MONASH University

School of Physics and Astronomy
ASP4000
2017

APS4000 Stars

Topic Information Sheet

Overview

Stars are the source of most light in the universe and forge almost all heavy elements beyond helium. This course will give an advanced overview of stellar evolution and nuclear astrophysics. We will discuss evolution of stars and the nuclear burning phases over the entire mass range, from stars like the sun to the most massive stars that die as supernovae, leaving behind a neutron star or a black hole. This course will combine theoretical background lectures as well as practical aspects, e.g., building you own stellar structure model or the use of stellar evolution codes to follow the evolution of your own stellar model.

General Information

Lecturer: Prof Alexander Heger, Rm TBD, Bldg TBD
email: alexander.heger@monash.edu, phone: 990-54478

Location: honours teaching labs

Lectures: 18 @ 50 min

Times/dates: TBD - weeks 1-6 for Semester 1

Assessment

There will be weekly assignment with total worth 50 % of the grade and a final examination making up the remaining 50 %.

Homework assignments and examples/discussions in class will give you an idea of what of what to expect from the exam.

Utilities

Some of the homework including exercises on stellar structure can be done just with a spreadsheet (if you are reasonably good as using formula, no script programming needed),

but generally the use of a programming language like Python 3, C/C++, or Fortran can be handy; for using the stellar evolution code, FORTRAN/Fortran 90 will be needed. Generally, for plotting and analysis of the results I recommend to use python/matplotlib. Whereas not required, submissions in LaTeX/pdf will be appreciated where appropriate (for homework, not exam). You may also want to explore the use if IPython notebooks, though converting them to pdf has caused sometimes issues in the past some students have done all HW in that form (and submitted pdf along with the ipynb file). You may find it useful being able to re-use code, etc. I can also provide you my list of LaTeX macros and symbol definitions.

Syllabus

- Equation of State of Stellar Gas
- Stellar Structure
- Stellar Stability
- Stellar Structure and Polytropes
- Nuclear Reactions
- Nuclear Burning Phases in Stars
- Evolution of Massive Stars
- Supernovae
- Evolution of Low- and Intermediate-Mass Stars
- Evolution of the Sun
- Neutron Stars and Black Holes

Literature

- Prialnik, Diana: *An Introduction to the Theory of Stellar Structure and Evolution*, Second Edition, Cambridge University Press, Paperback, 2010, ISBN 978-0-521-86604-0.
- Kippenhahn, R. & Weigert, A., *Stellar structure and evolution,* Springer-Verlag, 1990.
  or
  Kippenhahn, R, Weigert, A., Weiss, A., *Stellar Structure and Evolution,* 2nd ed. 2012, Springer-Verlag, ISBN 978-3-642-30304-3.
- Iliadis, C: *Nuclear Physics of Stars*, 2nd Eddition, Wiley, 2015, ISBN: 978-3-527-33648-7
- Clayton, D. D.: *Principles of Stellar Evolution and Nucleosynthesis,* University of Chicago Press, 1968, ISBN 978-0-226-10953-4.

- Jose, J., *Stellar Explosions*, CRC Press, 2016, ISBN 978-1-4389-5306-1.

Prialnik will give you a basic introduction, Kippenhahn+ gives a more detailed introduction I would recommend for the honours level. The Iliadis and Clayton books give more detailed introduction into nuclear astrophysics and nuclear physics topics. The book by Jose provides some advanced discussion of stellar explosions.