School of Computing, Engineering and Physical Sciences

# Astronomy
# by Distance Learning

**BSc (Hons) in Astronomy**
**Diploma of Higher Education in Astronomy**

**Certificate of Higher Education in Astronomy**

**University Certificates** in:
Astronomy, Cosmology,

Sun, Earth and Climate, Astrobiology

## Module Catalogue
## May 2017 versions

The module descriptors in this catalogue were approved following the PCR in April 2017.

The modules are components of the following awards.

| Award | Programme Code |
|---|---|
| BSc (Hons) in Astronomy | *VSASTR513* |
| Diploma of Higher Education in Astronomy | *VSASTR512* |
| Certificate of Higher Education in Astronomy | *VSASTR511* |
| University Certificate in Astronomy | *VSASTR501* |
| University Certificate in Cosmology | *VSCOSM501* |
| University Certificate in Sun, Earth and Climate | *VSASUN501* |
| University Certificate in Astrobiology | *VSABIO501* |


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Distance Learning Website: www.studyastronomy.com
University Elearn Server: elearn.uclan.ac.uk.

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## Module and Level — Page number

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Introduction to Astronomy** | | | | | |
| **MODULE CODE** | AA1051 (L4) | **JACS CODE** | **F500** | **CREDIT VALUE** | 20 credits | |
| **DATE OF APPROVAL** | *April 2017* | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **None** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Provide an introduction to astronomy, suitable for people with little prior knowledge of the subject and with a limited background in physics and maths.
- Provide an understanding of the physical laws as applied to the Universe.
- Provide an introduction to aspects of observational astronomy.
- Develop elementary problem solving skills.
- Provide the opportunity to develop skills and techniques used in astronomy, which have wider applications (these include data analysis, preparation of scientific reports)
- Enhance the student's key skills (communication, numerical skills, IT, time-management).

## MODULE CONTENT

**Introduction**
Astronomy as an observational science, fundamental naked-eye observations, time, seasons, coordinates, optical telescopes, the electromagnetic spectrum, modern observing platforms.

**Stars**
The measurement of stars. The observational Hertzsprung-Russell diagram and the basic properties of stars, the Sun as a star. Binary star orbits. Nuclear energy generation in stars and a descriptive overview of stellar structure. Overview of stellar evolution and its late stages. An overview of the Milky Way Galaxy.

**Galaxies and the Universe**
The extragalactic distance scale and expansion of the Universe. Galaxy morphology and classifications, spiral structure, rotation curves and dark matter. An introduction to special relativity, cosmological models and the origin of the Universe.

**Activities include:** Naked eye observations, telescopes; coordinate systems and time; Analysis of images the moons of Jupiter and using them to deduce the mass of Jupiter; astronomical imaging; imaging and analysis of the moon's surface structure; Computer Assisted Learning Packages; stellar classification; Plotting a Hertzsprung-Russell diagram for stars, Expansion rate of Crab Nebula.

## INTENDED LEARNING OUTCOMES

| **On successful completion of this module a student will be able to:** | |
|---|---|
| **1.** | describe or define concepts and astronomical terms from the syllabus |

 

| | |
|---|---|
| **2.** | solve elementary problems in basic astronomy |
| **3.** | demonstrate elementary skills in measurement, log keeping and data analysis |
| **4.** | demonstrate elementary laboratory report writing skills |
| **5.** | summarise simple scientific information and concepts and draw conclusions. (eg following a laboratory experiment or observation) |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 1 | Experimental Report | 40% | 2000 words | Coursework | 3,4,5 |
| 2 | Question Sheet (including problems and conceptual questions | 2 x 30% | About 8 questions | Coursework | 1,2 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

## APPENDIX
## MODULE CODE: AA1051 (L4) MODULE TITLE: Introduction to Astronomy
## LOCATION OF STUDY: *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Kate Pattle |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN
*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**
**DISTANCE LEARNING STUDENTS**.

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required.

The learning materials include Course Notes with worked examples, self-test exercises, guidance on practical observations and scientific report writing and assessed coursework. Additional material and suggested further reading are available via Blackboard. Some of the activities contain questions to encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheets. The assessed question sheets are designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.

Other activities are designed to develop students' observational and laboratory skills such as designing a simple experiment, making observations, analysing data and developing their skills in writing a formal scientific report.

The observational exercises are designed so that students require no specialist equipment such as binoculars or telescope to complete the course. However students are encouraged to use them in optional exercises and to attend an optional non-assessed weekend course at the Alston Observatory.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | **No of hours** |
|---|---|
| Online tutorial | |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |
| **GUIDED INDEPENDENT STUDY** | |
| First reading of course materials (equiv to lectures) | |
| Working through details | |
| Background Reading | |
| Working on coursework assignments | |
| Reflection on feedback | |
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS*** ***These must add up to 200 hours per 20 credits*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa1051*

# MODULE DESCRIPTOR

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Introduction to Cosmology** | | | | | | |
| **MODULE CODE** | AA1053 (L4) | **JACS CODE** | **F500** | **CREDIT VALUE** | **20 credits** | | |
| **DATE OF APPROVAL** | *April 2017* | | | | **VERSION NUMBER** | 1 | |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **None** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to

- Provide an introduction to cosmology, suitable for people with little prior knowledge of the subject and with a limited background in physics and maths.
- To provide an understanding of the physical laws as applied to the Universe.
- To provide an introduction to basic concepts in Cosmology.
- To develop elementary problem solving skills.
- To provide the opportunity to develop skills and techniques used in astronomy, which have wider applications (these include problem solving and preparation of scientific essays).
- To enhance the student's key skills (communication, numerical skills, IT, time-management).

 

## MODULE CONTENT

THE BIG BANG - THE SECOND ERA

- the hot big bang model - the “standard model”
- expansion --> cooling
- hot particles and radiation
- what happened to antimatter
- protons and neutrons form
- atomic nuclei form
- atoms form - recombination
- decoupling - cosmic background radiation

BEFORE THE BIG BANG - THE FIRST ERA

* inflation
  * theory + speculation
  * why the big bang was hot
  * why the universe expands
  * total energy = zero ?
  * solving the horizon and flatness problems
* cosmology <--> particle physics

AFTER THE BIG BANG - THE THIRD ERA

* steady expansion, astrophysics
* the meaning of expansion and accelerated expansion
* distance becomes harder to define
* Einstein’s equations
* redshift
* horizons
* the Cosmic Background Radiation (CBR)
* observational evidence for expansion
  * Hubble
  * Tolman test (1991)
  * CBR hotter in the past
  * absorption lines
* Hubble’s constant
* galaxy formation
  * epoch of formation
  * dark matter
  * Hubble Space Telescope images, Keck results.
* open or closed
* exciting research topics

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | describe or define concepts and cosmological terms from the syllabus |
| **2.** | solve elementary problems in basic cosmology |
| **3.** | summarise scientific information and concepts and draw conclusions. |
| **4.** | use library or on-line resources to research a scientific topic |

 

| | |
|---|---|
| | |
| **5.** | collate material from a variety of sources and write a coherent essay in this subject area |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| **Number of Assessments** | **Form of Assessment** | **% weighting** | **Size of Assessment/Duration/ Wordcount** *(indicative only – see Workload Table for guidance)* | **Category of assessment** | **Learning Outcomes being assessed** |
|---|---|---|---|---|---|
| 2 | Question Sheets Mixed problems and questions | 2 x 33.33% | 6-7 questions/problems | Coursework | 1,2,3 |
| 1 | Scientific Essay | 33.33% | 800-1000 words | Coursework | 3,4,5 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

**APPENDIX**
**MODULE CODE:** AA1053 (L4) **MODULE TITLE:** Introduction to Cosmology
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | *Roger Clowes* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required.

The learning materials include Course Notes with worked examples, self-test exercises, guidance on researching and writing a scientific essay and assessed coursework. The *Course Notes,* closely linked to a course textbook, are based around how we use observations coupled to basic physical principles to understand the phenomena of the Universe. Additional material and suggested further reading are available via Blackboard. Some of the activities contain questions to encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheets. The assessed question sheets are designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.

The essay titles are chosen to be topical, reflecting recent cosmological research. The essay is designed to enable students to develop their research skills and ability to summarise results, draw conclusions and write them up in a formal essay.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|
| Tutorial | |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

First reading of posted materials (equiv. to lectures)
Working through details
*Background reading*
*Working on coursework assignments*
*Reflection on feedback*

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa1053*

# MODULE DESCRIPTOR

| | | | | | |
|---|---|---|---|---|---|
| **MODULE TITLE** | **IT for Astronomy** | | | | |
| **MODULE CODE** | AA1055(L4) | **JACS CODE** | **F500** | **CREDIT VALUE** | 20 credits |
| **DATE OF APPROVAL** | *April 2017* | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **AA1051** | **Excluded Combinations** | **None** |

## MODULE AIMS

The module aims to:

- Provide an introduction to the use of computers in astronomy for people who already have some knowledge of astronomy
- Introduce the use of online sources of astronomical information.
- Provide an introduction to the IT skills required for scientific communication.
- Build the confidence to develop new skills and techniques via online tools and to use computers independently.

## MODULE CONTENT

This module focuses on the skills and information technologies surrounding the discovery, manipulation, and communication of astronomical data and information. It has four strands:

A. **Digital Literacy** - PC specifications and peripheral components. Operating Systems. Applications software. The components of the internet.
B. **Digital Authoring** – The use of standard Office software (word processors, spreadsheets, and presentations). Including best practice in writing scientific reports/texts, analysing simple data sets, and displaying data.
C. **Astronomy Online** – The types of online information sources available, how to use and evaluate them. Including static information sources and online tools. How information is published online.
D. **Astronomy on the Desktop** - An introduction to major astronomical software packages and their file formats (e.g. FITS files). This includes but is not limited to sky viewers, basic data reduction, photometry, plotting, and educational software.

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | Use a computer, operating system, and office applications effectively |
| **2.** | Use appropriate word processing, spreadsheet and presentation packages. |
| **3.** | Explore the internet for astronomical data sources, information and appropriate applications |
| **4.** | Prepare scientific documents that include: simple data analysis, equations, tables, diagrams, and images |
| **5.** | Use basic astronomical applications to analyse simple data sets. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 1 | Scientific document preparation | 20% | 10 pages | Coursework | 1,2,4 |
| 1 | Preparation of a work using online resources | 40% | 1600 words | Coursework | 1,2,3 |
| 1 | Presentation of scientific results | *40%* | 7-15 slides equivalent to 15 minute presentation + preparatory data analysis | Coursework | 1,4,5 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

## APPENDIX
## MODULE CODE: AA1055 (L4) MODULE TITLE: IT for Astronomy
## LOCATION OF STUDY: *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Jason Kirk |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN
*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required.

The learning materials include Course Notes with worked examples, practice exercises based on topics familiar from the pre-requisite module and assessed coursework. Additional material and suggested further reading will be available via Blackboard, including links to online training packages. Students will be encouraged to make frequent contributions to open discussions via electronic forums.

The first assessment develops students' IT skills to produce well-presented and structured scientific documents including practice in plotting astronomical graphs and summarising information. These are essential skills.

The second assessment gives practice in locating and using web resources and writing up the results in a short report.
The third assessment is designed to give students confidence in analysing astronomical data and writing it up in a scientific report.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|
| Tutorial | |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

First reading of posted materials (equiv. to lectures)
*Working through details*
*Background reading*
*Working on coursework assignments*
*Reflection on feedback*

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=AA1055*

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Energy, Matter and the Universe** | | | | | |
| **MODULE CODE** | AA1056 (L4) | **JACS CODE** | **F300** | **CREDIT VALUE** | **20 credits** | |
| **DATE OF APPROVAL** | *April 2017* | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **AA1051** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Provide astronomy students with a quantitative understanding of the physical and mathematical concepts underlying astrophysical processes and a foundation for Level 5 study in astronomy.
- Provide an understanding of physical laws and concepts as applied to the Universe.
- Provide the opportunity to develop skills and techniques used in astronomy, which have wider applications (eg problem solving).
- Enable students to solve elementary problems in physics and maths and to use independent judgement and extrapolation /synthesis of concepts to solve more open-ended problems in astronomy

## MODULE CONTENT

**Fundamental Interactions**

gravity according to Newton and Einstein
electromagnetism
weak and strong nuclear forces

### Classical Forces And Fields

the physical and mathematical description of gravity and magnetism
forces that push and pull: newton's laws, linear momentum
forces that turn: torque and angular momentum

### Motion Of Objects

describing motion
orbits: planetary, stellar and spacecraft
rotating bodies: planets, stars and galaxies
particle trajectories

### Energy

energy of motion: the kinetic energy of particles and bodies; rotational KE
energy of place: gravitational potential energy
forces: doing work and transferring energy
energy stored in fields: electromagnetic field energy density

### Light In The Universe

emission and absorption of light: classical and quantum processes
the spectrum of light
the nature of light: electromagnetic waves and photons

### Matter In The Universe

the fundamental particles: the particle zoo; particle transformations and decays

the core of atoms - nuclei: atomic number and weight; isotopes
changing nuclei: binding energies; fission; fusion; particle capture and emission
creating the elements
the rest of the atom - electrons and shells: Bohr model and simple quantum physics

Light And Matter: Fundamentals of Spectroscopy

characteristic spectra of the elements
formation of spectra: electronic structure; emission and absorption of photons
the atom alone: the effects of temperature on electron states and spectra
the atom in a gas: the effects of pressure on spectral lines

Heat And Matter

the meaning of temperature
the meaning of 'heat' energy
thermal properties of gases: the ideal gas law; other equations of state
energy stored: heat capacity in gases; degrees of freedom

Relativity

the absolute velocity of light, Michelson-Morley experiment, Lorentz transformation
the effects of relative motion: time dilation and length contraction; the mysterious muon
velocity transformation, relativistic mass, energy and momentum.

Mathematics

understanding functions in physics: physical variables and parameters
manipulating and displaying variables: simple functions and plots
properties and use of trigonometric functions
interpreting and solving algebraic equations in physics
describing motion: co-ordinates and vectors
physical meaning of differentiation and integration
differentiating and integrating useful functions in physics
the meaning of simple differential equations in physics: Newton's laws, equations of state

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | Explain physical concepts relevant to a range of astronomical topics. |
| **2.** | Use relevant physical and mathematical concepts and tools to solve simple problems in physics and astronomy. |
| **3.** | Use independent judgement and extrapolation /synthesis of concepts to solve open-ended problems in astronomy |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 2 | Question Sheets | 2 x 30% | 6-8 Problems | Coursework | 1,2 |
| 1 | Question Sheet with Open-Ended Problem | 40% | 3-5 problems + Open-ended problem | Coursework | 3 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

**APPENDIX**
**MODULE CODE:** AA1056 (L4) **MODULE TITLE:** Energy, Matter and the Universe
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Anne Sansom |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | | |

## MODULE LEARNING PLAN

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required.

The learning materials include Course Notes with worked examples, self-test exercises with detailed model answers, and assessed coursework. Additional material and suggested further reading are available via Blackboard. Some of the activities contain questions to encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheets. The assessed question sheets are designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.

The maths topics are chosen to provide the mathematical tools required for the physics of this module and future modules at levels 5 and 6. The mathematical techniques are assessed early in the module and later assessment is designed to use these techniques and build confidence in applying them to physical problems.

The final assessment is more open ended and is designed to enable students to use independent judgement and extrapolation /synthesis of concepts to solve open-ended problems in astronomy.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|
| **Tutorial** | |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

First reading of posted materials (equiv. to lectures)
*Working through details*
*Background reading*
*Working on coursework assignments*
*Reflection of feedback*

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa1056*

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Investigations in Astronomy** | | | | | |
| **MODULE CODE** | AA1057 (L4) | **JACS CODE** | **F500** | **CREDIT VALUE** | 20 credits | |
| **DATE OF APPROVAL** | *April 2017* | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | | **Pre-requisites** | **AA1051 and AA1053 or equivalent** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Develop students' ability to undertake in-depth research and locate suitable resource, building on their basic knowledge of astronomy and cosmology.
- Provide opportunity for student to practise extracting key issues and arguments from a number of sources to synthesise different strands of subject material
- Provide practice in applying their IT skills to astronomical research and communication.
- Enable students to demonstrate that they have the ability to integrate subject knowledge and skills across individual modules.

## MODULE CONTENT

This module builds upon the pre-requisite modules and assumes a basic knowledge of astronomy and cosmology.

Students will select topics for a more detailed investigation. Possible topics might be:

- The Astronomical Distance Ladder.
- Exploration of the Cosmic Microwave Background, past, present and future.
- The Development of Large Ground-Based Telescopes.
- Active Galaxies
- Galactic Structure
- Space Technology

## INTENDED LEARNING OUTCOMES

| **On successful completion of this module a student will be able to:** | |
|---|---|
| **1.** | Use library or on-line resources independently to research an astronomical topic |
| **2.** | Extract key issues and arguments from a number of sources to synthesise different strands of subject material |
| **3.** | Write a coherent and structured scientific report using appropriate IT packages |
| **4.** | Prepare a competent on-line presentation of an astronomical topic. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 1 | Topic 1 Report | 25% | 1,000 words | Coursework | 2,3 |
| 1 | Topic 2 Presentation | 30% | 7-10 slides (10 minute) | Coursework | 1,2,4 |
| 1 | Topic 3 Report | 45% | 2000 words | Coursework | 1,2,3 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

**APPENDIX**
**MODULE CODE:** AA1057 (L4) **MODULE TITLE:** Investigations in Astronomy
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Alex Dunhill, Barbara Hassall |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

This module makes further use of the Course Notes for each of the prerequisite modules. Supplementary material on specific topics is provided on Blackboard.

Learning materials provide guidance on relevant research methods, and techniques of summarising selected topics. Tutorial support via online discussion forums, online classrooms email and telephone as required.

The first topic (e.g. *The Astronomical Distance Ladder*) is specified in the briefing together with details of the appropriate research methods and structure for the written presentation of the subject matter. Students are asked to submit an extensive summary of the main issues and problems. Feedback will be provided on this initial report before the students submit the second item of coursework.

The students will have a choice of topics for their second and third assessments. The assessments are designed to enable students to show increasing independence in their research and presentation skills (second assessment) and in producing the report (third assessment). The Report will enable students to demonstrate good IT skills to write a structured scientific report on the results of data analysis carried out by the student.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|
| **Tutorial** | |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

First reading of posted materials (equiv. to lectures)
*Working through details*
*Background reading*
*Working on coursework assignments* *Reflection on feedback*

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa1057*

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Sun, Earth and Climate** | | | | | |
| **MODULE CODE** | AA1058 (L4) | **JACS CODE** | **F530** | **CREDIT VALUE** | 20 credits | |
| **DATE OF APPROVAL** | April 2017 | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **None** | **Excluded Combinations** | **None** |

## MODULE AIMS

The aims of this module are to :

- Provide an introduction to Sun, Earth and Climate, suitable for people with little prior knowledge of the subject and with a limited background in physics and maths.
- Provide an understanding of physical laws and concepts as applied to the Sun-Earth system and the Earth's climate.
- Provide an introduction to aspects of observational solar astronomy, including the ways in which our Sun (a variable star) can affect the Earth's environment in space and how it may influence our climate.
- Develop elementary problem solving skills.
- Provide the opportunity to develop skills and techniques used in solar astronomy and solar-terrestrial physics, which have wider applications (these include data analysis, preparation of scientific reports).
- Enhance the key skills (communication, numerical skills, IT, time-management)..

## MODULE CONTENT

This course covers a number of topics:

**The Solar System**
The Sun and Earth are presented in the context of Astronomy, with a description of orbital motions, Kepler's Laws, Newtonian gravitation, solar eclipses, transits of Mercury and Venus and related phenomena. Basics Physics concepts of relevance to the course are also introduced: these include charged particles; electrical, gravitational and magnetic forces and fields; the concept of astrophysical plasmas; and the nature of light and the electromagnetic spectrum.

**The structure of the Sun and the Earth**
Brief overview of internal structure of Sun and Earth, leading to characteristics of the various regions of the solar and terrestrial atmospheres; comparison between the magnetic field of the Sun and the Earth; names and dimensions of the atmospheric layers; the structure of the magnetosphere and ionosphere. The solar spectrum as seen from the Earth. The sunspot cycle and the solar dynamo; Maunder minimum; "proxies" for solar activity.

**Observations of the Sun and the Earth**
Techniques for safe solar observing (also refer to workbook exercise on safe observing); solar and Earth observations from the ground and from space; historical observations; solar features; geomagnetic observations and indices; weather stations.

**Energy from the Sun to the Earth**

The flow of energy from Sun to Earth is described in its various forms. The concepts of solar irradiance and insolation are introduced, and the way in which they affect the Earth's energy budget discussed. The influence on the Earth of solar flares and Coronal Mass Ejections.

**Earth's climate and climate change**
Brief review of selected components of the Earth's climate: general circulation; cyclones/anticyclones; quasi-biennial oscillation; El Niño/La Niña. Observational evidence of global warming is reviewed and the role of climatic forcings discussed, including anthropogenic forcing from greenhouse gas emissions and solar forcing.

**Space Weather**
The effects of solar eruptions on the Earth's space environment and technologies are presented. The phenomenon of the Aurorae and its link to solar events are discussed.

**Sun, Earth and Climate Exercises**
Introduction to safe solar observing: projection techniques, telescopes. Data analysis exercises, question sheets and assessment briefing.

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | Describe or define concepts and astronomical terms from the syllabus |
| **2.** | Solve elementary problems in basic solar astronomy and solar-terrestrial physics |
| **3.** | Demonstrate elementary skills in ***safe*** solar observation, measurement, and log keeping |
| **4.** | Demonstrate elementary data analysis and laboratory report writing skills |
| **5.** | Summarise simple scientific information and concepts and draw conclusions. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module. *Only summative assessment should be included.*

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 2 | Question Sheets including problems and descriptive questions. | 2 x 30% | 6-8 questions | Coursework | 1,2 |
| 1 | Experimental report | 40% | 2000 words | Coursework | 3,4,5 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

**APPENDIX**
**MODULE CODE:** AA1058 (L4) **MODULE TITLE:** Sun, Earth and Climate
**LOCATION OF STUDY:***UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Silvia Dalla |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required.

The learning materials include Course Notes with worked examples, self-test exercises, guidance on practical observations and scientific report writing and assessed coursework. Additional material and suggested further reading will be available via Blackboard. The student is encouraged to develop questions from the solar and solar-terrestrial observations presented in the introductory section. These questions will then be addressed throughout the module. The enquiring process will be facilitated by the use of a discussion thread set up on the module elearn site, where interactions between students and tutor will be encouraged.

Some of the activities contain questions to encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheets. The assessed question sheets are designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.

Other activities are designed to develop students' observational and laboratory skills such as designing a simple experiment, making observations, analysing data and developing their skills in writing a formal scientific report. The observational exercises combine data analysis and simple, safe observations that can be carried out at home without any specialist equipment such as binoculars or telescope.

The assessed report requires analysis of solar and geophysical data supplied on-line, and is designed to develop students' abilities to summarise data and write a scientific report.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|
| Tutorial | *8* |

**GUIDED INDEPENDENT STUDY**

First reading of posted materials (equiv. to lectures)
*Working through details*
*Background reading*
*Working on coursework assignments*
*Reflection on feedback*

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS*** ***(eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa1058*

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Introduction to Astrobiology** | | | | | |
| **MODULE CODE** | AA1059 (L4) | **JACS CODE** | **F510** | **CREDIT VALUE** | *20 credits* | |
| **DATE OF APPROVAL** | April 2017 | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **None** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Provide an introduction to astrobiology, including basic chemistry and biology, suitable for people with little prior knowledge of the subject.
- Provide an understanding of scientific laws and concepts as applied to the universe and astrobiology
- Provide an introduction to aspects of observational or laboratory science
- Develop elementary problem solving skills
- Provide the opportunity to develop skills and techniques used in astrobiology (astrophysics, biology and chemistry), which have wider application (these include data analysis, preparation of scientific reports.
- Enhance the student's key skills (communication, numerical skills, IT, time-management).

## MODULE CONTENT

**Life on Earth:** life sustaining environments, evolution, origins, range, limitations. Chemistry/biochemistry. Fossil records.

**Solar System Sites that might support life:** Planets and Moons. Sites with the possibility of liquid water, complex chemistry and organic material. Comets.

**Search for terrestrial planets:** detection techniques, searching for planetary atmospheres and chemical composition. Space missions and ground-based surveys. Signatures of appropriate biochemistry.

**Extraterrestrial biochemistry:** Alternatives to carbon and oxygen, other probable processes, constraints of physics, biology and chemistry on possibilities

**Space origins of life:** panspermia, comets as a source of biological material, life on Mars

**Human factors for space exploration:** physiological and psychological impact of isolation, crowded or constrained living and working spaces and engaging in high risk activities

**Environmental influences on life:** radiation, gravity, temperature, pressure, atmospheric composition, extremophiles as examples of life in unexpected places.

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | Describe biochemical and physical processes that take place in the universe with relevance to |

| | |
|---|---|
| | astrobiology. |
| **2.** | Describe a range of environments capable of supporting a wide range of life forms. |
| **3.** | Conduct a scientific investigation and rigorously report on the outcomes. |
| **4.** | Solve elementary problems and apply appropriate practical skills. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module. *Only summative assessment should be included.*

| **Number of Assessments** | **Form of Assessment** | **% weighting** | **Size of Assessment/Duration/ Wordcount** | **Category of assessment** | **Learning Outcomes being assessed** |
|---|---|---|---|---|---|
| 2 | Question/ Problem sheets | 25+35% | 6-8 questions | Coursework | 1,2,4 |
| 1 | Report on scientific experiment | 40% | 1600 words | Coursework | 3,4 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

**APPENDIX**
**MODULE CODE:** AA1059 (L4) **MODULE TITLE:** Introduction to Astrobiology
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Dimitris Stamatellos |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required.

The learning materials include Course Notes with worked examples, self-test exercises and assessed coursework. Additional material and suggested further reading will be available via Blackboard. Some of the activities contain questions to encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheets. The assessed question sheets are designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.

Other activities are designed to develop students' observational and laboratory skills such as designing a simple experiment, making observations, analysing data and developing their skills in writing a formal scientific report.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|
| **Tutorial** | *8* |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

First reading of posted materials (equiv. to lectures)
*Working through details*
*Background reading*
*Working on coursework assignments*
*Reflection on feedback*

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa1059*

# MODULE DESCRIPTOR

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Great Astronomers in History** | | | | | | |
| **MODULE CODE** | AA1066 (L4) | **JACS CODE** | **F500** | **CREDIT VALUE** | 20 credits | | |
| **DATE OF APPROVAL** | *April 2017* | | | | **VERSION NUMBER** | 1 | |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **None** | **Excluded Combinations** | None |

## MODULE AIMS

The aims of the module are to:

- Provide an introduction to the history of astronomy by focussing on some key individuals and issues in astronomy
- Promote understanding both of the nature of historical study and the nature and dynamics of scientific discovery in its cultural context.
- To provide an insight into the historical and philosophical context of astronomy and its impact on the development of science from a European perspective.
- Encourage a broader perspective on astronomy by exploring the history of science.

To enhance the student's key skills (IT and communication).

## MODULE CONTENT

**1. The nature of history and science**

**2. The Greek beginnings.**

**3. Nicholas Copernicus**

**4. Tycho Brahe**

**5. Johannes Kepler**

**6. Galileo Galilei**

**7. Jeremiah Horrocks**

**8. Isaac Newton**

**9. William Herschel: Galaxies and stellar dynamics**

**10. Theoretical and Observational Astronomy**

**11. Physics and Astronomy: the interconnection of science**

**12. Extra Terrestrials and the Emperor's New Canals?**

## INTENDED LEARNING OUTCOMES

| **On successful completion of this module a student will be able to:** | |
|---|---|
| **1.** | Explain the nature of historical study as applied to science, recognising the need to avoid 'hindsight' with concepts not available to contemporaries |
| **2.** | Write a coherent, researched essay on the subject matter |
| **3.** | Recognise and explain the paradigmatic nature of science, and the dynamics of the development of scientific ideas |
| **4.** | Describe and illustrate the context in which key astronomers operated and developments in astronomy in the period up to 1900. |

## ASSESSMENT METHODS

| **Number of Assessments** | **Form of Assessment** | **% weighting** | **Size of Assessment/Duration/ Wordcount** | **Category of assessment** | **Learning Outcomes being assessed** |
|---|---|---|---|---|---|
| 1 | Book Review | 25% | 1000 words | Coursework | 1,4 |
| 1 | Role Play Letter | 25% | 1000 words | Coursework | 1,4 |
| 1 | Essay | 50% | 2000 words | Coursework | 2,3,4 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

## APPENDIX
## MODULE CODE: AA1066 (L4) MODULE TITLE: Great Astronomers in History
## LOCATION OF STUDY: *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Paul Marston |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required.

The learning materials include Course Notes and a *Workbook* containing the assessed coursework, comprehensive bibliography and guidance in preparing essays and book reviews. Additional material and suggested further reading is available via Blackboard.

The assessments are chosen to cover three periods of historical development of astronomy and to assess three different types of writing.

- The formal essay enables students to research materials from diverse sources, including relevant reprints of original sources (in translation if appropriate), critically compare them and write a coherent essay.
- The book review encourages students to use their knowledge of the module content to critically assess their selected book, and to highlight any strengths or errors in it.
- The role play letter requires students to have a detailed insight into the timeline of developments surrounding key individuals and to show awareness of the context in which the individuals lived. The style requires some 'creative writing' providing an opportunity for students to write in a different style than for formal essays or scientific reports.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|
| Tutorial | *8* |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

First reading of posted materials (equiv. to lectures)
*Working through details*
*Background reading*
*Working on coursework assignments*
*Reflection on feedback*

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa1066*

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **The Milky Way** | | | | | |
| **MODULE CODE** | AA2051 (L5) | **JACS CODE** | **F500** | **CREDIT VALUE** | *20 credits* | |
| **DATE OF APPROVAL** | April 2017 | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **AA1051** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to

- Provide a broad introduction to the content, structure and evolution of the Milky Way, based on basic astronomy knowledge. Its approach is quantitative without taking a highly mathematical approach.
- Demonstrate how observations coupled to basic physical principles yield our current understanding of the Galaxy.
- Develop the student's ability to analyse scientific problems and enhance their ability to review and present scientific information in a logical and coherent way.
- Enhance the student's key skills (communication, numerical skills, IT, time-management).
- Provide practice in planning and producing a scientific essay.

## MODULE CONTENT

**1. The Milky Way: past, present and future.**
Context of evolution in the universe. Revising and reviewing relevant parts pre-requisite module, especially galaxies and parts of stellar lifecycle.

**2. The solar neighbourhood.**
Distances, star number densities, types of stars and structures; the Sun in an old SNR cavity; SNR gas; local disk structure; local motions and local moving group (giving age).

**3. Nebulae and Giant Molecular Clouds: stellar nurseries in the Galaxy.**
Gaseous nebulae; cold interstellar gas - optical discovery, star formation sites, hot interstellar gas, plasma, the X-ray Galaxy.

**4. Star clusters: open and globular.**
Case studies of young and older open clusters. Types of stars in open clusters.
Globular clusters; their positions and dynamics in the Galaxy. Population I and II (and III) stars.

**5. Interstellar dust.**
Discovery of interstellar obscuration. Absorption, scattering, reddening, colour excess and distance modulus. Composition, shape and sizes. Wavelength-dependence. Role in the life cycle of stars.

**6. The Radio Galaxy: spiral arms.**
Tools to probe the overall structure of the galactic disk. Spiral structure and spiral density waves. Radio observation of molecules, complex organic molecules in the Galaxy.

**7. Dark Matter and the Halo**
Pop II, bulge and halo. Dynamical mass; velocity distribution. Evidence for dark matter in the Galaxy. Searches for it. What's in the halo? Candidates for dark matter.

**8. Journey to the Centre of the Galaxy**
Towards the Centre. The IR Galaxy and IR sources. Barred spiral. Supermassive black hole. The birth and death of

the Galaxy.

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | Describe the contents and discuss the complexities of the overall structure of the Milky Way. |
| **2.** | Explain the physical principles and processes involved in the Galaxy's evolution and relate them to its present-day structure |
| **3.** | Solve numerical problems in this subject area |
| **4.** | Plan, research and produce a structured scientific essay in this subject area. |
| **5.** | Analyse conceptual problems, make inferences and provide reasoned arguments to justify the conclusions drawn. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 2 | Question sheets (numerical and conceptual questions) | 30%, 35% | 5 questions | Coursework | 1,2,3 |
| 1 | Scientific essay | 35% | 1,500 words | Coursework | 2,4,5 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

**APPENDIX**
**MODULE CODE:** AA2051 (L5) **MODULE TITLE:** The Milky Way
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Victor Debattista |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required. Students will be encouraged to participate in on-line discussions.

The learning materials include Course Notes with worked examples, and assessed coursework. Additional material and suggested further reading are available via Blackboard. The essay assignment is prefaced by guidance on researching and writing a scientific essay.

The self-test questions encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheets.

The assessed question sheets are designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.

The essay titles are chosen to be topical, reflecting recent galactic research. The essay is designed to enable students to develop their skills to plan, research and produce a structured scientific essay in this subject area.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | No. of hours |
|---|---|
| **Tutorial** | *8* |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

*First reading of posted materials (equiv. to lectures)*
*Working through details*
*Background reading*
*Working on coursework assignments*
*Reflection on feedback*

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: http://readinglists.central-lancashire.ac.uk/search.html?q=AA2051

# MODULE DESCRIPTOR

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Galaxies Beyond the Milky Way** | | | | | | |
| **MODULE CODE** | AA2052 (L5) | **JACS CODE** | **F500** | **CREDIT VALUE** | *20 Credits* | | |
| **DATE OF APPROVAL** | April 2017 | | | | **VERSION NUMBER** | 1 | |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **AA1051 AA2051** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Provide a broad introduction to galaxies beyond the Milky Way, building on the prerequisite modules. Its approach is quantitative without taking a highly mathematical approach.
- Provide students with an understanding of the location of our Galaxy in the universe the characteristics of other types of galaxies.
- Enable students to carry out estimates of physical properties of galaxies based on their analysis of observational data.
- Provide a broad overview of observations and how observations with new instruments in different wavebands may answer questions about galaxy evolution in the coming years.
- provide practice in transferable skills relevant to communicating scientific concepts.

## MODULE CONTENT

THE LOCAL UNIVERSE

- Classification by morphology
- Stellar content
- Theoretical considerations
- Interstellar medium
- Disks, bars and spiral arms

DYNAMICS

- Motions within galaxies
- Galaxy masses, missing mass in galaxies
- Powering of AGN
- Jets from galactic nuclei
- Velocity-distance relation

THE LOCAL GROUP

- Morphology and distribution
- Star formation history
- Future evolution

CLUSTERING OF GALAXIES

- Clusters and superclusters
- Morphological mix
- Cluster dynamics, missing mass in clusters
- Motion of our Galaxy in the universe

EVOLUTION

- Evolution in the universe from the big bang
- When did galaxies first appear?
- Changes with look-back time
- Galaxy interactions

CHALLENGES FOR THE FUTURE

- The problem of the first stars
- Dwarf galaxies
- Absorption line systems
- Future instrumentation

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | Describe the structure and characteristics of different types of galaxies and how this is inferred from multi-wavelength observations. |
| **2.** | Use basic physical and astrophysical principles to explain the phenomena of galaxies in the universe and solve problems in this subject area |
| **3.** | Analyse range of astronomical data to investigate open-ended problems. |
| **4.** | Summarise scientific information and concepts, evaluate results and draw conclusions. |
| **5.** | Write structured and coherent scientific documents |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 1 | Question sheet (numerical and conceptual) | 35% | 5 questions | Coursework | 1,2 |
| 1 | Data Analysis and Report | 40% | 1600 words | Coursework | 3,4,5 |
| 1 | Critical Summary of Article | 25% | 1000 words | Coursework | 4,5 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

**APPENDIX**
**MODULE CODE:** AA2052 (L5) **MODULE TITLE:** Galaxies Beyond the Milky Way
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Victor Debattista |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required. Students will be encouraged to participate in on-line discussions.

The learning materials include Course Notes with worked examples, and assessed coursework. Additional material and suggested further reading are available via Blackboard.

The self-test questions encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheet.

The assessed question sheets is designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.
The data analysis report provides practice in accessing a range of online astronomical data sources, analysing the data to investigate an open-ended problem and drawing conclusions. The resulting scientific report develops students' scientific writing skills.

The assessment "The critical summary of an Article", develops students' critical analysis and their ability to summarise in the form of a structured and coherent scientific document.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | No. of hours |
|---|---|
| Tutorial | 8 |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

First reading of posted materials (equiv. to lectures)
Working through details
Background reading
Working on coursework assignments
Reflection on feedback

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |

| | |
|---|---|
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: http://readinglists.central-lancashire.ac.uk/search.html?q=AA2052

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Ultraviolet, Optical and Infrared Astronomy (UVOIR)** | | | | | |
| **MODULE CODE** | AA2053 (L5) | **JACS CODE** | **F500** | **CREDIT VALUE** | *20 credits* | |
| **DATE OF APPROVAL** | April 2017 | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **AA1051** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Provide students with a detailed understanding of astronomical detectors and technologies for the ultraviolet, optical and infrared wavelengths.
- Provide an understanding of physical laws and concepts as applied to Astronomy.
- Provide an understanding of the techniques and the opportunity to develop their skills in quantitative observational astronomy.
- Provide the opportunity to develop techniques used in astronomy which have wider applications
- Enhance the student's key skills in data analysis, astronomical techniques and application of related physical concepts.

## MODULE CONTENT

**Atmospheric Effects**
The effects of the atmosphere on observations - extinction, air mass, refraction, dispersion, seeing. Sky background radiation.

**Telescopes**
Limits to resolution. Limiting magnitude. Characteristics of good observing sites. Telescope mountings and focuses. Optical aberrations. Planning an observing programme.

**Photometry**
Photometric techniques. Magnitudes and photometric systems, astronomical applications.

**Detectors**
Single-pixel and multi-pixel detectors. Photoemissive process. Photoconductive process. Semiconductors. Imaging, Micro-channel plates. Junction diodes. p-i-n diodes. CCDs, CMOS, Infrared arrays. Bolometers. Signal-to-noise ratio.

**Experimental and observational work**
Planning and carrying out observations/data analysis/experiments using detectors.
Acquire astronomical images (using their own equipment and/or data provided by the University). Data reduction and analysis using software from specified open access sources.

## INTENDED LEARNING OUTCOMES

| On successful completion of this module a student will be able to: | |
|---|---|
| **1.** | Explain the principles of observational techniques and astronomical detectors including the physics of their operation for ultraviolet, optical and infrared wavelengths. |
| **2.** | Solve problems involving topics found in the syllabus. |
| **3.** | Extract and summarise relevant information from a given text or case study. |
| **4.** | Carry out a variety of quantitative observing and/or data reduction techniques at optical wavelengths. |
| **5.** | Record, analyse, present and report astronomical data with the aid of suitable software and IT packages. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 1 | Question Sheet (including problems conceptual question). | 40% | Approx. 4 problems | Coursework | 1,2,3 |
| 1 | Case study report (instrumentation) | 30% | 1200 words | Coursework | 1,3 |
| 1 | Data Analysis report based on imaging observations and their reduction. | 30% | 1600 words | Coursework | 3,4,5 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

**APPENDIX**
**MODULE CODE:** AA2053 (L5) **MODULE TITLE:** Ultraviolet, Optical and Infrared Astronomy
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Anne Sansom |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required.

The learning materials include Course Notes with worked examples, self-test exercises, and assessed coursework. The *Course Notes,* are based around how we use observations coupled to basic physical principles to understand the phenomena of the Universe. Additional material and suggested further reading are available via Blackboard. Self-test exercises contain questions to encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheets.

This module consists of theoretical and practical material.

**Theoretical material**

Specific case studies enable students to see how the fundamental techniques apply both to observing with small telescopes and for professional use and will be used to illustrate current developments in satellite and ground-based telescopes and detectors. Tutorials based on the case studies will highlight the structure of scientific articles and emphasise the need for selectivity when reporting and summarising.

**Practical material**

Students will carry out observations and/or data analysis with guided support via e-Learn discussions and emails. This will also be supported by online simulated experiments. For this reason it is essential for distance learning students to be prepared to download and install appropriate data analysis software. Experiments, data logging and formal reports are designed to develop the students' experimental/observational and transferable skills.

Familiarisation exercises are designed to develop the student's practical skills before tackling the formally assessed work. The experimental work will be written up as a formal report including evidence of understanding of instrumentation.

Assessments consist of one question sheet based on the theoretical material, and two reports based on the practical material.

- The assessed question sheet is designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.
- The case study requires the students to document the characteristics of a working telescope and

instrument combination according to the brief, using information obtained from reference manuals on Observatory websites. This develops their ability to Extract and summarise relevant information.

- The report requires students to analyse electronic images obtained with a telescope and electronic area detector combination. Data processing techniques will be used to illustrate how astronomical images are processed. The data will be used in an astronomical application to estimate physical properties, including realistic error estimates. The analysis provides important practice in these important subject skills using astronomical IT packages and the production of the report further develops skills in scientific writing.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | No. of hours |
|---|---|
| Tutorial | 8 |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

**First reading of posted materials (equiv. to lectures)**
**Working through details**
**Background reading**
**Working on coursework assignments**
**Reflection on feedback**

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| | |
| | |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: http://readinglists.central-lancashire.ac.uk/search.html?q=AA2053

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Exploring the Solar System** | | | | | |
| **MODULE CODE** | AA2054 (L5) | **JACS CODE** | **F520** | **CREDIT VALUE** | *20 credits* | |
| **DATE OF APPROVAL** | *April 2017* | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | | **PARTNER INSTITUTION** | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Provides an introduction to the Solar System complementing stellar and galactic work covered elsewhere in the Astronomy degree programmes.
- Introduce students to images and results from recent space research and exploration.
- Develop students' research skills
- Develop students' communication skills.

## MODULE CONTENT

### Introduction

An overview of the Solar System: its structure, scale and content.

### Overview of Space Exploration

History, the motivation, technology, past present and future missions.
Methods of exploration: remote observation and space probes.
Prospects for future exploration and colonisation; mining mineral resources beyond the Earth. Outstanding questions in planetary studies.

### The Sun: our Nearest Star

The Sun in context as the powerhouse of the Solar System.
This includes how the Sun's influence is felt by bodies in the Solar System (including the Earth) and how its evolution will affect those bodies.

### The Earth and Terrestrial Environment

The Earth as a planet: its atmosphere, surface, and interior.
Origin, structure, and evolution of the atmosphere – including man made influences.
Humanities interaction with their planet.

### The Planets and their Satellites

The terrestrial planets: application of Earth sciences to other worlds.
The giant planets and their systems.
Comparison of the properties of the planets and satellites: atmospheres, surfaces, interiors.

 

History of the Solar System

Origin and history of the Sun and planets as supported by evidence.
Comparison and evidence from extrasolar planets.

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | Describe, compare and contrast the contents of the Solar System and the Sun |
| **2.** | Explain the processes underlying the similarities and differences between Earth and the other planets |
| **3.** | Discuss how space exploration contributes to our current understanding of the Solar System |
| **4.** | Collect and collate material from a variety of sources and write a substantial, coherent essay in this subject area |
| **5.** | Use IT software to present information about a space mission or similar topic. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 1 | Question Sheet | 40% | A portfolio of questions & activities (equivalent to 1600 words) | Coursework | 1,2 |
| 1 | Preparation of a presentation | 20% | 7-10 slides (equivalent to 12 minute presentation) | Coursework | 3,5 |
| 1 | Researched essay | 40% | 1600 words | Coursework | 3,4 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

## APPENDIX
**MODULE CODE:** AA2054 (L5 **MODULE TITLE:** Exploring the Solar System
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Jason Kirk |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN
*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support for off-campus students will be provided by e-mail, electronic discussion groups and telephone. Students will be encouraged to participate in on-line or class discussions.

A *Study Guide* containing directed reading from recommended textbooks, internet resources. This is supported by tutorials and on-line discussions. Students will have access (e.g. through Blackboard) to self-test questions. The essay and presentation assessments will be prefaced by appropriate tutorial guidance on content and preparation.

- The assessed question sheet is designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.
- The presentation encourages students to use recent results from the literature, enhancing their experience of refereed journals. It also develops their skills in using IT to produce a presentation.
- The essay titles are chosen to be topical, reflecting recent solar system research. The essay is designed to enable students to develop their research skills and ability to summarise results, draw conclusions and write them up in a formal essay.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|
| Tutorial | *8* |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

*First reading of posted materials (equiv to lectures)*
*Working through details*
*Background reading*
*Working on coursework assignments*
*Reflection on feedback*

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa2054*

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Solar Astrophysics** | | | | | |
| **MODULE CODE** | AA2055 (L5) | **JACS CODE** | **F510** | **CREDIT VALUE** | *20 credits* | |
| **DATE OF APPROVAL** | *April 2017* | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **AA1051 or AA1058** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Provide a broad introduction to Solar Astrophysics, as a foundation for further study
- Present a mixture of theoretical and observational approaches to demonstrate and explain the various solar phenomena.
- Provide an understanding of physical laws and concepts as applied to Solar Astrophysics.
- Provide an understanding of the techniques for observing the sun.
- Provide the opportunity to develop techniques used in astronomy which have wider applications (eg data analysis, imaging techniques, preparation of scientific reports, and IT).
- Enhance the key skills (communication, numerical skills, IT, time-management).

## MODULE CONTENT

1. Our Closest Star

Sun's place in Universe; birth, life and death of the star; characteristics of the Sun; how we observe the Sun from space today (SOHO, TRACE)

2. Probing the solar interior

The inferno in the solar core: nuclear fusion; solar neutrinos and SNP; detection of solar interior oscillations: basic techniques in helioseismology; solar rotation and the Best Model Sun

3. The Sun's magnetic personality

Solar convection zone; the solar dynamo; the magnetic activity cycle; journeying into the photosphere

4. Facing the universe

The solar atmosphere (chromosphere, transition region, corona); spectral diagnostics of this environment-remote sensing of density, temperature and velocity

5. The magnetised atmosphere

Closed (loops) and open (coronal holes) magnetic fields; prominences; bright points; basic ideas in solar magnetohydrodynamics

6. The coronal heating problem

Outlining the coronal heating problem; solutions via (i) solar waves; (ii) breaking and rejoining magnetic field structures - reconnection

7. The dynamic sun

Solar flares; coronal mass ejections; predicting solar storms and their effect on space weather

8. THE FUTURE OF SOLAR ASTROPHYSICS

Outlining upcoming space-based solar missions; for example, currently Solar Orbiter, Solar Probe Plus, Solar-C and Solar-D, Proba-3; major outstanding research questions.

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | Explain the physical principles and processes giving rise to solar phenomena |
| **2.** | Describe techniques for observing the sun |
| **3.** | Solve quantitative problems |
| **4.** | Analyse solar data to investigate closed and open-ended problems. |
| **5.** | Write a structured and coherent scientific report of publication style. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| **Number of Assessments** | **Form of Assessment** | **% weighting** | **Size of Assessment/Duration/ Wordcount** | **Category of assessment** *(* | **Learning Outcomes being assessed** |
|---|---|---|---|---|---|
| 2 | Question and problem sheets | 25%,35% | 4-5 questions | Coursework | 1,2,3 |
| 1 | Experimental report based on data analysis | 40% | 1600 words | Coursework | 3,4,5 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

**APPENDIX**
**MODULE CODE:** AA2055 (L5) **MODULE TITLE:** Solar Astrophysics
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | *Aimilia Smyrli* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

**Distance learning students** will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required. Students will be encouraged to participate in on-line class discussions.

The learning materials include Course Notes with worked examples, self-test exercises and assessed coursework. Additional material and suggested further reading are available via Blackboard. The approach is quantitative without being highly mathematical. Self test exercises contain questions to encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheets.

- The assessed question sheet is designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.
- The experimental report is based on data sets provided on-line to the student and will involve data analysis and use of IT in their presentation to a high standard.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|
| Tutorial | *8* |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

First reading of posted materials (equiv. to lectures)
Working through details
Background reading
Working on coursework assignments
Reflection on feedback

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa2055*

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Solar-Stellar Connections** | | | | | |
| **MODULE CODE** | AA2056 (L5) | **JACS CODE** | **F540** | **CREDIT VALUE** | 20credits | |
| **DATE OF APPROVAL** | April 2017 | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **AA2055** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Provide an understanding of physical laws and concepts as applied to Solar Astrophysics.
- Link a range of stellar phenomena and topics in stellar astrophysics to solar astrophysics using the Sun as a detailed case study and setting it in the wider context of solar-like and other stars.
- Provide the opportunity to develop techniques used in astronomy which have wider applications (eg data analysis, imaging techniques, preparation of scientific reports, essay writing and IT).
- Enhance the key skills (communication, numerical skills, IT, time-management

## MODULE CONTENT

### 1. The variety of stars

The Sun in context: masses, compositions, spectral types and luminosities of stars. (Includes revision and review of prerequisite material.) Variable stars and stellar evolution. Standard stars, variable stars, eruptive variable stars and cataclysmic variable stars.

### 2. Solar-type stars and the main sequence

Main sequence for solar-type stars. The Zero-Age Main Sequence and subsequent evolution within the main sequence. Solar structure and evolution, and effects on the rest of the Solar System. Chemical composition of main-sequence stars. Population II solar-mass stars. The extent of main sequence.

### 3. Activity and adolescent stars

Solar and stellar chromospheric and coronal activity. Flares on late-type stars. Starspots and stellar coronae. Fast rotation, powerful coronae and high activity. Stellar structure and evolution just before and just after the main sequence. Violent outbursts of spotty adolescents. Close binaries and tidally-locked activity.

### 4. Activity Cycles

Solar and stellar activity cycles, observations and theory. The solar-stellar activity connection. Low-activity phases. Solar "twins". Activity observed at different wavelengths.

### 5. Music of the spheres

The methods and applications of helio-seismology and astero-seismology. Asteroseismology of solar-type stars. Oscillations of early-type stars and peculiar stars. Observational facilities and missions.

6. Early evolution

The distant past in the solar system. Origins of the Sun and solar-type stars. early evolution of the Sun. The solar-stellar connection in galactic open clusters.

7. The far future

Structure and evolution of solar-type stars as they leave the main sequence. The Sun as a red giant. Solar and stellar winds and mass loss in stars. Other types of giant stars. The Sun and solar-type stars as planetary nebulae.

8. The end of the road

White dwarfs: Pressure and degeneracy pressure. The Sun and solar-type stars as white dwarfs. Low-mass stars and brown dwarfs. The end state for more massive stars. Solar-stellar connections and the astrophysics of the Galaxy.

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | Describe or define concepts and astronomical terms from the syllabus and discuss observational data and links between solar and stellar astrophysics; |
| **2.** | Explain the physical principles and processes involved in solar and stellar astrophysics and basic stellar structure and evolution; |
| **3.** | Solve numerical problems |
| **4.** | Plan, research and produce a structured scientific essay |
| **5.** | Analyse conceptual problems, make inferences and provide reasoned arguments to justify conclusions drawn. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module. *Only summative assessment should be included.*

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 1 | Question sheet (conceptual questions and problems) | 40% | 5 questions | Coursework | 1,2,3 |
| 1 | Essay, | 30% | 1500 words | Coursework | 2,4,5 |
| 1 | Timed coursework (open book) | 30% | 3-4 questions during specified 2.5 day window. | Coursework | 1,2,3 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

**APPENDIX**
**MODULE CODE:** AA2056 (L5) **MODULE TITLE:** Solar-Stellar Connections
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Dan Holdsworth |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

Distance learning students will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required. Students will be encouraged to participate in on-line class discussions.

The learning materials include Course Notes in eight sections with worked examples, self-test exercises and assessed coursework. Additional material and suggested further reading are available via Blackboard. The approach is quantitative without being highly mathematical. Self test exercises contain questions to encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheet and timed online assignment.

- The assessed question sheet is designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.
- The essay assignment will be prefaced by guidance on researching and writing a scientific essay and enables students to develop their research skills and scientific writing.
- Finally, the on-line timed assignment will enable students to demonstrate understanding of the module material and provide logical summaries within short time constraints.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|
| Tutorial | *8* |
| **TOTAL SCHEDULED LEARNING HOURS** | 8 |

**GUIDED INDEPENDENT STUDY**

*First reading of posted materials (equiv. to lectures)*
*Working through details*
*Background reading*
*Working on course work assignments*
*Reflection on feedback*

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 192 |
| ***TOTAL STUDENT LEARNING HOURS (eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa2056*

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Astronomy Dissertation** | | | | | |
| **MODULE CODE** | AA3050 (L6) | **JACS CODE** | **F500** | **CREDIT VALUE** | *20 credits* | |
| **DATE OF APPROVAL** | April 2017 | | | **VERSION NUMBER** | 1 | |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | **N/A** | | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **None** | **Excluded Combinations** | **None** |

## MODULE AIMS

Students are expected to conduct a detailed investigation of a chosen topic at an advanced level in liaison with an academic supervisor.

The module aims are to:

- encourage the development of an independent study that is largely initiated and planned by the student and to see the work through to completion.
- write a substantial coherent report on an astronomical topic or theme.

## MODULE CONTENT

The dissertation is an extended piece of work that requires research by way of a literature search and/or web search of up-to-date material and approval to proceed will be based on the availability of appropriate learning resource and the possibility of effective supervision by a member of staff.

Students will select an area of interest and formulate an appropriate title similar to those encountered in current research projects. The chosen topic must be sufficienty focused to allow an indepth review of the topic and for the discussion to be at an advanced academic level.

## INTENDED LEARNING OUTCOMES

| **On successful completion of this module a student will be able to:** | |
|---|---|
| **1.** | Use the library and internet resources to research a topic. |
| **2.** | Plan and carry out a piece of work with minimal supervision. |
| **3.** | Critically assess ideas and concepts and draw conclusions. |
| **4.** | Producing a coherent, structured, high quality written report of a substantial piece of work |
| **5.** | Present the work and answer specific questions on the dissertation with confidence and competence. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| **Number of Assessments** | **Form of Assessment** | **% weighting** | **Size of Assessment/Duration/** | **Category of assessment** | **Learning Outcomes** |
|---|---|---|---|---|---|

| | | | **Wordcount** | | **being assessed** |
|---|---|---|---|---|---|
| 1 | Dissertation | 80% | 8000 words | Coursework | 1,3,4, |
| 1 | Viva voce or equivalent | 20% | Approx 20 minutes | Practical Assessment | 2,3,5 |
| 1 | Log book | 0% | N/A | Coursework | 2 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

## APPENDIX
**MODULE CODE:** AA3050 (L6) **MODULE TITLE:** Astronomy Dissertation
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Barbara Hassall |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN
*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

**Distance learning students** will learn via self-study according to a Module Schedule, Students will be expected to interact with their dissertation supervisor on a regular basis via email, telephone or Elearn. Distance Learning students will undertake their dissertation viva via telephone or video conferencing.

This module is normally taken during the final year of study of the BSc (Hons).

After initial discussions at the start of the module, the student will be assigned a dissertation supervisor. Students will also receive a briefing document with guidance on the operation of the module, the production of the dissertation and the conduct of the viva. In collaboration with their supervisor, students must identify a theme from a short list of topics which they will explore. The student will develop the theme into a dissertation proposal and workplan, on which they will receive formative feedback.

In the sessions with their supervisor the student will be encouraged to develop an alertness to coherence of argument, precision in the interpretation of the text, clarity of style and methodological problems and solutions, exact and scrupulous observation of scholarly and bibliographical conventions and to practise presentations of their ideas. General progress will be monitored regularly throughout the module and the student will be expected to take on board ideas and input from the supervisor.

The dissertation itself enables the student to show that they have completed a substantial piece of work, supported by research and presented to a high standard in a structured, coherent report.

On completion of the dissertation, each student will be expected to participate in a viva in which they present a short summary of the work that they have undertaken and take part in a question and answer session on the content of the dissertation.

In addition, students will be required to submit evidence of the development of their work in the form of an informal logbook or diary. The diary will be used as an independent check on the originality of the work in the dissertation and is therefore *a compulsory component*. The logbook or diary will not be awarded a formal mark but may be discussed in the viva.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | No. of hours |
|---|---|
| Tutorial | 6 |
| **TOTAL SCHEDULED LEARNING HOURS (GUIDED INDEPENDENT STUDY)** | |

| | |
|---|---|
| Background Reading | |
| Prep of dissertation<br><br>Reflection on feedback | |
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 194 |
| ***TOTAL STUDENT LEARNING HOURS***<br>***These must add up to 200 hours per 20 credits*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: http://readinglists.central-lancashire.ac.uk/search.html?q=AA3050

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Origins** | | | | | |
| **MODULE CODE** | AA3051 (L6) | **JACS CODE** | **F500** | **CREDIT VALUE** | **20 Credits** | |
| **DATE OF APPROVAL** | *April 2017* | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **None** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Enable students to investigate the scientific highlights of current astronomical research.
- Give students insight into the scientific method for investigating problems.
- Encourage students to research recent literature in preparing presentations and participate in mature discussions with other students.
- Provide practice in maintaining a portfolio of work on current topics in astronomy or astrophysics

## MODULE CONTENT

This module is based on a selection of topics that are drawn from those projects that are regarded as “cutting edge research” in astronomy or astrophysics. In general the module will concentrate on the topics that are likely to be featured in the media or play an important role in national research programmes.

Origins of:-

The universe (including the large scale structure and dark matter)
Life in the Universe
Stars
Planetary systems

Large astronomical instrumentation (e.g. new telescopes, satellites, detectors.)
Computational infrastructure for astronomy (e.g. Astro-grid).

## INTENDED LEARNING OUTCOMES

| **On successful completion of this module a student will be able to:** | |
|---|---|
| **1.** | analyse the scientific motivation for current initiatives in astronomy research and how these drive the planning and development of major research programmes. |
| **2.** | prepare a critical literature review of a current research topic. |
| **3.** | critically assess information and concepts and draw conclusions from them. |
| **4.** | use IT resources at a high level to deliver a scientifically mature seminar. |
| **5.** | summarise and communicate scientific ideas. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes.
Students must demonstrate successful achievement of these learning outcomes to pass the module.
*Only summative assessment should be included.*

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 1 | Seminar Presentation | 25% | Equivalent to 20 mins (max 15 slides) | Coursework | 3,4,5 |
| 1 | Critical/analytical essay | 35% | 1500 words | Coursework | 2,3,5 |
| 1 | Portfolio of student seminars | 40% | Write-ups of about 3 seminars Approx 2000 words | Coursework | 1,3 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

## APPENDIX
## MODULE CODE: AA3051 (L6) MODULE TITLE: Origins
## LOCATION OF STUDY: *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | Dan Holdsworth,<br>Barbara Hassall |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

**Distance learning students** will learn via self-study according to a Module Schedule, supported by distance learning material supplied by the Course Team via Elearn. To fulfil the seminar aspects of the module, students will be required to participate in on-line discussions in classroom meetings and via the noticeboards. The Elearn student presentation facility will be used to enable students to see each others' seminars and contribute to class discussion.

Presentations will be submitted electronically with full referencing and notes of the commentary to accompany each slide. Students will create mini presentations for informal feedback and to gain experience in interacting in the question and answer sessions in the discussion forums, before submitting their assessed seminar.

All assessments in this module require students to research and critically assess information and concepts and draw conclusions from them.

- The assessed seminar in addition will develop their IT presentation skills and their ability to participate in mature question and answer sessions, similar to a seminar environment.
- The assessed essay will develop the students' ability to prepare a critical literature review of a current research topic.
- The portfolio will encourage the students to participate in the online discussions and hence contribute to the learning community essential to this module. It will also show their ability to critically analyse information, carry out further research and draw their own conclusions.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | **No of hours** |
|---|---|
| On-line tutorial (DL students) | |
| **TOTAL SCHEDULED LEARNING HOURS** | 6 |
| **GUIDED INDEPENDENT STUDY** | |
| Reading lecture notes | |
| Reviewing course notes | |
| Exercise questions | |
| Background Reading | |
| Working on coursework assignments | |
| Reflection on feedback | |

| | |
|---|---|
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 194 |
| ***TOTAL STUDENT LEARNING HOURS***<br>***These must add up to 200 hours per 20 credits*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: http://readinglists.central-lancashire.ac.uk/search.html?q=AA3051

# MODULE DESCRIPTOR

| | | | | | |
|---|---|---|---|---|---|
| **MODULE TITLE** | **Cosmology and Relativity** | | | | |
| **MODULE CODE** | AA3053 (L6) | **JACS CODE** | **F500** | **CREDIT VALUE** | *20* |
| **DATE OF APPROVAL** | April 2017 | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **None** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Introduce a mathematical approach to Cosmology and Relativity.
- Present the essentials of cosmology and relativity, emphasising the underlying physics and the observational consequences.
- To build upon previous study of introductory cosmology.

## MODULE CONTENT

**RELATIVITY**

**Special Relativity**

The demise of Galilean relativity, Lorentz transformations, velocity transformations, relativistic Doppler effect, transverse Doppler effect, mass, energy and momentum, four-vectors, invariants, dynamics. Applications in astronomy – stellar aberration, cosmic rays – confinement by galactic magnetic fields, interaction with Cosmic Background Radiation, muon half-life.

**General relativity (GR)**

The equivalence principle, the metric, geodesics, curvature of space. Observational confirmation of GR: including gravitational redshift, deflection of light precession of perihelion of Mercury's orbit, what GPS can do for GR.

Gravitational lensing, Einstein ring, applications to cosmology (*eg* masses of lensing objects, path differences and time delays to measure $H_o$, microlensing)

**COSMOLOGY**

Review of fundamental observations: Olber's paradox, recession of galaxies, Hubble's law, isotropy and homogeneity, the Cosmological Principle. Cosmic microwave background, Sunyaev-Zeldovich effect, acoustic peaks, polarization. The Robertson-Walker metric, distances and luminosities. Dynamics of the hot big bang model, $H_o$.

The fluid equation and Friedmann equation, Models for the Universe. The Cosmological Constant.

The history of the Universe: particles in the early universe and relationship with the 'standard model', symmetry breaking, matter and antimatter, synthesis of the elements, recombination. Inflation, acoustic waves. Recent developments including the accelerating universe and dark energy.

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | Describe and explain the fundamental observational and experimental results in the fields of Cosmology and Relativity. |
| **2.** | Explain the ideas and principles used to interpret these results. |
| **3.** | Analyse and solve problems relating to Cosmology and Relativity. |
| **4.** | Critically assess ideas and results and draw conclusions. |
| **5.** | Communicate complex ideas in a scientifically mature manner. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 2 | Question Sheet (conceptual questions and mathematical problem-solving.) | 2x35% | 3-4 substantial questions | Coursework | 1,2,3,4 |
| 1 | Critical review | 30% | 1500 words | Coursework | 4,5 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

## APPENDIX
## MODULE CODE: AA3053 MODULE TITLE: Cosmology and Relativity
## LOCATION OF STUDY: *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | *Roger Clowes/ Tim Cawthorne* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**
**DISTANCE LEARNING**

**Distance learning students** will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required. Students will be encouraged to participate in on-line class discussions.

The learning materials include Course Notes with worked examples, self-test exercises and assessed coursework. Additional material and suggested further reading are available via Blackboard. The approach is quantitative and more mathematical than previous cosmology modules. Self test exercises contain questions to encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheets.

- The assessed question sheets are designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.
- The critical review will be prefaced by guidance on researching and writing a scientific essay. It will enable students to critically assess ideas and results, draw conclusions and communicate complex ideas in a scientifically mature manner.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | **No of hours** |
|---|---|
| Online tutorial | |
| **TOTAL SCHEDULED LEARNING HOURS** | 6 |
| **GUIDED INDEPENDENT STUDY**<br>Reading lecture notes<br>Reviewing course notes<br>Exercise questions<br>Background Reading<br>Working on coursework assignments<br>Reflection on feedback | |
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 194 |
| ***TOTAL STUDENT LEARNING HOURS***<br>***These must add up to 200 hours per 20 credits*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: http://readinglists.central-lancashire.ac.uk/search.html?q=AA3053

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Extreme States of Matter** | | | | | |
| **MODULE CODE** | AA3056 (L6) | **JACS CODE** | **F510** | **CREDIT VALUE** | *20 credits* | |
| **DATE OF APPROVAL** | April 2017 | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | | **PARTNER INSTITUTION** | | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | **AA1056** | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Present at an advanced level the physical concepts behind a number of astrophysical phenomena that occur in extreme conditions.
- Extend students' mathematical and physical skills and understanding
- Provide a solid foundation for further study.

## MODULE CONTENT

**Nucleosynthesis:** origin of the elements, problems with production of heavy elements, binding energies, neutron-capture, cross-sections, beta-decay, s process abundances, r process abundances massive stars and SN events, mass loss in AGB stars and Planetary Nebulae, novae.

**Emission Mechanisms:** electromagnetic radiation, astrophysical plasma, bremsstrahlung, cyclotron, synchrotron, masers, radiative transfer. Applications in jets, novae, accretion disks, Eddington limit.

**Quantum and Statistical Mechanics:** wave-particle duality, particle in box, density of states, Fermi Energy, degenerate matter, relativistic and non-relativistic cases, degenerate equations of state and their application to WD and NS. He-flash in stellar cores.

**Spectroscopy and its applications:** dipole and quadrapole radiation, absorption and emission processes, forbidden lines. Examples of astrophysical spectra.

**Thermodynamics:** classical thermodynamics, temperature, entropy, heat, equilibrium, radiation. Black Holes, horizon, application of thermodynamics to black holes, pair production and evaporation from BH, rotating BH, time reversal of BH.

**Gravitational Radiation:** production of gravitational waves, quadrapole mechanism, inverse square law geometric dilution of gravitational waves, frequency spectrum. Interaction with matter/cross-section for absorption. Sources of gravitational waves (energy/frequency plot), gravitational wave detectors, results so far.

## INTENDED LEARNING OUTCOMES

**On successful completion of this module a student will be able to:**

| | |
|---|---|
| **1.** | use advanced mathematics to describe astrophysical processes or circumstances. |
| **2.** | explain the behaviour of astrophysical phenomena using advanced physics concepts. |
| **3.** | use mathematical techniques and physical concepts to model astrophysical objects. |

| | |
|---|---|
| **4.** | solve advanced problems associated with topics on the syllabus and derive numerical results or estimates. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 2 | Question Sheets (problems involving maths/physics application to Astrophysics) | 30%+40% | 4-6 questions | Coursework | 1,2,3,4 |
| 1 | Timed coursework (open book) | 30% | 3-4 questions during specified 2.5 day window. | Coursework | 1,2,3,4 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

## APPENDIX
**MODULE CODE:** AA3056 (L6) **MODULE TITLE:** Extreme States of Matter
**LOCATION OF STUDY:** *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | *Barbara Hassall* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN
*All modules should include details of the average learning time based upon 200 hours per 20 credits.*

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

**Distance learning students** will learn via self-study, supported by detailed distance learning material supplied by the Course Team according to a Course Schedule. Tutorial support via online discussion forums, online classrooms email and telephone as required. Students will be encouraged to participate in on-line class discussions.

The learning materials include Course Notes with worked examples, self-test exercises and assessed coursework. Additional material and suggested further reading are available via Blackboard. The approach is advanced and more mathematical than previous modules.
Each syllabus topic in the course notes will have two approaches; the first will concentrate on the physics and mathematics and the second will use the material to describe an astrophysical example.
This module will be taught using detailed course notes, directed reading, self-test problems and problem/question sheets which will be used for feedback and assessment.
Self test exercises contain questions with detailed model answers to encourage students to solve conceptual and numerical problems and to build their confidence prior to attempting the assessed question sheets.

- The assessed question sheet is designed to enable students to demonstrate their understanding and ability to solve problems and explain the concepts involved.
- The timed assessment is essentially open book, but requires students to undertake the work within a 2-3 day period. This strategy requires the student to have consolidated their knowledge and understanding, and is therefore a robust test of their ability to grasp the advanced subject matter.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | No. of hours |
|---|---|
| On-line tutorial | |
| **TOTAL SCHEDULED LEARNING HOURS** | 6 |
| **GUIDED INDEPENDENT STUDY** | |
| Reading lecture notes<br>Reviewing course notes<br>Exercise questions<br>Background reading<br>Working on coursework assignments<br>Reflection on feedback | |
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 194 |

| | |
|---|---|
| ***TOTAL STUDENT LEARNING HOURS*** ***(eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: http://readinglists.central-lancashire.ac.uk/search.html?q=AA3056

# MODULE DESCRIPTOR

| | | | | | | |
|---|---|---|---|---|---|---|
| **MODULE TITLE** | **Collaborative Investigation** | | | | | |
| **MODULE CODE** | AA3057 (L6) | **JACS CODE** | **F500** | **CREDIT VALUE** | *20 credits.* | |
| **DATE OF APPROVAL** | April 2017 | | | | **VERSION NUMBER** | 1 |
| **SCHOOL** | **Physical Sciences and Computing** | | **PARTNER INSTITUTION** | | **N/A** | |

## RELATIONSHIP WITH OTHER MODULES

| | | | | | |
|---|---|---|---|---|---|
| **Co-requisites** | **NONE** | **Pre-requisites** | | **Excluded Combinations** | **None** |

## MODULE AIMS

This module aims to:

- Develop the students' skills in group working, taking formal administrative roles, sharing information and working towards common aims and objectives.
- Provide an insight into the mode of collaboration through electronic communication by which many professional astronomers undertake their research
- Build upon research skills of previous modules.
- Provide students with experience in producing high quality group reports and presentations, using high level IT expertise.

## MODULE CONTENT

There is no specific syllabus for this module. Students will research and study a current scientific topic that is appropriate to their degree programme.

**Examples of possible Group Study topics are:**

- Intermediate mass black holes
- Building blocks for galaxies
- Writing a scientific observing proposal for a major telescope
- Topics in binary stars
- Science from the Galaxy Zoo
- Future Astrophysics or Solar System Space Missions
- Developing vehicles for interstellar travel
- Educational issues/national outreach programmes in Astronomy
- International collaborations in Astronomy to provide ground-based and space facilities.

## INTENDED LEARNING OUTCOMES

| **On successful completion of this module a student will be able to:** | |
|---|---|
| **1.** | work as a team member towards common aims and objectives, meeting the team's self imposed deadlines. |
| **2.** | collect and collate information that is relevant to the team project. |

| | |
|---|---|
| **3.** | exercise scientific judgement on material. |
| **4.** | make a significant (and integrated) contribution to a team presentation. |
| **5.** | make a significant independent and integrated contribution to the common report. |

## ASSESSMENT METHODS

The method of assessment for this module has been designed to test all the learning outcomes. Students must demonstrate successful achievement of these learning outcomes to pass the module.

| Number of Assessments | Form of Assessment | % weighting | Size of Assessment/Duration/ Wordcount | Category of assessment | Learning Outcomes being assessed |
|---|---|---|---|---|---|
| 1 | Work done and contribution to the group effort. (Assessed by peer group) | 30% | Not applicable. | Coursework | 1,2,4,5 |
| 1 | Final Report | 40% | 3000 words per student | Coursework | 1,2,3,5 |
| 1 | On-line Presentation | 30% | Equivalent to about 8 minutes per student. | Coursework | 3,4 |

## MODULE PASS REQUIREMENTS

**To pass this module you must achieve a mark of 40% or above, aggregated across all the assessments.**

## APPENDIX
## MODULE CODE: AA3057 (L6) MODULE TITLE: Collaborative Investigations
## LOCATION OF STUDY: *UCLAN CAMPUS*

| | |
|---|---|
| **MODULE TUTOR(S)** | *Barbara Hassall*<br>*Mark Norris* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **MODULE DELIVERY** | Semester Long | Semester 1 | | Semester 2 | | Semester 3 | | |
| | Year long | Semester 1 & 2 | ✓ | Semester 2 & 3 | | | | |
| | Other (please indicate pattern of delivery) | DISTANCE LEARNING | | | | | | |

## MODULE LEARNING PLAN

**LEARNING, TEACHING AND ASSESSMENT STRATEGY**

**Distance learning students** will learn via self-study according to a Module Schedule, supported by distance learning material supplied by the Course Team via Elearn Tutorial support is provided online (Blackboard), online discussion groups, email and telephone.
To fulfil the groupwork aspects of the module, students will be required to participate in on-line discussions in classroom meetings and via the noticeboards. The Elearn student presentation facility will be used to enable students to take part in group meetings and contribute to class discussions.

Students will learn through:

- regular formal on-line group meetings that are also attended by a group supervisor and
- independent/team work to collect and collate information relevant to the selected topic.

Each student will have a particular role within the team and will be expected to execute the tasks assigned in the formal meetings. Priorities and scope of the investigation will be the collective responsibility of the team.

Students will also be expected to undertake private study to complete tasks to bring forward to the next group meeting. During this study period each student is expected to work for the collective good of the team feeding relevant information to other team members and where necessary taking the initiative to bring new ideas into the group study. Each group member will be expected to meet the objectives set by the group in the formal group meetings.

The group work will be supported by on-line resources and exercises to develop students' skills in: researching material, information retrieval, specialist IT skills, conducting meetings, writing up minutes of meetings, role of logbooks and supervisor and project management.

The entire team will be working towards common goals:

- to produce a professional group presentation – to be submitted on-line with full references and commentary to accompany each slide
- to produce a common scientific report to produce other documentary evidence of work done (eg in form of minutes of meetings).

The group supervisor will provide feedback on a draft of each student's contribution to the report.

- The students will undertake peer assessment, in which they assess the performance of other members of their group against criteria such as contribution of ideas, or being a good team member. The students will have much better feel for this than the group supervisor.
- The group report will provide evidence that the students have worked together as a team and have produced a well-researched, well presented document.
- The group presentation is designed to show that students can select the important aspects of their report and present them in a coherent group presentation.

| **SCHEDULED LEARNING AND TEACHING ACTIVITY** | *No. of hours* |
|---|---|

| | |
|---|---|
| On- line tutorial | |
| **TOTAL SCHEDULED LEARNING HOURS** | 10 |
| **GUIDED INDEPENDENT STUDY**<br><br>Background reading<br>Discussions with fellow students<br>Reflection on feedback<br>Preparation of the report<br>Preparation of the presentation | |
| **TOTAL GUIDED INDEPENDENT STUDY HOURS** | 190 |
| ***TOTAL STUDENT LEARNING HOURS***<br>***(eg 200 hours per 20 credits)*** | 200 |

## BIBLIOGRAPHY AND LEARNING SUPPORT MATERIAL

On-line Booklist: *http://readinglists.central-lancashire.ac.uk/search.html?q=aa3057*