Key contacts

- course website: http://mmathphys.physics.ox.ac.uk
- email: mathematical.physics@maths.ox.ac.uk
- your departmental academic advisor
- director of study: Lionel Mason
- chair of JSC: Steve Simon
- your college academic advisor/senior tutor
- course administration: ***Jasmine Smith***
  backup=Sandhya Patel (+Gemma Proctor)

(we also have a facebook page)

Oxford Master Course in Mathematical and Theoretical Physics

Department of Physics/Theoretical Physics

Mathematical Institute

week 0, academic induction event

Key documents
https://mmathphys.physics.ox.ac.uk/students

- course handbook
- exam conventions
- past exam papers
- dissertation guidance

What is it?

A high-level master course in Mathematical and Theoretical Physics

MMathPhys (Students with Oxford BA): you pursue in your fourth year instead of following the fourth year of the MPhys/MMath/MPhysPhil.

OR

MSc (Students with BA from elsewhere): you are admitted to a one year program from a prior degree elsewhere.

What are you required to do?

2 General Structure of the Examination

All courses in this programme either have a component of formal assessment - through written invigilated exams, take-home exams or mini-projects - or a homework completion requirement. Some courses may be offered with a combination of formal assessment and homework requirement. Any course with a component of formal assessment will be referred to as a formally assessed course. The table in Appendix A specifies which courses are formally assessed and by which method and it indicates which courses have a homework completion requirement.

Students are required to undertake at least ten units within the programme, where one unit corresponds to a 16-hour lecture course. This means that a 16-hour lecture course counts as one unit, while, for example, a 24 hour lecture course counts as 1.5 units. More specifically, students are required to offer

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

(b) at least three further units that are formally assessed by written invigilated exams or in other ways (see section 3)

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

(d) an oral presentation

A dissertation replaces one, in the case of an extended dissertation two, of the units in (b) or (c). 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). Please note that it is a student's responsibility to ensure that she/he fulfils the requirements for the overall number of units and the number of formally assessed units.

Yes.....

It will be exciting

It will be challenging

It will be a lot of work

... we are confident you can do it!

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How are you classified?

USM = University Standardized Marks

Outcomes for all courses with assessment will be published as USMs. The object of the USMs is to allow direct comparison between the results of examinations in different subjects. The correspondence between USM ranges and classes is given below in Section 8.1.

A course with formal assessment is considered completed if the USM of the course is $\geq 50\%$ and if any homework requirement has been completed. A course with no formal assessment is considered completed if the homework requirement has been completed.

C Calculating the overall $\overline{USM}$

Let $\{c_1, \ldots, c_n\}$ be the set of formally assessed courses a student has offered. For each of these courses c_i, the number of units of the course is denoted by u_i, the number of units assessed by a written invigilated exam by w_i (zero if the course does not have a written invigilated exam) and the USM achieved by m_i. For a subset of these courses, given by an index set $S \subset \{1, \ldots, n\}$, we define the total number of units, $|S|$, the total number of units with written invigilated exam, $||S||$, and the average USM, $\bar{S}$, of this subset by

$$|S| = \sum_{i \in S} u_i \,, \qquad ||S|| = \sum_{i \in S} w_i \,, \qquad \bar{S} = \frac{1}{|S|} \sum_{i \in S} u_i m_i \,.$$

The $\overline{USM}$ is then given by

$$\overline{USM} = \max_{S\,:\,|S| \geq 7 \text{ and } ||S|| \geq 4} \left(\bar{S}\right) \,.$$

What are you required to do?

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(d) an oral presentation

A dissertation replaces one, in the case of an extended dissertation two, of the units in (b) or (c). 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). Please note that it is a student's responsibility to ensure that she/he fulfils the requirements for the overall number of units and the number of formally assessed units.

- A *Distinction* will be awarded if all of the following conditions are satisfied.
  - i) The candidate offers at least 10 units. These must contain at least 7 formally assessed units of which at least 4 units have a written invigilated exam.
  - ii) At least 10 units have been completed. In exceptional circumstances, the examiners may relax this requirement.
  - iii) $\overline{USM} \geq 70$
  - iv) The oral examination has been passed.
- A *Merit* will be awarded if all of the following conditions are satisfied.
  - i) The candidate offers at least 10 units. These must contain at least 7 formally assessed units of which at least 4 units have a written invigilated exam.
  - ii) At least 9 units have been completed. In exceptional circumstances, the examiners may relax this requirement.
  - iii) $\overline{USM} \geq 65$
  - iv) The oral examination has been passed.
  - v) The candidate does not qualify for a distinction.
- A *Pass* will be awarded if all of the following conditions are satisfied.
  - i) The candidate offers at least 10 units. These must contain at least 7 formally assessed units of which at least 4 units have a written invigilated exam.
  - ii) At least 8 units have been completed. In exceptional circumstances, the examiners may relax this requirement.
  - iii) $\overline{USM} \geq 50$
  - iv) The oral examination has been passed.
  - v) The candidate does not qualify for a merit or distinction.

• A candidate not meeting any of these criteria is deemed to have failed.

How are you classified?

USM = University Standardized Marks

Outcomes for all courses with assessment will be published as USMs. The object of the USMs is to allow direct comparison between the results of examinations in different subjects. The correspondence between USM ranges and classes is given below in Section 8.1.

A course with formal assessment is considered completed if the USM of the course is $\geq 50\%$ and if any homework requirement has been completed. A course with no formal assessment is considered completed if the homework requirement has been completed.

C Calculating the overall $\overline{USM}$

Let $\{c_1, \ldots, c_n\}$ be the set of formally assessed courses a student has offered. For each of these courses c_i, the number of units of the course is denoted by u_i, the number of units assessed by a written invigilated exam by w_i (zero if the course does not have a written invigilated exam) and the USM achieved by m_i. For a subset of these courses, given by an index set $S \subset \{1, \ldots, n\}$, we define the total number of units, $|S|$, the total number of units with written invigilated exam, $|S|$, and the average USM, $\bar{S}$, of this subset by

$$|S| = \sum_{i \in S} u_i \,, \qquad |S| = \sum_{i \in S} w_i \,, \qquad \bar{S} = \frac{1}{|S|} \sum_{i \in S} u_i m_i \,.$$

The $\overline{USM}$ is then given by

$$\overline{USM} = \max_{S\,:\,|S| \geq 7 \text{ and } ||S|| \geq 4} \left(\bar{S}\right) \,.$$

Many possible pathways, for example

Caution: Info not up to date

Pathway	*MT*	*HT*	*TT*
Generalist Theoretical Physicist *"TEORICA UNIVERSALIS"* **Core 5.25 units** Total 10.25-11.75 units	**1. QFT 24** **2-4. *Three of*** **Kinetic Theory 28** **GR I 16** **Pert. Methods 16**	1-3. *Three of* **Noneq. Stat. Phys 16** Advanced QFT 24 Renormalisation Group 16* Advanced Quan. Th. 20 Adv. Fluid Dyn. 16 Soft Matter 16 Collisionless Plasma Physics 18 Cosmology 16	1-3. *Three of* Quantum Matter 16 Standard Model 16* QFT in Curved Space 16 Dissertation
Applied Mathematician *"APPLICATA"* **Core 6.75 units** Total 10.5 units	**1. Kinetic Theory 28** **2. GR I 16** **3. Pert. Methods 16** 4. *One of* **Diff. Geometry 16** Num. Lin. Algebra 16	**1. Adv. Fluid Dyn. 16** 2. *One of* **Noneq. Stat. Phys 16** Networks 16 Collisionless Plasma Physics 18 Galactic Dyn. 16 GR II 16 Symbolic, Num. and Graphical Scientific Prog. 16 **3. Complex Variables 16**	1-2. *Two of* Disc Accretion in Astro. 12 Collisional Plasma Physics 18 Dissertation
Fluid Dynamicist *"CONTINUA"* **Core 3.75 units** Total 10.5 units	**1. Kinetic Theory 28** **2. Pert. Methods 16**	**1. Adv. Fluid Dyn. 16** 2. Soft Matter Phys. 16 3. Collisionless Plasma Physics 18 4. Complex Variables 16 5. Noneq. Stat. Phys 16	1. Collisional Plasma Physics 18 2. Disc Accretion in Astro. 12 2. Dissertation
Mathematician with a physics streak *"GEOMETRA"* **Core 5.5 units** Total 10–10.5 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	**1. String Theory II 16** 2. *Two of* CFT 16 The Standard Model 16* (Aspects of) Beyond the SM & Astroparticle Phys. 16* QFT in Curved Space 16

What do we learn?

The four main areas covered by the course are:

- 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

Many possible pathways, for example:

Particle Phenomenologist *"PARTICULATA"* **Core 6.5 units** Total 10.5units	**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. *One of* String Theory I 16 GR II 16 Cosmology 16	**1. The Standard Model 16*** 3. *One of* String Theory II 16 (Aspects of) Beyond the SM & Astroparticle Phys. 16* QFT in Curved Space 16
Hard-core String Theorist *"SUPERCORDULA"* **Core 7.5 units** Total 10.5 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 GR II 16 Cosmology 16	**1. String Theory II 16** **2. CFT 16** 3. *One of* The Standard Model 16* (Aspects of) Beyond the SM & Astroparticle Phys. 16* QFT in Curved Space 16
Condensed Matter Theorist *"CONDENSATA"* **Core 4.5 units** Total 11–12.75 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. Soft Matter 16** 3. Advanced QFT 24 4. Adv. Fluid Dyn. 16 5. Renormalisation Group 16*	**1. Quantum Matter 16** 2. Topics Quant. CMP 8 3. Topics Soft Matter 8 4. CFT 16
Hard-core Hard Condensed Matter Theorist *"DURACELLA"* **Core 4.25 units** Total 10–10.5 units	**1. QFT 24** **2. Advanced Quant. Th. 20** 3. Kinetic Theory 28 4. Pert. Methods 16	1. Noneq. Stat. Phys. 16 2. Advanced QFT 24 3. String Theory I 16 4. Renormalisation Group 16* 5. Adv. Fluid Dyn. 16	**1. Quantum Matter 16** **2. Topics Quant. CMP 8** 3. CFT 16
Soft Condensed Matter Physicist/Biophysicist *"MOLLIS"* **Core 5.25 units** Total 10.75 units	1. QFT 24 **2. Kinetic Theory 28** 3. Pert. Methods 16	**1. Adv. Fluid Dyn. 16** **2. Noneq. Stat. Phys. 16** **3. Soft Matter 16** 4. Networks 16 5. Collisionless Plasma 16	**1. Topics Soft Matter 8** **2. Dissertation**

What lecture courses on offer?

Most updated list on web

Can take up to 3 credits of Mphys or Mmath Part C courses by approval

Bold: a foundational course;

Plain: an interdisciplinary course share

Italic: a course special to a particular s

Red$^{(PU;NN)}$: a course also taught (in some ca

Blue$^{(MU;NNN)}$: a course also taught as a Part B

Purple$^{(MG)}$: a course also taught as a PG cou

Black: an MMathPhys/MSc course, als

$^{(*)}$ a course that may not be availat

Overview of Lecture Courses			
	Theoretical Particle Physics	*Theoretical Condensed Matter Physics*	*Theor. Astrophysics, Plasma Physics & Physics of Continuous Media*
MT	**Quantum Field Theory** (24)		
		Advanced Quantum Theory$^{(PU;CS)}$ (16)	
		Topological Quantum Theory (16)	
		Kinetic Theory (28)	
			Rad. Proc. & High Energy Astro. (20)
			Quantum Processes in Hot Plasma (12)
	Gen. Relativity I$^{(MU;CT;S)}$ (16)	⇐ ⇒	**Gen. Relativity I**$^{(MU;CT;S)}$ (16)
	Perturbation Methods$^{(MU;CS;S)}$ **(16)**		
	Numerical Linear Algebra$^{(MU;CS;1)}$ (16)		
	Groups and Representations (24)		
	Algebraic Topology$^{(MU;CS;1)}$ *(16)*		
	Differential Geometry $^{(MU;CS;3)}$ (16)	⇐ ⇒	Differential Geometry $^{(MU;CS;3)}$ (16)
	Advanced Philosophy of Physics(16)		
	Algebraic Geometry$^{(MU;CS;4)}$ *(16)*		
HT		Advanced Fluid Dynamics (16)	
		Soft Matter Physics (16)	
		Renormalisation Group (16)	
		Nonequilibrium Statistical Physics(16)	
	Advanced QFT (24)		*High Energy Density Physics(16)*
	String Theory I$^{(MU)}$ *(16)*	*Networks*$^{(MU;CS;4)}$ *(16)*	*Collisionless Plasma Physics (18)*
	Supersymmetry & Sugra (16)		*Galactic & Planetary Dyn. (16)*
	Intro to Quantum Information $^{(MU;CT;4)}$ (16)		
	Gen. Relativity II$^{(MU;CT;6)}$ (16)	⇐ ⇒	Gen. Relativity II$^{(MU;CT;6)}$ (16)
	Cosmology (16)	⇐ ⇒	Cosmology (16)
	~~*Lattice QFT (16)*~~		
	Applied Complex Variables$^{(MU;CS;6)}$ (16)		
	Symbolic, Numerical and Graphical Scientific Programming (16)		
	Advanced Philosophy of Physics(16)		
	Geom. Group Th.$^{(MU;CS;3)}$ *(16)*		
TT	Conformal Field Theory $^{(*)}$ (16)		
		Topics in Soft & Active Matter Physics (8)	
	String Theory II$^{(MG,*)}$ *(16)*		
	The Standard Model $^{(*)}$ *(16)*	*Topics in Quant. CMP (8)*	*Collisional Plasma Physics (16)*
	(Aspects of)Beyond the St. Model (16)		
			Disc Accretion in Astrophysics (12)
		←	*Quantum Matter (16)*
	QFT in Curved Space$^{(*)}$ (16)	⇐ ⇒	QFT in Curved Space$^{(*)}$ (16)
	Dissertation, replacing one or two 16-hour lecture course		

Some Resources and Facilities

Work area in Mezzanine study room
(computers available, copiers, scanners, etc)

Cafes (institute and physics)

Libraries
Radcliffe Science Library
(Whitehead Math Library through Radcliffe)

Entry to Physics and Mathematics – need to ask at recept

Many possible pathways, for example:

All-round Astrophysicist *"ASTRA-STELLA"* **Core 5 units** Total 10–10.5 units	**1. Kinetic Theory 28** **2. GR I 16** 3. *One of* QFT 24 Quantum Processes in Hot Plasma 16 Rad. Proc and High Energy Astro 20 Pert. Methods 16	**1.Galactic Dyn. 16** **2. Cosmology 16** 3. *Two of* Adv. Fluid Dyn. 16 Collisionless Plasma Physics 18 High Energy Density 16	1. **Disc Accretion in Astro. 12** 2. (Aspects of) Beyond the SM & Astroparticle Phys. 16* 3. *One of* QFT in Curved Space 16 Dissertation
Dedicated Cosmologist *"COSMICOSMICA"* **Core 4 units** Total 10–11 units	**1. GR I 16** 2-3. *Two of* QFT 24 Kinetic Theory 28 Pert. Methods 16 Rad. Proc. and High Energy Astro 20	**1. Cosmology 16** **2. GR II 16** 3. Galactic Dyn. 16	1. QFT in Curved Space 16 **2. (Aspects of) Beyond the SM & Astroparticle Phys. 16*** **3. Disc Accretion in Astro. 12**
Plasma Theorist *"PLASMA"* **Core 5.75 units** Total 10.25 units	**1. Kinetic Theory 28** **3. Pert. Methods 16** 4. Quantum Processes in Hot Plasma (12MT)	**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. Collisional Plasma Phys. 18** 2. Dissertation 3. Disc Accretion in Astro. 12)

Or make your own!

JSC and Maths GSC representatives

The JSC (Joint Supervisory Committee) oversees all matte relating to the teaching of the course

The JSC membership includes (2) student representatives

Students can ask their representative to raise matters with the JSC

Students are invited to nominate, or volunteer as, as course representative

The mathematics GSC also has an MSc representative who you can approach.