

DISCOVER THE OPPORTUNITIES

Undergraduate Courses at the Institute of Astronomy, University of Cambridge  
**PART II & PART III IN ASTROPHYSICS 2024-2025**



## SUMMARY

The Institute of Astronomy offers two exciting courses in Astrophysics, providing the University's only dedicated astronomy course at the Part II level and a Part III course that combines a wide choice of high level courses with the opportunity to conduct a substantial research project. (See the frequently asked questions section for a summary of other options for studying some astrophysics within other Triposes.) The philosophy behind our courses is to teach the fundamental physics that is necessary to understand the workings of the Universe on interstellar and larger scales, and to illustrate its application through a range of fascinating problems in contemporary astronomy. The Part II course is taken both by those intending to proceed to Part III Astrophysics (many of whom will be considering postgraduate research in the subject) and by those who graduate after three years and who use the training in physical inference that the course provides in a range of other disciplines after graduating. (See below for further details on the destinations of Astrophysics graduates.)

The Institute of Astronomy is one of the foremost research institutions in the world and, with its setting of lawns and woodland, provides a delightful environment for undergraduate study. Students benefit from the relatively small class sizes and the friendly atmosphere of the Institute. In addition to formal participation by elected student representatives from both Part II and Part III on the IoA Teaching Committee, students are encouraged to participate widely in the life of the Institute through public outreach and joining the weekly bread and cheese lunch and various seminars and colloquia. The free coffee and biscuits for students are particularly appreciated!

Many students find the excitement of learning astrophysics at the Institute re-invigorates their interest in science and mathematics. See below for some recent student comments on their experience of the course.

For further information please email [\*\*undergraduate.admin@ast.cam.ac.uk\*\*](mailto:undergraduate.admin@ast.cam.ac.uk)

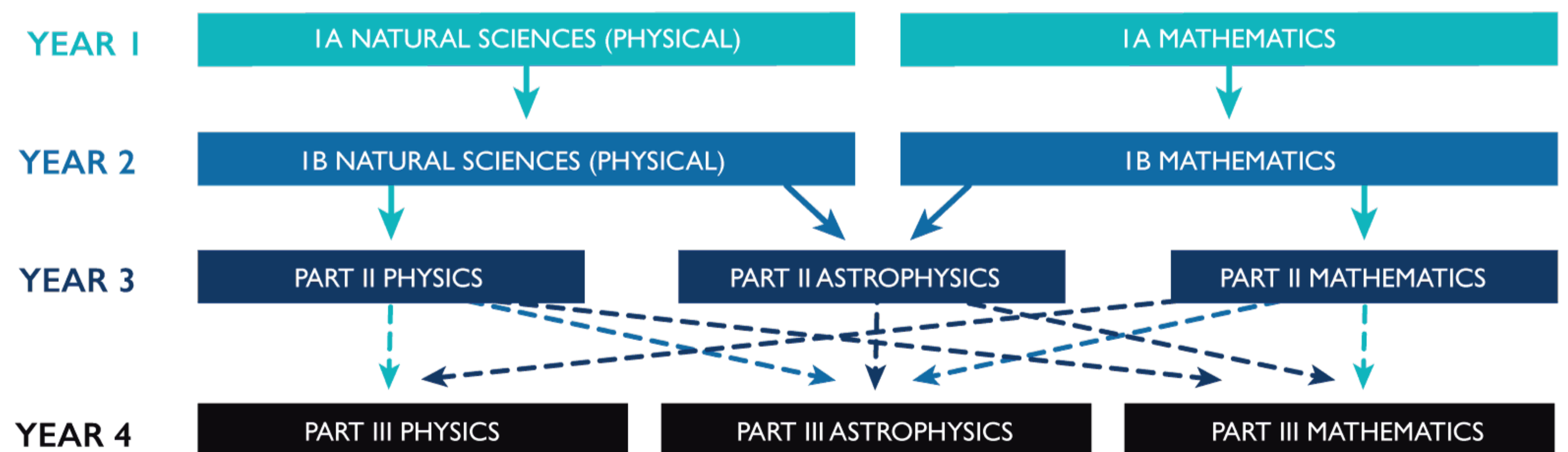


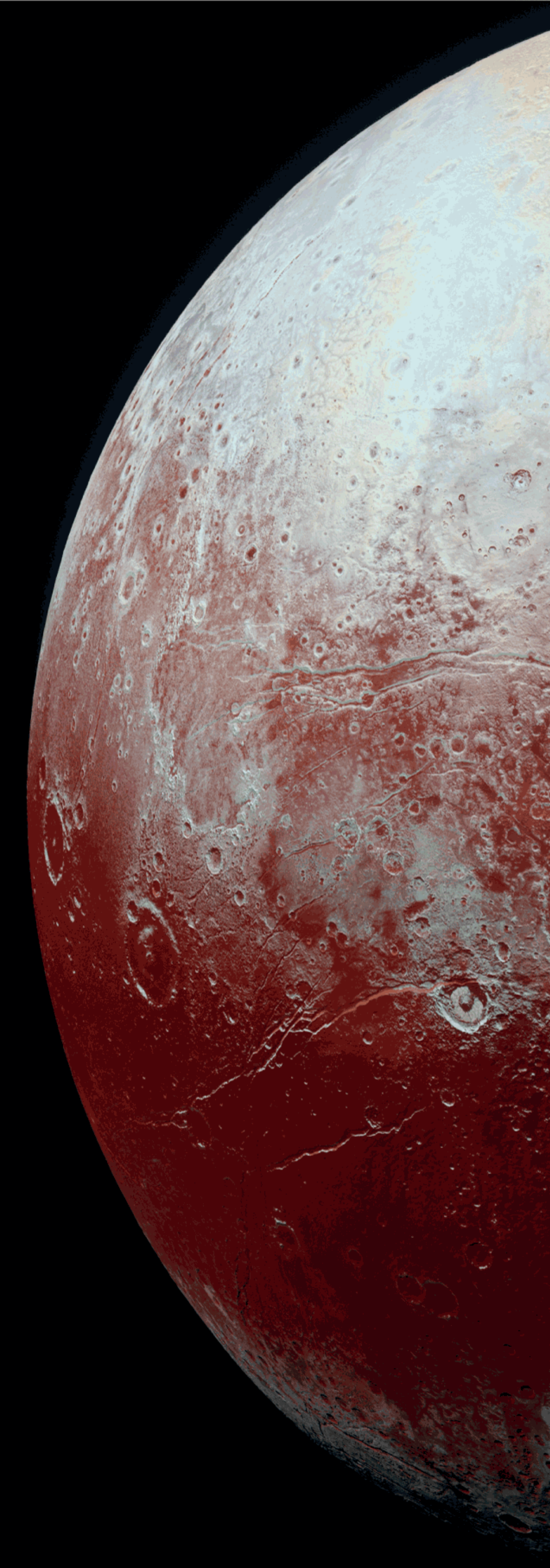
## THE CHOICE: PART II ASTROPHYSICS OR PART II & III ASTROPHYSICS?

Students usually enter Part II Astrophysics on completion of Part IB in either Mathematics or Natural Sciences. Those going on to Part III Astrophysics have normally taken Part II Astrophysics. There is a possibility of changing to Part III Astrophysics from Part II Mathematics or Part II Physics. There is no restriction on entry for Part II Astrophysics, but the number of Part III places is limited to about 30 by the number of potential projects (and project supervisors) available. Preference is given to qualified students who have taken Part II Astrophysics.

All students who proceed to Part III Astrophysics are generally required to complete at least one of the CATAM computer projects organized by the Mathematics Faculty. The computer project work may either be taken for examination credit during the year (in lieu of the extended essay) or, alternatively, completed during the long vacation following completion of Part II. A mark of at least a 50% for the project is required for admission to the Part III course.

It is not necessary for students to decide on whether to apply to go on to take Part III Astrophysics at the time they begin the Part II course. However, a II.I in an appropriate Part II will be required for entry to Part III. In order to be a candidate for honours in Astrophysics in Part III of the Natural Sciences Tripos, a student should have obtained at least a II.I in Astrophysics or Physics in Part II of the Natural Sciences Tripos. Part II Mathematics Tripos students should have obtained at least a II.I and will be considered on a case-by-case basis because it is required that they should have demonstrated a good grasp of at least three appropriate applied mathematics courses in the examination.





## PART II ASTROPHYSICS: COURSE CONTENT

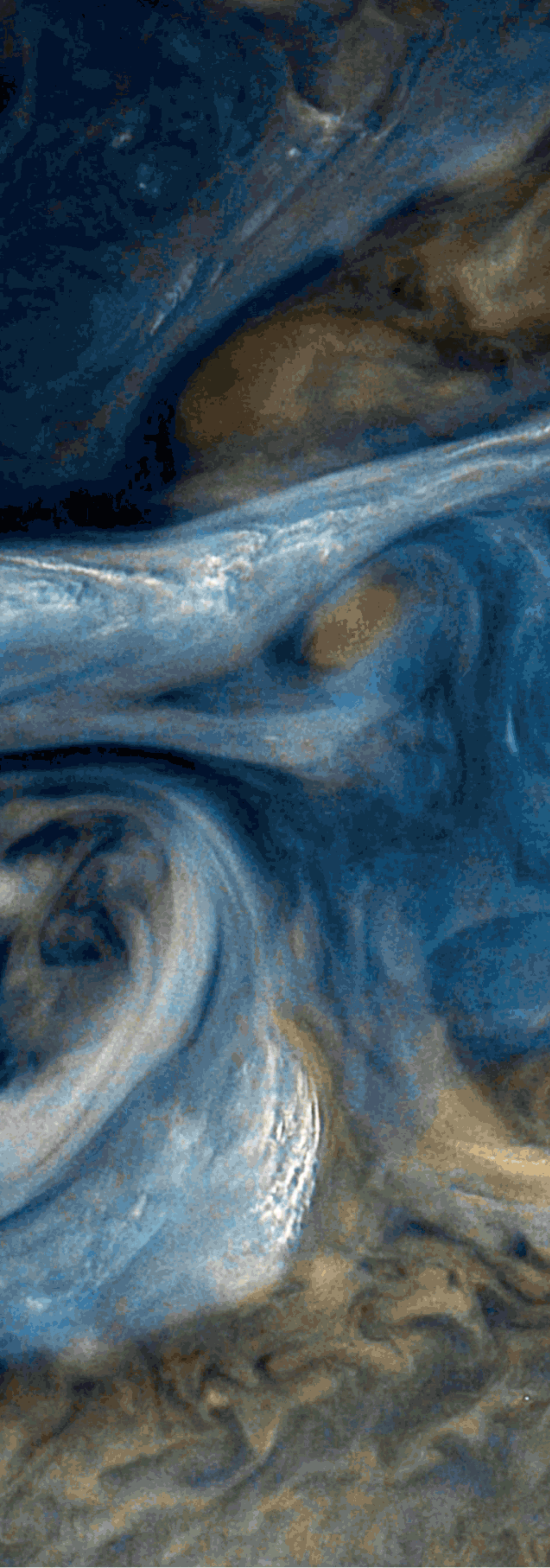
The syllabus includes eight lecture courses split between the Michaelmas and Lent terms. These lecture courses come in two flavours: those which teach the fundamental physics underlying the rest of the course and those which apply these concepts to particular astronomical subject areas.

This year there were four courses in the Michaelmas Term, two on essential physics, Principles of Quantum Mechanics (taught in the Mathematics Department) and Relativity (in the Physics department) plus two courses in astrophysics, Structure and Evolution of Stars and Stellar Dynamics and Structure of Galaxies (both at the IoA). There are four further courses in the Lent term. Topics in Astrophysics plays the dual role of introducing students to a range of exciting topics in contemporary astrophysics, while developing abilities in physical reasoning and order of magnitude estimates in an astronomical context. Statistical Physics (in Mathematics) and Astrophysical Fluid Dynamics continue the essential physics education and Introduction to Cosmology (at the IoA) adds a further course in applied astrophysics.

The style throughout requires minimal memorising of descriptive terminology, and avoids the simple quoting and application of complicated formulae. Rather, lecturers will concentrate on the derivations of fundamentals from first principles, and the teaching of basic understanding. For further details please see the Part II Astrophysics Course Guide.

There is also an examinable coursework component (comprising about 1/8 of the marks) for which students have two options: an extended essay (selected from a list of titles on contemporary research issues, announced in the Michaelmas term) or else the completion of typically two of the CATAM computer projects organised by the Mathematics Faculty, and which include astrophysical options. The projects are aimed at enabling students with a research career in mind to develop the necessary ability to solve various problems by numerical means. Note that although students may freely choose which option to take, any students proceeding to Part III Astrophysics will be required to demonstrate the necessary computing skills, normally by completing at least one CATAM computing project, before commencing Part III; thus any such students who chose the essay as examinable work will need to complete a CATAM project over the summer.

For further details please see the Part II Astrophysics Course Guide.



## PART III ASTROPHYSICS

This course leads to a MSci. degree and is mainly intended as preparation for graduate studies in astrophysics, although the high level of mathematical rigour means that graduates are also highly attractive to employers in other sectors. Lecture courses are taken mainly from the wide selection of astrophysics courses taught, often by Institute of Astronomy staff, as part of the Part III Mathematics and from selected courses from Part III Physics. Students normally take four lecture courses for examination although they often attend a wider range of lectures for interest.

Although most of those taking Part III Astrophysics will have taken Part II Astrophysics, the fact that most Part III Astrophysics and Part III Mathematics lectures (and examinations) are the same, means that for interested Part II Mathematics students of sufficient standard, Part III Astrophysics is an alternative to Part III Mathematics. The main difference is that Part III Astrophysics students take one fewer lecture course (and examination), but must undertake a more substantial project, instead of an Essay. It is also possible in principle, for mathematically-able students who have taken Part II Physics to take Part III Astrophysics (at the discretion of their Director of Studies and of the IoA), provided they have taken the Lent Term option in Astrophysical Fluid Dynamics. Students contemplating the route from either Part II Maths or Part II Physics into Part III Astrophysics should be aware that, in the case of over-subscription, priority will be given to suitably qualified students who have done Part II Astrophysics.

Astrophysics courses currently offered in Part III Mathematics (these change from year to year) include Structure and Evolution of Stars, Astrophysical Fluid Dynamics, Planetary System Dynamics, The Life and Death of Galaxies, Astrophysical Black Holes and Dynamics of Astrophysical Discs. Further details of the courses may be found at the Faculty of Mathematics. Examinations are the same as those taken by students taking Part III Mathematics.

Part III Astrophysics students may also offer the Part III Physics courses (these change from year to year): Physics of the Earth as a Planet, Relativistic Astrophysics and Cosmology, Particle Physics and Exoplanets and Planetary Systems. Further details of the courses may be found at the Department of Physics. Examinations are the same as those taken by students taking Part III Physics.

Students 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 the interdisciplinary courses or Nuclear Power Engineering from Part III Engineering.

A major component of the Part III Astrophysics course (accounting for one third of the marks) is the research project which is supervised by staff at the IoA over the Michaelmas and Lent Terms. This provides undergraduates with a unique opportunity to get to the cutting edge of astronomical research and the resulting dissertation often contains work of publishable quality. Projects often either involve the analysis of astronomical data or the running of computer simulations. In addition, students develop their communication skills through giving an oral presentation on their project.

All Part II students who proceed to Part III Astrophysics, but who offered an extended essay for examination in lieu of computer projects organized by the Mathematical Faculty, must submit (no later than 1 September prior to commencing Part III Astrophysics) a project of at least 8 units from a selection provided by the IoA CATAM advisor.

For further details please see the Part III Astrophysics Course Guide.



## FREQUENTLY ASKED QUESTIONS

### **How mathematical is the Part II Astrophysics course - would the average physicist cope?**

The Part II Astrophysics course is somewhat more mathematical than Part II Physics and thus may involve some adjustment by students from a physics background during the first term of the course. Nevertheless we find that some of our most mathematically rigorous courses are among the most popular and successful courses for students from all backgrounds.

### **Mathematicians and physicists entering Part II Astrophysics have different skills and have done different courses in Part IB - so how does this work?**

Both mathematicians and physicists will meet both familiar and unfamiliar material. For example mathematicians may be familiar with some of the topics covered in the Astrophysical Fluid Dynamics course and physicists will likewise have met some material in the Statistical Physics course. The differences in approach of mathematics and physics students are addressed in supervisions: physicists learn greater confidence with mathematics whilst mathematicians are encouraged to develop more physically intuitive ways of looking at problems. In practice, the differences between former mathematicians and former Nat. Scis. are much less pronounced by the end of the year.

### **Will I learn less fundamental physics than in Part II/ Part III physics?**

The key thing here is that you will learn different physics (with some overlap, of course) with the physics emphasised being that which is most relevant to astronomical rather than terrestrial contexts. Thus you'll learn considerably more dynamics but considerably less about solid state physics than in the physics course.

### **Do I restrict my options by doing Part II Astrophysics?**

Inevitably, yes: any specialisation closes some doors and opens others. In practice this means that any student contemplating postgraduate research in another branch of physics (such as condensed matter) should remain in the Physics Tripos.

### **Are there any practicals or opportunities to use telescopes?**

There is currently no practical component of the course, although we review this issue regularly in consultation with the students. The IoA however houses a number of telescopes, including the historic Northumberland and Thorrowgood telescopes, and students are encouraged to join CUAS, who provide training in the use of these telescopes as well as organising a programme of entertaining astronomical lectures, and to participate in public outreach.

### **How difficult is the Part II course?**

Part II Astrophysics should not be regarded as a soft option and it is found to be challenging to mathematicians and physicists alike. On the other hand, students on average advance a class in Tripos between their Part I and Part II Astrophysics result, suggesting that the majority of students rise to this challenge. More dramatic changes in class (e.g. III  $\rightarrow$  I) are not unknown, as students are inspired by the course content and rediscover their scientific curiosity. Due to the small class size, exams are not marked to conform to a standard mark distribution which therefore varies greatly from year to year according to the enthusiasms and abilities of the student cohort.



## FREQUENTLY ASKED QUESTIONS *continued*

### **How difficult is the Part III course?**

The taught component of Part III Astrophysics derives from Part III Maths and so one should not underestimate the pace and mathematical rigour of the course. On the other hand, our selection procedure for this course means that the students who go on to Part III Astrophysics appear to be well-equipped for the course, judging by their Part III results (to date the great majority have obtained 2.1s and Firsts).

### **Can I study astrophysics within the Mathematics and Physics Triposes?**

The answer is yes in both cases. For mathematicians there are two Part II courses covering astrophysical topics (Cosmology and General Relativity), with a wide range of topics at the Part III level. Physicists take a Relativity course in the Michaelmas Term and can opt to take the IoA's Astrophysical Fluid Dynamics course as a Lent Term option (the latter is shared with Part II Astrophysics). In Part III Physics, students may take a major option and some minor options in Part III that are astronomically related, as well as having the opportunity to do some astronomically related project work. The breadth and depth of astrophysical courses offered in Part III Physics is in some cases less than in Part III Astrophysics (or Mathematics) but, as a trade-off, students obtain a better grounding in non-astronomically related physics at the Part III level.

### **Can I make non-standard transitions between Mathematics and Astrophysics and Physics at the Part III level?**

Maybe, but this is a matter for discussion with your Director of Studies and the departments involved. In general, transitions between Mathematics and Astrophysics at the Part II to Part III level are straightforward in either direction for qualified students. Transfers between Physics and Astrophysics after three years are now possible for suitably qualified students who have taken the Astrophysical Fluid Dynamics option in the Lent Term of Part II Physics. In addition, such students will be expected to complete a CATAM computing project over the summer. Those wishing to transfer into Astrophysics at the Part III level should note that, in the case of over-subscription, priority will be given to those coming from Part II Astrophysics. Transfers between Part II Astrophysics and Part III Physics are not encouraged.

### **What do people do after Part II and Part III Astrophysics?**

The destinations of Astrophysics graduates after Cambridge are very varied. Many have proceeded to PhDs in astronomy; in recent years, most of our students taking this path have taken the Part III Astrophysics course, which is regarded as an elite qualification by astronomy departments both in Cambridge and elsewhere in the U.K. A number of students have also gone on to acquire a range of (non astronomy related) further qualifications that build on the solid mathematical skills acquired in Part II Astrophysics. Astrophysics degrees also equip graduates for a range of non academic jobs, including teaching, software development, financial services and accountancy. Our graduates include investment bankers, business analysts, workers in the media and a vicar. In the words of an alumnus from 1996/1997 “...having ‘Astrophysics Cambridge’ on one’s CV certainly opens a lot of doors!”

AND ON PART III

"A very enjoyable course and well organised."

"I have had a wonderful year and thoroughly enjoyed the course."

"Department is great. Very welcoming. Completely comprehensive access to facilities. Often attended seminars and colloquia. The staff are all very approachable and keen to help if they can"

"I think the IoA staff and facilities are amazing. It was very easy to see people and I really felt welcomed into the department. It is a lovely environment to work in and if anything was going to convince me into further study it would have been the people and atmosphere at the IoA."

## HOW TO APPLY

### Part IB to Part II Astrophysics

#### Students entering Part II via the Natural Sciences Tripos

In the Easter Term, all part IB NST students will be asked to complete an online form detailing which department they wish to study with in Part II as part of the Part II subject allocation process. Once the allocations have been made, students will be notified by the NST Co-ordinator, who will also advise the College Tutorial Office to finalise the transfer on CamSIS.

#### Students entering Part II via the Mathematical Tripos

Students wishing to enrol for Part II Astrophysics must seek the approval of their Director of Studies, who will then advise the College Tutorial Office to finalise the transfer on CamSIS.

It is helpful for the Institute of Astronomy to know of your intention to take the course by the end of the previous Easter term so we can keep you informed of introductory lectures and arrange supervisions in good time.

### Part II to Part III Astrophysics

Those taking Part II Astrophysics will be asked to confirm whether they intend on taking Part III Astrophysics in Lent Term. A student with a II.I may proceed automatically to Part III. A student who fails to get a II.I may request consideration as a special case.

Those taking Part II Mathematics or Part II Physics who are interested in taking Part III Astrophysics in their 4th year should contact the Institute of Astronomy's Undergraduate Co-ordinator as early as possible preferably no later than the end of the previous Easter. Each application will be considered individually following the release of Part II results; a minimum of a II.I is required. Candidates from Mathematics are expected to have scored alphas in at least three different theoretical physics courses. Candidates may also be asked to attend interview.

Any requests for further information should be directed to Professor Christopher Tout ([cat@ast.cam.ac.uk](mailto:cat@ast.cam.ac.uk)) or to the Undergraduate Co-ordinator ([undergraduate.admin@ast.cam.ac.uk](mailto:undergraduate.admin@ast.cam.ac.uk)).

## AND FINALLY...

We end with some quotes made by our Part II students over the last decade, which we selected from many in similarly enthusiastic vein:

*"Though hard at times, I'm very glad I chose to study this as my third year option and have really enjoyed the course content and also the atmosphere of the department: the friendliness and relaxed atmosphere have made it even more enjoyable"*

*"...now doing a PhD in Astrophysics. The Institute provided me with the academic background I needed. It also provided me with great inspiration and motivation"*

*"The course was fantastic and more than lived up to my expectations, and the IoA is a really cool place"*

*"I think I cannot praise it much higher than to say that if the rest of my time at Cambridge had been like this year than I might not be leaving. I think the course is a credit to the people involved with it...I have enjoyed it and had my interest re-ignited, something I feared had been killed off for good"*