ASTR377

Astrophysics

S1 Day 2019

Dept of Physics and Astronomy

Contents

General Information

Unit convenor and teaching staff Unit Convenor, Lecturer Mark Wardle mark.wardle@mq.edu.au 7WW (E6B) 2.702 Lecturer Orsola De Marco orsola.demarco@mq.edu.au Contact via orsola.demarco@mq.edu.au 7WW (E6B) 2.706 Lab instructor Lee Spitler lee.spitler@mq.edu.au 7WW (E6B) 2.605 Tayyaba Zafar tayyaba.zafar@mq.edu.au
Credit points 3
Prerequisites MATH235 and PHYS201 and PHYS202
Corequisites
Co-badged status
Unit description The first part of this unit covers the physical mechanisms responsible for the generation, absorption and scattering of light in environments as diverse as rarefied nebulae, hot compact stellar atmospheres and distant galaxies. During the second part of the unit the theory of stellar structure and evolution is developed. Students become familiar with the UNIX computing environment and the python programming language, and carry out a project using computer models of how stars are born and die.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

- Understand the principles and difficulties of observational methods that allow us to interpret the physical characteristics of an astronomical object based on the light we receive from it.
- Demonstrate understanding of the way radiation interacts with matter in different astrophysical environments through solving radiative transfer problems.
- Be able to describe the internal structure of our Sun and stars other than the Sun, and explain the key observational properties of different types of stars.
- Apply the equations of stellar structure and the simplifications that lead to polytropic stellar models.
- Be able to explain the processes and physics involved in stellar evolution, including the processes that bring about stellar death.
- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

General Assessment Information

Hurdle tasks

This unit has hurdle requirements, specifying a minimum standard that must be attained in aspects of the unit. To pass this unit you must obtain marks of at least 40% in the final examination, 40% in the laboratory project, and (of course) an overall 50% in the unit.

Supplementary examinations

If you receive special consideration for the final exam, a supplementary exam will be scheduled in the interval between the regular exam period and the start of the next session. By making a special consideration application for the final exam you are declaring yourself available for a resit during the supplementary examination period and will not be eligible for a second special consideration approval based on pre-existing commitments. Please ensure you are familiar with the policy prior to submitting an application. You can check the supplementary exam information page on FSE101 in iLearn (bit.ly/FSESupp) for dates, and approved applicants will receive an individual notification one week prior to the exam with the exact date and time of their supplementary examination.

If you are given a second opportunity to sit the final examination as a result of failing to meet the minimum mark required, you will be offered that chance during the same supplementary examination period and will be notified of the exact day and time after the publication of final results for the unit.

Late Assessments Policy

The non-examination assessment components should be submitted via iLearn by the due date and time.

The penalty for late submission is deduction of 5% of the possible mark for that item for each 24 hour period (or part) overdue. Assessments will not be accepted for marking if submitted more than 1 week past the due date. Extensions to the due dates for assignments, practical assessments, and project will only be considered if requested with valid reason prior to the due date.

Students anticipating or experiencing difficulties in meeting a deadline should discuss this with one of the lecturers in the first instance, ideally ahead of the deadline, if at all possible. Students should also be familiar with the University's provisions for Special Considerations.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignments	20%	No	Throughout semester
Practical Assessments	20%	No	Weeks 2, 5, 7, and 10
Project	20%	Yes	Week 13
Final Examination	40%	Yes	Session 1 exam period

Assignments

Due: **Throughout semester**
Weighting: **20%**

In the first half of the unit there will be 4 short assignments, each worth 2.5% of the final grade. In the 2nd half, there will be two assignments due in weeks 10 and 13 and each worth worth 5% of the final grade. The assignments will be based on the lecture material. They are an integral part of the unit and aid your understanding of the material.

On successful completion you will be able to:

- Understand the principles and difficulties of observational methods that allow us to interpret the physical characteristics of an astronomical object based on the light we receive from it.
- Demonstrate understanding of the way radiation interacts with matter in different astrophysical environments through solving radiative transfer problems.
- Be able to describe the internal structure of our Sun and stars other than the Sun, and explain the key observational properties of different types of stars.
- Apply the equations of stellar structure and the simplifications that lead to polytropic

stellar models.

- Be able to explain the processes and physics involved in stellar evolution, including the processes that bring about stellar death.
- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

Practical Assessments

Due: **Weeks 2, 5, 7, and 10**
Weighting: **20%**

The lab sessions will take the form of exercises using the python computing language to manipulate functions that represent physical systems considered during lectures. The lab work will reinforce concepts from the lectures, and demonstrate how computers can be used to test and explore physical models. Basic numerical techniques and data visualisation will be covered. There will be 4 equally-weighted assessment tasks. Each task will be assigned two-three weeks of lab time. Python notebooks will be used to conduct the labs, and completed notebooks will be submitted and graded electronically. Each notebook will be due one week after its lab time is completed.

On successful completion you will be able to:

- Understand the principles and difficulties of observational methods that allow us to interpret the physical characteristics of an astronomical object based on the light we receive from it.
- Demonstrate understanding of the way radiation interacts with matter in different astrophysical environments through solving radiative transfer problems.
- Be able to describe the internal structure of our Sun and stars other than the Sun, and explain the key observational properties of different types of stars.
- Apply the equations of stellar structure and the simplifications that lead to polytropic stellar models.
- Be able to explain the processes and physics involved in stellar evolution, including the processes that bring about stellar death.
- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

Project

Due: **Week 13**
Weighting: **20%**

This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

Students will undertake a practical project involving computer programming, astrophysical interpretation, report and presentation. Computational facilities will be available in the laboratory. The project will be undertaken during Weeks 10-13.

Satisfactory completion of the project is a hurdle requirement. You must obtain a project mark of at least 40% to pass the unit. If instead you receive a mark of 30-39%, you must within two weeks arrange a new deadline to submit a revised project.

On successful completion you will be able to:

- Understand the principles and difficulties of observational methods that allow us to interpret the physical characteristics of an astronomical object based on the light we receive from it.
- Be able to describe the internal structure of our Sun and stars other than the Sun, and explain the key observational properties of different types of stars.
- Apply the equations of stellar structure and the simplifications that lead to polytropic stellar models.
- Be able to explain the processes and physics involved in stellar evolution, including the processes that bring about stellar death.
- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

Final Examination

Due: **Session 1 exam period**
Weighting: **40%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

The final examination will be of three hours duration plus ten minutes reading time.

You are expected to present yourself for the final examination at the time and place designated in the University examination timetable (http://www.timetables.mq.edu.au/). The timetable will be available in draft form approximately eight weeks before the commencement of examinations and in final form approximately four weeks before the commencement of examinations.

The only exception to not sitting the examination at the designated time is because of documented illness or unavoidable disruption. In these circumstances you may wish to apply for Special Consideration (see 'Special Consideration' in this Guide). If a supplementary examination is granted as a result of the special consideration process the examination will be scheduled after the conclusion of the official examination period.

The final examination is a hurdle requirement. You must obtain a mark of at least 40% to pass the unit. If your mark in the final examination is between 30% and 39% inclusive then you will be a given a second and final chance to attain the required level of performance.

On successful completion you will be able to:

- Understand the principles and difficulties of observational methods that allow us to interpret the physical characteristics of an astronomical object based on the light we receive from it.
- Demonstrate understanding of the way radiation interacts with matter in different astrophysical environments through solving radiative transfer problems.
- Be able to describe the internal structure of our Sun and stars other than the Sun, and explain the key observational properties of different types of stars.
- Apply the equations of stellar structure and the simplifications that lead to polytropic stellar models.
- Be able to explain the processes and physics involved in stellar evolution, including the processes that bring about stellar death.

Delivery and Resources

Your lecturers are Professors Mark Wardle and Orsola De Marco. The lectures will include some tutorial-style material with problem solving examples.

Lab sessions will be hosted by Dr Lee Spitler conducted in the Physics and Astronomy computer lab, and will make use of Python Notebooks, running via the Anaconda python package. **Note that labs start in Week 1.**

Resources will be announced on iLearn. There is no required text, but the course will be closely based on material drawn from one of our favourite books: "An Introduction to Modern Astrophysics" by Carroll and Ostlie.

Unit Schedule

Week 1: Introduction to stars and astrophysical radiation

Week 2: Properties of radiation fields

Week 3: Saha and Boltzmann Equations

Week 4: Atomic processes

Week 5: Radiative transfer

Week 6: Bremsstrahlung from HII regions and clusters of galaxies

Week 7: Opacity in stellar interiors

Week 8: Stellar structure equations

Week 9: Thermodynamics and convection

Week 10: Stellar energy generation and nucleosynthesis

Week 11: Stellar evolution

Week 12: The evolution of massive stars

Week 13: Stellar remnants

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcome

- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

Assessment task

- Project

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcome

- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

Assessment tasks

- Practical Assessments
- Project

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- Understand the principles and difficulties of observational methods that allow us to interpret the physical characteristics of an astronomical object based on the light we receive from it.
- Demonstrate understanding of the way radiation interacts with matter in different astrophysical environments through solving radiative transfer problems.
- Be able to describe the internal structure of our Sun and stars other than the Sun, and explain the key observational properties of different types of stars.
- Apply the equations of stellar structure and the simplifications that lead to polytropic stellar models.
- Be able to explain the processes and physics involved in stellar evolution, including the

processes that bring about stellar death.
- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

Assessment tasks

- Assignments
- Practical Assessments
- Project

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Understand the principles and difficulties of observational methods that allow us to interpret the physical characteristics of an astronomical object based on the light we receive from it.
- Demonstrate understanding of the way radiation interacts with matter in different astrophysical environments through solving radiative transfer problems.
- Be able to describe the internal structure of our Sun and stars other than the Sun, and explain the key observational properties of different types of stars.
- Apply the equations of stellar structure and the simplifications that lead to polytropic stellar models.
- Be able to explain the processes and physics involved in stellar evolution, including the processes that bring about stellar death.
- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

Assessment tasks

- Assignments

- Practical Assessments
- Project
- Final Examination

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Understand the principles and difficulties of observational methods that allow us to interpret the physical characteristics of an astronomical object based on the light we receive from it.
- Demonstrate understanding of the way radiation interacts with matter in different astrophysical environments through solving radiative transfer problems.
- Be able to describe the internal structure of our Sun and stars other than the Sun, and explain the key observational properties of different types of stars.
- Apply the equations of stellar structure and the simplifications that lead to polytropic stellar models.
- Be able to explain the processes and physics involved in stellar evolution, including the processes that bring about stellar death.
- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

Assessment tasks

- Assignments
- Practical Assessments
- Project
- Final Examination

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Understand the principles and difficulties of observational methods that allow us to interpret the physical characteristics of an astronomical object based on the light we receive from it.
- Demonstrate understanding of the way radiation interacts with matter in different astrophysical environments through solving radiative transfer problems.
- Be able to describe the internal structure of our Sun and stars other than the Sun, and explain the key observational properties of different types of stars.
- Apply the equations of stellar structure and the simplifications that lead to polytropic stellar models.
- Be able to explain the processes and physics involved in stellar evolution, including the processes that bring about stellar death.
- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

Assessment tasks

- Assignments
- Practical Assessments
- Project
- Final Examination

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcome

- Be able to apply computational techniques to model physical phenomena in different astrophysical environments using the Unix environment and elements of the python computing language.

Assessment tasks

- Assignments
- Project
- Final Examination