1. **Title of the module**

PHYS5070 (PH507) - The Multiwavelength Universe and Exoplanets

1. **School or partner institution which will be responsible for management of the module**

Physical Sciences

1. **The level of the module (Level 4, Level 5, Level 6 or Level 7)**

Level 5

1. **The number of credits and the ECTS value which the module represents**

15 credits (7.5 ECTS)

1. **Which term(s) the module is to be taught in (or other teaching pattern)**

Spring

1. **Prerequisite and co-requisite modules**

None

1. **The programmes of study to which the module contributes**

BSc/BSc with Year in Industry/BSc with Foundation Year/MPhys/MPhys with Year Abroad Physics (Optional)

BSc/ BSc with Year in Industry/MPhys/MPhys with Year Abroad Physics with Astrophysics

BSc/ BSc with Year in Industry/MPhys/MPhys with Year Abroad Astronomy Space Science and Astrophysics

This is not available as a wild module.

1. **The intended subject specific learning outcomes.
On successfully completing the module students will be able to:**
	1. Demonstrate knowledge and understanding of physical laws and principles of astronomy, astrophysics and space science, and their application to diverse areas of physics.
	2. Demonstrate knowledge and understanding of aspects of the theory and practice of astronomy, astrophysics and space science, and of those aspects upon which astronomy, astrophysics and space science depends.
	3. Identify relevant principles and laws when dealing with problems in astronomy, astrophysics and space science, and to make approximations necessary to obtain solutions.
	4. Solve problems in astronomy, astrophysics and space science using appropriate mathematical tools.
	5. Use mathematical techniques and analysis to model physical behaviour within astronomy, astrophysics and space science.
	6. Comment critically on how spacecraft are designed, their principles of operation, and their use to access and explore space, and on how telescopes (operating at various wavelengths) are designed, their principles of operation, and their use in astronomy and astrophysics research.
	7. Present and interpret astronomical, astrophysical and space science information graphically.
	8. Make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning.
2. **The intended generic learning outcomes.
On successfully completing the module students will be able to:**
	1. Solve problems, in the context of both problems with well-defined solutions and open-ended problems; an ability to formulate problems in precise terms and to identify key issues, and the confidence to try different approaches in order to make progress on challenging problems. Numeracy is subsumed within this area.
	2. Use analytical skills – associated with the need to pay attention to detail and to develop an ability to manipulate precise and intricate ideas, to construct logical arguments and to use technical language correctly.
3. **A synopsis of the curriculum**

Aims: To provide a basic but rigorous grounding in observational, computational and theoretical aspects of astrophysics to build on the descriptive course in Stage 1, and to consider evidence for the existence of exoplanets in other Solar Systems.

Telescopes and detectors:

Radio telescopes; detection of radio waves, heterodyne receivers, bolometers; Optical/NIR Telescopes and detectors; basic band gap theory; CCD cameras; bias, dark and flatfield calibration frames and data reduction; Stellar Photometry: Factors affecting signal from a stars; atmospheric absorption and scattering; Filters; UBV system; Colour Index as temperature diagnostic.

Basic stellar properties:

Mass measurements: Kepler’s laws; solar system; binary stars; Visual binaries; Eclipsing binaries, Spectroscopic binaries; Introduction to the Hertzsprung-Russel diagram; spectroscopic parallax Introduction to star formation: Molecular clouds; Jeans criterion for collapse; Protostars; T-Tauri stars; Contraction onto the Main Sequence; Heyney and Hayashi Tracks; Stellar spectral classification: Basic stellar properties; back body radiation; stellar spectra; radiative transfer in stellar atmospheres

Stellar Structure:

equation of hydrostatic support; Virial theorem; central pressure; mean temperature; astrophysical time scales; equations of energy generation and transportation; convective vs radiative energy transport;

Extra Solar Planets

Detection Methods; Direct Detection; Radial velocity technique; Transit method; Microlensing and direct imaging; the population of exoplanet systems, Metallicity, Eccentricity, Core Accretion and Gravitational Instability

Galaxies:

Introduction to Galaxies; Hubble classification; the Milky Way; Spirals; Dark matter; Ellipticals; Irregulars; luminosity functions; Galaxy Clusters, distributions and physical processes; The Hubble Constant, Evolution, Mergers, Star Formation History; Quasars, Seyferts and Radio Galaxies

1. **Reading list (Indicative list, current at time of publication. Reading lists will be published annually)**
* An Introduction to Modern Astrophysics (Jul 2013), by Bradley W. Carroll and Dale A. Ostlie,
* Berry, Principles of Cosmology and Gravitation, Adam Hilger [QB891]
* Roos, Introduction to Cosmology, Wiley [QB891]
* Cosmological Physics; Peacock, J.A (1999)
1. **Learning and teaching methods**

Total contact hours: 36

Private study hours: 114

Total study hours: 150

1. **Assessment methods**
	1. Main assessment methods

Take-home Test 1 (10 hrs, 15%)

Take-home Test 2 (10 hrs, 15%)

Examination (2hrs, 70%)

13.2 Reassessment methods

Like-for-like

1. **Map of module learning outcomes (sections 8 & 9) to learning and teaching methods (section12) and methods of assessment (section 13)**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Module learning outcome** | *8.1* | *8.2* | *8.3* | *8.4* | *8.5* | *8.6* | *8.7* | *8.8* | *9.1* | *9.2* |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |  |  |
| Private Study | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| Lectures | **x** | **x** | **x** |  |  | **x** |  |  | **x** | **x** |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |
| Take-Home Tests | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** | **x** |
| Exam | **x** | **x** | **x** | **x** | **x** | **x** | **x** |  | **x** | **x** |

1. **Inclusive module design**

The School recognises and has embedded the expectations of current equality legislation, by ensuring that the module is as accessible as possible by design. Additional alternative arrangements for students with Inclusive Learning Plans (ILPs)/declared disabilities will be made on an individual basis, in consultation with the relevant policies and support services.

The inclusive practices in the guidance (see Annex B Appendix A) have been considered in order to support all students in the following areas:

a) Accessible resources and curriculum

b) Learning, teaching and assessment methods

1. **Campus(es) or centre(s) where module will be delivered**

Canterbury

1. **Internationalisation**

Physics is an international subject with physical laws discovered and techniques developed and refined by Physicists across the globe. Mastery of the subject-specific learning outcomes, will equip students to apply the theories and techniques of this module in a wide range of international contexts. The module team is drawn from the School of Physical Sciences, which includes many members of staff with international experience of teaching and research collaboration. In compiling the reading list, consideration has been given to the range of texts that are available internationally and a selection of texts has been identified to complement the delivery of the material. The support SPS provides to its students is also internationally attuned given our international student body.

**FACULTIES SUPPORT OFFICE USE ONLY**

**Revision record – all revisions must be recorded in the grid and full details of the change retained in the appropriate committee records.**

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| Date approved | Major/minor revision | Start date of the delivery of revised version | Section revised | Impacts PLOs (Q6&7 cover sheet) |
| 10/07/2019 | Minor | January 2020 | 10, 13 |  |
|  |  |  |  |  |