PHYS1116

ASTROPHYSICS

School of Physics

Faculty of Science

Term 2, 2022

Faculty of Science - Course Outline

1. Information about the course

NB: Some of this information is available on the UNSW Handbook[1]

Year of delivery	2022
Course Code	PHYS1116
Course name	Astrophysics
Academic unit	School of Physics
Level of course	1
Units of credit	6 UOC
Session(s) offered	Term 2
Assumed knowledge, prerequisites or co-requisites	None
Hours per week	Approximately 15 hours per week of self-directed study. Note that this course is mostly online, so most of this time is spent engaging with online course resources and completing assessments. The rest of the time is spent in a face-to-face two-hour tutorial.
Number of weeks	10 weeks
Commencement date	30 May 2022
Grading	This course uses standard university grading.
Component	**Details**
Lectures	These are available on Moodle and contain a mixture of written material, pre-recorded videos, and example and practice problems.
Quizzes	A series of weekly Moodle quizzes that contain numerical and conceptual problems for students to test their understanding of course material.
Laboratory Exercises	You will complete three at-home or independent simulation experiments and summarise their findings.
Short Reports	You will analyse a provided prompt or scenario and prepare a brief written report.
Written assignment	You will use the knowledge and communication skills you have gained in the course to write an article based upon a topic provided by the course facilitator.

[1] UNSW Online Handbook: http://www.handbook.unsw.edu.au

2. Staff Involved in the Course

Role	Name	Contact details	Consultation times	Queries
Facilitator The facilitator is your main point of contact during the term	Dr. Ben Montet	b.montet@unsw.edu.au	Email to arrange a time	Course content Administration questions
Editor	Dr. Kate Jackson	kate.jackson1@unsw.edu.au	Email to arrange a time	Administration questions
Teaching assistants	Announced on Moodle			Queries related to marking
Other support staff	Zofia Krawczyk-Bernotas	z.krawczyk-bernotas@unsw.edu.au Room G06, OMB	Email to arrange a time	Administration questions

3. Course details

Course description (Handbook entry)	This course provides an introduction to astrophysics aimed at students who are taking a science or advanced science degree and majoring in physics or a physical science, or who want a more challenging, higher level introduction to the subject. The topics covered in this course are the same as PHYS1160, but with an increased quantitative perspective. An additional focus will be provided on the details of the facilities and techniques used in modern astrophysics research. Astrophysics features more advanced assessment, including a separate problem-solving tutorial and distinct laboratory exercises. Topics to be covered include: astronomical techniques, the history of astronomy across cultures, the Big Bang and beginnings of the universe, formation and evolution of galaxies, the origin of life on Earth and search for life elsewhere, stellar structure and evolution, planet formation, black holes, and compact objects.
Course aims	This course is intended primarily as a technical subject and a pathway into the higher year astrophysics subjects PHYS2116 and PHYS3116. It has Physics 1A (PHYS1121) as assumed prior knowledge. Students without a background in physics should consider instead PHYS1160 Introduction to Astronomy, which is a standalone course with a broader, more qualitative focus.
Student learning outcomes	At the conclusion of this course students should be able to: • Analyse astronomical data from modern telescope surveys of stars and galaxies using techniques frequently used by professional astronomers. • Solve astronomy-related problems using quantitative methods. • Apply knowledge of key concepts in astronomy and astrobiology, including the formation of stars, planets, and galaxies; the history of life on Earth; and the beginning and ultimate fate of the Universe. • Justify how, using simple experimental techniques, astrophysical phenomena can be observed and used to demonstrate our understanding of the Universe. • Demonstrate an ability to communicate astronomical concepts accurately and at an appropriate level to technical audiences.
Graduate attributes developed in this course	
Graduate attributes	**These learning outcomes have been associated with this graduate attribute:**
The skills involved in scholarly enquiry	Analyse astronomical data from modern telescope surveys of stars and galaxies using techniques frequently used by professional astronomers. Justify how, using simple experimental techniques, astrophysical phenomena can be observed and used to demonstrate our understanding of the Universe.
The capacity for analytical and critical thinking and for creative problem-solving	Analyse astronomical data from modern telescope surveys of stars and galaxies using techniques frequently used by professional astronomers. Solve astronomy-related problems using quantitative methods.
The ability to engage in independent and reflective learning	Demonstrate an ability to communicate astronomical concepts accurately and at an appropriate level to technical audiences.
Information literacy: the skills to appropriately locate, evaluate and use relevant information	Justify how, using simple experimental techniques, astrophysical phenomena can be observed and used to demonstrate our understanding of the Universe. Demonstrate an ability to communicate astronomical concepts accurately and at an appropriate level to technical audiences.
Relationship to other courses within the program	This is a stand-alone course as it is not a required course of any program.

Syllabus	**Theme 1: What are historical and modern astronomy?**
	• Lecture 1: What is astronomy? An introduction into historical and modern astronomy, and the physics of taking astronomical observations. • Lecture 2: What physics is important to astronomy? A detailed look into the physics needed for understanding astronomy.
	Theme 2: How did the Universe begin?
	• Lecture 3: What is cosmology? A detailed look into the beginning of the Universe and the observational evidence for the underlying theories.
	Theme 3: What are galaxies?
	• Lecture 4: What are galaxies? Galaxy types, formation, and evolution, including mergers and active galactic nuclei. • Lecture 5: The Milky Way Galaxy A quantitative look into our own home galaxy and the observational evidence for what we know.
	Theme 4: What are stars?
	• Lecture 6: What are stars? The physics behind stars, including star formation, stellar evolution, and why binaries are so important. • Lecture 7: What is so special about the Sun? The Sun's structure, nuclear fusion in the Sun, and solar activity.
	Theme 5: What is the Solar system?
	• Lecture 8: What is the Solar system? A quantitative analysis of Kepler's laws in how the Solar System works, as well as the Solar System bodies. • Lecture 9: What is the Earth? A look into the formation and evolution of the Earth.
	Theme 6: Is there life in the Solar system?
	• Lecture 10: What is life? An introduction into the necessities for life. • Lecture 11: Is there life in the Solar system? A look into the possible locations that life could exist in our own Solar System.

	Theme 7: What is beyond the Solar system?
	• Lecture 12: What is beyond the Solar system? Analysing exoplanet detection methods (using data) and classifying different types of exoplanets.
	Theme 8: Is there life in the Universe?
	• Lecture 13: How do we find life on other worlds? What evidence of life can we detect, and how do we detect it? Where are the best places to look for life, and what tools do we use? • Lecture 14: How else can we find life? An introduction into SETI and AI life.
	Theme 9: How does everything end?
	• Lecture 15: What are supernovae and stellar remnants? A detailed look into the final objects of stars, how metals permeate the Universe, and a precursor to the Universe's end. • Lecture 16: What are gravitational waves? An introduction into the 100-year-old theory finally proven correct, including physics of gravitational waves and black hole/neutron star mergers. • Lecture 17: How will the Universe end? A look into what is likely to occur at the end of the Universe, which includes a discussion on dark matter and energy, and the Hubble constant controversy.

4. Rationale and strategies underpinning the course

Teaching strategies	This course is largely online. Each week, students will have videos to watch and course material to read as part of lectures that look at different concepts in astronomy. In most weeks, students will complete a short quiz consisting of quantitative and qualitative questions. Feedback for incorrect answers will be provided. The quizzes (8 in total) contribute 10% to the final grade. While learning the material, students will be posed problems or scenarios to answer, in the form of a short report. These written assignments will provide students the opportunity to develop their quantitative reasoning and technical communication skills. These short reports (3 in total) contribute 30% to the final grade. Astrophysics is a physical science, with a long history of progress driven through experimentation and observation. To gain experience with astronomical techniques and scientific communication, students will complete three laboratory or simulation exercises from six options throughout the term. They will produce a brief report detailing their lab activity and answering quantitative questions about their analysis. These labs (3 in total) contribute 30% to the final grade. During the course, students will be allocated NASA Astronomy Picture of the Day (APOD) images. Students will select an image from the ones allocated to them to make the focus of an original written assessment. This allows students to choose an image related to topics that interests them and aims to improve students' research and communication skills. Students will submit the written piece to Turnitin via Moodle in two phases: a draft worth 5% and the final assessment worth 25%. Marking will be done by a teaching assistant.
Rationale for learning and teaching in this course	This course aims to expose students to a wide variety of astronomy concepts and engage them by allowing creativity and the freedom to research their own interests. The rationale behind this approach is to give students astronomical literacy (i.e., allow them to read and understand a variety of media about astronomy) and engage their sense of wonder for astronomy by allowing independent research on a topic of choice. By allowing student-directed assessments, students' intrinsic motivation to complete the assessment tasks increases. Additionally, students gain vital research and communication skills that can be applied to future employment situations.
Rationale for assessment in this course	As this course aims to increase the astronomical literacy and sense of wonder for astronomy of each student, the capstone assessment for the course is an original written assessment. Students are assigned multiple NASA APOD images, of which the student chooses one to be the focus of their assessment. Giving students flexibility in the topic of their assessment allows them to follow their interests and increases intrinsic motivation. Additionally, students engage their creativity by formatting the assessment in any style they choose, provided that the information can be conveyed sufficiently. The skills needed to complete the assessment are scaffolded during the course by completing three short reports, where students will prepare a short analysis of a posed question or scenario. Students also submit a draft of the capstone assessment and get feedback from tutors on their approach. To ensure astronomical literacy, students will complete astronomy questions based on the concepts covered in each lecture in weekly quizzes, due most weeks. To gain hands-on experience with astrophysical techniques, students will complete three at-home or simulation-based experiments and present their findings.

5. Course schedule

Week	Theme	Lecture	Assignment and submission dates (see also 'Assessment tasks & feedback')
Week 1	What is historical astronomy? What is modern astronomy?	Lecture 1: What is astronomy? Lecture 2: What physics is important to astronomy?	
Week 2	How did the Universe begin?	Lecture 3: What is cosmology?	Quiz 1 Short Report 1
Week 3	What are galaxies?	Lecture 4: What are galaxies? Lecture 5: The Milky Way Galaxy	Quiz 2 Lab 1
Week 4	What are stars?	Lecture 6: What are stars? Lecture 7: What is so special about the Sun?	Quiz 3 Short Report 2
Week 5	What is the Solar system?	Lecture 8: What is the Solar system? Lecture 9: What is the Earth?	Quiz 4 Written Assignment Draft
Week 6	Flexibility Week	Additional Lecture: Astronomy as a professional practice	
Week 7	Is there life in the Solar system?	Lecture 10: What is life? Lecture 11: Is there life in the Solar system?	Quiz 5 Lab 2
Week 8	What is beyond the Solar system?	Lecture 12: What is beyond the Solar system?	Quiz 6 Short Report 3
Week 9	Is there life in the Universe?	Lecture 13: How do we find life on other worlds? Lecture 14: How else can we find life?	Quiz 7 Written Assignment
Week 10	How does everything end?	Lecture 15: What are supernovae and stellar remnants? Lecture 16: What are gravitational waves? Lecture 17: How will the universe end?	Quiz 8 Lab 3

6. Assessment tasks and feedback

Task	Knowledge & abilities assessed	Assessment criteria	% of total mark	Date of		Feedback		
				Release	Submission[2]	WHO	WHEN	HOW
Quizzes	Solve astronomy-related problems using quantitative methods. Apply knowledge of key concepts in astronomy and astrobiology.	Students need to correctly answer the quiz questions.	10% = 1.25% × 8	At start of course	Friday (at the end of most weeks) At 11:59 PM	Facilitator	Marks and feedback available immediately after quiz attempt	Marks and feedback provided in Moodle quiz.
Short reports	Apply knowledge of key concepts in astronomy and astrobiology. Demonstrate an ability to communicate astronomical concepts accurately and at an appropriate level to technical audiences.	Students need to respond to a given question or scenario and submit a report to Turnitin	30% = 10% × 3	At start of course	10/06/22 24/06/22 22/07/22 At 11:59 PM	Tutor	20/06/22 04/07/22 01/08/22	Comments and rubric in Turnitin[3]
Laboratory exercises	Analyse astronomical data from modern telescope surveys of stars and galaxies using techniques frequently used by professional astronomers. Justify how, using simple experimental techniques, astrophysical phenomena can be observed and used to demonstrate our understanding of the Universe.	Students need to conduct at-home or simulation experiments and submit their findings	30% = 10% × 3	At start of course	17/06/22 15/07/22 05/08/22 At 11:59 PM	Tutor	27/06/22 25/07/22 15/08/22	Comments and rubric on Moodle
Written assessment	Apply knowledge of key concepts in astronomy and astrobiology. Demonstrate an ability to communicate astronomical concepts accurately and at an appropriate level to technical audiences.	This task has 3 parts: 1. Allocation of APOD images. 2. Submit a draft of your assessment. 3. Submit your final assessment.	30% = 5% 25%	By start of week 2	 01/07/22 29/07/22 At 11:59 PM	Facilitator Tutor Tutor	 11/07/22 08/08/22	Moodle Comments and rubric in Turnitin[3]

[2] All times and dates are given for Australian Eastern Standard Time (AEST, Sydney) or Australian Eastern Daylight Time (AEDT, Sydney). If a student is studying from overseas, it is their responsibility to check that they submit it by the due time.
[3] Marking rubrics can be found on the Moodle site for this course.

7. Additional resources and support

Textbooks	No prescribed text
Required readings	Will be made available on Moodle
Additional readings	If students want a textbook for the course (not required), we recommend the book Carroll, B., & Ostlie, D. (2017). An Introduction to Modern Astrophysics (2nd ed.). Cambridge: Cambridge University Press, which can be obtained from the Library.
Recommended internet sites	Will be made available on Moodle

8. Required equipment, training and enabling skills

Equipment required	No equipment is required other than a computer.
Enabling skills training required to complete this course	ELISE It is highly recommended that you complete the Moodle module on academic integrity before submitting assessments for this course. Plagiarism and contract cheating have been a problem with previous cohorts. These cases have been found and acted upon. Please ensure that you are aware of the University's expectations around academic integrity.

9. Course evaluation and development

Student feedback is gathered periodically by various means. Such feedback is considered carefully with a view to acting on it constructively wherever possible. This course outline conveys how feedback has helped to shape and develop this course.

Mechanisms of review	Last review date	Comments or changes resulting from reviews
Major course review	T2 2022	The course is new in T2 2022.

10. Administration matters

Expectations of students	Even though this course is largely online, the assumption is that students will spend the same amount of time working on it as a face-to-face first year course. Students should spend approximately 15 hours a week engaging with course materials, including online materials and self-directed study of the subject.		
Assignment submissions	All submission times are in Australian Eastern Standard Time (AEST, Sydney) or Australian Eastern Daylight Time (AEDT). There is a 5% penalty for each day the written assessment and short reports are late. Submissions 5+ days late (120 hours past the deadline) *will not be marked*. This is applied using the time Moodle shows the assignment was submitted (in Turnitin). Students should submit well in advance of the submission deadline as the Moodle can slow down due to heavy usage at the due time. **If a student experiences any difficulty submitting an assignment through Moodle, they must email a copy of the assignment to the course facilitator before the assignment is due with a report of what went wrong (so that we can fix it).** Quizzes will be taken and submitted through the Moodle quiz interface. These will be marked through this system, with scores and feedback provided directly to students immediately after completing the quiz. Short reports and the written assignment will be submitted through the Turnitin interface inside of Moodle. These assignments will be marked by tutors, following a rubric to ensure consistency across groups, and feedback will be provided to students within ten days of submission. Laboratory exercise activities will be submitted through Moodle, with students completing video-based reports describing their analysis and findings, and answering posed questions. These videos will be reviewed by tutors, who will provide feedback and marks, following a rubric to ensure consistency across groups. Feedback will be provided to students within ten days of submission. If you are not able to submit one of the assessments for reasons beyond your control, you should submit a special consideration request with supporting documentation.		
Occupational health and safety[4]	OH&S is very important. Familiarise yourself with any potential risks encountered while completing this course.		
Assessment procedures UNSW assessment policy[5]	The UNSW special consideration information can be found here.		
Equity and diversity	Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course facilitator prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (or 9385 4734). Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.		
Student complaint procedure[6]	**School contact** A. Prof. Elizabeth Angstmann First year Physics Director e.angstmann@unsw.edu.au Or Prof. Adam Micolich, Director of Teaching, Physics adam.micolich@unsw.edu.au	**Faculty contact** Deputy Dean Education A. Prof. Alison Beavis a.beavis@unsw.edu.au	**University contact** Student Conduct and Appeals Officer (SCAO) within the Office of the Pro-Vice-Chancellor (Students) and Registrar. Telephone 02 9385 8515, email studentcomplaints@unsw.edu.au University Counselling and Psychological Services[7] Tel: 9385 5418

[4] UNSW OHS Home page
[5] UNSW Assessment Policy
[6] UNSW Student Complaint Procedure
[7] University Counselling and Psychological Services

11. Academic integrity, referencing and plagiarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.

Further information about referencing styles can be located here.

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage.[8] At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity and plagiarism can be located at:

- The Current Students site, and
- The ELISE training site.

The Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student.

[8] International Center for Academic Integrity, 'The Fundamental Values of Academic Integrity', T. Fishman (ed), Clemson University, 2013.