SFSU Astronomy 400/700: Stellar Astrophysics

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Thornton 308, (415) 338-2450

Lectures & Office Hours
Lectures: MWF 9:10–10:00 in Thornton Hall 428.
Office Hours: TBD in Thornton Hall 308.

Quick note on e-mail contact
So that I can identify and respond to e-mails from you expeditiously, please put [ASTRO400] or [ASTRO700] at the beginning of the subject line.

Course Overview & Objectives
Astronomy 400/700 is an introduction to the theory of stellar astrophysics: the birth, life and death of stars. Topics include: stellar properties from observation; stellar spectra & atmospheres; equations of state & stellar interiors; energy generation (gravity, nuclear fusion) and energy transport (radiation, convection); star formation; stellar evolution, death, and end states (white dwarfs, neutron stars, black holes); the Solar Cycle and the Sun-Earth connection. If time permits, we may cover binary evolution and/or stellar pulsations.

Course objectives and student learning outcomes include:
(1) To understand how the theories of mechanics, electromagnetism, thermodynamics & statistical mechanics, quantum mechanics, and relativity all are necessary to understand the nature of stars.
(2) To qualitatively and quantitatively describe the life-cycle of stars from birth, life, and ultimately death.
(3) To develop and apply mathematical tools (vector calculus, linear algebra, differential equations, numerical/computational methods) to solve problems in stellar astrophysics.
(4) To describe how experimental observations are used to inform scientific theory, and vice versa.

Learning Resources
REQUIRED:
(2) Access to computer and mathematical software such as MATLAB, Mathematica, or IDL (for graphing and numerically solving differential equations).
Useful Websites

(1) www.physics.sfsu.edu – Department of Physics & Astronomy
(2) ilearn.sfsu.edu (note: no www in web address) – Login to access course website. Please check frequently for new announcements, updates to the syllabus & schedule, tips & tricks on the homework, and links to additional learning resources.
(3) http://www.pas.rochester.edu/~emamajek/sun.txt – The most up-to-date experimental data for the Sun.
(4) http://www.astro.wisc.edu/~dolan/constants/calc.html – Astro-physical calculator: an online calculator with buttons for fundamental constants and astronomical data
(5) http://mathworld.wolfram.com/ – Wolfram Mathworld

Recommended Preparation

(1) Physics 320 (Modern Physics I)
(2) Physics 330 (Analytic Mechanics I)
(3) Physics 385 (Introduction to Theoretical Physics I)
(4) Computer Science 309 (Computer Programming for Scientists & Engineers)
Please see me if you have any concerns about your preparation.

Assignment of Grades

Grades will be determined by your performance on homework (40%), 2 midterm exams (10% each), an in-class oral presentation (10%), and a final exam (30%). Note that students enrolled in the graduate version of this course will have additional reading and longer, more challenging homework assignments. The midterm and final exam will also have take-home components for graduate students.

Letter grades will assigned according to the following scheme:

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<th>Grade</th>
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<tr>
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Homework

You cannot learn physics solely from lectures. You must work through many problems, seeing how the theoretical concepts discussed in lecture apply in various different contexts. Homework is an integral part of the learning process; how serious you take the homework will ultimately determine how much you will understand physics and how well you will do in the course overall. There will be approximately one homework assignment due per week. Most problems will require analytic solutions, however there will usually be one problem per assignment that will involve graphing and numerical solution with computer software such as Microsoft Excel, MATLAB, or Mathematica.
Policy on Collaboration & Academic Integrity  
You are strongly encouraged to discuss course material with your fellow classmates. When working on homework, first try to solve the problems on your own. Struggle. Struggle some more. If you get stuck, feel free to discuss overall methods and approaches with your classmates, but not the details! Your written solutions should be solely your own, and should be written-up in isolation from your fellow classmates. Copying is strictly prohibited. Cheating via any method on exams will result in a grade of zero on that exam and being reported to the department chair and college dean for possible discipline. Please see the official academic integrity policy for the Department of Physics & Astronomy at: www.physics.sfsu.edu/policy/plagiarism.pdf.

Drop, Withdrawal & Repeat Policy

The “Drop” deadline is Friday, February 8. You can drop yourself online without any penalty and without any record, for any reason. After February 8, students must petition for an official “withdrawal.” Documents must be provided to support the petition to withdraw. If the petition is approved, the designation “W” will appear on the transcript. Students are only allowed to repeat a class once at SFSU. Note that designations of W, WU, NC count toward this limit.

Expected Code of Conduct

Classroom discussion and participation are strongly encouraged. However, please refrain from unrelated chatter. Also, please remember to place cell phones and other electronic communication devices on silent or vibration mode so as not to distract your fellow classmates. If you must arrive late or leave early, please sit toward the back of the room near the doors so as to minimize disruption.

Disability Access

Students with disabilities who need reasonable accommodations are encouraged to contact me early in the semester. The Disability Programs and Resource Center is available to facilitate the reasonable accommodations process. The DPRC, located in Student Services Building 110, can be reached by phone at 415-338-2472 (voice/TTY) or by e-mail at dprc@sfsu.edu.

Religious Holidays

The faculty of San Francisco State University shall accommodate students wishing to observe religious holidays when such observances require students to be absent from class activities. It is the responsibility of the student to inform the instructor, in writing, about such holidays during the first two weeks of the class each semester. It is the responsibility of the instructor to make every reasonable effort to honor the student request without penalty, and of the student to make up the work missed.
Preliminary Schedule (Subject to change!)

Jan. 28 - Feb. 1 course introduction; radiation concepts
Feb. 4-8 stellar spectra and stellar atmospheres
Feb. 11-15 Hertzsprung-Russell diagram; binary stars
Feb. 18-22 hydrostatic balance and equations of state
Feb. 28 - Mar. 1 energy transport
Mar. 4-8 energy transport
Mar. 11-15 nuclear processes
Mar. 18-22 nuclear processes
Mar. 25-29 SPRING BREAK
Apr. 1-5 stellar evolution: low mass stars
Apr. 8-12 stellar evolution: high mass stars
Apr. 15-19 stellar death
Apr. 22-26 stellar death
Apr. 29 - May 3 star & planet formation
May 6-10 interacting binaries
May 13-17 oral presentations
May 22 Final Exam, 8:00 – 10:30

Suggested Topics for Oral Presentation

- stellar pulsations & astroseismology
- solar neutrino problem and its resolution
- sunspots and the solar cycle
- solar flares, coronal mass ejections
- interaction of solar wind and planetary magnetospheres
- star formation and the Initial Mass Function (IMF)
- brown dwarf, white dwarf, and/or neutron star cooling
- brown dwarf atmospheres and weather
- brown dwarf demographics and formation
- rotation of neutron stars/pulsars
- differential stellar rotation and the Rossiter-McLaughlin effect
- red giant evolution, winds & planetary nebulae
- supernovae spectra and light curves
- magnetic fields and star formation
- detection of exoplanets; the planet-stellar metallicity correlation
- T-Tauri stars & protoplanetary disks: theory or observation
- blue stragglers
- binaries in globular clusters
- interacting binaries, cataclysmic variables, novae
- using stars to measure distances in the universe
- gamma ray bursts
- mergers of neutron stars and/or black holes
- solar corona and magnetic reconnection
- metallicity gradients in the Milky Way Galaxy
- high velocity stars and ejection of stars from the galaxy
- astrometry in the center of the galaxy to constrain the central black hole
- archeoastronomy and the use of stars in calendars, navigation