School of Physics & Astronomy

General degree students wishing to enter 3000-level modules and non-graduating students wishing to enter 3000-level, 4000-level or 5000-level modules must consult with the relevant Honours Adviser within the School to confirm they are permitted to enter the module.

Astronomy (AS) modules

AS3013 Computational Astrophysics

SCOTCAT Credits:	15	SCQF Level 9	**Semester:**	2
Academic year:	2017/8 & 2018/9			
Planned timetable:	2.00 pm - 5.30 pm Mon and Thu (TBC)			

The aim of this module is to introduce students to computational methods in astrophysics. Based on a general introduction to the programming language Fortran-90, students are shown how to apply simple numerical algorithms to calculate integrals, iteratively find the roots of non-linear equations, solve systems of ordinary differential equations, and to develop tools for statistical data analysis. Further emphasis is put on the development of skills to make convincing plots from the calculated data. The practical exercises include applications to the initial mass function in star formation, the calculation of orbits for N-body gravitational problems and in mean galactic potentials, and planet transition light-curves. Students gain experience with the basics of numerical accuracy, and the development of problem-solving algorithms in general.

Programme module type:	Compulsory for Astrophysics Optional for Physics, Theoretical Physics, Physics and Mathematics, Theoretical Physics and Mathematics	
Pre-requisite(s):	PH2011, PH2012, MT2001 or (MT2501 and MT2503)	
Learning and teaching methods and delivery:	**Weekly contact**: 2 x 3.5-hour supervised or taught sessions (x 10 weeks). Mostly hands-on guided work on computers, but with occasional presentation.	
	Scheduled learning: 70 hours	**Guided independent study:** 80 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%	
	As used by St Andrews: Coursework (practical work, the submission of computer code and computational solutions to given problems) = 100%	
Re-assessment pattern:	No Re-assessment available - laboratory based	
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.	
Module coordinator:	Dr P Woitke	
Module teaching staff:	Dr P Woitke, Dr M Dominik, Dr H S Zhao, Prof K Horne	

AS4010 Extragalactic Astronomy

SCOTCAT Credits:	15	SCQF Level 10	**Semester:**	1
Academic year:	2017/8 & 2018/9			
Planned timetable:	12.00 noon Mon, Tue, Thu (TBC)			

This module introduces the basic elements of extragalactic astronomy. This includes the morphological, structural and spectral properties of elliptical, spiral, quiescent and star-forming galaxies. We study how galaxy populations change from the distant galaxies in the early Universe into those observed in our local neighbourhood, including the coincident growth of super massive black holes at the centres of massive galaxies. Galaxy formation theory is introduced in relation to the growth of structure in a cold-dark matter Universe, and galaxy evolution in regions of high and low density is investigated. The module includes a look at modern instrumentation used in extragalactic astrophysics. Specialist lecturers from within the galaxy evolution research group will provide a direct link between material learnt in lectures and research currently being undertaken at the University of St Andrews.

Programme module type:	Compulsory for Astrophysics BSc and MPhys Optional for Physics, Theoretical Physics, Physics and Mathematics, Theoretical Physics and Mathematics	
Pre-requisite(s):	AS2001 or AS2101, PH2011, PH2012, MT2001 or (MT2501 and MT2503)	
Anti-requisite(s):	AS4022 Cosmology and AS3011 Galaxies	
Required for:	AS5003 unless other pre-requisites for that module met.	
Learning and teaching methods and delivery:	**Weekly contact**: 3 lectures occasionally replaced by tutorials	
	Scheduled learning: 30 hours	**Guided independent study:** 120 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 90%, Practical Examinations = 0%, Coursework = 10%	
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework (10% Class Test, 10% Essay) = 20%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.	
Module coordinator:	Dr V Wild	
Module teaching staff:	Dr V Wild	

AS4011 The Physics of Nebulae and Stars 1

SCOTCAT Credits:	15	SCQF Level 10	**Semester:**	1
Academic year:	2017/8 & 2018/9			
Planned timetable:	10.00 am Tue, Wed, Thu (TBC)			

This module introduces the physics of astrophysical plasmas, as found in stars and interstellar space, where interactions between matter and radiation play a dominant role. A variety of absorption, emission, and scattering processes are introduced to describe exchanges of energy and momentum, which link up in various contexts to control the state and motion of the matter, to regulate the flow of light through the matter, and to impress fingerprints on the emergent spectrum. The theory is developed in sufficient detail to illustrate how astronomers interpret observed spectra to infer physical properties of astrophysical plasmas. Applications are considered to photo-ionise nebulae, interstellar shocks, nova and supernova shells, accretion discs, quasar-absorption-line clouds, radio synchrotron jets, radio pulsars, and x-ray plasmas. Monte-Carlo computational techniques are introduced to model radiative transfer.

Programme module type:	Compulsory for Astrophysics MPhys At least 2 of AS4011, AS4012, AS4015, AS4021, AS4025, PH4031 are compulsory for Astrophysics BSc Optional for Astrophysics, Physics BSc Optional for Physics, Theoretical Physics, Physics and Mathematics, Theoretical Physics and Mathematics MPhys		
Pre-requisite(s):	AS2001 or AS2101, PH2011, PH2012, MT2001 or (MT2501 and MT2503), PH3081 or PH3082 or MT2003 or (MT2506 and MT2507)		
Anti-requisite(s):	AS4023, AS3015	**Required for:**	AS4012
Learning and teaching methods and delivery:	**Weekly contact**: 3 lectures occasionally replaced by whole-group tutorials.		
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%		
	As used by St Andrews: 2-hour Written Examination = 75%, Coursework = 25%		
Re-assessment pattern:	Oral Re-assessment, capped at grade 7		
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.		
Module coordinator:	Dr K Wood		
Module teaching staff:	Dr K Wood		

AS4012 The Physics of Nebulae and Stars 2

SCOTCAT Credits:	15	SCQF Level 10	**Semester:**	2
Academic year:	2017/8 & 2018/9			
Planned timetable:	11.00 am odd Mon, Wed, Fri, 3.00 pm even Tue (TBC)			

This module develops the physics of stellar interiors and atmospheres from the basic equations of stellar structure introduced in AS2001/AS2101 using the radiative transfer concepts developed in Nebulae and Stars I. Topics include: the equation of state that provides pressure support at the high temperatures and densities found in normal and white-dwarf stars; the interaction of radiation with matter, both in terms of radiation-pressure support in super-massive stars and in terms of the role of opacity in controlling the flow of energy from the stellar interior to the surface; the equation of radiative transfer and the effects of local temperatures, pressures and velocity fields on the continuum and line absorption profiles in the emergent spectrum. Computer-aided tutorial exercises illustrate the computational schemes that represent one of the triumphs of late twentieth-century physics, in their ability to predict the observable properties of a star from its radius and luminosity, which in turn are determined by its mass, age and chemical composition.

Programme module type:	Compulsory for Astrophysics MPhys At least 2 of AS4011, AS4012, AS4015, AS4021, AS4025, PH4031 are compulsory for Astrophysics BSc Optional for Physics, Theoretical Physics, Physics and Mathematics, Theoretical Physics and Mathematics		
Pre-requisite(s):	AS4011	**Anti-requisite(s):**	AS4023, AS3015
Learning and teaching methods and delivery:	**Weekly contact**: 3 lectures occasionally replaced by whole-group tutorials.		
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%		
	As used by St Andrews: 2-hour Written Examination = 75%, Coursework = 25%		
Re-assessment pattern:	Oral Re-assessment, capped at grade 7		
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.		
Module coordinator:	Prof A C Cameron		
Module teaching staff:	Prof A C Cameron, Dr P Woitke		

AS4015 Gravitational and Accretion Physics

SCOTCAT Credits:	15	SCQF Level 10	**Semester:**	2
Academic year:	2017/8 & 2018/9			
Planned timetable:	9.05 am - 12.00 noon Mon, Wed, Fri			

This theoretical module is open to both physics and astrophysics students. It aims to explore the basics of gravitational dynamics and its application to systems ranging from planetary and stellar systems to clusters of galaxies. The dynamics responsible for the growth of super-massive black holes in galaxies and the accretion discs in stellar systems are also covered. Starting from two-body motion and orbits under a central-force law, the module describes the calculation of extended potentials and their associated orbits. The use of the virial theorem and the statistical treatment of large numbers of selfgravitating bodies is then developed with application to stellar systems. Applications of these methods are made to several different astrophysical objects ranging from collisions in globular clusters to the presence of dark matter in the universe.

Programme module type:	At least 2 of AS4015, AS4025, PH4031 are compulsory for Astrophysics MPhys At least 2 of AS4011, AS4012, AS4015, AS4021, AS4025, PH4031 are compulsory for Astrophysics BSc Optional for Physics, Theoretical Physics, Physics and Mathematics, Theoretical Physics and Mathematics	
Pre-requisite(s):	PH2011, PH2012, MT2001 or (MT2501 and MT2503), (PH3081 or PH3082 or MT2003 or [MT2506 and MT2507])	
Learning and teaching methods and delivery:	**Weekly contact**: 3 lectures occasionally replaced by whole-group tutorials.	
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%	
	As used by St Andrews: 2-hour Written Examination = 100%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.	
Module coordinator:	Prof I Bonnell	
Module teaching staff:	Prof I Bonnell	

AS4025 Observational Astrophysics

SCOTCAT Credits:	15	SCQF Level 10	**Semester:**	1
Academic year:	2017/8 & 2018/9			
Planned timetable:	2.00 pm - 5.30 pm Mon and Thu, plus some nights. (TBC)			
This is an observational and laboratory-based module that introduces students to the hands-on practical aspects of planning observing programmes, conducting the observations and reducing and analysing the data. Students use the James Gregory Telescope for CCD imaging and structural analysis of galaxies, and for CCD photometry of transiting exoplanet candidates. Further sources of data may be made available from international observatories. Observations are also secured at the University Observatory using a student-built radio telescope to observe low-frequency radio emission from the Galactic plane. Students gain experience in observation, data analysis, the UNIX operating system, standard astronomical software packages and modelling, and report writing.				
Programme module type:	At least 2 of AS4011, AS4012, AS4015, AS4021, AS4025, PH4031 are compulsory for Astrophysics BSc Optional for Astrophysics, Physics, Theoretical Physics, Physics and Mathematics, Theoretical Physics and Mathematics			
Pre-requisite(s):	AS2001 or AS2101, PH2011, PH2012, (MT2001 or [MT2501 and MT2503])			
Learning and teaching methods and delivery:	**Weekly contact**: 2 x 3.5-hour laboratories plus supervised work in the observatory.			
	Scheduled learning: 78 hours		**Guided independent study:** 72 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available - laboratory based			
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.			
Module coordinator:	Dr C Cyganowski			
Module teaching staff:	Dr C Cyganowski, Prof A Cameron, Prof K Horne			

AS4103 Astrophysics Project (BSc)

SCOTCAT Credits:	30	SCQF Level 10	**Semester:**	Whole Year
Academic year:	2017/8 & 2018/9			
Availability restrictions:	Available only to BSc Astrophysics students, and normally only in their final year.			
Planned timetable:	Half time in second semester, plus some preparation in first semester.			

The project aims to develop students' skills in searching the physics literature and in experimental design, the evaluation and interpretation of data, and in the presentation of results. The main project is preceded by a pre-project report on a topic which is usually related to the theme of the project. There is no specific syllabus for this module. Students taking the BSc degree select a project from a list offered, and are supervised by a member of staff. Project choice and some preparatory work is undertaken in semester one, but normally most of the 30 credits' worth of work is undertaken in semester two.

The aim is that students provide the intellectual drive for the project work, and should take on a role similar to that of a research student in the School. Support will be offered by the academic staff member(s) supervising the project and usually also by other members of a research team. Many projects will be carried out in the School's research labs, but other arrangements are possible. A pre-project report precedes the experimental/computational/theoretical work of the project, and is expected to be directly relevant to the subsequent experimental studies.

Programme module type:	Compulsory for Astrophysics BSc	
Pre-requisite(s):	PH2011, PH2012, MT2001 or (MT2501 and MT2503), (PH3081 or PH3082 or [MT2003 or (MT2506 and MT2507)]), AS3013, PH3081, PH3012 Entry to final year of BSc Astrophysics programme.	
Anti-requisite(s):	AS5101, PH4111, PH5101, PH5103, PH4796	
Learning and teaching methods and delivery:	**Weekly contact**: Project students work "half-time" on their project through semester 2. All students must meet weekly with their project supervisor and attend fortnightly meetings with their peer-support group. Most projects are based in computer clusters in the School, where students can benefit from peer support and informal interaction with academic supervisor and other members of research teams. It is expected that the 20 hours a week will be primarily in this environment.	
	Scheduled learning: 18 hours	**Guided independent study:** 282 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%	
	As used by St Andrews: Coursework (Review Article, Project Report, Presentation and Oral Examination) = 100%	
Re-assessment pattern:	No Re-assessment available - Final year project	
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.	
Module coordinator:	Dr C Cyganowski	
Module teaching staff:	Dr C Cyganowski with others	

AS5001 Advanced Data Analysis

SCOTCAT Credits:	15	SCQF Level 11	**Semester:**	1
Academic year:	2017/8 & 2018/9			
Availability restrictions:	This module is intended for students in the final year of an MPhys or MSci programme involving the School			
Planned timetable:	9.00 am Tue, Thu, 10.00 am Mon, 12.00 noon Thu and 3.00 pm - 5.00 pm Tue (Lab) (TBC)			
This module develops an understanding of basic concepts and offers practical experience with the techniques of quantitative data analysis. Beginning with fundamental concepts of probability theory and random variables, practical techniques are developed for using quantitative observational data to answer questions and test hypotheses about models of the physical world. The methods are illustrated by applications to the analysis of time series, imaging, spectroscopy, and tomography datasets. Students develop their computer programming skills, acquire a data analysis toolkit, and gain practical experience by analyzing real datasets.				
Programme module type:	At least two of AS5001, AS5002, and AS5003 are compulsory for MPhys Astrophysics Optional for Physics MPhys, Theoretical Physics, Theoretical Physics and Mathematics			
Pre-requisite(s):	Familiarity with scientific programming language essential, for example through AS3013 or PH3080. Entry to an MPhys programme in the School.			
Learning and teaching methods and delivery:	**Weekly contact**: 3 lectures or tutorials and some supervised computer lab sessions			
	Scheduled learning: 42 hours		**Guided independent study:** 108 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available - laboratory based			
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.			
Module coordinator:	Prof K Horne			
Module teaching staff:	Prof K Horne			

AS5002 Magnetofluids and Space Plasmas

SCOTCAT Credits:	15	SCQF Level 11	**Semester:**	1
Academic year:	2017/8 & 2018/9			
Availability restrictions:	This module is intended for students in the final year of an MPhys or MSci programme involving the School			
Planned timetable:	11.00 am Mon, Tue, Thu (TBC)			

This module is aimed at both physics and astrophysics students with interests in the physics of plasmas. The interaction of a magnetic field with an ionized gas (or plasma) is fundamental to many problems in astrophysics, solar- terrestrial physics and efforts to harness fusion power using tokamaks. The syllabus comprises: Solar-like magnetic activity on other stars. The basic equations of magneto-hydrodynamics. Stellar coronae: X-ray properties and energetics of coronal loops. Energetics of magnetic field configurations. MHD waves and propagation of information. Solar and stellar dynamos: mean field models. Star formation: properties of magnetic cloud cores, magnetic support. Physics of accretion discs: transport of mass and angular momentum. Accretion on to compact objects and protostars. Rotation and magnetic fields in protostellar discs. Rotation distributions of young solar-type stars. Magnetic braking via a hot, magnetically channelled stellar wind.

Programme module type:	At least two of AS5001, AS5002, and AS5003 must be taken for MPhys Astrophysics Optional for Physics MPhys, Theoretical Physics, Theoretical Physics and Mathematics	
Pre-requisite(s):	(PH3007 or MT4510 or MT4553) AND (AS3013 or PH4030 or PH3080 or AS3013 or MT3802 or MT4112)	
Learning and teaching methods and delivery:	**Weekly contact**: 3 lectures or tutorials.	
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%	
	As used by St Andrews: 2-hour Written Examination = 100%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.	
Module coordinator:	Prof M M Jardine	
Module teaching staff:	Prof M M Jardine	

AS5003 Contemporary Astrophysics

SCOTCAT Credits:	15	SCQF Level 11	**Semester:**	1
Academic year:	2017/8 & 2018/9			
Availability restrictions:	Available only to MPhys Astronomy students or a taught postgraduate programme in the School.			
Planned timetable:	12.00 noon Wed, Fri and 3.00 pm Mon (TBC)			
This module will provide an annual survey of the latest, most interesting, developments in astronomy and astrophysics at the research level. Emphasis will be placed upon the application of knowledge and expertise gained by students in their other modules to these current research topics.				
Programme module type:	At least two of AS5001, AS5002, and AS5003 are compulsory for MPhys Astrophysics			
Pre-requisite(s):	AS4010, AS4012, PH3061, PH3081.			
Learning and teaching methods and delivery:	**Weekly contact**: 3 lectures and tutorials			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 100%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.			
Module coordinator:	Dr H Zhao			
Module teaching staff:	Dr H Zhao, Dr A Mortier, Dr D Forgan			

AS5101 Astrophysics Project (MPhys)

SCOTCAT Credits:	60	SCQF Level 11	**Semester:**	Whole Year
Academic year:	2017/8 & 2018/9			
Availability restrictions:	Available only to final year MPhys Astronomy students			
Planned timetable:	Full time in second semester, plus some preparation in first semester.			

The project aims to develop students' skills in searching the appropriate literature, in experimental and observational design, the evaluation and interpretation of data, and the presentation of a report. The main project is preceded by a pre-project report. There is no specific syllabus for this module. Students taking the MPhys degree select a project from a list of those which are available, and are supervised by a member of the academic staff. Project choice and some preparatory work is undertaken in semester one, but normally most of the 60 credits' worth of work is undertaken in semester two.

The aim is that students provide the intellectual drive for the project work, and should take on a role similar to that of a research student in the School. Support will be offered by the academic staff member(s) supervising the project and sometimes also by other members of a research team. Many projects will be carried out in one of the astronomy computing clusters, but other arrangements are possible. A pre-project report precedes the experimental/computational/theoretical work of the project, and is expected to be directly relevant to the subsequent experimental studies.

Programme module type:	Compulsory for Astrophysics MPhys	
Pre-requisite(s):	PH2011, PH2012, (PH3081 or PH3082 or (MT2003 or (MT2506 and MT2507), AS3013, AS4012, Entry to final year MPhys Astronomy	
Anti-requisite(s):	AS4103, PH4111, PH5101, PH5103, PH4796	
Learning and teaching methods and delivery:	**Weekly contact**: Project students work "full-time" on their MPhys project through semester 2. All students must meet weekly with their project supervisor and attend fortnightly meetings with their peer-support group. Most projects are based in astronomy computer clusters in the School, where students can benefit from peer support and informal interaction with academic supervisor and other members of research teams. It is expected that the 40 hours a week will be primarily in this environment.	
	Scheduled learning: 21 hours	**Guided independent study:** 579 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%	
	As used by St Andrews: Coursework = 100%	
Re-assessment pattern:	No Re-assessment available - Final year project	
Additional information from School:	Please see also the information in the School's Handbook for Honours modules available via https://www.st-andrews.ac.uk/physics/staff_students/timetables.php This link also gives access to timetables for the modules.	
Module coordinator:	Dr C Cyganowski	
Module teaching staff:	Dr C Cyganowski with others	