PX387-15 Astrophysics

20/21

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

Description

Introductory description

In this module, we will discuss the compact objects - white dwarfs, neutron stars and black holes (BH) - that can form when burnt out stars collapse under their own gravity. The extreme conditions in their neighbourhood mean that they affect strongly other objects and even the structure of the space-time around them. For example, they can lead to very high luminosity phenomena, such as synchrotron radiation and jets of ionised particles that we can observe from Earth.

Compact objects also accrete material from surrounding gases and nearby stars. In the case of BHs this can lead to the supermassive BHs thought to be at the centre of most galaxies. In the most extreme events (mergers of these objects), the gravitational waves (GW) that are emitted are now beginning to be detected on earth (the first GW detection was reported in 2015 almost exactly 100 years after their prediction by Einstein).

Module web page

Module aims

To introduce the physical processes and detection methods required for understanding the broad band emission spectra of astrophysical objects from the radio regime to X-rays and gamma-rays, to provide a basis for further studies in observational astrophysics.

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.

Observational instrumentation, telescope design, detectors;
Accretion onto compact objects as a source of energy;
The Eddington limit: a maximum accretion rate;
The structure and the emission of accretion disks;
The occurence of jets in astrophysical objects;
Binary stars: configuration, evolution, stable and unstable mass transfer;
Accretion onto magnetic stars, Alven radius;
Radiation from free electrons, Larmor formula, synchrotron radiation, cyclotron radiation;
Thermal bremsstrahlung from hot accretion plasmas;
Stable and unstable nuclear shell burning in accreting white dwarfs and neutron stars;
Black holes of different masses;
Supernovae and gamma-ray burst: massive stars, exploding white dwarfs, merging neutron stars;
Pulsars: origin, emission, evolution.

Learning outcomes

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

- Identify the major emission mechanisms of astrophysical objects
- Describe the physical basis of detection methods for UV-radiation and X-rays from astrophysical sources
- Explain how electromagnetic theory and quantum mechanics are used to predict the emission of radiation
- Quantify physical conditions in a variety of astrophysical systems using measured data
- Explain how gravitational potential energy produces most of the high-energy radiation of the Universe through the process of accretion

Indicative reading list

H Bradt, Astronomy Methods: A Physical Approach to Astronomical Observations, Cambridge University Press
J Frank, AR King and DJ Raine, Accretion Power in Astrophysics, CUP
C Hellier Cataclysmic Variables: How and why they vary, Springer

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

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.

Assessment

You must pass all assessment components to pass the module.

Assessment group B1

	Weighting	Study time	Eligible for self-certification
Assessment component			
In-person Examination Answer 2 question from 3	100%		No

- 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 PX387

Availability

Courses

This module is Option list A for:

- Year 3 of UPXA-F300 Undergraduate Physics (BSc)
- Year 3 of UPXA-F303 Undergraduate Physics (MPhys)
- Year 4 of UPXA-F301 Undergraduate Physics (with Intercalated Year)

This module is Option list B for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
  - Year 3 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)
- UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
  - Year 3 of G106 Mathematics (MMath) with Study in Europe
  - Year 4 of G106 Mathematics (MMath) with Study in Europe
- Year 3 of UPXA-FG33 Undergraduate Mathematics and Physics (BSc MMathPhys)
- 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 UPXA-GF14 Undergraduate Mathematics and Physics (with Intercalated Year)
- Year 4 of UMAA-G101 Undergraduate Mathematics with Intercalated Year
- Year 3 of UPXA-F303 Undergraduate Physics (MPhys)