STELLAR EVOLUTION & COSMOLOGY

PHYS3080

Lecturer

Dr John Ross

STELLAR EVOLUTION & COSMOLOGY PHYS3080 2003

Units #2
Class contact hours 4C (35L, 17C)
Other formal details 2nd semester

Purpose of the course

Through a study of basic astrophysical data, stellar structure and evolution, the synthesis of the elements in stars and the structure and evolution of the universe the course provides students with an overview of how the nature and evolution of the universe is controlled by basic physical laws and provides students with an adequate background for further more advanced study in the field of astronomy/astrophysics. While the course is primarily intended to serve the needs of students from the physical sciences the course should be of interest and prove accessible to students from other disciplines provided they have a suitable background.

Staff

Dr John Ross
Room 2.26 Physics Annexe
3365 3429
ross@physics.uq.edu.au
Office Hours: Hours arranged by email

Online Information.

Both the course profile and course material can be found by going to the Physics home page (www.physics.uq.edu.au), selecting Teaching, then selecting either Course Profiles or Course Web Sites.
More information is available on my web page under people on the Physics web site *www.physics.uq.edu.au*

Assumed background

Pre: PHYS2020 + MATH2000

These courses represent the minimum requirements for entry to PHYS3080; exposure to additional courses in physics and or mathematics is beneficial.

Course goals

On completing this course students will:

- Understand how the basic properties of stars such as their distance, energy output, mass, radius, and chemical composition can be determined from astronomical observations.
- Understand how stars are formed, how the total energy of a star in equilibrium is distributed between the translational kinetic energy of the particles making up the star, radiation, and gravitational potential energy of the star, how a star in the course of its evolution can become unstable.
- Understand how the internal structure of a star is governed by basic equations whose solution enables the structure to be determined and how, as a result of a gradual change in the chemical composition of a star, a star evolves.
- Understand how as a result of stellar evolution a star can become a brown dwarf, white dwarf, neutron star or black hole.
- Understand how the basic properties of nuclei and physical conditions in a star lead to thermonuclear reactions which are responsible for the sustained energy output of a star and the synthesis of elements in stars.
- Understand how astronomical observations of the universe at large lead to important information on the current and past structure of the universe and how basic physical laws determine the structure and evolution of the universe.

Graduate Attributes:

The following graduate attributes will be developed in the course –

- In-Depth Knowledge in the Field of Study
- Effective Communication
- Independence and Creativity
- Critical Judgement
- Ethical and Social Understanding

The development of graduate attributes through course content, learning modes and assessment is outlined in the following tables.

For more information on the University policy on development of graduate attributes in courses, http://www.uq.edu.au/hupp/contents/view.asp?s1=3&s2=20&s3=5

PHYS3080 Graduate Attributes developed and how achieved

Learning experience	In-Depth Knowledge of the Field of Study	Effective Communication	Independence and Creativity	Critical Judgment	Ethical And Social Understanding
Lectures	subject matter covered	listening, note-taking, questioning, accessing web information		identification of essential physics of situation and synthesise links between pieces of information	a knowledge and respect of the scientific method
Tutorials	understanding and synthesising links between pieces of information	comprehending, effective interaction, conveying ideas in written, spoken and symbolic forms	Identifying problems and producing own solutions		Ethical standards in collaborations
Astronomy nights	specific, practical application of theory	presenting & understanding observations in various forms, interacting with lab partners to work towards a common outcome	Ability to adapt to new environments and improve current practices	evaluating validity, usefulness of data and presentations in appropriate reporting format	Ethical standards in experimentation, teamwork ,collaboration and avoidance of plagiarism
Independent study	use of texts and other resource material, problem solving		working independently		

PHYS3080 Graduate Attributes assessed

Assessment task	In-Depth Knowledge of the Field of Study	Effective Communication	Independence and Creativity	Critical Judgment	Ethical And Social Understanding
Solutions to tutorial problems	encompassing competency in mathematical and analytical skills	writing, understanding of questions, drawing diagrams	ability to understand principles and develop own coherent solution	critical evaluation of solutions presented	applications of ethical standards in qualitative and quantitative solutions
End of semester exam	in depth understanding and application of standard techniques, conceptualising physical situations, numerical problem-solving	writing, drawing diagrams, comprehending written questions	supervised independent work, free response, adaptation to unfamiliar problems	identification & analysis of problem	

Teaching and learning methods

3 lectures (approximately) per week (Wednesday 9.00, Rm 7-302 and Thursday 10.00, Rm 7-302).
2 tutorials(approximately) per week (Friday 2.00 to 4.00, Rm 7-302)

Lectures (34h) will cover the formal course content. Typed lecture notes will be available at cost. The lectures will be supplemented by 17 informal contact hours in which problems set in lecture notes and additional assignment problems are discussed. The lecture and informal contact times may be interchanged. Handout solutions will be provided.

Assessment program

The course will be progressively assessed by tutorial assignments worth 20% throughout the semester.
There will be a final centrally-timetabled three hour examination in the examination period. The exam is worth 80%.

Assessment criteria

Assessment will be criterion based, and not norm based, as required by University policy.

The students understanding of the course will be shown by their being able to:

- Define, explain and interrelate the key concepts involved in the course.
- Recognise the regime of applicability of the theory presented.
- Use the basic theory to describe qualitatively and quantitatively the behaviour of important astrophysical systems treated in the course.
- Utilise the appropriate mathematical and other techniques to derive relationships for physical quantities.

This understanding will be assessed by requiring the student to:

- Complete assignments
- Attend written examinations and tests

Which in total will range over the topics, key concepts and class of problems covered in the course as set out in the Course Profile (unless notified to the contrary by the Course Coordinator(s)). The assessment program will not necessarily address every topic covered in the syllabus.

Criteria for the award of grades

To earn a Grade of 7, a student must demonstrate an excellent understanding of the course material, and be highly proficient in applying appropriate techniques to accurately solve both theoretical and practical problems.

To earn a Grade of 6, a student must demonstrate a comprehensive understanding of the course material, and be proficient in applying techniques to solve both theoretical and practical problems. This may be exemplified by the ability to solve non-routine problems and apply ideas to novel situations.

To earn a Grade of 5, a student must demonstrate good understanding of the course material and adequate ability to apply techniques to solve problems, using and applying fundamental concepts and skills of the course.

To earn a Grade of 4, a student must satisfy the basic learning requirements for the course, such as understanding of the fundamental concepts and performance of basic skills. The student must demonstrate knowledge of techniques used to solve problems.

To earn a Grade of 3, a student must demonstrate some understanding of the basic concepts and knowledge of techniques used to solve problems. The student falls short of satisfying all requirements for a Pass but may be close to satisfactory overall, or have compensating strengths in some aspects of the course.

To earn a Grade of 2, a student, although failing to satisfy basic requirements of the course, must demonstrate some knowledge of the basic concepts and limited knowledge of techniques used to solve problems.

A student will earn a Grade of 1 if he/she shows a very poor knowledge of the basic concepts in the course material. This includes attempts at answering questions that demonstrate very limited understanding of the key concepts.

Assessment and grading

- Each assessment item will be given the weighting for the determination of the final grade as set out in the Course Profile.
- Assessment will be in terms of the extent to which the student has achieved the goals of the course. The grade awarded, which will be in the range 1 to 7, will reflect this achievement.
- Assessment will be based on the judgement of the assessors as to how well the particular item being assessed demonstrates the student's level of understanding.
- Unless specified to the contrary, assessment will be carried out by the Course Coordinator(s) and other Teaching Staff assigned by the Head of Department.

Assessment policies

- Calculators/pocket computers may be used in the examination, so long as they are small, portable, silent and battery powered. They must however have a *restricted display capability not exceeding 150 characters*. QWERTY keyboards are permitted and memories need not be zeroed. Notebook or lap top computers may not be used. All such devices must be presented for inspection at the examination and approved by the lecturer concerned.
- Penalties for non-conformity with Assessment Program, such as late submission of work, non attendance at tests or examinations, plagiarism, illness and so on, will be in conformity with general University Policies dealing with these matters. Such policies are outlined in the Assessment Rules, set out in the University of Queensland Calendar

Plagiarism

The University expects and encourages you to act with integrity, ethically and with mutual respect for fellow members of the University community. A breach of the appropriate standard of conduct or of University rules may constitute misconduct and will be dealt with according to University procedures. See Undergraduate Handbook; Student services and Information Section. Also URL http://www.admin.uq.edu.au/HAI/hai-home.html

Supplementary examinations

In some programs, supplementary examinations may be awarded to students who fail their major examinations (generally with a grade of 2 or 3). You should check the program rules for your degree program for information on the possible award of supplementary examinations. Applications for supplementary examinations must be made to the Director of Studies in the Faculty.

Special examinations

If a student is unable to sit a scheduled examination for medical or other adverse reasons, she/he can and should apply for a special examination. Applications made on medical grounds should be accompanied by a medical certificate; those on other grounds must be supported by a personal declaration stating the facts on which the application relies; other corroborative evidence may also be accepted.

Applications for special examinations for central exams must be made to the Director of Studies in the Faculty. Applications for special examinations in departmental exams must be made to the course coordinator.

More information on the University's assessment policy may be found
http://www.uq.edu.au/hupp/contents/view.asp?s1=3&s2=30&s3=5

EPSA Faculty policy on the award of special and supplementary exams may be found at
http://www.epsa.uq.edu.au/index.html?id=7674&pid7564

Feedback on assessment: http://www.uq.edu.au/hupp/contents/view.asp?s1=3&s2=30&s3=6

You may request feedback on assessment in this course progressively throughout the semester from the course coordinator. Feedback on assessment may include discussion, written comments on work, lists of common mistakes and the like.

Students may peruse examinations scripts and obtain feedback on performance in a final examination provided that the request is made within six months of the release of final course results. After a period of six months following the release of results, examination scripts may be destroyed.

Information on the University's policy on access to feedback on assessment may be found at
http://www.uq.edu.au/hupp/contents/view.asp?s1=3&s2=30&s3=5

EPSA Faculty policy on feedback and re-marking may be found at
http://www.epsa.uq.edu.au/index.html?id=7674&pid7564

Recommended texts and references

Textbook:

No specific textbook is recommended. The course is based on B. J. O'Mara's notes. Page references refer to these notes.

Important reference books are:

Structure and Evolution of the Stars, M. Schwarzschild, Princeton University Press 1958.
Stellar Interiors, D.H. Menzel, P.L. Bhantnagar, and H.K. Sen, John Wiley and Son 1963.

Other reference books are:

Introductory Astronomy & Astrophysics 4th Ed., M. Zeilik and S.A. Gregory, Harcourt Brace and Co. 1998.

Student with disabilities

Any student with a disability who may require alternative academic arrangements in any course offered by this department is encouraged to seek advice at the commencement of the semester from a Disability Adviser at the Student Support Services.

Library contact:

The liaison librarian for Earth Sciences/Maths/Physics is located in the Physical Sciences and Engineering Library in the Hawken Building and may be consulted for assistance in the course:

Physics: Leith Woodall
Email: l.woodall@library.uq.edu.au
Extension: 52367

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Assistance for Students:

Students with English language difficulties should contact the course coordinator or tutors for the course.

Students with English language difficulties who require development of their English skills should contact the Institute for Continuing and TESOL Education on extension 56565.

The Learning Assistance Unit located in the Relaxation Block in Student Support Services. You may consult learning advisers in the unit to provide assistance with study skills, writing assignments and the like. Individual sessions are available. Student Support Services also offers workshops to assist students. For more information, phone 51704 or on the web http://www.sss.uq.edu.au/index.html.

Student Liaison Officer*:*

The School of Physical Sciences has a Student Liaison Officer as an independent source of advice to assist students with resolving academic difficulties.

The Student Liaison officer during semester 22003 will be Dr Peter Adams Rm 547 Priestly Building (email pa@maths.uq.edu.au)

Syllabus *Thirty-four Lectures*

The lectures are based on lecture notes with topics divided into the following chapters:

1. BASIC ASTROPHYSICAL DATA

   Introduction, the physical content of the universe, Stellar spectra and photometry, spectral classification of stars, UBV photometry, interstellar reddening, the Hertzsprung Russell Diagram, colour-magnitude diagrams for Globular and Galactic star clusters, the bolometric correction, distance scales in the universe, trigonometric parallax, the moving cluster method, statistical parallax, main-sequence photometry, variable stars, other methods for determining distance, stellar masses from visual and spectroscopic binary stars, the mass-luminosity relation for stars, stellar radii, the chemical composition for stars, the mass function for stars, creation and destruction of matter, conservation laws, causality, classical limit.

2. AN OVERVIEW OF STELLAR STRUCTURE AND EVOLUTION

   The formation of stars and galaxies, Jeans' Criterion for gravitational instability, the Virial theorem, the total energy content of a star, the mean temperature and pressure of the sun, Kelvin-Helmholtz contraction and the age of the sun, the Virial theorem and stellar stability, an outline of the life history of a star.

3. THE STELLAR STRUCTURE EQUATIONS

   The equation of hydrostatic equilibrium, the equation of mass continuity, consequences of departures from hydrostatic equilibrium, the luminosity gradient equation, the temperature gradient equation, radiative and convective transport, the overall problem of stellar structure and evolution, the Russell-Vogt theorem.

4 THE CONSTITUTIVE RELATIONS

   Possible nuclear energy sources in a star, basic properties of nuclei, the condition for thermonuclear reactions to be possible, the classical impossibility of thermonuclear reactions, quantum tunnelling and the possibility of thermonuclear reactions, hydrogen burning, the p-p cycle, the CNO cycle, the triple alpha reaction, stellar opacity sources, bound-free and free-free transitions, electron scattering and thermal conduction, the equation of state for stellar matter, the equation of state for degenerate and relativistically degenerate electrons.

5. THE LANE-EMDEN PROBLEM

   The Lane-Emden equation and its solutions, polytropes and their properties.

6. WHITE DWARFS NEUTRON STARS AND BLACK HOLES

   White dwarfs, neutron stars, the evolution of stars and the ultimate fate of stars, black holes and the maximum radius for cold catalysed bodies.

7. THE SYNTHESIS OF THE ELEMENTS

   Element synthesis in the early universe, element synthesis in stars as proposed by Burbidge, Burbidge, Fowler and Hoyle.

8. COSMOLOGY

   The isotropy and homogeneity of the universe, the age of the universe, cosmic blackbody radiation. Newtonian cosmology, the critical density, the cosmological

redshift, the influence of General Relativity on Cosmology, open and closed universes, the early history of the universe.