



Natural Sciences Tripos

Part III/MASt Astrophysics

COURSE GUIDE

2016-2017



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## Aims and objectives

The Part III course is designed to develop students' analytical, critical and numerical skills to the point that they are equipped to undertake independent research in astrophysics. These aims are advanced through taught courses, which develop students' mathematical skills through detailed analysis of topics at the forefront of contemporary research and through the hands on experience of a substantial research project. The project work encourages students to develop a critical attitude and an innovative approach to problem solving. The more independent working style is developed under the guidance of a supervisor from the Institute of Astronomy.

## Feedback and Consultation Mechanisms

During the first two weeks of Michaelmas Term students will be invited to elect one representative from their Part III Astrophysics cohort to attend Teaching Committee meetings. Normally these meetings are held at 2pm on the fourth Thursday of each Full Term.

Students are invited to complete feedback questionnaires for each lecture course. These are relayed to the lecturer. In addition, at the end of the year, there is a general feedback questionnaire on the course as a whole and a feedback meeting with the Course Coordinator and Chair of the Teaching Committee, which takes place at the end of Lent Term. These outcomes are considered by the Astrophysics Teaching Committee.

## Key Contacts

Role	Contact	Phone	Office	E-mail
Course Coordinator	George Efstathiou	37530	Kavli Rm 13	gpe@ast.cam.ac.uk
Course Secretary	Judith Moss	37521	Hoyle Rm 48	jm@ast.cam.ac.uk
Teaching Committee Chair	Christopher Tout	37502	Hoyle Rm 61	cat@ast.cam.ac.uk
IoA Acting Director	Andrew Fabian	37509	Hoyle Rm 49	acf@ast.cam.ac.uk
Acting Director's PA	Judith Moss	37521	Hoyle Rm 48	jm@ast.cam.ac.uk
IoA Librarian	Mark Hurn	37537	Obs Library Office	hurnm@ast.cam.ac.uk
Public Astronomer	Carolyn Crawford	37510	Hoyle Rm 60	csc@ast.cam.ac.uk

Students should immediately notify the Course Coordinator if they encounter problems and for general guidance. Day to day queries may be handled by the Course Secretary.

## Lecture Courses

A typical lecture load consists of an average of nine lectures per week during the Michaelmas and Lent terms. It is usual to give more courses than this at the start of each term and then cut down to those of greatest interest. This equates to about 18 examinable units over the year. The compulsory project accounts for a further 6 units so that a typical total examination entry of 18 units requires that you prepare fully for examination only about two-thirds of the courses for which you have attended lectures.

### Courses recommended by the Institute of Astronomy

Timetable	
Michaelmas 2016	Lent 2017
Prof. G. I. Ogilvie Astrophysical Fluid Dynamics M.W.F. 9 MR13 [3 units] [M]	Prof. R. Maiolino Formation and Structure in the Universe † M..F. 9 <i>Small Lecture Theatre</i> [1 unit] [P]
Dr J Rudge and Dr David Al-Attar Physics of the Earth as a Planet † M.W.F. 9 <i>Small Lecture Theatre</i> [2 units] [P]	Prof. M.R.E. Proctor Convection and Magnetoconvection Tu.Th. 9, MR13 [2units] [M]
Dr M. Dunajski, Prof H.S. Reall General Relativity M.W.F. 10 MR2 [3 units] [M]	Dynamics of Astrophysical Discs Dr H. Latter Tu. Th. 10, MR9 [2 units] [M]
Prof. A.C. Fabian and Prof. A. N. Lasenby Relativistic Astrophysics and Cosmology † M.W F. 10 MR11 <i>Small Lecture Theatre</i> [2 units] [P]	Dr A. D. Challinor and Dr T. Baldauf Advanced Cosmology M.W.F. 10 MR12 [3 units] [M]
Dr M. C. Wyatt Planetary System Dynamics M.W F. 11 MR11 [3 units] [M]	Prof. N.W. Evans Galactic Astronomy and Dynamics M.W.F. 9 MR12 [3 units] [M]
Dr C. G. Lester Particle Physics † M.F. 11 and F 3pm for 2 weeks, then M. W .F. 11 <i>Small Lecture Theatre</i> [2 units] [P]	Prof. R. D. E. Saunders Frontiers of Observational Astrophysics † M.F. 10 <i>Ryle Seminar Room</i> [1 unit] [P]]
Dr A. Zytkow Structure and Evolution of Stars M.W.F. 12 MR13 [3 units] [M]	Dr N. Madhusudhan Extrasolar Planets M.W.F. 11, MR12 [3 units] [M]

Dr J. R. Fergusson, Dr C M Marsh Cosmology Tu.Th.S. 11 MR2 [3 units] [M]	Dr J.E. Santos Black Holes M.W.F.12 MR3 [3 units] [M]
Prof. B. Allanach Quantum Field Theory Tu.Th.S. 12, [2 units] MR2	Dr C.A. Tout Binary Stars Tu.Th. 11 MR12 [2 units] [M]
	Dr I.R. Parry Optical and Infrared Astronomical Telescopes and Instruments Tu.Th. 12, MR12 [2 units] [M]

*In addition, attendance at a short orientation course, covering practical aspects of Unix and use of the Institute of Astronomy Science Cluster is required.*

Dr R M Johnstone\* Introduction to Unix & Computing –See calendar for timetable of lectures.

*All lectures will be held in the Centre for Mathematical Sciences meeting rooms (MR) Clarkson Road except \* which will be held at the IoA, Madingley Road and † in the Cavendish Laboratory (West Cambridge). [Mathematics [M], Physics [P]].*

The majority of courses you choose for examination must be drawn from the above list. You may also choose to be examined in courses, amounting to a maximum of three units, chosen from any of the full suite of Part III Mathematics courses or from the Part III Physics courses except "Exoplanets and Planetary Systems", which have too much overlap with our recommended courses. You may not choose the interdisciplinary courses or "Nuclear Power Engineering" from Part III Engineering. All mathematics courses are examined in June. Those of 24 lectures have a 3-hour exam and count 3 units while those of 16 lectures have a 2-hour exam and count 2 units. Physics major options have a 2-hour exam at the beginning of the Lent term and count 2 units. Physics minor options have a 1.5-hour exam at the start of the Easter term and count 1 unit. The courses offered in Part III vary from year to year and students should consult the Part III Coordinator for guidance in choosing.

The compulsory project accounts for a further 6 units so that a typical total examination entry of 18 units requires that you prepare fully for examination only about two-thirds of the courses for which you have attended lectures.

The lecture courses are supported by Examples Classes organised by the lecturer.

Part III Examples and some Lecture Notes are here:

<http://www.damtp.cam.ac.uk/user/examples/indexP3.html>

## Talks

There are a number of seminars of astronomical interest within various Cambridge departments. Students are encouraged to attend seminars, although the large number of possibilities implies that students need to be selective in those they attend. The Institute of Astronomy has two regular series of talks, the Wednesday lunchtime talks at 1.15 pm (which are preceded by bread and cheese lunch from 12.30 and which usually constitute 2 half-hour talks on specialised research topics) and the Colloquia (Thursdays at 4.00 pm during Michaelmas Full Term) which are preceded by tea at 3:30 pm and followed by wine at 5.00 pm. The Colloquia are hour-long talks that generally contain a larger review element, as well as presenting latest scientific results.

In addition, the Cavendish Astrophysics Seminar takes place at 2 pm on Tuesdays and informal lunchtime talks are held at DAMTP (Monday 1.00 pm for the Cambridge Cosmology and Astrophysics Lunch and Tuesday 1.00 pm for Astrophysical Fluid Dynamics and Nonlinear Patterns).

Commitments to lecture courses and project work mean that it is essential to be selective about which talks to attend. However, in addition to the benefits of attending a talk containing relevant subject matter, critical assessment of a number of talks offers the opportunity to gain direct experience of what does and does not, work when presenting material to a non-specialist audience. Such experience is likely to be of direct benefit when preparing the project oral presentation to the Examiners in the Easter Term.

The schedule of talks for the forthcoming week can be found on the [IoA website](#).

## **General Information**

It is hoped as a Part III Astrophysics student that you will feel part of the Institute of Astronomy and will participate in some of the activities that maintain its friendly and interactive atmosphere.

## **Coffee**

The Institute of Astronomy staff have coffee (and tea) in the Hoyle building foyer from about 11.00 am. Part III Astrophysics students are invited to enjoy coffee with the staff and postgraduate students, although this may on occasions not be possible given the location and timing of Part III lectures. There is no charge for coffee for Part III Astrophysics students.

## **Journal Club and Socials**

There will be a series of sessions for Part II and Part III students which are designed to build confidence in giving presentations and will also allow socialising between the two year groups. The sessions are run by enthusiastic PhD students who will offer friendly advice on preparing and giving scientific talks (lecturers do not attend!). There will also be wine and nibbles after the talk. *Events this term are to be decided.*

## **Public Outreach**

The IoA runs an extremely successful programme of Public Outreach on Wednesday evenings. Student participation is welcome: details available at the introductory session on 7<sup>th</sup> October or email [csc@ast.cam.ac.uk](mailto:csc@ast.cam.ac.uk).

## **Food**

There are a number of possibilities for lunchtime food provision. Snacks can be obtained on site from the vending machine located in the Hoyle building. On Wednesdays the Institute of Astronomy organises a bread and cheese lunch at 12.30 pm. This precedes the seminars. Off-site there are several possibilities for canteen style food (CMS, Cavendish Laboratory and Greenwich House) and a full range of meals at the Hauser Forum as well.

## **Computing**

Part III students are given full access to the Institute of Astronomy Science Cluster. A limited number of bookable dedicated terminals are available in Library Room B at the Institute of Astronomy,

A 5-lecture "Introduction to Unix and Computing" course is given at the start of the Michaelmas Term in order to familiarise students with the operating system and use of the Science Cluster.

## **Library**

The [Institute of Astronomy library](#) holds 8 000 books and 11 000 volumes of astronomical periodicals. Part III students are encouraged to use the library facilities but may not sign out books. If you need any help ask the Librarian, Mark Hurn, who has an office in the library area in the Observatory Building.

## **Photocopying**

There is a photocopier in the reprographic room (opposite the vending machines), another outside to the right of the stairs to the Sackler Lecture Theatre and one in the main library in the Observatory building. Course-related copying is free of charge. For private copying there is a charge of 3p per A4 sheet.

## **E-mail**

Students' correspondence will be delivered via email

## **CMS Facilities**

In the CMS, Part III Astrophysics students may use the large Part III Mathematics Room and the associated facilities. More details may be found in the Part III Mathematics Handbook.

## **Printing at DAMTP**

Part III students are given a free allocation of printer credit for use on the PWF-MATHS printers at CMS. PWF-MATHS credit cannot be spent on UCS or college printers. Similarly, credits purchased at the UCS or in college cannot be used at CMS. If you run out of printer credit send an email to [jm@ast.cam.ac.uk](mailto:jm@ast.cam.ac.uk). You may be asked to explain why the standard allocation proved to be insufficient.

Please note that printing facilities are provided solely for academic use. Please use other printers in college or at the UCS for personal use. Note that non-academic use of printers, or unnecessary waste of paper (including large amounts of output left uncollected), may result in a charge being made.



## Part III /MASt Calendar

### ASTROPHYSICS CALENDAR FOR 2016/2017 :

please note some details may be subject to change and additions made.

**MATHS CALENDAR FOR 2016/2017 - pp25 and 26 of Maths Part III Handbook - note some entries are duplicated below but it is advisable to check the Maths version, which contains additional entries.**

\*Students offering a **Part III Physics** course for examination must complete and return their college examination forms by the appropriate deadline. Please ensure that one copy of the form is submitted to the Course Secretary in the Institute of Astronomy during Michaelmas Term. Further information about procedures for examination entries will be made available at the beginning of the Michaelmas Term. Students **must** register on the Physics [TIS](#) in order to receive important emails from the Teaching Office. Failure to do so will result in not being informed about lecture timing changes due to unforeseen circumstances as well as **supervision allocation**. If you have any difficulty in registering ask the Astrophysics course secretary at IoA for assistance.

Date and Time	Subject	Venue/Details
<b>MICHAELMAS TERM 2016</b>		
<b>OCTOBER</b>		
Tues 4 October	Full MICHAELMAS term begins	
Tues 4 October 10.30 -photos [11.00 coffee] 11.30 meeting	Introductory meeting with Course Coordinator, and Chair of Teaching Committee followed by Library Tour (Mark Hurn: Librarian). [student portrait photographs taken from 10.30]	Sackler Lecture Theatre
Tues 4 October 14.00-15.30	Computing Induction meeting – laptop set up - with Roderick Johnstone (MASt students)	Hoyle Committee Room
Wed 5 October	Maths Introductory Meeting at CMS (see note for timetable)	MR2 and MR3
Wed 5 October 12.30-13.00	Meeting with Carolin Crawford on outreach opportunities at IoA	Sackler Lecture Theatre
Wed 5 October 14:00-16:00	Maths: Presentations by DAMTP <b>subject advisers</b> on their courses.	CMS MR2 and MR3
Thur 6 October	Michaelmas Term Lectures begin	CMS and Cavendish Laboratory (see lecture list)

Thur 6 October	Computing Induction meeting – laptop set up - with Roderick Johnstone (Part III students)	
Mon 10 October 14.30-15:30	Introduction to Unix and Computing (Roderick Johnstone) Lecture 1 (MASt students only)	Hoyle Committee Room
Tues 11 October 14.30-15:30	Introduction to Unix and Computing (Roderick Johnstone) Lecture 1 (Part III students only)	Hoyle Committee Room
Wed 12 October 14:30-15:30	Introduction to Unix and Computing (Roderick Johnstone) Lecture 1 (MASt students only)	Hoyle Committee Room
Thurs 13 October 14:30-15:30	Introduction to Unix and Computing (Roderick Johnstone) Lecture 2 (Part III students only)	Hoyle Committee Room
Fri 14 October 14:30-15:30	Ranked list of projects to George Efstathiou	via email <a href="mailto:gpe@ast.cam.ac.uk">gpe@ast.cam.ac.uk</a>
Mon 17 October 14.30-15:30	Introduction to Unix and Computing (Roderick Johnstone) Lecture 1 (MASt students only)	Hoyle Committee Room
Tues 18 October	Ranked list of projects to Course Coordinator	Via emails from (gpe/jm)
Tues 18 October 14:30-15:30	Introduction to Unix and Computing (Roderick Johnstone) Lecture 2 (Part III students only)	via email
Wed 19 October 14:30-15:30	Introduction to Unix and Computing (Roderick Johnstone) Lecture 1 (MASt students only)	Hoyle Committee Room
Thur 20 October 14.30-15:30	Introduction to Unix and Computing (Roderick Johnstone) Lecture 2 (Part III students only)	Hoyle Committee Room
Mon 24 October 14.30-15:30	Introduction to Unix and Computing (Roderick Johnstone) Lecture 1 (MASt	Hoyle Committee Room

	students only)	
Tues 25 October 14:30-15:30	Introduction to Unix and Computing (Roderick Johnstone) Lecture 2 (Part III students only)	Hoyle Committee Room
31 October 2:45pm	Progress meeting with Course Coordinator and Chair of Teaching Committee	Ryle Large Meeting Room

### NOVEMBER

1 November	List of examination courses announced in the Reporter by this date.	
	Provisional Maths Tripos entries. Confirm Physics Major Options -- email Judith Moss	
	*Deadline to enter for Physics Major Options examinations	
Wed 30 November	Last day of Michaelmas Term lectures	
Fri 2 December (no later than)	Interim Progress Report to be delivered to Course Secretary bearing the signatures of the supervisors. Electronic version is acceptable (jm@ast.cam.ac.uk)	Hoyle Room 48
<b>Fri 4 December</b>	Full Michaelmas Term ends	

### LENT TERM 2017

### JANUARY

Tues 17 January	Full LENT Term begins	
As soon as possible	Liaise with Project Supervisor to organise supervisions	As appropriate

January [SEE REPORTER and Dept of Physics]	Particle physics (NST3ET Major Topic 4)	TBC
Thur 19 January	Lent term lectures begin	CMS
<b>FEBRUARY</b>		
Wed 15 February, 2.30pm (tbc)	[For information: IoA staff presentations to potential Part II/III Astrophysics students, Sackler Lecture Theatre.]	Sackler Lecture Theatre
During week commencing Mon 27 February	Timetable for practice oral presentations to be received from Course Coordinator (via Course Secretary) by email. You are advised to check that your presentation works on the IoA digital system. Please contact Course Secretary [jm@ast.cam.ac.uk] to make arrangements in good time.	
TBA	"How to give a PowerPoint Presentation" by Craig Mackay	Hoyle Committee Room
<b>MARCH</b>		
Wed 15 March	Last day of Lent Term lectures	CMS
Wed & Thur & Fri 15,16, & 17 March	Practice oral presentations (20 mins for talk, 10 mins for questions). Project Coordinator, Project Supervisors part of audience (this constitutes final and 4th supervision of the Lent Term [i.e. 7th out of total of 8]).	Hoyle Committee Room
Thurs MARCH 10 12.30-13.00	Feedback meeting with Course Coordinator and member of IoA Teaching Committee	Hoyle Committee Room
	Deadline to enter for Physics Minor Options examinations	jm@ast.cam.ac.uk
Thurs 16 March	Feedback meeting with Course Coordinator and member of IoA	Hoyle Committee Room

12.00-12.30	Teaching Committee	
Fri 17 March	Full Lent Term ends	

### EASTER TERM 2017

#### APRIL

Wed 19 April (not later than)	Draft of Final Project Report to be handed to Project Supervisor <u>and</u> to the <u>second</u> supervisor at the same time	
During week commencing Mon 24 April	Timetable for final oral presentations to be emailed during this period. (20 mins for talk and 10 mins for questions)	
Tues 25 April TBC	Full EASTER Term begins.  Candidates receive examination entry forms to indicate choice of examination papers (Maths).	
AS EARLY AS POSSIBLE	You are advised to again make sure that your presentation works on the IoA digital system. Please contact Course Secretary [jm@ast.cam.ac.uk] to make arrangements in good time.	Hoyle Committee Room

#### MAY

No later than Tues 2 May by 16.30	<b>Submission of Final Project Report:</b> Deliver 2 copies to Course Secretary, identified by name only (i.e. University Examinations Number must NOT appear anywhere in the report) and include declaration ( <a href="#">here</a> ). Submit electronic file to Course Secretary [jm(at)ast.cam.ac.uk] by this deadline	
Fri 5 May by NOON	Deadline for return of forms giving choice of examination papers <sup>1</sup> : see correspondence from, Faculty Office	Faculty Office, CMS Room B1.28

TBC	Secretary CMS. (It is very important to copy the form to the Course Secretary - email is acceptable.)	
<b>NB Mon, Tues, Wed 15<sup>th</sup>, 16<sup>th</sup>, 17<sup>th</sup> May</b>	<b>Formal, assessed oral presentations to Part III Examiners</b>	<b>Ryle Large Meeting Room</b>
	<sup>1</sup> Deadline for withdrawing a paper - notice via your Director of Studies	Undergraduate office, CMS
	Part III Examinations - to be announced in "Reporter"	CMS - seminar and lecture rooms. Room numbers tbc.
Thurs 24 May	Full Easter Term ends	
<b>JUNE</b>		
Thurs 1 June	Part III examinations begin	
Tues 13 June	Part III Examinations end	
Fri 16 June	Full Easter Term ends	
Tues 20 June	NST Part III Astrophysics Examiners meeting	
Wed 21 June approx 09.30	It is expected your examination results will be available to you (and no-one else) via CamSIS	
Thurs 22 June <b>**16.30**</b>	Examination results announced at Senate House	
Finally ...	<i>Project Reports may be collected from Course Secretary. If not collected after Examinations the report will be sent to the address provided on the cover sheet.</i>	

## **Research Projects**

A compulsory element of the course is a substantial research project, extending over two terms. This is undertaken with the guidance of a supervisor from the Institute of Astronomy. The research project accounts for a third of the total marks available for the course.

Each year the Institute produces a booklet containing descriptions of the individual projects available. Each entry contains a brief description of the background to the project along with a summary of the type of work involved and several references to where more information can be obtained. Following the project descriptions, details of the timetable, format of the project write-ups and the criteria to be used in the assessment of the projects are included.

Please read the University's [guidelines on plagiarism](#).

## **Project Timetable**

### **Michaelmas Term**

An orientation course (5 lectures) covering unix, the Institute of Astronomy Science Cluster, LaTeX (text-processing facility) and information resources available on-line commences on the first Tuesday of Michaelmas Full Term (10 or 11 October 2016).

Choice of up to five projects, in rank order, should be handed to the Course Secretary by 4.30 pm on the second Friday of Michaelmas Full Term (14 October 2016). Students who do not supply rank-ordered choices by the deadline will be allocated a project by the Project Coordinator.

Notification of approval of project choice will be made by e-mail no later than the third Tuesday of Michaelmas Full Term (18 October 2016). The equivalent of 3 formal Supervisions will be offered by the Project Supervisor in the Michaelmas Term.

An interim progress report, length no more than 1,000 words, bearing the signature(s) of the main supervisor(s) and second supervisor, must be handed to Judith Moss no later than the last day of Michaelmas Full Term (2 December 2016). The report should be produced with LaTeX, or an equivalent text-processing package and may contain material that can be incorporated in the final project report. The interim report must indicate the progress made so far and show preliminary results. It should also give a clear indication of the project aims and a detailed plan of how these aims will be achieved. This is particularly important where the results of the project depend on data that has yet to be analysed. There is no need for the interim report to reiterate the material given in the Project Handbook. The interim reports do not constitute part of the formal assessment but are regarded as an essential part of the monitoring procedure.

### **Lent Term**

The equivalent of 3 formal Supervisions will be offered by the Project Supervisor.

Practice oral presentations, consisting of a 20 minute talk followed by up to 10 minutes of questions, to an audience of Part III Astrophysics students, Project Supervisors and the Project Coordinator will

be given on the last Thursday and Friday of Lent Term (15, 16, and 17 March 2017). A final timetable for the presentations will be provided by e-mail during the previous week. The presentation is not formally assessed but offers the opportunity to become familiar with the format of the presentation, to be assessed by the Part III Examiners in the Easter Term. The Project Supervisor's attendance at the informal presentation and subsequent feedback constitutes the fourth and final, Supervision of the Lent Term.

### **Easter Term**

A draft of the final project report, generated with LaTeX or an equivalent text-processing package, should be handed to the Project Supervisor no later than 19 April 2017. An eighth Supervision, to discuss the draft report, should take place no later than the first Tuesday of Easter Full Term (25 April 2017).

Two copies of the final project report must be handed, in person to the Course Secretary no later than 4.30 pm on the second Tuesday of Easter Full Term (2 May 2017). Late submissions must be submitted via your College Tutor with an accompanying letter of explanation from the Tutor. Your University Examination Number must NOT appear anywhere in the report or on the cover sheet.

A formal, assessed, oral presentation to Part III Astrophysics Examiners will take place on the second Thursday or Friday of Easter Full Term (**please note that the orals have been moved to Monday, 15, or Tuesday, 16 or Wednesday, 17 May in 2017**). A final timetable for the presentations will be provided via e-mail during the previous week. The presentation should consist of a 20 minute description of the project with PowerPoint or equivalent on a laptop computer. The presentation will be followed by up to 10 minutes of questions. The Examiners will allocate approximately 15% of the total marks for the project on the basis of the presentation. The NST Part III Astrophysics Examiners meeting takes place on Tuesday 20 June 2017.

Project reports may be collected from the Course Secretary after 9.00 am on Wednesday 21 June 2017.

### **Project Report Format and Content**

The report should read as a self-contained document, presented in the style of a scientific research report or paper in a scientific journal. The main sections of the report will describe the work undertaken, the results obtained and an assessment of their significance. An Abstract, Introduction, Conclusions and References should also be included. Supporting Figures and Tables should be used both as an aid in presenting data and results and also to enhance the clarity of the submission. In some circumstances an appendix containing more extensive tabular material/results may be included.

Reports should consist of a text of no more than 8,000 words, not counting Figures, Tables, Captions, References, Equations and any Appendices. The submission must be produced with LaTeX, or another text-processing package, with computer generated figures. You must include a declaration that the text does not exceed 8,000 words excluding Figures, Tables, Captions, References, Equations and any Appendices. Projects found to exceed this limit will be returned for shortening and a penalty will apply for late submission.



The submission should be logically structured, clear and complete, while remaining concise. The reader should be able to understand the context in which the investigation was undertaken, the main features of the project, the results and how they relate to the advancement of the subject. In addition to the descriptive material, questions a report would be expected to address include, "Why were particular approaches adopted?" - back of the envelope calculations will often be helpful and relevant - "What has been learnt?" and "What information/work would have helped us to learn more?"

It is a fundamental tenet of scientific research that due acknowledgment is given to the work and ideas of others that form the basis of, or are incorporated in, a research presentation. You must always acknowledge the source of an idea or material you use with a specific reference. Plagiarism, including the use of another individual's ideas, data or text, is regarded as an extremely serious disciplinary offence by the University: for further guidance on what constitutes plagiarism, see <http://www.admin.cam.ac.uk/univ/plagiarism/>. It is a requirement that the project investigation and the project report are both the work of the candidate alone and no form of collaboration is allowed.

Each report (two copies) must be accompanied by a cover sheet that should bear (1) the title of the project, (2) your name, (3) your college, (4) your home address and (5) a signed declaration that reads:

I declare that this project report represents work undertaken as part of the NST Part III Astrophysics Examination. It is the result of my own work and, includes nothing which was performed in collaboration. No part of the report has been submitted for any degree, diploma or any other qualification at any other university and it does not exceed 8000 words, excluding Figures, Tables, Captions, References, Equations and any Appendices. I also declare that an electronic file containing this work has been sent by email (jm@ast.cam.ac.uk) on this date.

Signed.....

Date .....

If you are in any doubt as to whether you can sign such a declaration you should consult the Part III Coordinator before submitting your report. In the event that your project report is not collected after examinations the report will be sent to the address provided on the cover sheet.

## Examinations

### Course Choices

Students offering courses for examination which are given as part of Part III Physics must complete and return their college examination forms by the appropriate deadline. Please ensure that one copy of the form is submitted to the Course Secretary in the Institute of Astronomy during the Michaelmas Term. Further information about procedures for examination entries will be made available at the beginning of the Michaelmas Term. Students **must** register on the Physics [TIS](#) in order to receive important emails from the Teaching Office. Failure to do so will result in not being informed about lecture timing changes due to unforeseen circumstances and **supervision allocation**.

Students are required to submit notification of which courses they will be offering for examination given as Part III Mathematics no later than noon on Friday, 5 May 2017. Three copies of your choice of courses must be submitted, one to your College Director of Studies in College, one to the DAMTP Faculty Office and one to the Course Secretary at the Institute of Astronomy. Your Director of Studies needs to check, approve, sign and forward your nomination form to DAMTP. Make sure you allow your DoS at least 3 week days to complete the process.

Students may be examined in up to a maximum of 21 units, including 6 units for the compulsory project. The Examiners will base their decision on 17, 18 or 19 units consisting of 6 project units plus the most favourable combination of examination units. The majority of courses should be selected from the recommended list. Courses amounting to 3 units or fewer may be selected from the full suite of Part III Mathematics courses or the allowed list of Part III Physics courses or a mixture of both.

[Click here](#) for the reports of the External Examiner.

### Calculators

**The use of electronic calculators will NOT be permitted in any papers set for the Mathematical Tripos.**

#### **NST Part III Physics - Major and Minor Options**

#### **Electronic calculators in University examinations, 2016–17 (Cambridge Reporter 6 Oct. 2016)**

For the above examinations the following calculators marked in the approved manner are permitted:

CASIO fx 991 (any version)

CASIO fx 115 (any version)

CASIO fx 570 (any version)

It is the responsibility of each student to equip themselves with a suitable calculator as described.

Each such calculator permitted in an examination must be marked by the Department in the approved fashion so that they are clearly identified as being permitted during the examination. No other calculator may be brought into the examination.

### **Sale of approved calculators**

Approved calculators, marked in the approved fashion, will be on sale from:

- Department of Physics, Bragg Building (Natural Sciences Tripos)

Approved calculators bought elsewhere will need to have the approved marking applied by the Department.

### **Criteria for Marking**

The Part III Mathematics and Physics examination papers are marked by Assessors (who are normally the course lecturers) appointed by the relevant department and these marks are relayed to the Part III Astrophysics Examiners who consider them in conjunction with the marks obtained on the project.

The Institute of Astronomy Teaching Committee recommends that the degree class be allocated according to the following criteria. An explanation of the marking scheme can be found [here](#).

#### **First class marks**

A candidate placed in the first class will be able to demonstrate a full command and a secure understanding of the examinable material. Scripts will contain substantially correct solutions to most of the quantitative parts of a question, showing a good grasp of mathematical skills. For questions of an essay nature, first class marks will be awarded for work which is excellent, both in range and in depth of knowledge and in the argument and analysis that it brings to bear.

A project gaining First Class marks will demonstrate an excellent understanding of the methods and results obtained and an ability to argue for the significance of these results in terms of their wider scientific context. Reports awarded First Class marks should demonstrate excellent organisation and clarity of thought; an Oral Presentation awarded First Class marks should likewise demonstrate outstanding organisation and clarity and the response to questions should exhibit a commanding grasp of the subject matter and wider context.

#### **Upper Second class marks, II.1**

A candidate placed in the upper second class will be able to demonstrate a good command and some understanding of the examinable material. Scripts will contain solutions to most of the quantitative parts of a question, thereby demonstrating the basic skills involved. For the essay and questions of an essay nature, II.1 marks will be awarded for work that demonstrates knowledge, but which does not provide as impressive a display of understanding, argument and analysis as those in the first class.

A project gaining an upper second class should demonstrate a good understanding of the methods and results obtained and an ability to synthesise these results in their wider scientific context in a

well organised report. Oral presentations in this category should be well organised and attractive. The response to questions should demonstrate that the student has understood the subject material, but would not demonstrate the same critical flair as candidates awarded a First class in this category.

### **Lower Second class marks, II.2**

A candidate placed in the lower second class will be able to demonstrate some command of the examinable material but with limited understanding. Candidates should demonstrate the ability to make good attempts at the straightforward parts of questions but limited ability to tackle any of the more challenging topics. Answers to questions of a mathematical nature will show an indication of what is required, but fail to proceed sufficiently far into the later parts to demonstrate the skills involved.

A project gaining a lower second class would demonstrate a sound understanding of the methods and results obtained, but would not exhibit the same originality of approach or grasp of the connection to the wider field as projects awarded higher class marks. Reports in this category are expected to be reasonably well organised, to clearly set out the work undertaken and to contain appropriate references. Oral presentations in this category will make clear what the student has accomplished but the response to questions may indicate that the understanding is relatively shallow.

### **Third class marks**

A candidate placed in the third class will be able to demonstrate some knowledge, but have a poor command of the skills expected and very limited understanding of the examinable material.

A project gaining a Third class mark would demonstrate relatively poor progress with pursuing the research topic and/or evidence of incomplete understanding of the methods or results obtained. A report gaining a Third class mark may be poorly structured and unable to fully justify and explain the results obtained. Likewise an oral presentation in this category may be incoherent, with the response to questions indicating a poor grasp of the material.

### **Ordinary/Fail**

A fail mark will be given when a candidate demonstrates little or no knowledge of the material and little or no ability to begin to tackle questions of a mathematical nature.

A project would be awarded a fail mark in the case that the student had failed to achieve any of the significant objectives of the research topic and had failed to provide a reasoned account of why this was the case. A report in this category would provide little evidence of engagement with, or understanding of, the research topic or its relation to the wider field. Likewise an oral awarded a fail mark would fail to communicate the results and relevance of the project work and the answers to questions would reveal a lack of understanding.

## **Examiners Criteria for Marking the Project Report and Oral Presentation**

The project element of the NST Part III Astrophysics course constitutes one third of the course (equivalent to the marks assigned to two 24-lecture Mathematics Part III lecture courses).

Approximately 15% of the marks for the project will be assigned on the basis of the assessed oral presentation that takes place in the Easter Term. The balance of the marks will be assigned on the basis of the written project report. The Examiners will award marks under three broad headings, i) scientific understanding, ii) quality of the research, iii) presentational and communication skills.

The format and timetable for submission form part of the Examination process. In their assessment of the project, the Examiners will take account of any breaches of the guidelines, including exceeding the word limit and late submission of the report.

### **Oral Presentation**

The Examiners assessment will take into account the following:

- Visual Material: including relevance, clarity, attractiveness
- Oral Presentation: including overall structure, clarity, time keeping
- Response to Questions: including grasp of subject material, precision of answers

### **Written Project Report**

The Examiners will assess the report under the following headings:

- Overall structure and clarity of the report
- Planning, organisation and prosecution of the research
- Understanding of the physics and the general scientific content
- Technical proficiency
- Analytical and Interpretational skills
- Significance of the results

### **Special Examination Arrangements**

Any student who believes there are circumstances that require special treatment by the examiners must ensure that this information is communicated to the Course Secretary by their College at the earliest opportunity and well before the project presentations, see

<http://www.admin.cam.ac.uk/students/studentregistry/exams/undergraduate/>

### **Institute of Astronomy Prize**

The Institute of Astronomy Prize is awarded annually to that candidate for Astrophysics in Part III of the Natural Sciences Tripos or Master of Advanced Study in Astrophysics candidate who has in the

judgement of the Examiners shown the greatest distinction in that examination, provided that his or her work is of sufficient merit. The value of the Prize for academic year 2013/14 is £500.

### **Examination Results**

Examinations are a University matter and covered by strict regulations. Whether you have a complaint or not, you should not, under any circumstances, seek to discuss your examination result with your examiners. The University has a standard procedure for dealing with complaints about examination results.

Any complaints or requests for reconsideration must be made in writing by your College (usually via your Senior Tutor) to the Chairman of the Examiners. You should therefore discuss the matter with your College Tutor who will advise you further. You should note that any investigation by the University will usually confine itself to seeing that the examiners acted correctly (for example that all the marks you received were entered into the mark book) and not try to second guess the examiners by re-marking your papers.

### **Part III Exam Papers**

Past exam papers for Part III Astrophysics are available from either DAMTP or the Physics department.

## **Transferable Skills**

All students in the University are encouraged to engage in personal development planning. The astrophysics courses are designed to provide all students with opportunities to develop a wide range of transferable skills. The University also offers plenty of opportunities to acquire skills outside the curriculum particularly in College-based activities and in numerous specialist interest clubs and societies.

The Institute of Astronomy has identified the following set of skills and attributes which all undergraduates can reasonably expect to acquire during their university career. These skills enhance students' academic performance, can be used beyond university, and are valued by employers.

This note sets out the ways in which transferable skills are acquired through the teaching programme offered by the Institute. The Part II and Part III Astrophysics courses overlap with courses provided by the Departments of Physics and Applied Mathematics and Theoretical Physics and so the transferable skills policy statements of those departments are also relevant.

## **Intellectual skills**

The most important intellectual skills which our students learn are abilities at quantitative and qualitative reasoning in the exact physical sciences and the application of this understanding to problem-solving. Examples include: development of models of phenomena; mathematical analysis of models; appropriate approximation; statistical analysis. These skills are developed in: Department: through lectures, examples classes, seminars, projects and examinations; College: supervisions involving discussion, reasoning, problem solving, and critical analysis.

## **Communication skills**

All students develop their communication skills as part of the teaching and assessment programme. In Part II essays and Part III projects credit is given for the quality of the student's communication skills. The principal elements of the training involve:

### **Writing**

Department: Guidance notes provided by the Department on the preparation and presentation of Part II essays. Individual guidance by supervisors of Part III research projects, encouraging a critical attitude and an innovative approach to problem solving.

College: Supervisions involving the discussion and written solution of problems.

### **Oral**

Department: Oral presentations of project work in Part III (also including software presentation packages and visual aids).

College: Supervisions involving oral explanations and discussion with supervisors and other students. Non-verbal (development of an argument using mathematical concepts or symbolic language):

Department: Computational projects, essays and examples sheets. College: Supervisions involving problem solving. Organisational and interpersonal skills

Students develop self-discipline in the management of a complex work programme of lectures, supervisions, examples classes, projects, literature reviews and examinations with strict deadlines. Interpersonal skills and self expression are developed through constant interaction with peers, supervisors, lecturers and working within a research group as part of a Part III project.

Department: Provision of a framework within which the students carry out their work programme with clear deadlines. Advice on organising the programme of work in the Course Guide.

College and University societies: Oversight of the students' programmes is maintained by Directors of Study and Tutors. Advice on organisation of the work programme through supervisions. Living, working and socialising in a diverse community; taking positions of responsibility.

### **Research skills**

Students develop information-acquisition skills from the selection and use of appropriate text books to the sourcing and assimilation of scientific literature particularly for essays and projects.

Department: Development of all aspects of research skills involving the application of understanding of concepts to new problems. Use of library, electronic and Internet resources to supplement information given in lectures and supervisions; critical analysis of published papers in preparation for Part II essay; Part III research project. Appreciating how to access the experience and knowledge of expert scientists.

### **Numeracy and Computing**

Success in astrophysics is dependent on a high level of numeracy and computing skills, all of which are highly transferable to other spheres.

Department: In earlier years of the Natural Sciences Tripos students will have followed courses in mathematics. All astrophysics courses contain mathematical elements. Lectures and examples classes are provided in mathematical methods and statistical astrophysics; daily use of mathematics and computational methods for study and problem solving; data analysis in essays and projects. CATAM courses are specifically focussed on programming skills, many at a very advanced level.

College: Supervisions in all courses. Computing resources for the above; e-mail and Internet access. Word processing is used for all aspects of written communication.

### **Foreign Language Skills**

Students have access to the University's Language Centre and extensive opportunities for self-teaching in foreign languages.



## **Appendix I**

### Part III Examination Assessment

Each Part III Mathematics paper is marked by an assessor who is usually the lecturer. Assessors give a quality mark alpha+, alpha, alpha-, beta+, ..., gamma- to the whole paper. Individual questions are not assigned quality marks so there is no extra weight given to answers to more complete questions though assessors can, and often do, assign more marks to problem solving parts of questions than to book work. Paper quality marks alpha+ to beta+ are given to papers of first class standard (alpha+ to alpha- are of distinction standard and beta+ is of merit standard for the MAST) and beta and beta- are of II.1 standard (pass for the MAST). The project is assigned a similar quality mark by the Part III Astrophysics examiners. Physics papers are assigned a quality mark appropriate to the numerical mark assigned by the physics examiners. Quality marks are averaged linearly, weighted by number of units, including six units for the project and the best combination of eleven, twelve or thirteen units from the exam papers to obtain a final quality mark on which the examiners base their assessment for the class list.

Christopher Tout

Chair, Institute of Astronomy Teaching Committee

15 March 2012