Oxford Master Course
in
Mathematical and Theoretical Physics

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

Course Handbook

2015–2016
1 Introduction

The Oxford Master’s Course in Mathematical and Theoretical Physics fills a need to offer students a high-level education in mathematical and theoretical physics. As the name suggests, the course concentrates on the main areas of modern mathematical and theoretical physics: elementary-particle theory, including string theory, condensed matter theory (both quantum and soft matter), theoretical astrophysics, plasma physics and the physics of continuous media (including fluid dynamics and related areas usually associated with Applied Mathematics programmes in the UK system). If you are a physics (or physics & philosophy) student with a strong interest in theoretical physics or a mathematics student keen to apply high-level mathematics to physical systems, this is a course for you.

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, you are eligible to apply for transfer to the MMathPhys programme for the fourth year of your study. If accepted, you will spend your fourth year studying within the MMathPhys programme, rather than following the fourth year of your original degree programme. 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 from outside Oxford with a Bachelor or masters degree in physics or mathematics you can apply for the MSc mode, which leads to an “MSc in Mathematical and Theoretical Physics.”

Admission to the course is based on aptitude, potential and motivation to study mathematical and theoretical physics. Evaluation criteria include the BA degree class (or equivalent), letters of reference, personal statements and prior performance on mathematical and theoretical physics courses. A necessary condition for admission to the course is a 2.i or higher degree class at BA level for MMathPhys applicants or an equivalent qualification for MSc applicants. While this represents a minimum requirement it is not, by itself, a sufficient condition for acceptance, since the degree class will be considered together with the other indicators. It is anticipated that, in most cases, the students accepted into the course will have a 1st class BA degree or equivalent.

The programme offers considerable choice. You will be able to study focusing on a specific subject area or aim for a broader education across two or several fields, concentrate on “mathematical” or “physical” aspects. Your aim may be to prepare yourself for doctoral-level research in a chosen area or to explore theoretical physics broadly before deciding what to do. While the degree allows flexibility of choice, its salient feature is the coherent structure of its main themes. This handbook contains a section on possible pathways through the course, which can be found in Appendix B.

You will be required to take 10 units within the programme, with each unit corresponding to a 16-hour lecture course. At least 4 of these units must be assessed by invigilated written examinations and have to be covered by courses offering a written exam (typically the “foundational courses,” see below). This is, in fact, the only formal constraint on course choices and you are otherwise free to design your own pathway, although attention to the guidance offered to you is strongly encouraged. The remaining units will be assessed on the basis of written course work, take home papers or mini-projects. In addition, you will give an oral presentation towards the end of the course. Both the MMathPhys and MSc students will receive a graduate-style distinction/pass/fail classification. Note that, for Oxford students on the MMathPhys stream, this will be different from the 1st/2.1/2.2... degree classification they would have received had they continued with their original degree.

MPhys and MMMath courses in the UK both provide good undergraduate degrees with a broad overview of physics and mathematics. It is widely felt, however, that neither provides an adequate foundation that allows a student to proceed directly to research in modern mathematical and theoretical physics. Namely, on the one hand, it is felt that, MPhys degrees no longer provide adequate theoretical and mathematical training, while, on the other hand, MMMath degrees provide the mathematical training but are weak in their provision of quantum theory and classical field theory, which are the mainstays of a theoretical physicist’s intuition. Yet other core subjects, such as quantum field theory, the standard model of particle physics,
cosmology, or kinetic theory of gases and plasmas are not taught at all or not at sufficient depth to prepare for research in these, and related, areas. As a result, MPhys and MMath graduates have found the transition to postgraduate research in mathematical and theoretical physics increasingly difficult. The present programme is designed to resolve those problems. It provides 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 should be well-prepared for PhD studies in an area of mathematical and theoretical physics and in a prime position to secure a relevant PhD place.

The course will be offered for the first time in the academic year 2015/16. Oxford MMath, MPhys or MPhysPhil students who are in their second year in the academic year 2013/14 are the first cohort eligible to apply in the round of graduate applications in January 2015, to start the course in October 2015.

We hope that most of your questions are answered in the remainder of this handbook. If anything remains unclear, please contact Mrs. Charlotte Turner-Smith at academic.administrator@maths.ox.ac.uk.

2 Structure of the course

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 three strands:

- Theoretical Particle Physics,
- Theoretical Condensed Matter Physics,

As various areas of Theoretical Physics are in fact, interconnected, routed in universal principles and thrive on ideas that cross any sub-field boundaries, the programme offers a number of courses that are shared between the three strands and emphasise the unity of Theoretical Physics. 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. Besides these Theoretical Physics courses, the programme offers, in Michaelmas and Hilary Terms, a range of lecture courses teaching the underlying mathematical methods, as well as further mathematics courses for the more mathematically oriented students. Lecture courses will normally be accompanied by problem sets and problem classes. Note that, in any given year, the more specialised courses will be taught only if a sufficient number of students attend.

An overview of the courses can be found in the table accompanying this section; their syllabi can be found in Appendix A. You will have to attend at least 10 units worth of courses, with 1 unit corresponding to 16 hours of lectures. 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 B or C or MPhys Part C lecture courses that are not listed here, subject to approval by the Director of Studies.

The programme offers considerable flexibility and choice. There are no courses that all or any students are obliged to follow, and you will thus be able to choose a path reflecting your intellectual tastes or career choices. This arrangement caters both to students who prefer a broad theoretical education across subject areas and to those who have already firmly set their sights on one of the three subject areas (although they too are encouraged to explore across sub-field boundaries). Studies can be pursued with stronger emphasis on mathematical or on physical aspects.

Appendix B gives examples of different pathways through the course along with suggested prior courses you might take during your BA degree. 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 (the choice is not restricted to the examples in Appendix B). Course lecturers will also
advise on the recommended background for their courses or possible follow-up courses you might wish to choose.

The programme does not offer a research project as its emphasis is on offering its students an opportunity to receive an intensive and thorough academic training, which is an indispensable pre-requisite for a modern theoretical physicist or applied mathematician wishing to work on a level appropriate for PhD research or a similar occupation. Indeed, most past and current PhD students in Theoretical/Mathematical Physics or Applied Mathematics at the world’s leading research institutions have been educated in this way (sometimes via Master-level programmes similar to this one and sometimes via coursework during the first year of their doctoral degree). The present programme does, however, offer a substantial opportunity for independent study and research in the form of an optional dissertation (worth 1 unit). The dissertation is undertaken under the guidance of a member of staff and will typically involve investigating and then presenting in writing a particular area of Theoretical Physics or Mathematics, without the requirement (while not excluding the possibility) of obtaining original results.

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\(^{(PU:NN)}\): 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;

\(^{*}\) a course that may not be available every year.
### Overview of Lecture Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theoretical Particle Physics</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Theoretical Condensed Matter Physics</strong></td>
<td></td>
</tr>
<tr>
<td>Theor. Astrophysics, Plasma Physics &amp; Physics of Continuous Media</td>
<td></td>
</tr>
<tr>
<td><strong>Quantum Field Theory</strong></td>
<td>(24)</td>
</tr>
<tr>
<td>Statistical Mechanics <em>(MU,C6.2a)</em> (16)</td>
<td></td>
</tr>
<tr>
<td>Intro. Quant. CMP <em>(PU,C6)</em> (16)</td>
<td></td>
</tr>
<tr>
<td>Nonequilibrium Statistical Physics <em>(PU,C6)</em> (8)</td>
<td></td>
</tr>
<tr>
<td>Kinetic Theory (24)</td>
<td></td>
</tr>
<tr>
<td>Viscous Flow <em>(MU,B6)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Gen. Relativity I</strong> <em>(MU,C7.2a)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Perturbation Methods</strong> <em>(MU,C6.3a)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Scientific Computing I</strong> <em>(MG)</em> (12)</td>
<td></td>
</tr>
<tr>
<td><strong>Numerical Solutions to Differential Equations I</strong> <em>(MU,B21a)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Numerical Linear Algebra</strong> <em>(MU,C72.1a)</em> (16)</td>
<td></td>
</tr>
<tr>
<td>Groups and Representations (24)</td>
<td></td>
</tr>
<tr>
<td><strong>Algebraic Topology</strong> <em>(MU,C3.1a)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Algebraic Geometry</strong> <em>(MU,C3.4a)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Advanced Fluid Dynamics</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Soft Matter Physics</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Nonlinear Systems</strong> <em>(MU,B6)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Advanced QFT</strong> *(24)</td>
<td></td>
</tr>
<tr>
<td><strong>Quant. CMP II</strong> <em>(PU,C6)</em> (24)</td>
<td></td>
</tr>
<tr>
<td><strong>Networks</strong> <em>(MU,C6.2b)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Plasma Physics</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Galactic &amp; Planetary Dyn.</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Stellar Astrophysics</strong> <em>(PU,C1)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Gen. Relativity II</strong> <em>(MU,C7.2b)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Cosmology</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Applied Complex Variables</strong> <em>(MU,C6.3b)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Scientific Computing II</strong> <em>(MG)</em> (12)</td>
<td></td>
</tr>
<tr>
<td><strong>Numerical Solutions to Differential Equations II</strong> <em>(MU,B21b)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Differential Geometry</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Geom. Group Th</strong> <em>(MU,C3.20)</em> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Conformal Field Theory</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Introduction to Gauge-String Duality</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Topics in Soft &amp; Active Matter Physics</strong> (8)</td>
<td></td>
</tr>
<tr>
<td><strong>Complex Systems</strong> <em>(MG,</em>) (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Advanced Quant. CMP</strong> (8)</td>
<td></td>
</tr>
<tr>
<td><strong>Turbulence</strong> <em>(</em>) (16)</td>
<td></td>
</tr>
<tr>
<td><strong>The Standard Model</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Topics in Quant. CMP</strong> (8)</td>
<td></td>
</tr>
<tr>
<td><strong>Geophys. Fluid Dynamics</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Beyond the St. Model</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Critical Phenomena</strong> <em>(</em>) (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Advanced Plasma Physics</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Nonpert. Meth. in QFT</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Astrophys. Fluid Dynamics</strong> (16)</td>
<td></td>
</tr>
<tr>
<td><strong>High-Energy Astrophysics</strong> <em>(</em>) (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Astroparticle Phys.</strong> <em>(</em>) (16)</td>
<td></td>
</tr>
<tr>
<td><strong>QFT in Curved Space</strong> <em>(</em>) (16)</td>
<td></td>
</tr>
<tr>
<td><strong>Dissertation</strong>, replacing one 16-hour lecture course</td>
<td></td>
</tr>
</tbody>
</table>

* indicates the corresponding course is offered twice, one in the fall and one in the spring.
3 Admissions

Oxford students are eligible to apply for transfer to the MMathPhys in their fourth year, if they are enrolled in the third year of either the MPhys, MMath or MPhysPhil courses. Students from outside the University of Oxford wishing to enter the MSc mode can apply if they either hold a BA or a masters degree (or equivalent) in mathematics, physics or a related subject, or are enrolled in such a degree programme and are set to complete it by the time they intend to start the MSc.

3.1 Admission criteria

The aim of the admission procedure is to select applicants with the potential and preparedness to successfully complete the programme. Subject to equal opportunities principles and legislation, applications will be considered in light of a candidate’s ability to meet the following criteria:

- proven and potential academic excellence in mathematical and theoretical physics;

- motivation for studying mathematical and theoretical physics.

These will be assessed using indicators including

- the compatibility of the candidate’s previous programme of study with the prerequisites of the MMath-Phys course;

- the candidate’s performance in her/his previous programme of study and in particular in courses related to theoretical and mathematical physics. Candidates will normally be required to have completed at least a 2.1-class honours degree (or an equivalent qualification) in mathematics, physics, or a related discipline at the time their MMathPhys course starts;

- two reference letters;

- a short personal statement detailing the candidate’s motivation.

No interviews will be conducted.

3.2 Application procedure

At the time of application you may not yet have completed your first undergraduate degree. In this case your application will be assessed on the basis of your performance in your course thus far (for MMathPhys applicants, this means performance in Part A). If admitted, you will be given a conditional offer. A standard condition is completion of your BA degree at 2.i level or better (or equivalent).

Applying to enter the MMathPhys course does not entail a risk for Oxford students: should you miss your offer conditions, you can continue with your original programme (MMath, MPhys, or MPhysPhil) as long as you satisfy the necessary requirements to proceed according to the regulations for those degrees. If you are an Oxford student admitted to the MMathPhys part of the programme, you will be able to return to your original degree programme (MMath, MPhys, or MPhysPhil) during the first four weeks of the Michaelmas Term of your fourth year. This will allow you to continue with your original course if you find that the MMathPhys course is not to your liking. A return later than four weeks into Michaelmas Term is not possible, because catching up with the original course becomes too difficult. If you are an Oxford student and are considering the MMathPhys option, you are encouraged to consult your tutors prior to submitting an application.

For deadlines and practical details on how to apply, see Appendix C.
3.3 Other admissions requirements (for MSc applicants only)

- **English language requirement**: applicants whose first language is not English are usually required to provide evidence of proficiency in English at the higher level required by the University. See [http://www.ox.ac.uk/admissions/postgraduate_courses/apply/international_students.html](http://www.ox.ac.uk/admissions/postgraduate_courses/apply/international_students.html).

- **Whether or not an applicant has secured funding** is not taken into consideration in the decision to make an initial offer of a place, but this offer will not be confirmed until the College to which you applied or are assigned is satisfied that you have sufficient funding to cover the fees and living costs for the standard period of fee liability for your course.

3.4 Disability, health conditions, and specific learning difficulties

Students are selected for admission without regard to gender, marital or civil partnership status, disability, race, nationality, ethnic origin, religion or belief, sexual orientation, age, or social background. Decisions on admissions are based solely on the individual academic merits of each candidate and the application of the selection criteria appropriate to the programme of study. Further information on how these matters are handled during the admissions process is available at the following websites: [http://www.ox.ac.uk/admissions/postgraduate_courses/apply/disabilities.html](http://www.ox.ac.uk/admissions/postgraduate_courses/apply/disabilities.html), [http://www.ox.ac.uk/admissions/undergraduate_courses/why_oxford/support_wellbeing/disabled_students.html](http://www.ox.ac.uk/admissions/undergraduate_courses/why_oxford/support_wellbeing/disabled_students.html).

4 Suggested academic background

While there are no formal pre-requisites beyond the admissions criteria listed above, those applicants whose undergraduate degree programmes have optional components may wish to receive some guidance as to how best to prepare themselves for the MMathPhys/MSc programme. Below we give some suggestions for the Oxford students intending to apply to the MMathPhys. These suggestions might inform your choice of optional courses during the first three years of your undergraduate course. Equivalents might be available to MSc applicants at their own universities.

Note that in some cases, it might be useful to take a course early instead of waiting for the MMathPhys year (for example, some Part B Mathematics courses that are relevant for certain paths or general interests). If an overlap occurs between courses you have taken previously and some of the courses in this programme, you will have the flexibility and opportunity to explore another area, which you otherwise might not have had time for.

4.1 Suggestions for physics students (MPhys)

Parts A and B of the MPhys only have a small optional component consisting of Short Options. We consider the first three years of the MPhys to be adequate preparation for the MMathPhys. This said, if you are thinking of taking up the MMathPhys option in your 4th year, you may wish to consider the following Short Options:

- **All students**: S01 Functions of Complex Variables, S07 Classical Mechanics

- **Students interested in specialisations involving Quantum Field Theory and related topics (e.g., Teorica Universalsis, Geometra, Particulata, Supercordula, Condensata, and Duracella example pathways in Appendix B)**: S18 Advanced Quantum Mechanics

- It is possible within the MPhys to take Mathematics courses en lieu of Short Options. If you decide to do this, some of the suggestions for the Mathematics students in Section 4.3 may prove useful to you (we particularly recommend Part B Numerical Solutions to Differential Equations I, II).
4.2 Suggestions for Physics & Philosophy Students (MPhysPhil)

Part B of the MPhysPhil has an optional physics component. We recommend that you consider the following Part B papers:

- **All students**: B7 Classical Mechanics

- **Students interested in specialisations involving relativistic Quantum Field Theory, General Relativity, Cosmology, etc.** (e.g., Teorica Universalis, Geometra, Particulata, Supercordula, Condensata, Duracella, Astra-Stella, and Cosmicosmica example pathways in Appendix B): B2 Symmetry and Relativity, B3 General Relativity and Cosmology

- **Students interested in specialisations involving physics of continuous media of various kinds** (e.g., Applicata, Continua, Condensata, Mollis, Complicata, Astra-Stella, Cosmicosmica, Gaia, and Plasma example pathways in Appendix B): B1 Fluctuations, Flows and Complexity

4.3 Suggestions for Mathematics Students (MMath)

Both Parts A and B of the MMath have a large number of options. Here are some general recommendations to help the students interested in the MMathPhys make an informed choice.

- **All students**: We recommend the following courses that will teach you the basic mathematical and numerical techniques common to most areas of Theoretical/Mathematical Physics and Applied Mathematics: Part A: Numerical Analysis; Part B: Techniques of Applied Mathematics, Applied Partial Differential Equations, Numerical Solutions to Differential Equations I, II.

We also recommend recommend that you consider some of the suite of courses that cover the foundations of modern physics: Part A: Quantum Theory, Special Relativity, Fluids and Waves; Part B: Classical Mechanics, Quantum Mechanics, Electromagnetism (note: these three courses are in the process of being approved).

Some of these will be more important than others depending on the specialisation that you might choose in the MMathPhys (see example pathways in Appendix B and consult your tutor in the first instance if in doubt as to what courses might be relevant).

- **Students interested in specialisations involving physics of continuous media of various kinds** (e.g., Applicata, Continua, Condensata, Mollis, Complicata, Astra-Stella, Cosmicosmica, Gaia, and Plasma example pathways in Appendix B): B1 Fluctuations, Flows and Complexity

- **Students interested in mathematical physics specialisations that involve a substantial amount of modern geometry and algebra** (e.g., Geometra, Particulata and Supercordula example pathways in Appendix B): There are a number of pure mathematics options that may prove useful, e.g., Part A Group Theory, Projective Geometry, Topology; Part B Geometry of Surfaces, Algebraic Curves, Introduction to Representation Theory, Group Theory and an Introduction to Character Theory, Topology and Groups. Consult your tutor for further advice.
5 Assessment and exams

5.1 Requirements

You will be required to attend at least 10 units (with one unit defined as a 16 hour lecture course or a dissertation) from the programme of lectures courses described in Section 2. You can opt to replace one 16-hour lecture course by a dissertation. Your performance will be assessed by one or several of the following means: (i) Invigilated written exams. (ii) Course work marked on a pass/fail basis. (iii) Take-home papers. (iv) Mini-projects due shortly after the end of the lecture course. The modes of assessment for a given course are decided by the course lecturer and will be published at the beginning of each academic year. As a general rule, foundational courses will be offered with an invigilated exam while some of the more advanced courses will typically be relying on the other assessment methods mentioned above. In addition, you will be required to give an oral presentation towards the end of the academic year which will cover a more specialized and advanced topic related to one of the subject areas of the course.

At least four of the 10 units must be assessed by an invigilated exam and, therefore, have to be taken from lecture courses which provide this type of assessment. Apart from this restriction, you are free to choose from the available programme of lecture courses. However, it is strongly recommended that you consider the discussion on sensible pathways through the course given in Section 2 and Appendix B and, in case of doubt, seek advice from the Director of Studies or other designated academic advisors for the course.

5.2 Arrangements

Each setter, normally the course lecturer, will assess your exam papers, mini-projects and course work as appropriate, and produce a raw mark for the course. Assessment and scaling of mini-projects and take home exams will follow the conventions established in Mathematics and laid out in the MMath handbook. Invigilated written exams will be conducted according to the existing guidelines for mathematics and physics fourth year students. Lecture courses assessed with a take-home paper or by a mini-project will be marked by the course lecturer, and the final USMs will be awarded by the Examiners Panel based on the recommendation of the course lecturers. Dissertations will be assessed following the guidelines and procedures of part C of the mathematics course (see the guidelines at http://www.maths.ox.ac.uk/current-students/undergraduates/projects/).

We emphasize that there is no expectation that a dissertation includes original research.

Some courses in the MMathPhys programme are managed by one of the departments and are part of the MMath or MPhys courses. In all these cases you will be examined following the instructions of the corresponding department. Typically these courses are assessed by an invigilated exam at the end of TT. For other lecture courses taught in Michaelmas Term, exams are timetabled in week 0 of Hilary Term, for other courses taught in Hilary Term exams take place in week 1 of Trinity Term.

All students, both on the MMathPhys and MSc course, will attend a compulsory oral presentation (typically in TT), based on a somewhat more specialized and advanced topic which relates to a subject area in the course. A list of such topics will be published in this handbook. The oral presentation will be marked on a pass/fail basis and has to be passed. One re-take (in the same academic year) in case of a fail will be allowed.

A panel of examiners will be moderating the raw marks and produce a class list at the end of the academic year. Moderation of the marks by examiners will involve a suitable re-scaling algorithm. As a general principle, this algorithm will be the same for MSc and MMathPhys students and will, in particular, not be based on prior performance in the first three years of student’s degrees.

The Mathematical Institute and Physics Department have guidance on plagiarism and cheating in exams and these guidelines will be followed in the assessment procedures. Reasonable adjustments for disabled students will be made following the current practices in physics and mathematics, including, whenever it is necessary, the provision of alternative methods of assessment.
5.3 Classification

Degrees for both the MMathPhys and the MSc mode will have a distinction/pass/fail classification but with detailed transcripts provided. Note that this is different from the current MPhys and MMath classifications which follow the 1/2.1/2.2/3 scheme. As an MMathPhys student you will, therefore, be classified differently from your peers who have stayed on the MPhys or MMath programmes.

More precisely, as an MMathPhys student you will receive a double-classification, with the first part given by your BA degree class and the second part by your MMathPhys degree class as above. This means that as an MMathPhys student coming, for example, through Physics you would receive a classification as follows:

Parts A and B: first class honours in Physics
Part C: distinction in Mathematical and Theoretical Physics

A Syllabi

Below you will find syllabi for all courses in the programme, as listed in the table in Section 2. Note that the designated pre-requisites are only recommendations — they are not required as a conditions of enrolment in each course as some students may have already had adequate equivalent training during their Bachelor’s degree or may choose to catch up via an independent autodidactic effort.

A.1 Michaelmas Term

Quantum Field Theory [24 hours] FOUNDATIONAL COURSE.


Sequel: Advanced Quantum Field Theory for Particle Physics (HT), Conformal Field Theory (TT), Quantum Field Theory in Curved Space-Time (TT)

Statistical Mechanics [16 hours] (Maths C6.2a). This course can be taken by students who have not studied this subject before (e.g., as Physics A1) but would like to be able to follow the more specialised courses offered in Hilary and Trinity that require familiarity with Statistical Mechanics.

Syllabus (from the 2012–13 Mathematics Handbook). Thermodynamics and Probability: microscopic versus macroscopic viewpoints, the laws of thermodynamics, temperature, entropy, free energy, etc. Classical Statistical Mechanics: ideal gas, Gibbs paradox, canonical and grand canonical ensembles, Liouville’s theorem and ergodicity, Maxwell relations. Nonequilibrium Statistical Mechanics: Boltzmann equation, Boltzmann-Grad limit. Phase Transitions: order parameters, phase transitions, critical phenomena, Ising model, Potts model, renormalization, symmetry breaking. Other Topics and Applications: This could vary from year to year, but a good example would be Bose-Einstein condensates or statistical mechanics of random graphs.

Introduction to Quantum Condensed Matter Physics [16 hours] FOUNDATIONAL COURSE.

Part of this course is also offered as part of Physics C6.

Nonequilibrium Statistical Physics [8 hours]  FOUNDATIONAL COURSE. Part of this course is also offered as part of Physics C6.


Sequel: Soft Matter Physics (HT)

Kinetic Theory [24 hours]  FOUNDATIONAL COURSE.


Sequels: Advanced Fluid Dynamics (HT), Plasma Physics (HT), Galactic and Planetary Dynamics (HT)

Viscous Flow [16 hours]  (Maths B6a). This course is particularly recommended to the students who have not studied basic Fluid Dynamics (e.g., as Physics B1) and would like to be able to follow the more specialised courses offered in Hilary and Trinity and requiring familiarity with this subject.


Sequels: Advanced Fluid Dynamics (HT), Waves and Compressible Flow (HT)

General Relativity I [16 hours]  (Maths C7.2a).  FOUNDATIONAL COURSE. Some students may have studied this subject before (for example, as Physics B5).


Sequels: General Relativity II (HT), Cosmology (HT), Quantum Field Theory in Curved Space-Time (TT)
Perturbation Methods [16 hours]  (Maths C6.3a). FOUNDATIONAL COURSE.


Sequel: Applied Complex Variables (HT)

Scientific Computing I [12 hours]  Part of a 2-term 24-hour course, designed as an introduction to computing for doctoral students.

Syllabus. See Maths Graduate Handbook. URL: http://www.maths.ox.ac.uk/courses/course/19944

Sequel: Scientific Computing II (HT)

Numerical Solutions to Differential Equations I [16 hours]  (Maths B21a).


Sequel: Numerical Solutions to Differential Equations II (HT)

Numerical Linear Algebra [16 hours]  (Maths C12.1a).


Groups and Representations [24 hours]

Syllabus (written by A. Lukas). Basics on groups, representations, Schur’s Lemma, representations of finite groups, Lie groups, Lie algebras, Lorentz and Poincare groups, SU(n), SO(n), spinor representations, roots, classification of simple Lie algebras, weights, representations and Dynkin formalism.

Algebraic Topology [16 hours]  (Maths C3.1a).

Algebraic Geometry [16 hours]  (Maths C3.4a).

A.2 Hilary Term
Advanced Quantum Field Theory for Particle Physics [24 hours]
Prequel/pre-requisite: Quantum Field Theory (MT)
Syllabus (written by X. de la Ossa, G. Ross). Quantum Electrodynamics: Introduction, photon propagator, scalar electrodynamics (Feynman rules, radiative corrections), canonical quantization, fermions (fermions propagator, path integral and Feynman rules), spinor electrodynamics, sample calculations (scattering in spinor electrodynamics), beta function in QED. Non-Abelian Quantum Field Theory: SU(N) local gauge theory, path integral, gauge fixing, BRST, spontaneous symmetry breaking, anomalies, introduction to the standard model.
Sequels: The Standard Model (TT), Beyond the Standard Model (TT), Non-perturbative Methods in Quantum Field Theory (TT)

String Theory I [16 hours]
Pre-requisite: Quantum Field Theory (MT)
Syllabus (written by P. Candelas). String actions, equations of motion and constraints, open and closed strings — boundary conditions, Virasoro algebra, ghosts and BRS, physical spectrum, elementary consideration of D branes, Veneziano amplitude.
Sequels: String Theory II (TT), Introduction to Gauge-String Duality (TT)

Supersymmetry and Supergravity [24 hours]
Pre-requisite: Quantum Field Theory (MT)
Syllabus (written by J. Conlon). Motivations for supersymmetry, spinor algebras and representations, supersymmetry algebra and representations, extended supersymmetry and BPS states, superfields, SUSY field theories, non-renormalisation theorems, SUSY breaking, the MSSM and its phenomenology, rescaling anomalies, NSVZ beta function, basic properties of supergravity.
Advanced Fluid Dynamics [16 hours]

Prequels: Kinetic Theory (MT), Viscous Flow (MT)

Pre-requisites: basic familiarity with fluid equations and stress tensors as provided, e.g., by Kinetic Theory (MT).


Sequels: Astrophysical Fluid Dynamics (TT), Advanced Plasma Physics (TT), Topics in Soft and Active Matter Physics (TT), Turbulence (TT)

Soft Matter Physics [16 hours]

Prequel/pre-requisite: Nonequilibrium Statistical Physics (MT)


Sequel: Topics in Soft and Active Matter Physics (TT)

Nonlinear Systems [16 hours] (Maths B8b).


Part II: Maps. Stability and periodic orbits, bifurcations of one-dimensional maps. Poincaré sections and first-return maps. Part III: Chaos in Maps and Differential Equations. Maps: logistic map, Bernoulli shift map, symbolic dynamics, two-dimensional maps (examples could include Henon map, Chirikov-Taylor [“standard”] map, billiard systems). Differential equations: Lyapunov exponents, chaos in conservative systems (e.g., forced pendulum, Henon-Heiles), chaos in non-conservative systems (e.g., Lorenz equations).

Part IV: Other topics. Topics will vary from year to year and could include: dynamics on networks, solitary waves, spatio-temporal chaos, quantum chaos.

Quantum Condensed Matter Physics II [24 hours]

Prequel/pre-requisite: Introduction to Quantum Condensed Matter Physics (MT)


Sequels: Advanced Quantum Condensed Matter Physics (TT), Topics in Quantum Condensed Matter Physics (TT)
Networks [16 hours] (Maths C6.2b, to start in 2013-14)
Pre-requisite: Maths C6.2a or another undergraduate course in Statistical Mechanics.
Sequel: Complex Systems (TT)

Waves and Compressible Flow [16 hours] (Maths B6b).
Prequels: Viscous Flow (MT), Kinetic Theory (MT)
Sequels: Geophysical Fluid Dynamics (TT), Astrophysical Fluid Dynamics (TT), Turbulence (TT)

Plasma Physics [16 hours]
Prequel: Kinetic Theory (MT)
Pre-requisite: Kinetic Theory (MT) or a basic introductory course in Plasma Physics.
Sequel: Advanced Plasma Physics (TT)

Galactic and Planetary Dynamics — Celestial Mechanics for the 21st Century [16 hours]
Prequel/pre-requisite: Kinetic Theory (MT)

Stellar Astrophysics [16 hours] Part of this course is also offered as part of Physics C1.
Syllabus (written by P. Podsiadlowski). Part I: Modern Topics in Stellar Astrophysics. Late stages of stellar evolution; massive stars; supernovae, millisecond pulsars, hypernovae, gamma-ray bursts; compact binaries; the origin of elements, chemical evolution of the Universe. Part II: Accretion discs, Theory and Applications. Accretion disc theory, thin and thick discs; disc instabilities (thermal instability, gravitational instabilities [Toomre criterion]); optically thin advection-dominated flows, super-Eddington accretion.
Sequels: Astrophysical Fluid Dynamics (TT), High-Energy Astrophysics (TT), Astroparticle Physics (TT)
General Relativity II [16 hours] (Maths C7.2b, revised)

Prequel: General Relativity I (MT)
Pre-requisite: General Relativity I (MT) or equivalent.
Syllabus (written by X. de la Ossa). Lie derivative and isometries, linearised GR and the metric of an isolated body, Schwarzschild solution and extensions, Eddington-Finkelstein coordinates and Kruskal extension, Penrose diagrams, area theorem, stationarity, axisymmetric metrics and orthogonal transitivity, the Kerr solution and its properties, interpretation as rotating black hole, gravitational waves, the Einstein field equations with matter, energy momentum tensor for a perfect fluid, equations of motion from the conservation law, cosmological principle, homogeneity and isotropy, cosmological models, Friedman-Robertson Walker metric and solutions, observational consequences.

Cosmology [16 hours]

Pre-requisite: General Relativity I (MT) or equivalent.
Syllabus (written by P. Candelas, P. Ferreira). Einstein field equations and the Friedman equations, universe models, statistics of expanding background, relativistic cosmological perturbations, observations, from the Hubble flow to the CMB.

Applied Complex Variables [16 hours] (Maths C6.3b).

Prequel: Perturbation Methods (MT)

Scientific Computing II [12 hours] Part of a 2-term 24-hour course, designed as an introduction to computing for doctoral students.

Prequel/pre-requisite: Scientific Computing I (MT)
Syllabus. See Maths Graduate Handbook. URL: http://www.maths.ox.ac.uk/courses/course/19944

Numerical Solutions to Differential Equations II [16 hours] (Maths B21b).

Prequel: Numerical Solutions to Differential Equations I (MT)

Differential Geometry [16 hours]

Syllabus (written by X. de la Ossa, P. Candelas, A. Dancer, J. Sparks). Manifolds, tangent and cotangent spaces, differential forms and co-homology, Riemannian manifolds, fibre bundles (also principal bundles and vector bundles), connections on fiber bundles, characteristic classes, index theorems.
Geometric Group Theory [16 hours]  \((Maths\ C3.2b)\).


A.3 Trinity term

Conformal Field Theory [16 hours]

Prequel/pre-requisite: Quantum Field Theory (MT)

Syllabus (written by J. Cardy). Scale invariance and conformal invariance in critical behaviour, the role of the stress tensor, radial quantisation and the Virasoro algebra, CFT on the cylinder and torus, height models, loop models and Coulomb gas methods, boundary CFT and Schramm-Loewner evolution, perturbed conformal field theories: Zamolodchikov’s c-theorem, integrable perturbed CFTs: S-matrices and form factors.

Introduction to Gauge-String Duality [16 hours]

Prequel: String Theory I (HT)

Pre-requisite: Quantum Field Theory (MT)

Syllabus (written by A. Starinets). Duality in lattice statistical mechanics and quantum filed theory (an overview), black hole thermodynamics and black hole entropy, D-branes, the AdS-CFT correspondence, main recipes of gauge-string duality, gauge-string duality at finite temperature and density, fluid mechanics, black holes and holography, transport in strongly correlated systems from dual gravity, gauge-string duality and condensed matter physics, modern developments.

String Theory II [16 hours]

Prequel/pre-requisite: String Theory I (HT)

Syllabus (written by P. Candelas). Superstring action, super-Virasoro algebra, RNS model and GSO projection, physical spectrum, type I, IIA, IIB and heterotic strings, D-branes, string dualities.

The Standard Model [16 hours]

Prequel/pre-requisite: Advanced Quantum Field Theory for Particle Physics (HT)

Syllabus (written by X. de la Ossa, G. Zanderighi). Part I. Weak interactions, weak decays, non-renormalizable Fermi four-point interactions (violation of unitarity), \(SU(2)\times U_Y(1)\) gauge symmetry, spontaneous symmetry breaking (masses of gauge bosons), custodial symmetry and Yukawa masses, axial anomaly cancellation, accidental symmetries, renormalizability and power counting, neutrino masses (see-saw mechanism), Higgs phenomenology, Part II. Strong interaction, \(SU(3)\) symmetry, Lagrangian, color identities, beta-function and asymptotic freedom, infrared divergences and infrared safety, \(e^+e^-\to\) hadrons, R-ratio, parton model (failure with radiative corrections), parton distribution functions, dimensional regularisation, subtraction procedures for calculations of cross-sections, hadron collider phenomenology: event shapes, jets, benchmark processes (Drell-Yan, heavy quarks etc.).

Beyond the Standard Model (16 lectures, TT)

Prequel/pre-requisite: Advanced Quantum Field Theory for Particle Physics (HT)

Syllabus (written by J. March-Russell). SM precision tests, flavour physics, neutrino physics, strong CP and axions, hierarchy problem, motivations for susy/technicolour/warped extra dimensions and their basic phenomenology, introduction to grand unified theories.
Non-perturbative Methods in Quantum Field Theory [16 hours]

Prequel/pre-requisite: Advanced Quantum Field Theory for Particle Physics (HT)

Syllabus (written by M. Teper). Lattice Field Theory: Motivation and applications, gauge fields on a lattice and continuum limit(s), strong coupling calculations: confinement and mass gap, fermions on a lattice. Markovian Monte Carlo: Metropolis, heat bath, hybrid Monte Carlo, lightest glueball masses and their continuum limit, calculating the hadron spectrum, the running coupling. Solitons: kinks in D=1+1 scalar QFT, a no-go theorem and its limitations, vortices in D=2+1 scalar QFT (KT phase transition), vortices in D=2+1 gauge+scalar QFT, solitonic ‘strings’ in D=3+1 gauge+scalar QFT (Meissner effect and magnetic confinement), textures, domain walls, homotopy groups, monopoles in the D=3+1 Georgi-Glashow model. Instantons: tunnelling in D=1+1 Quantum Mechanics, Abelian-Higgs model in D=1+1: the dilute gas approximation, n-vacua and theta-vacua, Wilson loops and linear confinement, SU(2) gauge fields in D=3+1: the dilute gas calculations, n-vacua (Chern-Simons) and theta-vacua, SU(N) and intertwined theta-vacua, fermions and index theorems, anomalies and chiral symmetry breaking (Banks-Casher) in QCD, anomalies, sphalerons and the baryon asymmetry in SM.

Advanced Quantum Condensed Matter Physics [8 hours]

Prequel/pre-requisite: Introduction to Quantum Condensed Matter Physics (MT), Quantum Condensed Matter Physics II (HT)


Topics in Quantum Condensed Matter Physics [8 hours]

Prequel/pre-requisite: Quantum Condensed Matter Physics II (HT)

Syllabus (written by F. Essler). This is a reading course. Under the guidance of the course organiser, students will give presentations based on key papers in quantum condensed matter theory. Some examples of the topics for these presentations are: Kramers-Wannier duality for the Ising model. Feynman’s wavefunction approach to superfluid helium. The Haldane conjecture for integer quantum spin chains. Quantum friction. Homotopy and defects. Renormalisation group for Fermi liquids. The Kondo effect and scaling. Fractional statistics.

Complex Systems [16 hours]

Prequel: Networks (HT)

Pre-requisite: Maths C6.2a or another undergraduate course in Statistical Mechanics.

Syllabus (written by M. Porter). Percolation, fractals, self-organised criticality, and power laws. Stochastics and generative models: random walks, preferential attachment, master equations. Dynamical systems on networks: includes models of epidemics, social influence, voter models, etc. and how they are affected by network architecture. Agent-based models. Numerical methods: Monte Carlo, simulated annealing, etc.

Critical Phenomena [16 hours]

Pre-requisites: Quantum Field Theory (MT), Statistical Mechanics (MT) or equivalent.


Topics in Soft and Active Matter Physics [8 hours]

Prequels: Soft Matter Physics (HT), Advanced Fluid Dynamics (HT)
Pre-requisites: Soft Matter Physics (HT)

Syllabus (written by R. Golestanian, A. Louis, J. Yeomans). This is a reading course. Under the guidance of the course organiser, students will give presentations based on key papers in soft condensed matter theory. Some examples of the topics for these presentations are: Active nematics and active gels. Wetting, spreading and contact line dynamics. Hydrodynamics of microswimmers: Stokes equation, scallop theorem, multipole expansion, active suspensions. Fluctuations and response.

Turbulence [16 hours]

Prequels: Kinetic Theory (MT), Viscous Flow (MT), Advanced Fluid Dynamics (HT), Waves and Compressible Flow (HT)

Pre-requisite: basic familiarity with fluid equations as provided, e.g., by Kinetic Theory (MT), Maths B6a or an equivalent undergraduate course (e.g., Physics B1).


Geophysical Fluid Dynamics [16 hours]

Prequel: Waves and Compressible Flow (HT)

Pre-requisite: basic familiarity with fluid equations as provided, e.g., by Kinetic Theory (MT), Maths B6a or an equivalent undergraduate course (e.g., Physics B1).


Advanced Plasma Physics [16 hours]

Prequel: Plasma Physics (HT)

Pre-requisites: Plasma Physics (HT), Advanced Fluid Dynamics (HT)


Astrophysical Fluid Dynamics [16 hours]

Prequels: Advanced Fluid Dynamics (HT), Waves and Compressible Flow (HT)

Pre-requisite: Advanced Fluid Dynamics (HT) and/or a standard course in Fluid Dynamics.


High-Energy Astrophysics [16 hours]
Prequel: Stellar and Atomic Astrophysics (HT)

Astroparticle Physics [16 hours]
Pre-requisites: Quantum Field Theory (MT), General Relativity I (MT)
Syllabus (written by S. Sarkar). The Universe observed, constructing world models, reconstructing our thermal history, decoupling of the cosmic microwave background, primordial nucleosynthesis. Dark matter: astrophysical phenomenology, relic particles, direct and indirect detection. Cosmic particle accelerators, cosmic ray propagation in the Galaxy. The energy frontier: ultrahigh energy cosmic rays and neutrinos. The early Universe: constraints on new physics, baryo/leptogenesis, inflation, the formation of large-scale structure, dark energy.

Quantum Field Theory in Curved Space-Time [16 hours]
Prequels/pre-requisites: Quantum Field Theory (MT), General Relativity I (MT)
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.

<table>
<thead>
<tr>
<th>Pathway</th>
<th>MT</th>
<th>HT</th>
<th>TT</th>
</tr>
</thead>
<tbody>
<tr>
<td>“TEORICA UNIVERSALIS” (Generalist Theoretical Physicist)</td>
<td>1. QFT 24</td>
<td>1-3. Three of</td>
<td>1-3. Three of</td>
</tr>
<tr>
<td>Core 4–5 units</td>
<td>2-4. Three of</td>
<td>Advanced QFT 24</td>
<td>Gauge-String duality 16</td>
</tr>
<tr>
<td>Total 10–12 units</td>
<td>Intro. Quant. CMP 16</td>
<td>Quantum CMP II 24</td>
<td>Standard Model 16</td>
</tr>
<tr>
<td></td>
<td>Kinetic Theory 24</td>
<td>Soft Matter 16</td>
<td>Turbulence 16</td>
</tr>
<tr>
<td></td>
<td>GR I 16</td>
<td>Nonlinear Systems 16</td>
<td>AFD 16</td>
</tr>
<tr>
<td></td>
<td>Pert. Methods 16</td>
<td>Plasma Physics 16</td>
<td>QFT in Curved Space 16</td>
</tr>
<tr>
<td>Core 4–4.5 units</td>
<td>Noneq. Stat. Phys. 8</td>
<td>2. One of</td>
<td>Complex Systems 16</td>
</tr>
<tr>
<td>Total 10–10.5 units</td>
<td>Kinetic Theory 24</td>
<td>Nonlinear Systems 16</td>
<td>Turbulence 16</td>
</tr>
<tr>
<td></td>
<td>Visc. Flow 16</td>
<td>Networks 16</td>
<td>GFD 16</td>
</tr>
<tr>
<td></td>
<td>GR I 16</td>
<td>Waves/Comp. Flow 16</td>
<td>AFD 16</td>
</tr>
<tr>
<td></td>
<td>4. One of</td>
<td>Galactic Dyn. 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sci. Comp. I 12</td>
<td>GR II 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Num. Slns Diff. Eqns I 16</td>
<td>3. One of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Num. Lin. Algebra 16</td>
<td>Complex Variables 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diff. Geometry 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. One of</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sci. Comp. II 12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Num. Slns Diff. Eqns II 16</td>
<td></td>
</tr>
<tr>
<td>Core 8.5-9 units</td>
<td>2. Visc. Flow 16</td>
<td>2. Waves/Comp. Flow 16</td>
<td>Complex Systems 16</td>
</tr>
<tr>
<td>Total 10–10.5 units</td>
<td>3. Pert. Methods 16</td>
<td>3. One of</td>
<td>Turbulence 16</td>
</tr>
<tr>
<td></td>
<td>4. One of</td>
<td>Nonlinear Systems 16</td>
<td>GFD 16</td>
</tr>
<tr>
<td></td>
<td>Num. Slns Diff. Eqns I 16</td>
<td>Plasma Physics 16</td>
<td>Dissertations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complex Variables 16</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. One of</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sci. Comp. II 12</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Num. Slns Diff. Eqns II 16</td>
<td></td>
</tr>
</tbody>
</table>

21
<table>
<thead>
<tr>
<th>Program</th>
<th>Core Units</th>
<th>Total Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>“GEOMETRA”</strong>&lt;br&gt;(Mathematician with a physics streak)</td>
<td>5.5 units</td>
<td>10 units</td>
</tr>
<tr>
<td>1. <strong>QFT 24</strong>&lt;br&gt;2. <strong>GR I 16</strong>&lt;br&gt;3. <strong>One of</strong>&lt;br&gt;Groups &amp; Repr. 24&lt;br&gt;Algebraic Topology 16&lt;br&gt;Algebraic Geometry 16</td>
<td>1. <strong>String Theory I 16</strong>&lt;br&gt;2. <strong>Diff. Geometry 16</strong>&lt;br&gt;3. <strong>One of</strong>&lt;br&gt;Advanced QFT 24&lt;br&gt;SUSY &amp; SUGRA 24&lt;br&gt;GR II 16&lt;br&gt;Geom. Group Theory 16</td>
<td>1. <strong>String Theory II 16</strong>&lt;br&gt;2. <strong>Two of</strong>&lt;br&gt;CFT 16&lt;br&gt;Standard Model 16&lt;br&gt;Beyond the SM 16&lt;br&gt;QFT in Curved Space 16</td>
</tr>
<tr>
<td><strong>“PARTICULATA”</strong>&lt;br&gt;(Particle Phenomenologist)</td>
<td>8 units</td>
<td>10.5–11 units</td>
</tr>
<tr>
<td><strong>“SUPERCORDULA”</strong>&lt;br&gt;(Hard-core String Theorist)</td>
<td>7.5 units</td>
<td>10–10.5 units</td>
</tr>
<tr>
<td><strong>“CONDENSATA”</strong>&lt;br&gt;(Condensed Matter Theorist)</td>
<td>7 units</td>
<td>10.5–11.5 units</td>
</tr>
<tr>
<td><strong>“DURACELLA”</strong>&lt;br&gt;(Hard-core Hard Condensed Matter Theorist)</td>
<td>6.5 units</td>
<td>10–11.5 units</td>
</tr>
<tr>
<td><strong>“MOLLIS”</strong>&lt;br&gt;(Soft Condensed Matter Physicist/Biophysicist)</td>
<td>7 units</td>
<td>11.5 units</td>
</tr>
<tr>
<td>Course Code</td>
<td>Core Units</td>
<td>Total Units</td>
</tr>
<tr>
<td>-------------</td>
<td>------------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| "COMPLICATA" (Complexity Scientist) | 5–5.5 | 10–11 | 1. Noneq. Stat. Phys. 8  
2. Kinetic Theory 24  
3. Pert. Methods 16  
4. One of Sci. Comp. I 12  
Num. Slns Diff. Eqs I 16  
1. Soft Matter 16  
2. Nonlinear Systems 16  
3. Networks 16  
4. One of Sci. Comp. II 12  
Num. Slns D. Eqs II 16 |

| "ASTRA-STELLA" (All-round Astrophysicist) | 6.5 | 11–12 | 1. Kinetic Theory 24  
2. GR I 16  
3. One of QFT 24  
Pert. Methods 16  
4. One of Sci. Comp. I 12  
Num. Slns Diff. Eqs I 16  
1-2. Two of Galactic Dyn. 16  
Stellar Astrophys. 16  
Cosmology 16  
3. One of Waves/Comp. Flow 16  
Adv. Fluid Dyn. 16  
Plasma Physics 16  
4. One of Sci. Comp. II 12  
Num. Slns Diff. Eqs II 16 |

| "COSMICOSMICA" (Dedicated Cosmologist) | 4 | 10–11 | 1. GR I 16  
2-3. Two of QFT 24  
Kinetic Theory 24  
Pert. Methods 16  
4. One of Sci. Comp. I 12  
Num. Slns Diff. Eqs I 16  
1. Cosmology 16  
2. GR II 16  
3. One of Waves/Comp. Flow 16  
Galactic Dyn. 16  
Stellar Astrophys. 16  
4. One of Sci. Comp. II 12  
Num. Slns Diff. Eqs II 16 |

| "GAIA" (Geophysicist/Climate Physicist) | 4.5–5 | 10–10.5 | 1-2. Two of Kinetic Theory 24  
Viscous Flow 16  
Noneq. Stat. Phys. 8  
3. Pert. Methods 16  
4. One of Sci. Comp. I 12  
Num. Slns Diff. Eqs I 16  
1. Nonlinear Systems 16  
2. One of Networks 16  
Waves/Comp. Flow 16  
3. One of Sci. Comp. II 12  
Num. Slns D. Eqs II 16 |

| "PLASMA" (Plasma Theorist) | 7–7.5 | 10.5–11 | 1. Kinetic Theory 24  
3. Pert. Methods 16  
4. One of Sci. Comp. I 12  
Num. Slns Diff. Eqs I 16  
1. Adv. Fluid Dyn. 16  
2. Plasma Physics 16  
3. One of Nonlinear Systems 16  
Stellar Astrophys. 16  
Complex Variables 16  
4. One of Sci. Comp. II 12  
Num. Slns D. Eqs II 16 |
C Application procedure

MSc applicants should follow the usual Oxford University postgraduate admission procedure explained at http://www.ox.ac.uk/admissions/postgraduate_courses/apply/application_guide.html.

MMathPhys applicant should submit their application by the end of the first week of Hilary term, in January. Application documents should be sent, preferably in electronic form by email, to address, TBA email, TBA

The following documents are required.

- A transcript for the first two years of your study.
- A concise personal statement (maximal one page) in English, providing the reasons for applying, evidence of motivation for and understanding of the proposed area of study, commitment to the subject beyond the requirements of the degree course, capacity for sustained and intense work, reasoning ability, the ability to absorb abstract ideas and at a rapid pace and an indication of your intended pathway through the MMathPhys programme.
- Two academic references, typically written by your college tutors. In particular, these should include information about you intellectual ability, academic achievement, academic potential, and motivation, particularly with regard to mathematical and theoretical physics and your likely BA degree class. They should be sent directly, preferably by email, to the above address.