# PX3A6-15 Galaxies and Cosmology

## 22/23

**Department**
Physics
**Level**
Undergraduate Level 3
**Module leader**
Grant Kennedy
**Credit value**
15
**Module duration**
10 weeks
**Assessment**
100% exam
**Study location**
University of Warwick main campus, Coventry

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## Description

## Introductory description

A galaxy is a system of stars, dust, stellar remnants and other bodies bound by gravity. Galaxies usually form groups, bound by their gravitational interaction, and these groups themselves tend to be part of even larger superclusters. We will see that we can put together quite simple explanations of what we observe in these complex systems.

Questions about the origin of the Universe, where it is going and how it may get there are the domain of cosmology. One of the questions addressed in the module is whether the Universe will continue to expand or ultimately contract. Relevant experimental data include those on the Cosmic Microwave Background radiation and the distribution of galaxies.

Module web page

## Module aims

To illustrate how important physical principles, from different areas of physics, can be developed to yield a description of complex physical systems like galaxies. To present the credentials of the Universe as we know it (via experiment) and introduce the simplest models that can describe it. The module should stress the role of experimental data and emphasize cosmology as a physical science, which makes testable predictions that describe the observed Universe.

## Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Galaxy classification; the Hubble Tuning Fork; elliptical and spiral galaxies; surface brightness profiles. The Milky Way, its structure and properties; the role of stellar populations and the
interstellar medium.
Galaxy populations; luminosity functions, star formation vs AGN, radio galaxies and seyferts.
Galaxy kinematics; Tully-Fisher relation; rotation curves; dark matter; virial mass.
The role and origin of dust and gas in galaxies; dust extinction laws; types of dusty galaxies.
Introduction to galaxies at large scale: the Local Group and nearby clusters.

The history and foundations of modern cosmology: Olber's Paradox, Hubble's Law and the Cosmological Principle. Describing the evolution of the Universe: basics of space time and relativity, curvature, Friedmann equation, fluid and acceleration equations.
Model universes: describing the evolution when dominated by single component and multiple-components - the standard cosmological (benchmark) model.
Key properties of our Universe: tests of the standard cosmological model, evidence for dark matter; models for dark matter, origin of structure.
The early Universe: the Big Bang, connection to elementary particle physics and grand-unified field theories (GUTS), inflation, Big Bang nucleosynthesis, formation of the cosmic background radiation.

## Learning outcomes

By the end of the module, students should be able to:

- Describe the structure of our own Galaxy and how it fits into the 'zoo' of galaxies distributed through the Universe;
- Explain the physical principles behind the observations used to study galaxies
- Discuss the outstanding problems in the study of galaxies including the nature of galaxy cores and the roles of dark matter and dust
- Recognise the importance of observations in constraining possible cosmological theories
- Explain the evolution of model universes, and how this evolution depends on their energy density components
- Discuss areas of cosmology where more work is needed to reconcile theory and observations

## Indicative reading list

S Philipps, The Structure and Evolution of Galaxies, Wiley, 2005
B. Ryden: Introduction to Cosmology, Pearson 2013
Michael Berry: Principles of cosmology and gravitation, IoP 1989
A. Liddle: An Introduction to Modern Cosmology, Wiley, 2003

View reading list on Talis Aspire

## Subject specific skills

Knowledge of mathematics and physics. Skills in modelling, reasoning, thinking.

## Transferable skills

Analytical, communication, problem-solving, self-study

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## Study

## Study time

| Type | Required |
|---|---|
| Lectures | 30 sessions of 1 hour (20%) |
| Private study | 120 hours (80%) |
| Total | 150 hours |

## Private study description

Working through lecture notes, solving problems, wider reading, discussing with others taking the module, revising for exam, practising on past exam papers

## Costs

No further costs have been identified for this module.

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## Assessment

You must pass all assessment components to pass the module.

### Assessment group B

| Assessment component | Weighting | Study time | Eligible for self-certification |
|---|---|---|---|
| In-person Examination<br>Answer 3 questions | 100% | | No |

| | Weighting | Study time | Eligible for self-certification |
|---|---|---|---|

- Answerbook Pink (12 page)
- Students may use a calculator

**Reassessment component is the same**

### Feedback on assessment

Personal tutor, group feedback

Past exam papers for PX3A6

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## Availability

## Courses

This module is Core for:

- Year 3 of UPXA-F3F5 Undergraduate Physics with Astrophysics (BSc)
- Year 3 of UPXA-F3FA Undergraduate Physics with Astrophysics (MPhys)

This module is Option list A for:

- Year 3 of UPXA-F300 Undergraduate Physics (BSc)
- UPXA-F303 Undergraduate Physics (MPhys)
    - Year 3 of F300 Physics
    - Year 3 of F303 Physics (MPhys)

This module is Option list B for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
    - Year 4 of G105 Mathematics (MMath) with Intercalated Year
    - Year 5 of G105 Mathematics (MMath) with Intercalated Year
- Year 3 of UMAA-G100 Undergraduate Mathematics (BSc)
- UMAA-G103 Undergraduate Mathematics (MMath)
    - Year 3 of G100 Mathematics
    - Year 3 of G103 Mathematics (MMath)
    - Year 4 of G103 Mathematics (MMath)
- Year 4 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
- Year 3 of UPXA-GF13 Undergraduate Mathematics and Physics (BSc)
- UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
    - Year 3 of GF13 Mathematics and Physics
    - Year 3 of FG31 Mathematics and Physics (MMathPhys)

- Year 4 of UMAA-G101 Undergraduate Mathematics with Intercalated Year