School of Physics

# Course Outline 2020

# PHYS3116

# Astrophysics

School of Physics

Faculty of Science

T3, 2020

version 16 September 2020

# 1. Staff Involved in the Course

| Role | Name | Email | Consultation times and locations |
|---|---|---|---|
| Course Convenor | A/Prof Kim-Vy Tran | kim-vy.tran@unsw.edu.au | Consultation times: arrange by email |
| Lecturer | Prof Sarah Brough | s.brough@unsw.edu.au | Consultation times: arrange by email |
| Tutor | Shannon Melrose | s.melrose@unsw.edu.au | Consultation times: arrange by email |
| Teaching Support Officer | Zofia Krawczyk-Bernotas | z.krawczyk-bernotas@unsw.edu.au | School of Physics office G06, Old Main Building |

# 2. Course information

**Prerequisites**

PHYS2111 or PHYS2110, and MATH2069 or MATH2011 or MATH2111.

Knowledge of Python programming and Jupyter notebook is useful but not required.

## 2.1 Course summary

Stars form the basic building blocks of our Galaxy and make up one of the fundamental scales on which structure is found in the Universe. This course provides an introduction to the physics of stars, galaxies, and the universe. The aim is to give students an introduction to our current state of knowledge about fundamental astronomical objects, what they contain, their physical parameters, how they function, and how they evolve. The basic mathematical formalism governing the physics of these objects is presented, though the detailed solutions of the equations are not attempted.

Topics to be covered include: Stellar radiation, spectral classification. Hertzsprung Russell diagram, determination of stellar masses and radii. Equations of stellar structure. Energy sources in stars: nuclear reaction cycles, energy transport, equations of state, degeneracy, opacity. Properties of main sequence stars: stellar evolution, structure of red giants and white dwarfs. Galaxies: composition and evolution. The distance scale. Large-scale structure of the universe. Observational cosmology. Cosmic Microwave Background.

## 2.2 Graduate Attributes Developed in this Course

1. Research, inquiry and analytical thinking abilities
2. Capability and motivation for intellectual development
3. Ethical, social and professional understanding

4. Communication in a scientific/technical context
5. Teamwork, collaborative and management skills
6. Information literacy

## 2.3 Course learning outcomes (CLO)

Students will learn about the fundamentals of modern astrophysics from theoretical and observational perspectives. Topics in modern astrophysics include stellar structure, nucleosynthesis, the Milky Way, galaxy evolution, and cosmology.

By the end of this course, students will be able to:

1. Explain the basic physical parameters of stars and galaxies
2. Describe the life cycle of stars and the evolution of galaxies and the universe
3. Formulate the equations that govern the structure of stars, and recall the physical principles that govern their energy production

## 2.4 Relationship between course and program learning outcomes and assessments

Course learning outcomes 1-3 are assessed in the four assessment tasks. These assessments are largely of a critical-thinking nature designed to determine students' ability to deploy acquired knowledge to new situations, which is a key graduate attribute for successful university graduates.

# 3. Strategies and approaches to learning

## 3.1 Course Timetable

Lectures: 1 x 2hr (Monday), 2 x 1hr (Wednesday, Friday) per week (Week 1-5, 7-10)
Tutorials: 1 hr (Thursday) per week (Weeks 1-5, 7-10)

Synchronous online lectures via Blackboard Collaborate Ultra which is accessed through Moodle portal.

Synchronous Tutorials in person and online.

| Day | Time | Type | Location |
|---|---|---|---|
| Monday<br>Weeks 1-3, 5, 7-11 | 12:00-14:00 | Lecture | Online and recordings posted |
| Wednesday<br>Weeks 1-5, 7-10 | 13:00-14:00 | Lecture | Online and recordings posted |
| Thursday<br>Weeks 1-5, 7-10 | 14:00-15:00 | Tutorial | 14:00-15:00 CLB7 and recordings posted |
| Friday<br>Weeks 1-5, 7-10 | 11:00-12:00 | Lecture | Online and recordings posted |

**Staff Information**

This course is taught by two lecturers teaching 18 hours each:
Weeks 1-5 (Monday, Wednesday, Friday): Lecturer Kim-Vy Tran
Weeks 7-11 (Monday, Wednesday, Friday): Lecturer Sarah Brough

Thursday tutorials are taught by Shannon Melrose

## 3.2 Textbook and Resources

**Course Textbook**

*"An Introduction to Modern Astrophysics"* by Carroll and Ostlie, 2nd Edition, International version: Hardcopy and electronic versions available at UNSW Library as well as for purchase through Cambridge Press.

**Online communications**
Use Moodle for messaging and resources during lectures and tutorials. Direct email to the lecturers and/or tutor is recommended for inquiries outside of class times.

**Other Resources**

Lecture notes will be posted on Moodle along with lecture recordings.

## 3.3 Expectations of students

We believe that effective learning is best supported by a climate of enquiry where students are actively engaged in the learning process. To ensure effective learning, students are expected to participate in class. Effective learning is achieved when students attend class, have prepared for class by reviewing previous lecture notes, and attempted problems prior to the class.

**Academic misconduct will not be tolerated in any form in this course**. Substantiated instances of cheating, plagiarism or copying answers may result in a failure grade or significant deduction of marks. Please read https://student.unsw.edu.au/plagiarism if you are in any way unsure of what constitutes plagiarism.

# 4. Assessment

## 4.1 Assessment tasks

Course assessment comprises two assignments, one in-session test, and the final examination.

| Assessment task | Length | % of Total Mark | Due date |
|---|---|---|---|
| Assignment 1 | | 10% | Friday 16th October, by 17:00<br>Week 5 |
| Mid-term Test | 50 mins | 20% | Wednesday 28th October, 13:00-13:50<br>Week 7 |

| | | | |
|---|---|---|---|
| Assignment 2 | | 10% | Friday 13th November, by 17:00<br>Week 9 |
| Final Exam | 2 hours | 60% | See exam schedule (TBA) |

**Further information**

UNSW grading system: student.unsw.edu.au/grades

UNSW assessment policy: student.unsw.edu.au/assessment

## 4.2 Assessment criteria and standards

Please see Moodle for marking rubrics for each assessment task.

## 4.3 Submission of assessment tasks

**Assignment Submissions**
Unless otherwise specified, assignments should be submitted online to Moodle by 5pm on the due date.

A downloadable assignment cover sheet is available from
https://www.physics.unsw.edu.au/current-students/cover-sheet

Marks will be deducted for late assignments, at a rate of 5% of the maximum possible mark for the assignment per day. A weekend will count as two days. An assignment submitted after the solutions have been posted will automatically receive 0%.

## 4.4. Feedback on assessment

Please see Moodle for details on how feedback will be provided for each assessment task.

# 5. Course schedule

Week 1: The Celestial Sphere. Light. Special relativity
Reference textbook chapters 1, 2, 3, 4.1-4.3
Week 2: Observational Properties of Stars: Atmospheric windows, Black-body radiation, Luminosity and magnitude, Colours, Surface temperature and colour indices, Spectral class, Masses, Radii, Mass-luminosity law, Hertzsprung-Russell diagram, Cluster diagrams, Luminosity class, Variable stars
Reference textbook chapters 5-7
Week 3: The Sun. The Physics of Stellar Interiors, Nuclear energy release, Hydrogen cycles, Nuclear reaction rates, Neutrino astronomy, Helium burning, Sources of opacity
Reference textbook chapters 8, 10, 11
Week 4 (Monday holiday): Cosmology models and observation; Big Bang model, galaxy formation
Reference textbook chapter 29, 30
Week 5: Cosmic Microwave Background, Structure Formation
Reference textbook chapters 29, 30
**Week 6: No lectures**

Week 7: Structure and Evolution of Stars: General properties of homogeneous stars, main sequence, formation of stars, Pre-main sequence evolution, Post-main sequence evolution, Giant stage, Advanced evolutionary stages; Mid-term Exam (Wed, 28 October)

Reference textbook chapters 13, 14,15 & Section 18.5

Week 8: Degeneracy in stars, Equation of state under degenerate conditions. The Milky Way: basic properties, major components, stars, planets, interstellar medium

Reference textbook chapters 15, 16, 17, 24

Week 9: The Milky Way: rotation of the galaxy. Galaxies: Types, and basic properties.

Reference textbook chapters 24, 25

Week 10: Galaxies and their evolution – the present-day picture; look-back techniques; galaxy number counts, cluster and field galaxy evolution. The Distance Scale – primary, secondary and tertiary distance indicators; redshifts; Hubble's constant and its determination; bulk motions amongst galaxies. Active Galaxies

Reference textbook chapters 26, 27, 28

Week 11 (Lecture on Monday only): Structure of the Universe

Reference textbook chapter 27

Week 12+: Exams

# 6. 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 at student.unsw.edu.au/referencing

**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.[1] 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 student.unsw.edu.au/plagiarism**,** and
- The *ELISE* training site subjectguides.library.unsw.edu.au/elise

The *Conduct and Integrity Unit* provides further resources to assist you to understand your conduct obligations as a student: student.unsw.edu.au/conduct.

# 7. Administrative matters

**Communications**

Students should check their UNSW email account regularly as all official university communication will be sent to that address. Students should use their university email account when writing to UNSW staff and should always include their name and student number.

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

**Health and Safety**

The School of Physics is actively committed to the health, safety and welfare of its staff and students. Information on relevant UNSW Occupational Health and Safety policies and expectations is available at: www.ohs.unsw.edu.au and https://www.physics.unsw.edu.au/about/safety

**Recommended Internet Sites**

The School of Physics website is www.physics.unsw.edu.au. Under the "Current Students" link students will find information about degrees, courses, and assessment.

The University website my.unsw.edu.au provides links to the UNSW Handbook, Timetables, Calendars and other student information.

**Student Complaint Procedures**

UNSW has procedures for dealing with complaints. These aim to solve grievances as quickly and as close to the source as possible. Information is available here: student.unsw.edu.au/complaints. Staff who can assist include:

**School Contacts:**

Ms. Zofia Krawczyk-Bernotas
Teaching Support Manager
School of Physics
Room G06, OMB
z.krawczyk-bernotas@unsw.edu.au
Tel: 9385 5969

Prof Adam Micolich
Teaching Director
School of Physics
Room G57A, OMB
adam.micolich@gmail.com
Tel: 9385 6132

Prof Susan Coppersmith
Head of School
School of Physics
s.coppersmtih@unsw.edu.au
Tel: 9385 4553

A/Prof Julian Berengut
Honours Coordinator
School of Physics
julian.berengut@unsw.edu.au
Tel: 9385 7637

# 8. Additional support for students

- The *Current Students* Gateway: student.unsw.edu.au
- Academic Skills and Support: student.unsw.edu.au/skills
- Student Wellbeing, Health and Safety: student.unsw.edu.au/wellbeing
- Disability Support Services: student.unsw.edu.au/disability
- UNSW IT Service Centre: www.it.unsw.edu.au/students