ASTR707

Advanced Astrophysics

S2 Day 2018

Dept of Physics and Astronomy

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General Information

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Credit points
4

Prerequisites
Admission to MRes

Corequisites

Co-badged status

Unit description
This unit covers the fundamental physics of celestial objects such as stars and galaxies. It starts with the physics of fluid dynamics and the interaction of matter with light; these concepts are then used to describe the interstellar medium, including star formation and the stellar feedback of energy and new elements. The unit concludes with a discussion of galactic formation and evolution from the standpoints of interstellar gas and stellar populations. Observations of real celestial objects are used throughout the unit as examples of the processes we need to explain. Throughout the unit strong emphasis is placed on the connection between observations and interpretation. The student will gain an understanding of how different types of observations (imaging, spectroscopy, multi-wavelength approaches, survey approaches) can allow us to gain insight into specific astrophysical situations and how these observations can be interpreted in the light of theory. The scientific method will be used and emphasised as the backbone of all research and its stages underlined during class and all the activities.

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 dynamics of gas flows in Astrophysical environments (including magnetic fields, shocks and viscosity). Applications to disks and jets will be discussed in particular.

Understand stellar pulsations and role this plays in stellar evolution and mass loss.

Understand the synthesis of elements in stars and their observed chemical abundances

Solve problems in real-time during class tutorials, and demonstrate solutions to peers

Learn to communicate complex physical concepts in writing and orally.

Learn how to exploit computers to solve astrophysical problems.

General Assessment Information

Class participation: during lectured classes and tutorials there will be plenty of opportunities to ask and answer questions posted by the lecturers or by fellow students. Emphasis will not be given to giving correct answers but rather to ask pertinent questions.

Computer programming: programming a computer to answer questions that are not simple to answer in any other way is an essential skill not just in Astrophysics but in any job that require a science degree as a platform. This task comprises a part where the student writes a computer code, and a second part where the student uses a computer programme to model data. This task is a hurdle: the computer programming task must be completed satisfactorily to pass this unit.

Presentation: the ability to explain any concept in a clear fashion and according to some pre-agreed specification (level of depth, time constraints, etc.) is a key skill to be mastered by any science student. This is why this assessment task is part of this unit.

Short answers: in an ideal world students would read the material at home and come to class ready to have discussions about it. The lecturer would then be there to consolidate concepts and stimulate a deeper understanding. To ensure that students are ready for the material presented in any given week, a marked assessment will be given forcing students to carry out some basic preparation before the class. These very short weekly assessments cannot be caught up or handed in late. The penalty to miss them, however, is not just the grade, but rather the level of understanding that can be reached in the class.

Assignments: four exam style short assignments will be given to prepare students for the type of questions they might be getting in the final exam and to test their general understanding and their problem solving skills.

The final examination will be of three hours duration plus ten minutes reading time. The final examination is similar to the Assignments in style, but is carried out under controlled conditions

and without the help of books. Battery or solar powered calculators which do not have a full alphabet on the keyboard will be allowed into the examination. Calculators with text retrieval are not permitted for the final examination.

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. You are advised that it is the policy of the University not to set early examinations for individuals or groups of students. All students are expected to ensure that they are available until the end of the teaching semester, i.e. the final day of the examination period.

Assessment Tasks

Name	Weighting	Hurdle	Due
Class participation	10%	No	Throughout
Computer training	15%	Yes	Week 5 and 6: 28/08, 04/09
Presentation	15%	No	Week 7: 14/09
Short answers	10%	No	Monday weeks 8-13
Assignments	20%	No	04/09, 16,23,30/10
Final Exam	30%	Yes	University Exam Period

Class participation

Due: **Throughout**
Weighting: **10%**

Class participation can be demonstrated by class and tutorial attendance, question asking and active participation in seeking solutions to tutorial problems in group settings.

On successful completion you will be able to:

- Understand the dynamics of gas flows in Astrophysical environments (including magnetic fields, shocks and viscosity). Applications to disks and jets will be discussed in particular.
- Understand stellar pulsations and role this plays in stellar evolution and mass loss. Understand the synthesis of elements in stars and their observed chemical abundances

- Solve problems in real-time during class tutorials, and demonstrate solutions to peers
- Learn to communicate complex physical concepts in writing and orally.

Computer training

Due: **Week 5 and 6: 28/08, 04/09**
Weighting: **15%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

Each student will be carrying out an assignment involving computational modelling. This assignment is broken into two tasks, one involving programming and one involving pre-existing programs to model data. This assignment will be due before the mid-semester break and it is a hurdle: satisfactory completion of this task is necessary to pass this unit.

On successful completion you will be able to:

- Understand stellar pulsations and role this plays in stellar evolution and mass loss. Understand the synthesis of elements in stars and their observed chemical abundances
- Learn how to exploit computers to solve astrophysical problems.

Presentation

Due: **Week 7: 14/09**
Weighting: **15%**

In this task each student will be presenting for 10 minutes and hand in a 1 page report on a topic mutually agreed with the lecturer in Week 2.

On successful completion you will be able to:

- Learn to communicate complex physical concepts in writing and orally.

Short answers

Due: **Monday weeks 8-13**
Weighting: **10%**

Each week in the second part of the unit (weeks 8 to 13) students will be uploading a short answer to a question posted the previous week. The question will pertain material that the student has not yet been taught in class, but for which a specified reading will be given. The deadlines will be Monday 1, 8, 15, 12, 29 October and 5th November, before midnight and will be returned in class on the following day.

On successful completion you will be able to:

- Understand the dynamics of gas flows in Astrophysical environments (including magnetic fields, shocks and viscosity). Applications to disks and jets will be discussed in particular.

- Understand stellar pulsations and role this plays in stellar evolution and mass loss. Understand the synthesis of elements in stars and their observed chemical abundances
- Learn to communicate complex physical concepts in writing and orally.

Assignments

Due: **04/09, 16,23,30/10**
Weighting: **20%**

Four assignments comprising mixed exam style questions will be given in the second part of the unit.

On successful completion you will be able to:

- Understand the dynamics of gas flows in Astrophysical environments (including magnetic fields, shocks and viscosity). Applications to disks and jets will be discussed in particular.
- Understand stellar pulsations and role this plays in stellar evolution and mass loss. Understand the synthesis of elements in stars and their observed chemical abundances
- Solve problems in real-time during class tutorials, and demonstrate solutions to peers
- Learn to communicate complex physical concepts in writing and orally.

Final Exam

Due: **University Exam Period**
Weighting: **30%**
This is a hurdle assessment task (see assessment policy for more information on hurdle assessment tasks)

A 3-hour (plus 10 minute reading time) exam will cover all lectured content. Questions will be problem-style as well as short answer style.

On successful completion you will be able to:

- Understand the dynamics of gas flows in Astrophysical environments (including magnetic fields, shocks and viscosity). Applications to disks and jets will be discussed in particular.
- Understand stellar pulsations and role this plays in stellar evolution and mass loss. Understand the synthesis of elements in stars and their observed chemical abundances
- Solve problems in real-time during class tutorials, and demonstrate solutions to peers

Delivery and Resources

The course will be delivered through weekly lectures and tutorial sessions. The unit will cover four parts:

1) Stellar Pulsations and Stellar Nucleosynthesis (7 weeks, lecturer Devika Kamath)

2) The physics of fluids, astrophysics of accreting gas in star formation and binary interactions (6 weeks, lecturer Orsola De Marco)

Each part will be assessed via assignments during the term, and will be approximately proportionally represented in the final exam.

Unit Schedule

Week 1-3: Stellar pulsation

Week 4: Stellar pulsation (self-study week)

Week 5: Stellar pulsation and nucleosynthesis

Week 6-7: Nucleosynthesis: the genesis of the elements

Week 8: The equations of fluid dynamics

Week 9: The equations of fluid dynamics and shocks

Week 10: Shocks and viscosity

Week 11: Viscosity and accretion disks (and maybe jets)

Week 12-13: Accretion disks and jets

Learning and Teaching Activities

Lecturing

Classic style lecturing using Powerpoint-style presentations including movies as well as white board demonstration will be carried out for an approximately 2 hours per week.

Tutorials

Two hours per week will be dedicated to tutorials. These will include problem solving in small groups, class discussions, short presentations and Q and A sessions.

Presentations

Towards the end of the first part of the course, each student will present in class on a chosen topic.

Computer programming

Students will be using computer programming to solve problems.

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 shown in *iLearn*, 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.

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

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

PG - Capable of Professional and Personal Judgment and Initiative

Our postgraduates will demonstrate a high standard of discernment and common sense in their professional and personal judgment. They will have the ability to make informed choices and decisions that reflect both the nature of their professional work and their personal perspectives.

This graduate capability is supported by:

Learning outcome

- Learn to communicate complex physical concepts in writing and orally.

Assessment task

- Class participation

PG - Discipline Knowledge and Skills

Our postgraduates will be able to demonstrate a significantly enhanced depth and breadth of knowledge, scholarly understanding, and specific subject content knowledge in their chosen fields.

This graduate capability is supported by:

Learning outcomes

- Understand the dynamics of gas flows in Astrophysical environments (including magnetic fields, shocks and viscosity). Applications to disks and jets will be discussed in particular.
- Understand stellar pulsations and role this plays in stellar evolution and mass loss. Understand the synthesis of elements in stars and their observed chemical abundances
- Solve problems in real-time during class tutorials, and demonstrate solutions to peers
- Learn to communicate complex physical concepts in writing and orally.
- Learn how to exploit computers to solve astrophysical problems.

Assessment tasks

- Class participation
- Computer training
- Presentation
- Short answers
- Assignments
- Final Exam

Learning and teaching activities

- Classic style lecturing using Powerpoint-style presentations including movies as well as white board demonstration will be carried out for an approximately 2 hours per week.
- Two hours per week will be dedicated to tutorials. These will include problem solving in small groups, class discussions, short presentations and Q and A sessions.
- Towards the end of the first part of the course, each student will present in class on a chosen topic.
- Students will be using computer programming to solve problems.

PG - Critical, Analytical and Integrative Thinking

Our postgraduates will be capable of utilising and reflecting on prior knowledge and experience, of applying higher level critical thinking skills, and of integrating and synthesising learning and knowledge from a range of sources and environments. A characteristic of this form of thinking is the generation of new, professionally oriented knowledge through personal or group-based critique of practice and theory.

This graduate capability is supported by:

Learning outcomes

- Understand the dynamics of gas flows in Astrophysical environments (including magnetic fields, shocks and viscosity). Applications to disks and jets will be discussed in particular.
- Understand stellar pulsations and role this plays in stellar evolution and mass loss. Understand the synthesis of elements in stars and their observed chemical abundances
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- Learn how to exploit computers to solve astrophysical problems.

Assessment tasks

- Class participation
- Computer training
- Short answers

- Assignments
- Final Exam

Learning and teaching activities

- Classic style lecturing using Powerpoint-style presentations including movies as well as white board demonstration will be carried out for an approximately 2 hours per week.
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- Students will be using computer programming to solve problems.

PG - Research and Problem Solving Capability

Our postgraduates will be capable of systematic enquiry; able to use research skills to create new knowledge that can be applied to real world issues, or contribute to a field of study or practice to enhance society. They will be capable of creative questioning, problem finding and problem solving.

This graduate capability is supported by:

Learning outcomes

- Understand the dynamics of gas flows in Astrophysical environments (including magnetic fields, shocks and viscosity). Applications to disks and jets will be discussed in particular.
- Understand stellar pulsations and role this plays in stellar evolution and mass loss. Understand the synthesis of elements in stars and their observed chemical abundances
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Assessment tasks

- Class participation
- Computer training
- Short answers
- Assignments
- Final Exam

Learning and teaching activities

- Classic style lecturing using Powerpoint-style presentations including movies as well as white board demonstration will be carried out for an approximately 2 hours per week.
- Two hours per week will be dedicated to tutorials. These will include problem solving in small groups, class discussions, short presentations and Q and A sessions.
- Students will be using computer programming to solve problems.

PG - Effective Communication

Our postgraduates will be able to communicate effectively and convey their views to different social, cultural, and professional audiences. They will be able to use a variety of technologically supported media to communicate with empathy using a range of written, spoken or visual formats.

This graduate capability is supported by:

Learning outcomes

- Solve problems in real-time during class tutorials, and demonstrate solutions to peers
- Learn to communicate complex physical concepts in writing and orally.

Assessment tasks

- Class participation
- Presentation
- Short answers
- Assignments
- Final Exam

Learning and teaching activities

- Two hours per week will be dedicated to tutorials. These will include problem solving in small groups, class discussions, short presentations and Q and A sessions.
- Towards the end of the first part of the course, each student will present in class on a chosen topic.

PG - Engaged and Responsible, Active and Ethical Citizens

Our postgraduates will be ethically aware and capable of confident transformative action in relation to their professional responsibilities and the wider community. They will have a sense of connectedness with others and country and have a sense of mutual obligation. They will be able to appreciate the impact of their professional roles for social justice and inclusion related to national and global issues

This graduate capability is supported by:

Learning outcome

- Learn to communicate complex physical concepts in writing and orally.

Assessment tasks

- Class participation
- Presentation

Changes from Previous Offering

In the previous offering, the unit also contained:

1) Physics of the interstellar medium (3 weeks, lecturer Joanne Dawson)

2) MHD treatment of star formation (5 weeks, lecturer Orsola De Marco)

3) Nucleosynthesis and stellar pulsations (5 weeks, lecturer Devika Kamath)

Modifications this year will be:

1) Stellar pulsations and nucleosynthesis is expanded from 5 to 7 weeks in weeks 1-7 (lecturer Devika Kamath)

2) Magneto-hydrodynamics equations will be presented in connection with star formation as well as accretion in general and disk formation and evolution. Less emphasis on star formation will be given, particularly less emphasis on observations and star formation (lecturer Orsola De Marco)

Assessment was modified as follows:

1) The final exam weighting was reduced from 50 to 30%.

2) A class participation item was introduced with a weighting of 10%.

3) A presentation assessment was added.

4) An assessment task (short answers) was added to allow a flip of the classroom in the second half of the unit.

Changes since First Published

Date	Description
27/07/2018	Tweaked assessment task weighting and clarified deadlines.