivities in systems biology models*, PLoS Computational Biology, Volume 3, p.1871-1878, (2007)
4. Waterfall, J. J., Casey F. P., Gutenkunst R. N., Brown K. S., Myers C. R., Brouwer P. W., Elser V., and Sethna J. P. , *Sloppy-model universality class and the Vandermonde matrix*, Physical Review Letters, Volume 97, p.150601, (2006)

Survival of the Flattest or Arrival of the Frequent?

Adviser: Ard Louis (ard.louis@physics.ox.ac.uk)

Abstract: Evolution proceeds by mutations to genotypes that in turn change phenotypes (the organism). But since the number of genotypes is much larger than the number of phenotypes, concepts of genetic entropy must enter into the equations, which means methods from statistical mechanics become relevant. In some cases, the entropy means that the phenotypes that end up surviving are not the fittest. Two different scenarios are the "survival of the flattests" and the "arrival of the fittest". Sometimes these are confused, so a clear explanation of how they are similar, and where they differ is needed.

References:

1. Wilke CO, Wang JL, Ofria C, Lenski RE, Adami C, (2001) *Evolution of digital organisms at high mutation rates leads to survival of the attest*, Nature 412: 331–333.
2. Iwasa Y (1988), *Free fitness that always increases in evolution*, Journal of Theoretical Biology 135: 265–281.
3. Sella G, Hirsh AE (2005),*The application of statistical physics to evolutionary biology*, Proceedings of the National Academy of Sciences of the United States of America 102: 9541–9546.
4. Barton, NH & Coe, JB (2009), *On the application of statistical physics to evolutionary biology*, Journal of Theoretical Biology, vol 259, no. 2, pp. 317-324.
5. Schaper, S, & Louis A A (2014), *The Arrival of the Frequent: How Bias in Genotype-Phenotype Maps Can Steer Populations to Local Optima PLoS One*, 2014; 9(2): e86635.

Numerical analysis of conformal field theories

Adviser: Christopher Beem (christopher.beem@maths.ox.ac.uk)

ABSTRACT: Conformal field theories (CFTs) are (generically) strongly coupled quantum systems and are challenging to analyze using standard techniques of quantum field theory. They are of interest in statistical physics for describing thermal systems at second order phase transitions, as well as for more formal reasons in high energy physics. Over the past decade it has been realised that a conceptually simple numerical approach to the study of CFT based on conservative input data (symmetries and self-consistency conditions) can be surprisingly powerful, leading to precise predictions for these unruly physical systems. This is the so-called *numerical conformal bootstrap*.

The starting point of the project will be the derivation of the *crossing-symmetry equation* for a four-point correlation function of scalar operators in terms of the conformal block expansion. This is a foundational self-consistency condition that follows from physical principles. The main part of the dissertation will then focus on the application of numerical functional techniques to derive bounds on scaling dimensions in two-dimensional conformal field theories. This can be formulated as a linear programming problem or, with additional sophistication, as a semidefinite programming problem. There are also many possible extensions of the basic functional constraint in two dimensions (bounds for CFTs in higher dimensions, bounds arising from systems of correlation functions, bounds for coupling constants/OPE coefficients, *etc*.).

Some programming ability in C++ or Python will be useful, as well as experience with Mathematica or equivalent.

Prerequisites: Quantum Field theory (MT), Advanced Quantum Field Theory (HT), Renormalisation Group (HT), Conformal Field Theory (TT).

References

[1] D. Simmons-Duffin, *The Conformal Bootstrap,* arXiv:1602.07982 [hep-th].

[2] D. Poland, S. Rychkov, A. Vichi, *The Conformal Bootstrap: Theory, Numerical Techniques, and Applications,* Rev. Mod. Phys. **91**, no. 1, 15002 (2019) [arXiv:1805.04405].

[3] P. H. Ginsparg, *Applied Conformal Field Theory,* hep-th/9108028.

Modes of collisionless systems

Adviser: James Binney (binney@physics.ox.ac.uk)

A dissertation: 1. explaining the fundametal role that normal modes play in physics and engineering. 2. Contrasting the normal modes of solid or fluid systems with those of collisionless systems. 3. Explaining the difference and relations between van Kampen & Landau modes. 4. Describing what we know about such modes for (a) a homegeous electrostatic plasma, and (b) a spherical star cluster. 5. Discussing the most promising way to develop a theory of the thermal fluctuations of stellar systems and possibly the relevance of such a theory for contemporary observational data.

Reading

1. van Kampen, 1955 Physica 21, 949
2. Case 1959 Annals of Physics 7, 349
3. Antonov 1961 Sov Astron 4, 859
4. Ramos & White 1918, Physics of Plasmas 25 4501
5. Lau & Binney 2021 MNRAS 507, 2241 and 507, 2562
6. Hamilton & Heinemann, 2020 arXiv 201114812

Foundations of Statistical Mechanics and the Eigenstate Thermalisation Hypothesis

Supervisor: John Chalker (john.chalker@physics.ox.ac.uk)

Abstract: *Why does statistical mechanics work?* This long-standing question has recently acquired a new focus, partly because of experimental developments and partly as a result of new theoretical ideas. In particular, we can ask what happens if we attempt to evaluate thermal averages simply as quantum expectation values in a single eigenstate of a system. The eigenstate thermalisation hypothesis is the idea that – in a system of many interacting particles – this should lead to the same results as the canonical ensemble with its average over contributions from many eigenstates.

References:

1. L. D'Alessio, Y. Kafri, A. Polkovnikov and M. Rigol, Advances in Physics **65**, 239 (2016).
2. J.M. Deutsch, Phys. Rev. A **43**, 2046 (1991).
3. M. Srednicki, Phys. Rev. E **50**, 888 (1994).
4. M. Rigol, V. Dunjko and M. Olshanii, Nature **452**, 854 (2008).

Weight: single unit.

Quantum dimer models

Supervisor: John Chalker (John.Chalker@physics.ox.ac.uk)

Abstract: Quantum dimer models provide very simple examples of highly correlated systems which can show topological order and fractionalised quantum numbers. They illustrate how useful, minimal models can be constructed in theoretical condensed matter physics, with interesting emergent features in their long-distance properties.

References:

1. R. Moessner and K. S. Raman, https://arxiv.org/abs/0809.3051

2. D. Rokhsar and S. Kivelson, Phys. Rev. Lett. **61** 2376 (1988).

Weight: single unit.

How directed are directed networks?

Adviser: Renaud Lambiotte (renaud.lambiotte@maths.ox.ac.uk)

Many real-world networks are composed of directed edges that are not necessarily reciprocated. While several algorithms have been generalised to the case of directed networks, conceptual challenges, i.e. to quantify the level of hierarchy (and its impact on dynamics). In this project, we will investigate the notion of hierarchy in directed networks from different, possibly complementary viewpoints. The two main challenges will be to design embedding techniques allowing to rank nodes according to their importance, while grouping "similar nodes", and to investigate how hierarchies impact on linear dynamics, more specifically via the non-normality of the coupling matrices.

Prerequisites:
Taking the course C5.4. Networks is recommended.

Reading list:
MacKay, Robert S., Samuel Johnson, and Benedict Sansom. "How directed is a directed network?." *Royal Society open science* 7.9 (2020): 201138.
Lambiotte, Renaud, and Michael T. Schaub. *Modularity and Dynamics on Complex Networks*. Cambridge University Press, 2021.

Scalar gravitational Waves

Adviser: Pedro Ferreira (pedro.ferreira@physics.ox.ac.uk)

Gravitational waves have given us a completely new window onto the Universe. Thus far they have shown that the theory of gravity is well described by Einstein's theory of General Relativity. Extensions to Einstein's theory often invoke the presence of extra degrees of freedom in the form of scalar fields which may be non-trivially coupled to the metric. As a result, one may find that scalar gravitational waves are generated. It would be of interest to understand how detectable such scalar gravitational waves are – how they couple to detectors, what type of systematic effects may affect them, etc. In this project we will explore how we can quantify, or forecast, the detectability of scalar gravitational waves. We will try, as much as possible, to us analytic methods to do so but it will, inevitably, involve numerical work.

References:

Maggiore, M. "Gravitational Waves" Vol 1 and 2 (OUP)
Berti, E., Cardoso, V. & Will, C. https://arxiv.org/abs/gr-qc/0512160
Tattersall, O & Ferreira, P.G. https://arxiv.org/abs/1904.05112

E Glossary of Key Terms

A list of useful terms for new students.

Battels: The charges made to a member of a college (student or Fellow) for accommodation, meals etc.

Candidate Number: A number assigned to each student for the use of formal assessments and written examinations, which is usually available to students via student self-service after they have made their first exam entry. Candidate numbers are used instead of names to anonymise students during assessments. It is different from the student number.

Classes: Each Part C and MTP lecture course is accompanied by a set of classes (called 'intercollegiate classes' if they are held at Maths Institute and 'classes' if they are held in Physics.) For Maths courses, these will be run by a tutor and teaching assistant (TA), for Physics courses, these will be led by a TA, and will cover any problems that have arisen from the problem sheets.

College Office: The academic office based at your college who will be able to assist you with changing your examination entries if needed.

Consultation Sessions: Revision sessions which take place for courses run by the Maths Institute in Weeks 2-5 of Trinity term.

Consultative Committee for Graduates (CCG): A committee consisting of postgraduate representatives from the Mathematical Institute and the departments two DGSs.

Degree Days: Various days throughout the year on which students may graduate.

DGS: Director of Graduate Studies.

Don: A professor, a lecturer or a Fellow.

Examination Conventions: The Examination Conventions act as a supplement to the Examination Regulations. The Conventions explain how a student will be assessed for their course within the framework of the Examination Regulations.

Examination Regulations: Sometimes referred to as the 'Grey Book', the Examination Regulations govern all academic matters within the University.

Examination Schools: The building located on High Street where written examinations are held for the MMathPhys/MSc in Mathematical and Theoretical Physics degree, and where students hand in hard copies of their dissertations, mini-projects, and take-home examinations.

Formal Assessment: In the context of your degree, these are dissertations, mini-projects and take-Home Exams.

Invariants: A society run by students at the Mathematical Institute, which aims to promote Mathematics and to provide a social environment for students of Mathematics.

GSO: Graduate Studies Office, part of the central University.

GSR: Graduate Supervision Reporting. Supervisors will submit termly reports through GSR on their student's academic progress.

Hilary term: The second term of an academic year, running from January to March.

JSC: Acronym for the Joint Supervisory Committee in Mathematical and Theoretical Physics, consisting of Maths and Physics academics who meet at least once a term to make decisions about the degree. Student representatives for the degree also attend these meetings

Lectures Known as classes at some other institution, this is where the lecturer will present their subject to you as a larger audience. Classes at Oxford are where students split into smaller groups to work through problem sheets based on the lectures with a tutor and sometimes a teaching assistant.

Lecturer: Lecturers are those who have the responsibility to deliver lectures.

LGBTI∧3: A group of students aiming to provide a friendly environment for those LGBTQ-identifying individuals studying within the Mathematical Sciences.

Matriculation: Matriculation confers membership of the University on those students who are enrolled at the University of Oxford and following a degree-level course.

MCF: Masters in Mathematical and Computational Finance. An Master's course run by the Mathematical Institute.

MFoCS: Masters in Mathematics and Foundations of Computer Science. An MSc course run jointly by the Mathematical Institute and the Department of Computer Science.

Michaelmas term: The first term of an academic year, running from October to December.

Minerva: A system used by teaching staff to record attendance and marks for the students in their class at Maths. The class times, days and locations are exported from this system and are advertised to students through the departmental class lists.

Mirzakhani Society: A society at the Mathematical Institute for female and non-binary students.

MMSC: Masters in Mathematical Modelling and Scientific Computing. An MSc course run at the Mathematical Institute.

MPLS: Mathematical, Physical and Life Sciences Division.

MTP: The acronym for your degree, Mathematical and Theoretical Physics.

OMMS Oxford Master's course in Mathematical Sciences.

Oxford SU: Oxford University Student Union.

Papers: Constituent parts of an examination.

Part C: The term given to the fourth-year undergraduate students studying for an integrated Masters. Part C is used to describe the courses that are open to these students.

PhysSoc: Oxford University Physics Society

Practicals: In the context of your degree, this means the homework options you choose.

Proctors: The two Proctors (Senior and Junior) are elected each year by colleges in rotation to serve for one year. The statutes provide that they shall generally ensure that the statutes, regulations, customs, and privileges of the University are observed. They serve on the University's main committees, and where not members of committees, may receive their papers and attend meetings but not vote. They have responsibilities under the statutes and regulations for aspects of student discipline, for ensuring the proper conduct of examinations and for dealing with complaints. They also carry out ceremonial duties, e.g. at degree ceremonies.

Student number A number used to identify you as a student in day to day tasks, and can be used in conjunction with your name, unlike your candidate number.

Student Self Service: Student Self Service allows a student to access their student record and complete other tasks such as examination entry, and viewing examination results.

Sub fusc: Formal attire worn by students and academics on formal occasions, including matriculation, examinations and graduation.

Trinity term: The third term of an academic year, running from April to June.

Vac: Abbreviation of vacation.

Week 0: The week preceding the start of each term. Week 0 in Michaelmas Term is sometimes referred to as 'noughth week'.