AST 304, Fall 2014

Stars

Syllabus

This one-semester undergraduate course covers the physics governing the structure and evolution of stars and stellar-like objects.

Course goals

Stars are macroscopic objects, and describing their behavior requires weaving many separate topics in physics into a coherent narrative. The physics you will learn in this class therefore apply not only to astronomical phenomena, but also to many "real-world" applications, such as climate modeling and oceanography. In this course, you will also learn astronomical nomenclature and practical skills in numerical calculation and working collaboratively.

Instructor

Associate Professor Edward Brown

Dept. of Physics and Astronomy
Biomedical Physics Sciences Bldg.
567 Wilson Rd, Room 3258
884–5620

http://www.pa.msu.edu/~ebrown
browned@msu.edu
https://github.com/nworbde
http://twitter.com/nworbde

Meeting times and locations

Lecture 12:40–2:00 TTh, 1420 BPS

Office hours 11:30–12:30 TTh (right before lecture); also by appointment.

Textbook and course materials

LeBlanc, F. 2010, *An Introduction to Stellar Astrophysics* (Wiley & Sons, Ltd.).

Electronic versions of this book are available from Amazon, Barnes & Noble, and Google Play. If you do use an online version, please let me know—I'd like your feedback on how well it worked so I can make recommendations for future courses.

Supplementary reading and supporting material, as well as homework assignments and projects, will be posted on Dropbox™[at this link]. Course announcements will be posted on Twitter™: follow @MSUastroEd and look for `#AST304`.

I will make use of the open-source stellar evolution code `MESA`; if you want to explore `MESA` for yourself, you will find installation instructions and tutorials on its homepage and user-contributed materials at the `MESA` user forum.

Homework

Expect roughly weekly homework sets. For most sets, I will assign one of 4 grades: ⊘ (not done), ━ (below expectations), ✔ (meets expectations), ✚ (exceeds expectations). Note that a grade of ✔ or ✚ *does not guarantee* that the set is done correctly; it just means that the set appears to be on the right track. I will always work through the correct solutions in class, so you will have a chance to evaluate how you did. A few problem sets, randomly chosen, will be graded in detail. You are responsible for making sure that you understand the solutions—making mistakes, and learning from them, is much less expensive on the homework sets than on the exams!

I have no objections to you working on homework problems collaboratively; the set you turn in, however, must be your own.

> *No rule of scientific etiquette is more important than acknowledging the contributions of others.*[1]

If you do work on homework solutions in a group, you must list your collaborators and describe their contributions.

Group computational project

In addition to learning about stars, this course has two other ancillary goals:

1. learning some rudimentary numerical techniques, and
2. learning to collaborate on larger projects.

Numerical computation has become an indispensable component of modern science. While many sophisticated packages, such as Mathematica™ and MatLab™ exist, it is important to understand the algorithms used. In addition,

[1] K. S. Thorne 1987, *Some Specific Tips About Technical Writing*.

science is an increasingly collaborative affair. The ability to work effectively in teams is an essential skill for any technical career.

To develop your competence in these ares, you will work in teams of four to complete progressively more sophisticated computational projects over the semester. The teams will be constructed after you complete an online survey. You will be asked to review the performance of your group, using the online CATME tool; these reviews will form part of the grade.

Exams

Quizzes Expect short quizzes roughly once per week. The level of difficulty will be about that of a short homework problem.

Midterm There will be one midterm, tentatively scheduled for Thursday, 16 October.

Final Thursday, December 11, from 12:45–2:45. The final will be cumulative, but weighted toward the latter half of the course.

Weights for the overall course grade

Homework	Project	Quizzes	Midterm	Final
10%	20%	15%	20%	35%

Grading Standards

4.0 Mastery of subject, based on coursework and in-class performance. Able to consistently apply concepts to solve problems. Ready for graduate-level coursework.

3.0 Generally understands concepts, but has some difficulties in applying them.

2.0 Incomplete or incorrect understanding of basic concepts.

When there is a conflict

Disagreements and conflicts occur from time to time and are a fact of life; what is important is that they are swiftly and satisfactorily resolved. If you are unhappy about any aspect of the course, I propose that we follow a “24–48” rule: please bring your complaint to my attention promptly, within 24 hours of the issue arising; in turn, I shall evaluate your complaint and respond within 48 hours.

References—undergraduate-level stellar physics

Jeffrey O. Bennett, Megan O. Donahue, Nicholas Schneider, and Mark Voit. *The Cosmic Perspective*. Addison-Wesley, 7th edition, 2013.

Bradley W. Carroll and Dale A. Ostlie. *An Introduction to Modern Astrophysics*. Addison-Wesley, 2d edition, 2006.

Francis LeBlanc. *An Introduction to Stellar Astrophysics*. John Wiley & Sons, Ltd, West Sussex, UK, 2010.

A. C. Phillips. *The Physics of Stars*. John Wiley & Sons, Ltd, West Sussex, UK, 2d edition, 1999.

Dina Prialnik. *An Introduction to the Theory of Stellar Structure and Evolution*. Cambridge University Press, 2d edition, 2009.

References—graduate-level stellar physics

James Binney and Michael Merrifield. *Galactic Astronomy*. Princeton University Press, 1998.

Donald D. Clayton. *Principles of Stellar Evolution and Nucleosynthesis*. University of Chicago Press, 1983.

J. P. Cox. *Theory of Stellar Pulsation*. Princeton University Press, 1980.

Carl J. Hansen, Steven D. Kawaler, and Virginia Trimble. *Stellar Interiors*. Springer-Verlag, 2d edition, 2004.

R. Kippenhahn and A. Weigert. *Stellar Structure and Evolution*. Springer-Verlag, 1994.

D. Mihalas. *Stellar Atmospheres*. W. H. Freeman, 2d edition, 1978.

Bill Paxton, Lars Bildsten, Aaron Dotter, Falk Herwig, Pierre Lesaffre, and Frank Timmes. Modules for experiments in stellar astrophysics (MESA). *ApJS*, 192:3, January 2011.

Bill Paxton, Matteo Cantiello, Phil Arras, Lars Bildsten, Edward F. Brown, Aaron Dotter, Christopher Mankovich, M. H. Montgomery, Dennis Stello, F. X. Timmes, and Richard Townsend. Modules for experiments in stellar astrophysics (MESA): Planets, oscillations, rotation, and massive stars. *ApJS*, 208:4, 2013.

Stuart L. Shapiro and Saul A. Teukolsky. *Black Holes, White Dwarfs, and Neutron Stars*. Wiley, 1983.

Ya. B. Zel'dovich and I. D. Novikov. *Stars and Relativity*, volume 1 of *Relativistic Astrophysics*. University of Chicago Press, 1971.

References—coding (all free)

Software Carpentry. Lessons, 2014. URL `http://software-carpentry.org/lessons.html`.

Scott Chacon. *Pro Git*. Apress, 2009. URL `http://git-scm.com/book`.

Allen Downey. *Think Python*. Green Tea Press, 2013. URL `http://www.greenteapress.com/thinkpython/thinkpython.html`.

Bill Paxton. MESA: Modules for experiments in stellar astrophysics, 2014. URL `http://mesa.sourceforge.net`.

References—management & writing

Tom DeMarco. *The Deadline*. Dorset House, New York, 1997.

William Strunk, Jr. and E. B. White. *The Elements of Style*. Longman, 4th edition, 1999.

Edward R. Tufte. *The Visual Display of Quantitative Information*. Graphics Press, Chesire, CT, 2d edition, 2001.